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Level Crossing Design

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1.0	27 Apr 09		First issue. Supersedes NSW Standard SDS 18 v1.2 and Vic Standard ENG-SE-SPE-0001 Section 400.15
1.1	07 Oct 09		Disclaimer updated as per Risk & Safety Committee 14/09/2009
1.2	13 Aug 10	All	Issued as final.
1.3	22 Nov 12	4.3	Editorial Amendment to correct clause 4.3, paragraph 4 to end with “shall be increased by a further 5 seconds to 16 seconds” not “shall be increased by a further 5 seconds 11 seconds”
1.4	06 Jun 22	Numerous	Updated to align with Australian Level Crossing Standards, other minor changes and clarifications.
1.5	04 Oct 22	2.15, 3.2.3, 3.3, 3.13	Updated to align minimum track section length with ESD-05-14 and other minor editorial changes.

Table of Contents

1 Introduction

1.1 Purpose

This standard specifies minimum requirements for design of active level crossing and pedestrian level crossing on the ARTC network.

1.2 Scope

This document covers the requirements for active level crossing for public and private road, active pedestrian level crossing, interface to road traffic system and active advance warning assemblies on ARTC rail network.

All new level crossings are required to be compliant to this standard.

Some existing installations may not meet the current requirements as laid out in this standard. When modifications to existing level crossings are planned, consideration shall be given to bring any non-conforming aspects of the level crossing to the current standards. However, where level of effort required to bring an existing level crossing up to current standards is not justified by a corresponding reduction in risk, a documented risk assessment shall capture the decision with the justification.

1.3 Standard Owner

The General Manager Technical Standards is the Document Owner. For any query, initial contact to be made at standards@artc.com.au.

1.4 Responsibilities

The Signal Designers and Project Managers are responsible for the implementation of this standard.

1.5 Reference Documents

The following documents support this standard. Level crossing design, construction and testing shall be in accordance with the below standards:

- AS1742.7 Manual of uniform traffic control devices - Railway crossings
- AS7658 Railway Infrastructure – Railway Level crossing
- AS7705 Level Crossing Monitoring Systems
- AS7717 Signal Testing and Commissioning
- ESC-03-01 Level Crossing Equipment
- ESM-03-01 Level Crossing Maintenance
- ESD-09-01 Signalling Power System
- ESD-05-05 Level Crossing Monitoring Requirements
- ESD-05-02 HIMA Level Crossing Monitoring
- ESD-05-13 Resetting of Frauscher Axle Counter Systems
- ESD-05-14 Frauscher Axle Counter Systems

- ESC-21-01 Inspection and Testing of Signalling - Roles, Responsibilities & Authorities
- ESC-21-02 Inspection and Testing of Signalling Plans, Programs, Documentation and Packages
- ESC-21-03 Inspection and Testing of Signalling – Inspection and Testing Principles
- ESC-21-04 Inspection and Testing of Signalling – Standard forms
- Section 16 Level Crossings
- ETW-16-03 Methodology for Measuring Sighting Distances at Level Crossings

2 Level Crossings: Definitions, Types and Classifications

2.1 Introduction

All road/rail intersections (grade or level crossings) are provided with either passive or active protection. Passive protection is the application of passive traffic control devices (signage) which provides an unchanging warning to the road user whether or not a train is approaching the crossing.

Active protection is the application of warning devices to warn road users of the approach of a train when the train is a minimum time from entering the road-rail intersection. In some cases it also blocks access to the crossing.

This section addresses the terms and definitions relating to those locations where active level crossing warning or protection devices have been provided for the safety of road users, pedestrians, and rail traffic.

The terms and definitions used throughout this standard are generally aligned with the wording used in the current Australian Standards and other Rail Authority Documentation.

The arrangements proposed for each level crossing shall be approved by all the stakeholders for example Road Manager, Local Government, ARTC, other Rail Authorities involved and any other Local Traffic Management Authority before a detailed design can be commenced. The Project Manager for the work shall be responsible for producing a project scope for signature by the necessary parties to ensure that they are in agreement with the proposed level crossing arrangement.

2.2 Protected Level Crossing (Public or Private Road)

A Protected Level Crossing is defined to be a road-rail intersection at which a risk assessment has determined that the hazard is such that provision of active warning and/or protection devices is required in the interests of the safety of the road traffic, pedestrians and rail traffic.

Active warning devices are provide for the protection of crossing users and there are no passive traffic control devices such as “GIVE WAY” or “STOP” signs

Types of Active Level Crossing Protection

These are defined in this standard as

- Level Crossing controlled by Flashing Lights.
- Level Crossing controlled by Flashing Lights and Half-Boom Gates.

In this Standard the term Half-Boom Gate shall be synonymous with the terms Boom Barrier or Boom Gate.

AS1742.7 defines the signage, marking and road layout applicable to each type of crossing. In general, level crossings shall be designed, constructed, and utilize control devices consistent with AS 1742.7.

Private Level crossings shall be identified, risk assessed by relevant stakeholders and treated with appropriate controls or procedures. Where passive or active controls are installed, they shall comply with controls listed in AS 1742.7 and ALCAM assessment report. Some private crossings in the past were installed with supplementary lights on ARTC network. This arrangement is not to be installed for new private crossings.

2.3 Protected Pedestrian Level Crossing

Pedestrian crossings are level crossings provided for the exclusive use of pedestrians, who may be people travelling on foot, by bicycle (dismounted, where required) or by mobility aid (e.g. wheelchairs, scooters).

A Protected Pedestrian Level Crossing shall be installed where risk assessment has determined that the hazard is such that provision of active warning and/or protection devices is required in the interests of the safety of pedestrians based on the hierarchy control as per AS1742.7 Any active control devices such as lights, audible warning devices, swing gates and emergency gates shall be in accordance with AS 1742.7 and AS 7658.

Types of Pedestrian Level Crossing Protection

These are defined as:

- Pedestrian level crossing controlled by “Red Man” Don’t Walk lights and audible warning device/s.
- Pedestrian level crossing controlled by “Red Man” Don’t Walk lights, boom barriers or swing gates and audible warning device/s.

The requirements for pedestrian enclosures shall comply with requirements for access and mobility in accordance with AS 1428.1 and in accordance with SIA (Safety Interface Agreement).

Pedestrian crossing walkways, mazes and footpaths should comply with AS1742.7 requirements.

2.4 Level Crossing Warning Signs

A level crossing warning sign is a warning sign provided to advise road users of the location of a road-rail intersection as defined in AS 1742.7.

2.5 Level Crossing Passive Traffic Control Devices

A regulatory sign, as defined in AS 1742.7, provided to require compliance to a Road traffic law which defines road user actions required when crossing a road-rail intersection.

2.6 Types of Level Crossing Signs

All level crossing signs, both at and approaching the level crossing, shall be in accordance with Australian Standard 1742.7 except that in specific situations, supplementary signage may be added to define a particular function or requirement.

2.7 Warning Lights

The assembly for a protected road active level crossing shall be the RX-5 flashing light assembly defined in AS 1742.7.

In this standard the term RX-5 shall be synonymous with the term Type F Highway signal.

All new/upgraded installations shall use the R6-25 sign as part of the RX-5 assembly.

The lights shall have a flashing rate of between 35 and 65 flashes per minute.

2.8 Active Advance Warning Assemblies

Active Advance Warning Assemblies (AAWA) at level crossings shall take the form of twin alternating yellow warning lights as defined in AS 1742.7. Note, this assembly may also be referred to as an RX-11 assembly.

Active advance warning assemblies may be provided in advance of a crossing to supplement railway crossing flashing signals by providing visual advance warning to road users that there is a requirement to stop at a railway crossing due to the impending activation and during operation of the railway crossing flashing signals at the crossing.

Road manager are the owner and maintainer of AAWA unless agreed otherwise with ARTC. AAWA should be provided where the road layout, approach speed, sun glare or obstructions limit the motorist's view of the RX-5 assemblies at the level crossing or there are other risk factors identified. AAWA can be provided on all types of road level crossings.

2.9 Level Crossing Controls

Crossing Controls are defined to be the electrical (or electronic) controls necessary to initiate, maintain and end the operation of the warning and protection devices at a level crossing.

The Crossing Controls may be initiated automatically or manually or by a combination of both.

The Crossing Controls may have to be interlocked with railway signalling equipment controlling the passage of trains over the level crossing and depending on the complexity of the arrangements a number of "special controls" may be required.

At some locations it may be necessary to integrate the crossing controls with other systems, for example those controlling highway traffic lights.

2.10 Level Crossing Operation

Operation is defined to be the sequence and mode in which the Crossing Controls operate including the manner in which the level crossing warning and protection devices operate.

The mode of operation for all types of level crossing arrangements shall generally be in accordance with the AS 7658 and AS 1742.7

2.11 Level Crossing Warning Time

The level crossing warning time is defined as the minimum time of operation of the warning equipment for the fastest train from the initiation of the warning sequence until the front of the train reaches the road-rail intersection.

2.12 Approach section

This is the section of track which when occupied by an approaching train will cause the level crossing warning equipment to operate.

2.13 Holding section

On a multiple railway track, there may be two trains approaching a level crossing simultaneously. It is required to have a minimum time when the boom gates have lifted before they operate for the second train. A Holding track is used to extend the approach activation for the second train to include this additional time.

2.14 Road Manager

In relation to a private road—means the owner, or other person responsible for the care, control and management, of the road; or

In relation to a public road—means an authority, person or body responsible for the care, control or management of the road

2.15 Tail Flashing

This is when the level crossing continues to operate after the train has passed and no other train is approaching.

2.16 Security Locks

The security locks on the level crossing equipment shall be as defined for that jurisdiction.

3 Common Level Crossing Design Requirements

3.1 Legal and other requirements

The design of the level crossing shall conform to all statutory requirements and to the requirements of the organisations holding authority for the particular part of the work scope.

In addition, the design shall be in accordance with the requirements of AS7658 and AS1742.7.

The risks to safety at each level crossing must be assessed and risks reduced to safe SFAIRP in accordance with the Rail Safety National Law (RSNL).

3.2 Warning time

3.2.1 Absolute minimum warning time

The absolute minimum warning times between the flashing lights commencing to flash and a train, travelling at the maximum permissible approach speed, arriving at the level crossing applicable to road level crossings shall be as per this standard.

Design minimum warning times for road level crossing and pedestrian level crossings shall be: -

- 25 seconds for RX-5 light only installations
- 30 seconds for RX-5 light and boom barrier installations
- 20 seconds for pedestrian level crossings with lights only
- 25 seconds for pedestrian level crossings with lights and booms or swing gates

Note: Where the pedestrian level crossing is associated with a road level crossing, the times for the road level crossing will apply to the pedestrian level crossing. Additionally, where the design includes disabled access, these timings may need to be adjusted to suit the specific requirement.

3.2.2 Additional time allowances

Warning time may be increased based on design calculation with consideration of other factors such as local conditions, sighting, gradient, crossing width, road vehicle types and lengths etc.

At every site, one or both treatments as detailed in the following sections may be warranted.

Where these types of vehicles need to be considered in a level crossing design, a risk assessment shall be undertaken to determine which treatment/s shall be applied.

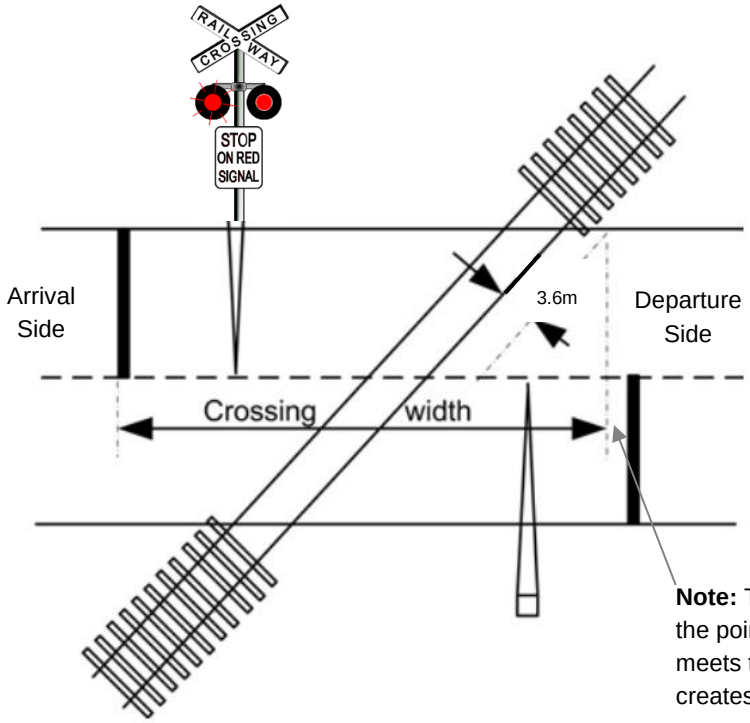
Where reasonably practicable, the warning time should not exceed 50 seconds for the slowest or stopping train.

3.2.2.1 Angled or ‘Wide’ Crossings

Where the intersection between the road and the railway deviates from 90^{o} the distance travelled by vehicles to clear the crossing is lengthened. In the case where the distance to clear the crossing is more than 15m then the minimum warning time shall be increased.

Crossing width should be calculated from Stop line on arrival side to the line drawn perpendicular to the road at the point where the 3.6m line (parallel to the rail) on departure side meets the edge of the lane on the road as shown in Figure 1. Based on site specific and design requirement, designer may use the stop line on the departure side for calculating crossing width.

Distance between the stop line and signal pedestal or boom barriers in its lowered position is minimum 3m as per AS 1742.7.



Note: This line is drawn perpendicular to the road at the point where the 3.6m line (parallel to the rail) meets the edge of the lane. Select the lane edge that creates the widest crossing width distance.

Fig 1 Calculation of the width of angled crossing

For every 3m above 15m width the minimum warning time shall be increased by 1 second. Crossing width may be more due to multiple tracks even though they are not angled road crossing.

3.2.2.2 Designated route for long vehicles

Where active level crossings are installed on designated routes for long and/or heavy vehicles such as B-Doubles, B-Triples, Road Trains etc, consideration shall be given to increasing both the minimum warning time to safely clear the tracks and time before the booms begin to descend to allow vehicles of these types to traverse the level crossing with a reduced risk of unnecessary damage to level crossing equipment and road motor vehicles.

Where differing combinations of these classes of vehicles use the same route, the worst-case scenario should be used. The following vehicle lengths should be used as a guide in considering the acceptable treatments.

a) Vehicles up to 26m in length - The minimum warning time as per Section 3.2.1 should be applicable unless there are additional factors that may affect sighting of the level crossing active equipment, crossing width etc.

b) Vehicles more than 26m in length – Boom gate delay time and minimum warning time shall be increased based on the design calculations considering parameters such as vehicle length, vehicle characteristics, crossing width, gradient of road, queuing risk etc. for safe passage of the vehicle. Designer should consider principle of Section 3.2.2.1 of increasing boom gate delay time and warning time by 1 second for every additional 3m length of the longer vehicles, more than 26m in length. All the design calculations should be recorded in the design report.

3.2.3 Other considerations

Care shall be exercised in relation to ascertaining the minimum warning time of the fastest trains for various level crossing applications having regard to the avoidance of excessive warning times as a result of slow or stopping train patterns.

Use of a constant warning time device may be used where the technology and application is suitable.

For private level crossing, where non-standard vehicles are required to travel through the crossing e.g. tractor, harvester, excavator etc., designer should consider the vehicle characteristics (e.g. acceleration, length of vehicle), crossing surfacing (e.g. unsealed road, ballast or loose fill) and approach (e.g. humped approach) for vehicle clearance time, warning time and boom gate delay time. For more information on private level crossing, please refer Section 16 – Level Crossings.

Where level crossing is shared with other rail infrastructure manager, designer should consider additional engineering control to minimise the impact on the line open for rail traffic during project and maintenance activities. For example, separate isolation switch or other engineering control may be provided in the design to minimise the risk on the operational line.

3.3 Initial Design Documentation Requirements

The initial design for signoff by the applicable stakeholders shall cover the following:

- A layout diagram of the crossing including proposed road markings
- A flashing lights alignment diagram showing the aiming distance of each of the flashing lights to ensure that stopping sight distance (SSD) complies to the focusing distance provided in ESC-03-01 and stopping sight distance (S1) requirements of AS1742.7. This diagram shall also indicate which lighting bus each light is fed from
- A written description of the sequence of operation of the crossing.
- The changes to the arrangement and controls of the signalling required to a level where operational signoff could be obtained (signal track plan or equivalent).
- Any other information requested by the signing authorities such as focusing diagram
- In accordance with Rail Safety Legislation act, a level crossing road interface agreement shall be drafted.

3.4 Power Supply

The power supply arrangements shall be in accordance with ESD-09-01 – Signalling Power supplies.

The power supply for the level crossing shall consist of a main AC power source unless the infrastructure manager indicates otherwise.

A standby battery and battery charger shall be permanently connected to this supply.

The standby battery shall be of sufficient capacity to ensure the proper operation of the crossing equipment, once the normal mains supply has been disconnected or had failed.

The objective of the standby battery is to maintain the operation of the level crossing (maximum crossing load) for greater than the maintenance response time.

One of the following battery backup arrangements is recommended.

- Continual system monitoring and automated daily battery test – 36 hours

- Continual system monitoring and no automated battery test – 72 hours
- No continual system monitoring and weekly manual battery testing – 7 days

In addition to the battery backup, generator backup to the level crossing may also be provided based on the particular requirement for the level crossing in consultation with local signal maintenance engineer. Where permanent generator back up is not provided then design should include an external weatherproof wall socket as per ESD-09-02 to connect portable emergency generator.

The design shall ensure that power interruptions occurring during any part of the warning cycle do not cause a premature boom barrier drop or rise.

3.5 Power Supplies for Pedestrian Crossings

Standalone pedestrian level crossings shall normally be provided with a single ac power supply and a standby battery power arrangement of sufficient capacity to ensure the proper operation of the pedestrian crossing, normally for 36 hours or based on the maintenance response time. If standby power supply is not provided, then failure of the primary power supply shall result pedestrian crossing in the safe condition. For example, limit the train movement through crossing by reverting protecting signals to stop if available or gates to be closed with lights and sounders are on.

3.6 Circuit Integrity

All of the level crossing controls shall be designed on the failsafe principle where this is possible.

Duplicated flasher units (or single units with internally duplicated flashers) and wiring shall be provided to operate the RX-5 flashing lights. The feed or return wiring to each RX-5 light assembly shall be duplicated as the circuitry permits so that the failure of one flasher or the open circuit failure of one wire, fuse or connection point shall not result in the total loss of all the highway signals on one side of the crossing.

The lights facing to one side of the crossing shall be fed so that half the lights are powered from one flashing bus and the other half from a separate flashing bus. Common fusing of both buses is not permitted. In the case where duplicated flasher units are mounted in one single unit the manufacturers recommended method of feeding the lights should be used.

All level crossing approach control designs shall consider the possibility of momentary loss of train shunt or the possibility of out of sequence reporting of track occupancy when short track sections are used. To counter this, the design will need to delay the operation of track functions taking care not to increase tail flashing

The design must ensure that:

- the crossing warning operation must not be interrupted
- holding section must not allow premature termination of the warning cycle
- booms must not rise and fall again
- pedestrian gates must not open and close again
- tail flashing prevention is reliable

3.7 Approach Warning Signs (Rail)

W7-4B warning signs to AS 1743 should be erected immediately to the left of the running line and adjacent to the start of the approach track section advising train drivers that they are approaching

an actively protected level crossing and to avoid bringing their trains to a stand on level crossing approach track circuits. This sign is shown in Figure 2.

Figure 2 – Sign used for non predictor level crossings

Alternatively, warning signs in accordance with applicable rule book may be installed to have consistency within applicable jurisdiction.

3.8 Crossing Monitoring

Level crossing functions shall be monitored locally with a level crossing monitor/event logger and shall meet the requirement of AS7705, ESD-05-05 and other applicable ARTC standards.

3.9 Emergency Switches

Where provided, Emergency switches shall be located and/or secured so that only authorised and competent personnel have access to them. Emergency switches shall be key-locked such that it is not possible to remove the keys unless the switches are in the correct position for normal operation. Emergency switches shall be unlocked by emergency keys. The key shall be captive in the switch when it has been switched off. It shall not be possible to close and lock the lid of the emergency switch box whilst an emergency switch is operated.

All level crossing installations in locations where an interlock can be provided which limits the ability of trains to operate through the crossing may be fitted with a single emergency switch to turn off the crossing. This will cause all booms to raise, pedestrian gates to open, lights to extinguish and to silence the audible warning device/s. When the emergency switch is operated, signals applying over the crossing must be designed to be held at stop. Where there is an additional risk identified for example SPAD risk, additional control for example relocating the signal or other engineering control in the design will be required subject to outcome of the risk assessment.

Independent emergency switches shall be provided enabling a manual control for extinguishing each of the flashing light highway signals. Single emergency switch shall be provided to disable the audio warning devices.

Each road boom will be provided with its own emergency boom switch. This will permit a damaged boom to be tied up and the mechanism disconnected so that it is not damaged while the rest of the crossing operates. While the boom is tied up it will not be possible to clear signals over the crossing.

Local emergency switches are not required for Level Crossings on private roads.

3.10 Local Test Switch and Manual Operation Switch

A test switch shall be provided to enable the highway signals, the half-boom barriers, the audible warning device/s and warning lights (each where fitted) to operate directly from the standby power supply, with the main supply switched off.

A manual operation switch shall be provided in a SL locked box or similar as per corridor practices for consistency. This switch shall not switch off the mains power supply to the level crossing equipment, but shall permit activation of the level crossing, even if the emergency switch has been operated where provided for consistency.

At crossings that are not remotely monitored the following power indication operating with the test switch shall be provided:

- A power supply indication shall be provided to enable the charge status of the standby battery to be determined when the test switch is activated.
- This shall be an indication lamp operating from a voltage-sensing device.
- The lamp shall be illuminated when the voltage of the standby battery is equal to or above a predetermined level.
- The lamp shall remain extinguished when the voltage of the standby battery is less than a predetermined level.
- Both these lamps shall be inhibited from operating when the test switch box is closed.
- The lamps shall be Ultra Bright LED type.

3.11 Audible Warning – Road Level Crossings

Audible warning devices provide level crossing users with an active audible warning of approaching trains.

Audible warning devices should be located and directed such that upon activation, an audible warning is heard by pedestrian crossing users approaching or crossing the railway tracks.

The minimum sound levels for pedestrian audible warning devices shall comply with the following standards:

- AS 1742.7 Manual of Uniform Traffic Control Devices – Railway Crossings,
- AS 7658 Railway Infrastructure: Railway Level Crossings,

The maximum volume of an audible warning device shall comply with local standards and legislation that minimise the risk of noise induced hearing loss and shall take into consideration the proximity of residential and commercial property to the audible warning devices

Where environmental or local situations warrant a reduction in audible warning sound levels, and a risk assessment involving the relevant authorities and human factors provides for safe mitigation (SFAIRP), then suppression of audible warning is permissible as detailed below.

The audible warning on one side of the level crossing may be silenced when both the half-boom barriers are fully lowered.

In those locations where pedestrian barriers and lights are fitted, both the level crossing audible warning devices can be suppressed if required when the booms are fully lowered provided that the pedestrian level crossing is fitted with controlled volume warning devices.

At night between the hours of 22:00 and 06:00, it is permissible to suppress both the road warning bells on meeting one of the following conditions:

- the road crossing is provided with booms and dedicated pedestrian audible warning devices are switched on in lieu of the road warning bells during the nominated time (22:00 and 06:00)

- an assessment has determined a low likelihood of pedestrians using the road crossing during the nominated time (22:00 and 06:00)

Pedestrian audible warning devices are not to be silenced.

Level crossings without booms are not to have audible warnings silenced.

3.12 Level Crossing Failure Modes

Level crossing warnings are intrinsically non-failsafe, since the absence of a warning implies that it is safe to cross. Level crossings shall be designed so as to minimise the impact of failures on the operation of the crossing. The following are acceptable minimum failure modes and goals.

- No single failure of the level crossing equipment shall result in the level crossing failing to give a warning indication when required. Modes that are to be protected against are:
    - Protection against inhibition of warning for next train in opposite direction on lines with traffic in both directions;
    - Protection as far as possible against extended continuous operation without train present;
    - Protection against widespread loss of lights caused by a single high resistance relay contact or terminal, broken wire or blown fuse.
- A failure of the external power supply shall not affect the integrity of the level crossing protection as permitted by the battery capacity.
- Lamp and flasher circuits shall be configured so that in the event of a single failure, a reduced, but effective warning is provided for vehicles approaching from both directions.
- Additional lights, when provided, shall be wired to enhance the operation in failure conditions.
- Boom mechanisms shall descend on failure.
- Pedestrian Emergency gates shall become accessible on failure.
- Pedestrian swing gates shall close on failure.
- Road Warning lights shall continue to be displayed until booms are fully raised.

3.13 Level Crossing fouling track section

All level crossings shall be designed so that if a train is within or adjacent to the rail – road intersections the level crossing will operate. A separate fouling track section shall be provided for each track across the crossing. The fouling track section may be provided as part of the approach track section if the traffic is unidirectional and there is no qualification on the approach track section.

Fouling track sections shall be not less than 30m long placed evenly to both sides of the crossing. The fouling track section may be increased in length to cover a pedestrian level crossing to the side of a road level crossing. Where a platform or siding is placed so that standing of train immediately to the run away side of the level crossing may be required, a shorter length may be used.

Fouling track sections are not required where shunters push buttons are provided as the soul means of the operation the level crossing.

4 Level Crossing Controlled by Flashing Lights Only

4.1 Introduction

This section addresses the design requirements for a level crossing controlled by flashing lights and audible warning devices only including its mode of operation and the determination of the appropriate crossing controls and indications. This covers operation by train detection and excludes shunter operated level crossings.

4.1.1 Provision of the Arrangement

This particular arrangement shall only be provided where a public road intersects a single line railway.

4.2 Local & Environmental Requirements

Local and environmental requirements shall determine the need to:

- provide additional RX-5 assembly.
- provide an additional audible warning devices.
- mute audible warning devices. Note: A controlled volume warning device may be used as a substitute for the standard audible warning devices at night where required. A controlled volume warning device may also be used outside this period as a noise abatement measure where approved by the infrastructure manager.
- AAWA (Active Advance Warning Assembly) may also be provided on one or both road approaches to the level crossing where the motorist's view of the RX-5 assemblies is compromised by the road layout or by in response to other risk factors. ALCAM is one method used to evaluate the risk factors of a level crossing.

4.3 Sequence of Operation

If no train is approaching the level crossing, then the RX-5 assembly shall be extinguished and the audible warning device shall be silent.

If a train is approaching the level crossing then the RX-5 assembly shall commence and continue to flash alternately and the audible warning device shall commence and continue to sound.

At crossings fitted with AAWA, the timing shall be as per section 12 of this standard and AS1742.7. The exact time shall be agreed with the Road Manager.

When the rear of the train passes clear of the level crossing then the RX-5 assemblies and AAWA where fitted, shall become extinguished and the audible warning device shall be silenced.

4.4 Warning Time

The warning time interval between the RX-5 assembly commencing to flash and a train travelling at the maximum permissible speed applicable to a particular level crossing arriving at the level crossing shall be designed to provide a minimum warning time in accordance with Section 3.2 of this standard.

4.5 Crossing Controls

The operation of the level crossing shall be initiated and maintained automatically by the occupation of a controlling section of track on the approach side to the level crossing.

The length of this controlling section of track shall be determined to ensure that the minimum warning time can be met.

Controls shall also be provided to prevent the continued operation of the level crossing when a departing train occupies the section of track controlling the operation of the level crossing for trains approaching from the opposite direction.

These controls shall be proved to have operated correctly in signal circuits prior to resetting in readiness for the approach of the next train – from either direction. Where these controls fail to be proven the level crossing shall begin to operate once more.

At some installations shunter's push buttons may be provided to operate the level crossing when shunting movements are taking place over the crossing on normally non track circuited sidings.

5 Level Crossing Controlled by Flashing Lights and Half-Boom Barriers

5.1 Introduction

Boom barriers and flashing lights is the preferred solution for new active level crossing on ARTC network unless there is an agreement with corridor signal engineers for other options supported by risk assessment.

This Principle addresses the requirements for a level crossing controlled by flashing lights and half-boom barriers and audible warning devices including its mode of operation and the determination of appropriate crossing controls and indications. This covers operation by train detection and excludes shunter operated level crossings.

5.1.1 Provision of the Arrangement

This particular arrangement shall be provided where a public road intersects two or more running lines of a railway.

On single lines, booms may be installed at other locations following a risk assessment.

5.2 Local & Environmental Requirements

Local and environmental requirements shall determine the need to:

- provide additional RX-5 assembly.
- mute or conditionally suppress audible warning devices at night.

5.3 Sequence of Operation

If no train is approaching the level crossing then the RX-5 assembly shall be extinguished, the half-boom barriers shall be in the fully raised position and the audible warning devices shall be silent.

If a train is approaching the level crossing, then the RX-5 assembly shall commence and continue to flash alternately and the audible warning devices shall commence and continue to sound.

The half-boom barriers shall commence to lower 11 seconds after the flashing light signals have commenced to flash.

The half-boom barriers shall reach the horizontal position within 13 seconds after they have commenced to lower and one of the audible warning devices may be silenced.

The boom barriers shall be fully horizontal for at least 6 seconds before train arrival.

When the train has cleared the crossing, the booms shall commence to rise to the upright position and the audible warning device shall be silenced.

Warning lights shall continue to operate until both boom gates are proven to be fully vertical.

The boom barriers should be in the vertical position within a maximum of 10 seconds after they have commenced to rise.

If the activation of the level crossing is cancelled for whatever reason, the crossing controls shall be designed such that once the boom gates begin to descend they shall completely descend to the horizontal prior to being driven back to vertical.

If a second train is approaching the level crossing as the rear of the first train passes clear of the level crossing and there is insufficient time for the half-boom barriers to rise and remain in the fully raised position for a time interval, given in section 5.4 before commencing to lower for the second train then they shall remain lowered until the rear of the second train has also passed clear of the level crossing.

5.4 Holding Section Time

The holding section time is intended to ensure that a vehicle which commences to cross at the completion of a train passing through the crossing can cross without danger of being struck by or of damaging the warning equipment due to unexpected boom descent.

Controls should be provided to ensure that an adequate minimum crossing open time between successive crossing activation is provided. Typically, this is 15 seconds between the crossing warning fully cancelling (i.e. booms, where provided, fully up and the flashing lights extinguished) and the crossing warning re-activating.

Where the holding section is used for traffic lights pre-emption or controlling AAWA signs, the length may be adjusted to suit the traffic lights requirements subject to the holding section timing achieved.

5.5 Crossing Controls

The operation of the level crossing shall be initiated and maintained automatically by the occupation of train detection section/s on the approach side of the level crossing to ensure the correct minimum warning time is obtained.

The operation of the level crossing shall also be maintained by the occupation of a holding train detection section on the approach side of the controlling train detection section.

If bi-directional movements take place then controls shall also be provided to prevent the continued operation of the level crossing when a departing train occupies the train detection section controlling the operation of the level crossing for trains approaching in the other direction.

These controls shall be proved to have operated correctly in signal circuits prior to resetting in readiness for the approach of the next train – from either direction. Where these controls fail to be proven the level crossing shall begin to operate once more.

At some installations shunter’s push buttons may be provided to operate the level crossing when shunting movements are taking place over the crossing in areas where there is no train detection equipment.

An additional train detection section may be provided on the siding track to hold the crossing down and provide an auto re-clear feature when the shunting movement has passed clear of the crossing.

6 Pedestrian Level Crossing Controlled by Lights Only

6.1 Introduction

This section addresses the requirements for pedestrian level crossings controlled by red lights and supplemented by controlled volume audible warning devices. It includes the mode of operation of the level crossing and the method of determination of appropriate crossing controls. This covers operation by train detection and excludes shunter operated level crossings.

6.2 Provision of the Particular Arrangement

This particular arrangement shall only be provided where a public pedestrian way intersects a single line railway and there is no more than a moderate volume of pedestrian and rail traffic.

Barriers or swing gates may be installed following the outcome of a risk assessment.

6.3 Local & Environmental Requirements

The pedestrian level crossings will be illuminated generally to conform to AS 1158.3 at level P1.

Battery supplied warning light circuits shall be provided.

Additional warning lights may need to be provided following assessment of the crossing.

6.4 Sequence of Operation

If no train is approaching the pedestrian level crossing then the red man warning lights shall be extinguished and the audible warning devices shall be silent (In Queensland a green walking man signal is to be displayed when the red man is extinguished).

If a train is approaching the pedestrian level crossing then the red man warning lights shall commence flashing and after 15 seconds display and maintain a steady red man indication. The audible warning devices shall commence and continue to sound until the train has passed clear of the crossing.

Once the rear of the train passes clear of the pedestrian level crossing then the red man warning lights shall become extinguished (In Queensland a green walking man signal is to be displayed when the red man is extinguished) and the audible warning devices shall be silenced.

6.5 Warning Time

The warning time interval between the red warning lights being displayed and a train travelling at the maximum permissible speed applicable to the pedestrian level crossing arriving at the level crossing shall be designed to provide a warning time in accordance with Section 3.2 of this standard.

The warning time shall reflect the greater of warning time as per Section 3.2 of this standard or the calculated walk speed + 2 seconds. The walk speed shall be calculated for the crossing using 1.0 mS^{-2} or 0.8 mS^{-2} in the case where disabled people use the crossing. Refer AS 1742.7.

6.6 Crossing Controls

The operation of the pedestrian level crossing shall be initiated and maintained automatically by the occupation of a controlling train detection section on the approach side to the level crossing.

The length of the controlling train detection section shall be determined to ensure that the prescribed warning time can be met.

If bidirectional movements take place then controls shall also be provided to prevent the continued operation of the level crossing when a departing train occupies the train detection section controlling the operation of the level crossing for trains approaching in the normal direction.

These controls shall be proved to have operated correctly in signal circuits prior to resetting in readiness for the approach of the next train – from either direction. Where these controls fail to be proven the level crossing shall begin to operate once more.

It is permissible to locate the crossing in the centre of the tuned loop of a jointless track circuit.

7 Pedestrian Level Crossing Controlled by Lights and Barriers or Swing Gates

7.1 Introduction

This Principle addresses the requirements for pedestrian level crossings controlled by red lights and barriers or swing gates and supplemented by controlled volume audible warning devices. It includes the mode of operation of the level crossing and the method of determination of appropriate crossing controls. Barriers should preferably be type approved swing gates. This covers operation by train detection and excludes shunter operated level crossings.

Functional requirements of the pedestrian swing gates and emergency exit gates are to be in accordance with AS 7658 requirements.

7.2 Provision of the Particular Arrangement

This particular arrangement shall be provided where a pedestrian way intersects two or more lines of a railway and there is a moderate volume of pedestrian and rail traffic, or where a pedestrian way intersects a single line railway and there is a high volume of pedestrian and rail traffic.

In areas with low to moderate volume of pedestrian and rail traffic, barriers or swing gates may be installed following the outcome of a risk assessment.

7.3 Local & Environmental Requirements

The pedestrian level crossings will be illuminated generally to conform to AS 1158.3 at level P1.

Battery supplied warning light circuits shall be provided in new works.

Additional warning lights may need to be provided following assessment of the crossing.

7.4 Sequence of Operation

If no train is approaching the pedestrian level crossing then the warning lights shall be extinguished (except in Queensland where a green man symbol shall be displayed), the barriers shall be in the fully open position and the audible warning devices shall be silent.

If a train is approaching the pedestrian level crossing then the warning lights shall display a flashing red man symbol for 15 seconds followed by a steady red man symbol. The audible warning devices shall commence and continue to sound on the approach of the train.

5 to 8 seconds after the warning lights have been displayed the gates should commence to close.

After a further minimum of 5 or maximum of 10 seconds, the barriers or gates shall reach the fully closed position.

These times may be extended depending on the crossing width and time required for pedestrian to cross.

5 to 7 seconds after the gates have commenced to open, they should be fully open and the warning lights shall be extinguished.

The front of the fastest approaching train shall not reach the level crossing in less than the minimum warning time.

When the rear of the approaching train passes clear of the pedestrian level crossing then either the barriers or gates shall commence to open and the audible warning devices shall be silenced.

7.5 Warning and Operating Times

Where the pedestrian warning system is provided at a road level crossing it shall operate to the same times and to the same warning sequence as the road level crossing.

For standalone crossings the warning time interval between the red man warning lights commencing to flash and the front of a train travelling at the maximum permissible speed arriving at the pedestrian level crossing shall be designed to provide warning time in accordance with Section 3.2 of this standard.

The minimum warning time shall be increased above the warning time if the time for gates to close plus the calculated walk time + 2 seconds is greater than the warning time in accordance with Section 3.2 of this standard. The walk time shall be calculated for the crossing using the crossing width and a walk speed of 1.0 mS^{-2} or 0.8 mS^{-2} in the case where disabled people use the crossing. Refer to AS1742.7 for more details.

7.6 Crossing Controls

The operation of the pedestrian level crossing shall be initiated and maintained automatically by the occupation of controlling train detection sections on the approach to the level crossing.

The length of this controlling train detection section shall be determined to ensure that the prescribed warning time can be met.

If bi-directional movements take place then controls shall also be provided to prevent the continued operation of the level crossing when a departing train occupies the train detection section controlling the operation of the level crossing for trains approaching in the other direction.

These controls shall be proved to have operated correctly in signal circuits prior to resetting in readiness for the approach of the next train – from either direction. Where these controls fail to be proven the level crossing shall begin to operate once more.

It is permissible to locate the crossing within the tuned loop of a jointless track circuit, if it is a separate pedestrian crossing.

8 Shunter Operated Level Crossings

8.1 Introduction

Where a RX-5 level crossing (with or without booms) is provided in a shunting area, the crossing may be protected by 'STOP' boards in either direction facing rail traffic.

The two types of crossings to be considered in this section are:

a. Level crossings without a train detection system (Fig 3)

b. Level crossings with a local cancelling train detection system. (Fig 4)

8.2 Level Crossings without Train Detection Systems

Where a RX-5 level crossing is provided and train detection is not feasible or required, the shunter's control is to be by Shunter's Switches or Push Buttons arranged in a two way switching arrangement. The shunter's switches are provided in a locked box adjacent to the 'STOP' boards. A battery backup is not required in the design unless the local power supply is intermittent.

8.3 Level Crossings with a Local Train Detection System

Where a RX-5 Level Crossing is provided and train detection is provided to automatically cancel the crossing after the passage of the train, Shunter's pushbuttons labelled "Start" and "Cancel" are to be provided on either side of the crossing adjacent to the Stop Board. The cancelling train detection section is to span the road rail intersection and cause the crossing to operate while it is occupied.

Operation of the 'Start' pushbutton shall cause the crossing to operate. Operating the 'Cancel' button or a train occupying the train detection section is to reset the start command. To avoid the unnecessary operation of the crossing with power supply interruptions, a battery backup supply is to be provided.

It is preferred to use the Axle counter as train detection in crossings where unreliable train detection can be an issue due to low traffic.

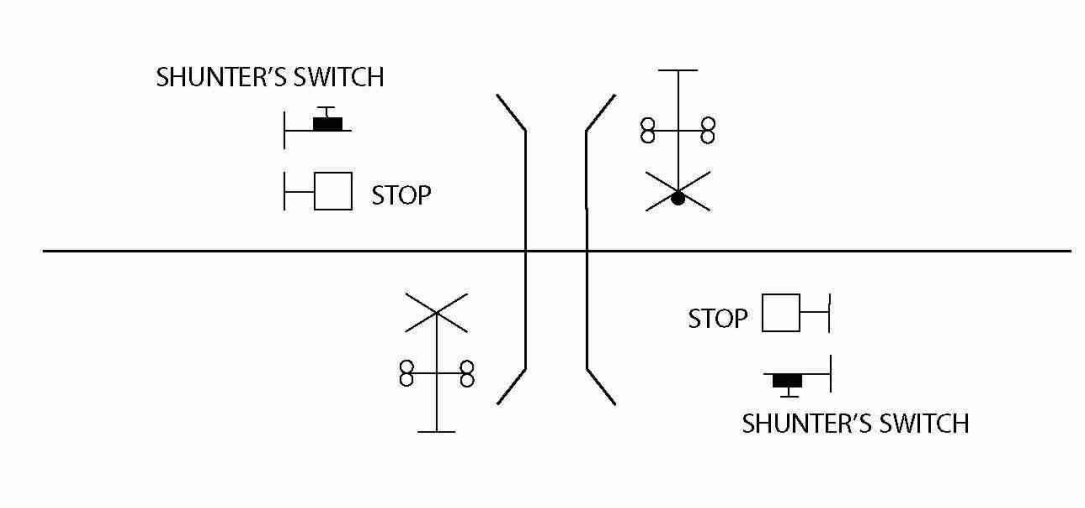


Fig 3 Crossing without train detection

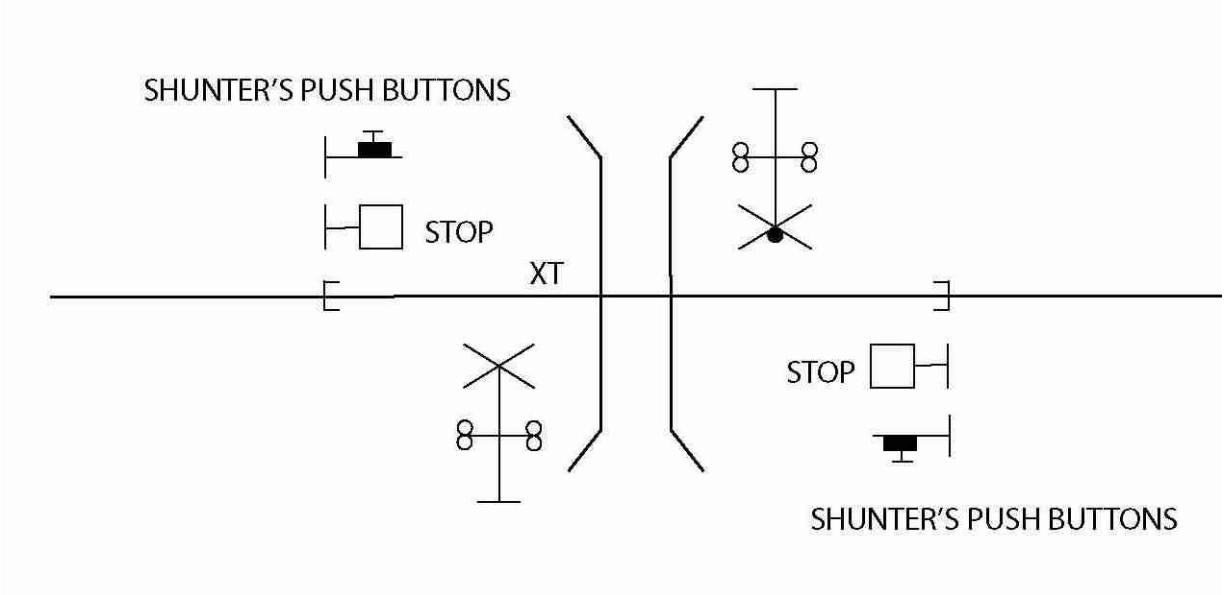


Fig 4 Crossing with train detection and push buttons

9 Level Crossings near Interlockings & Sidings

9.1 Introduction

At locations where protected level crossings exist at interlockings, arrangements need to be made to prevent unnecessary operation of the level crossing warning equipment while trains are shunting at the interlocking, standing at platforms, or waiting (for some other reason) on the level crossing warning approach train detection section.

9.2 Requirement

Where trains regularly approach level crossings, but where the movement over the crossing is not to be made for some time, the level crossing warning should not operate until the train is ready to proceed.

If this is an infrequent occurrence, time out type arrangements may be used to cancel the level crossing warning operation after the train has come to a stand.

However, where trains regularly approach the crossing but do not proceed over the crossing, the crossing warning should not operate on the train's initial approach.

9.3 Crossing Warning Cancelled after Train Comes to a Stand

This section applies to level crossings where shunting occurs less than twice per day and the intersecting road has moderate to low traffic volumes. In the situation where a siding exists within the approach train detection section/s of a level crossing, or where trains would come to a stand on the approach train detection section/s for an extended period it is necessary to provide arrangements to permit the level crossing warning to be cancelled.

Train Order Working Areas (For Per Way and other little used sidings)

Arrangements should consist of a mechanical duplex lock located on a Mechanical Point Indicator, or adjacent to a trailable points mechanism or points lever, whereby one lock is unlocked by an operator's key or master key releasing the key from the other lock to operate the ground frame, trailable points lever or other points lever. Removal of the key for the ground frame puts the Mechanical Point Indicator to stop and makes an electrical contract to cancel the level crossing operation. Removal of the key for the trailable points lever or other points lever also makes an electrical contact on the duplex lock to cancel the level crossing warning operation. After restoring the key for the ground frame to its lock on the ground frame, the Mechanical Point Indicator clears and the level crossing warning begins to operate with the train on the approach tracks. At this time the operator's key can be removed from the lock. Restoration of the key to duplex locks in the other cases also restores normal operation of the level crossing warning system. Refer to Figures 5 and 6

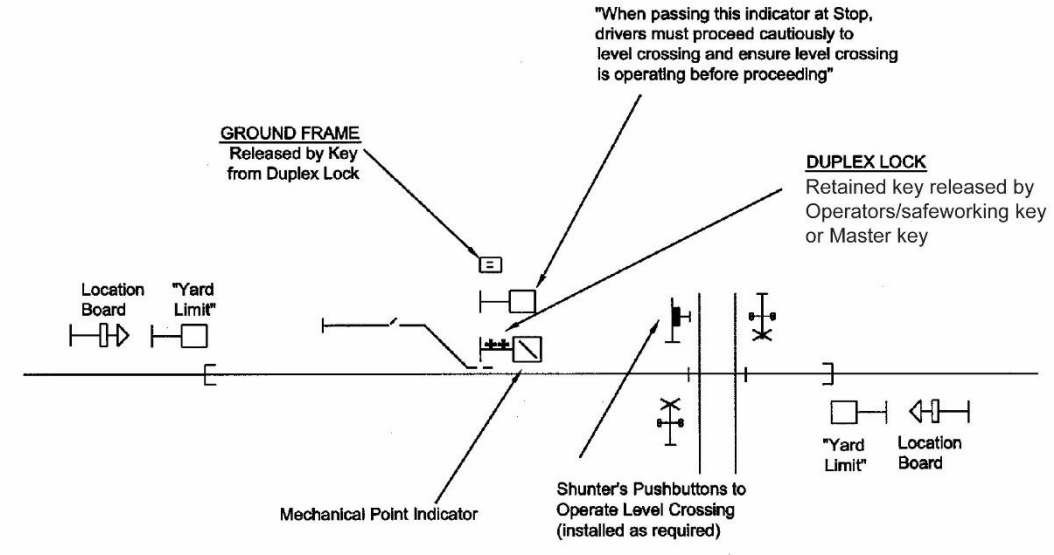


Fig 5 Level crossing in TO territory

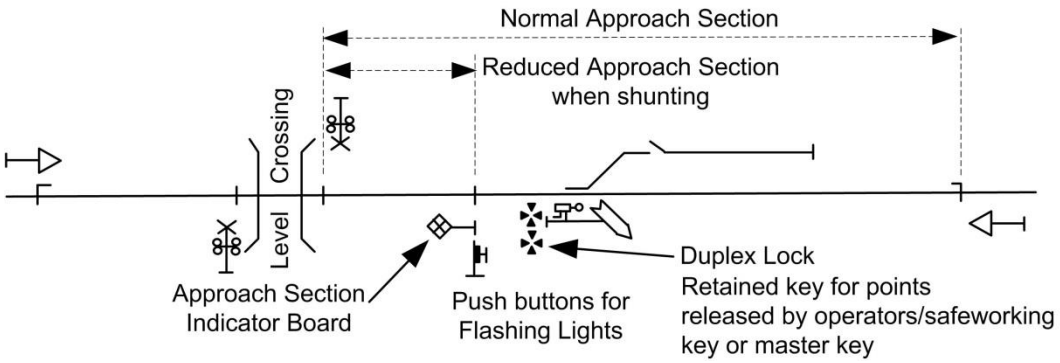


Fig 6 Level crossing in TO territory

General

If, after cancellation, shunting is to occur across the level crossing, then push buttons must be provided to initiate and cancel level crossing warning operation.

If the level crossing is in close proximity to the duplex lock the train crew will be aware of their interaction with the level crossing. If there is an area of the level crossing approach not cut out by the operation of the duplex lock, an approach section indicator board or other signage should be provided. Refer to Figure 6.

Special care needs to be taken with these arrangements to ensure reliable proving of direction stick functions, to prevent the proving circuitry from timing out and unnecessary operation of the crossing during shunting. Where these arrangements are difficult to apply or other operational requirements apply, a signal (or Main Line Indicator) should be installed.

9.4 Level Crossings Protected by Signals

Where trains regularly approach level crossings more than once per day and the movement over the crossing is not to proceed for operating reasons, then a signal (or a Main Line Indicator) should be provided to regulate the level crossing operation. Refer to Figure 7.

This signal or Main Line Indicator may be operated by one of the following methods:

- Operators/safeworking Key and/or duplex lock
- Locally controlled by a timer based on timetabled train movements
- Driver's push buttons
- Remotely controlled via the level crossing monitor or other remote control system
- Other method suitable for the situation

When the arrangement requires the signal or Main Line Indicator to be usually cleared the track circuited approach must be arranged for the fastest non-stopping train, and time releasing of approach locking is to be provided.

9.5 Power Arrangements and Circuit Configuration

Where normal and back up A.C. power supplies are not available the system may be configured such that a failure of the signal lights (or the Main Line Indicator lights) causes the qualification of the approach sections by the signal or main line indicator to be ineffective.

Signal or Main Line Indicator lighting is not normally to be supplied from the level crossing battery unless the level crossing battery has sufficient capacity to allow backup as per Section 3. Signals or mainline indicators provided to qualify level crossing approach section may be AC fed unless the power supply is unreliable in which case a separate battery back up should be provided.

Control functions whose failure cause operation of the level crossing should be powered from the level crossing backup battery

Level crossing monitors should be powered from the level crossing battery to allow remote alarm of any power failure.

9.6 Special Arrangements

Where a level crossing is remote, and signals or main line indicators are provided to protect the crossing, a failure of an approach track circuit, may after the elapse of a suitable time period, replace the signal or main line indicator to stop. Following the release of any approach locking it is permissible to qualify the level crossing operation and thus prevent unnecessary level crossing operation.

10 Level Crossing Operations in Train Order Areas

10.1 Introduction

Where level crossings are located in Train Order areas and trains stop or shunt within the approach sections, additional controls to prevent unnecessary operation of level crossing may be required. If shunting takes place less than twice per day and the intersecting road has low to medium traffic volumes the arrangements discussed in section 9 should be used. At locations which fall outside this criteria, Main Line Indicators or signals will be needed to regulate the operation of the level crossing when shunting is taking place on the approach track circuits.

The aim is to:

- Ensure the level crossing only operates when necessary on train approach.
- As far as possible, minimise level crossing operation during shunting.
- As far as possible maintain warning times so that neither inadequate nor excessive warning is given.

This description focuses on the use of Main Line Indicators, however these concepts also apply to signals used for the same purpose.

10.2 Application

The Main Line Indicators or signals may be configured to be:

- Normally clear – the usual application where trains do not stop on the approach
- Normally at stop and cleared for each train – used when most trains stop on the approach,

The Main Line indicator or signal shall be preceded by another signal or mainline indicator or landmark

10.3 Normally Clear Indicators

- As the travel time over the approach track circuits is likely to be less than the time required to brake from line speed, all MLIs used for qualification of approach track circuits shall incorporate time locking to a minimum of 2 minutes.
- MLIs protecting a level crossing requires track circuit cancellation which prevents the MLI reclearing for a train in the departing direction (i.e. away from the facing direction of the indicator).
- In addition to these requirements, the design of the MLI must be in accordance with the train order infrastructure requirements
- Where points are located in advance of the MLI, a Duplex Lock will be provided (released by Operators/safeworking Key and releases key for the frame or single lever). Operation of the Duplex Lock will place the MLI to stop to qualify the level crossing approach. Reclearing of the MLI to occur under two conditions as follows:
    1. When the Duplex Locks are restored and the track circuits are clear, (i.e. the train has left or is wholly within the loop).
    2. When the Operators push button is pressed.

- Shunters push buttons may be provided at the crossing for activation during shunting movements.
- When shunters pushbuttons are provided for operating and cancelling the crossing, lockout timing should always be provided to prevent manipulation of the buttons causing the booms to change direction mid rise.
- Operators push buttons for clearing of the MLI (and cancelling) are to be located at the MLI. Additional push buttons may be located adjacent to points from which trains may depart if required. Operation of a push button may override a Duplex Lock being reverse, to facilitate departure from the loop past the MLI to satisfy operating requirements.
- Designers should consider the possibility that Duplex Locks may be operated irregularly (for example after a through train has passed a frame in anticipation of one leaving a loop). Consequently, quick releasing of time locking should not be provided while a train is on the approach track sections.
- Quick releasing of time locking should be provided for reverse movements to the direction to the MLI. This quick releasing path must be carefully designed to ensure a single point failure will not override the timing function incorrectly.
- When MLI's at level crossings clear five types of interlocks are normally used:
    1. The MLI may clear immediately if there is no train approaching
    2. The indicator will clear and the level crossing operates together. This will apply if the train will have reduced speed, the MLI is set back far enough from the crossing so that the crossing would have operated for a sufficient time before the train reaches it.
    3. The level crossing operates for a time before the MLI clears and the distance to the crossing is sufficient such that a full warning time will be achieved. This generally applies if the MLI is located some distance back from the crossing within the full speed approach section.
    4. The crossing operates initially for either 10-15 seconds (or until the booms are lowered) before the MLI clears. This generally applies if the MLI is located at the crossing.
    5. The indicator will clear and the level crossing will then operate when the approach track is occupied by the train.
- Detection of the MLI red aspect lit is to be proved in the approach locking function.

See Figure 7

10.4 Normally at Stop Indicators

- These present less difficulty than normally clear indicators as there should be no scenario where they are placed to stop in advance of a train.
- Clearing of these MLI's is the same as for normally clear indicators.

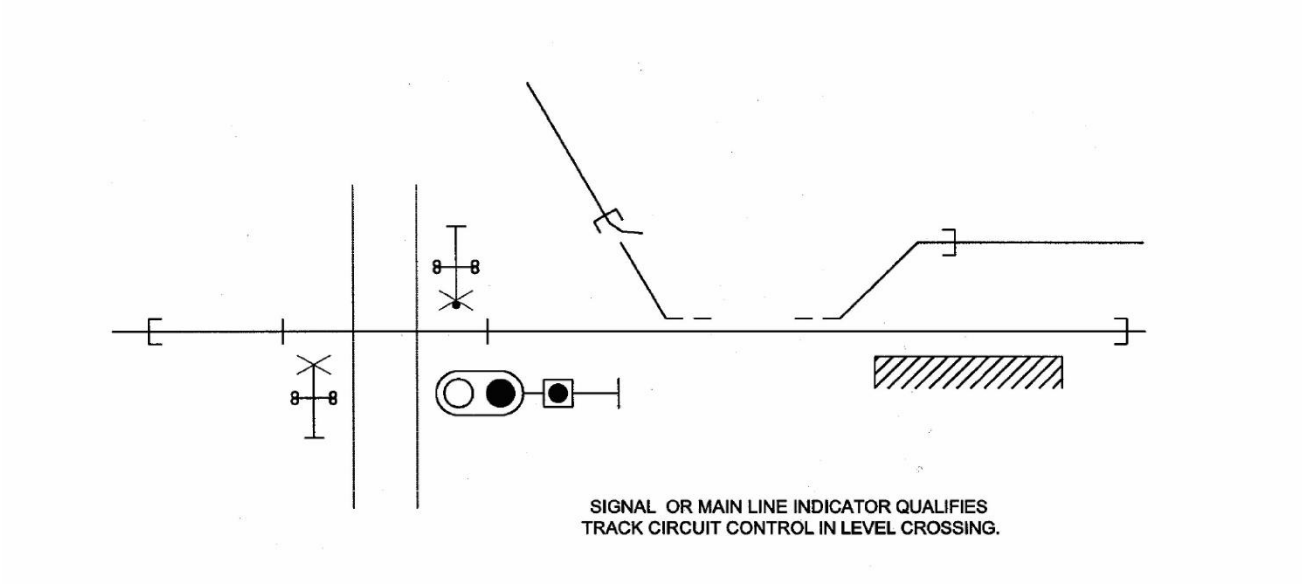


Fig 7 Mainline Indicator application

11 Level Crossing Interfaces to Road Traffic Lights

11.1 Introduction

Where a level crossing is located next to a set of traffic lights, the potential exists for motor vehicles to stop at the traffic lights and queue back across the railway or for a queue at a level crossing to obstruct the intersection behind. Where this occurs, interconnection between level crossing controls and the traffic lights are usually provided to assist in minimising this problem.

When interfacing a railway crossing system to a road traffic control system, the following interface arrangements shall be provided, unless agreed otherwise with the Road Manager.

11.2 Rail Signal and Road Signal Co-ordination

11.2.1 Requirement

The requirement is to co-ordinate railway level crossing operation with the operation of nearby traffic signals to ensure that the operation of one facility doesn't adversely impact on the safe operation of the other. In addition, the facilities and the interface between them need to be designed to minimise delays to both railway and road vehicles.

In order that the traffic lights can remove traffic conflicts with the level crossing operation, an advanced indication of train approach needs to be provided to the traffic lights controller. In this standard this is called the Train Demand (TD).

The road authorities in each state have their own descriptions for each co-ordination function and some of the functions operate differently. Section 11.3 covers this

The Road Manager will specify the Train Demand Response Time required.

In response to the Train Demand, the Road Manager will program the traffic lights cycles to

- Prevent through road traffic being directed onto the level crossing while it is operating, and
- Clear road traffic queued across the level crossing (Clearance Phase).

The worst case time for the traffic signals to reach Clearance Phase and the minimum duration of the Clearance Phase are determined by the Road Manager for each intersection.

When traffic lights are provided on both sides of the railway, the Road Manager will arrange the traffic light phasing so as to prevent a queue from forming, as far as practical. This may reduce the criticality of the clearance phase.

Where a traffic light is located prior to the level crossing or at the level crossing, it will be co-ordinated by the Road Manager to display 'stop' whenever the RX-5 assemblies are operating.

11.2.2 Traffic Light Train Demand point

Where possible the Train Demand initiation point should be aligned with the start of the holding section for the crossing (where used). If necessary the Train Demand initiation point shall be extended to accommodate this. In this case where the holding section is longer than the Train Demand time required by the Road Manager it shall be delayed by the time difference.

11.2.3 Automatic Signals within the Train Approach Zone

In this situation the signal is not interlocked with the traffic lights. A Train Demand input will be provided to the Road Manager when the train approaches. This input is to be timed off and if a

traffic light response is not received by the time the traffic lights demand time has expired a force shall be applied to the traffic lights controller.

The traffic lights will cycle through to Clearance Phase before activation of the level crossing. Activation of the crossing will occur when the train reaches the level crossing approach track section.

11.2.4 Controlled Signals Within the Train Approach Zone.

In this situation, the Road Manager will provide a Traffic Light Response (TLR) function to the level crossing.

When a rail movement is to be made, the Train Demand indication is provided to the traffic lights controller when the train approaches (with the signal clear) or the signal route is set (if a train is closely approaching). If the traffic lights cycle to the clearance phase earlier than the train demand time, an indication (Traffic Light Response) is provided to the rail signal system.

If a train is within the zone covered by the traffic light demand time, signal clearing must be delayed until the traffic lights are in the clearance phase or until the traffic lights demand time has expired. The TLR enables the Rail Signal clearing to progress without waiting for the expiration of the full Train Demand Response Time.

The level crossing activation is governed by the train being within the approach section. If the train is within the approach section when the signal is cleared the receipt of the TLR allows the activation of the crossing to commence immediately and this activation allows the interlocks between the signal and the level crossing to be fulfilled, thus allowing the signal to clear earlier than if the full train demand time was satisfied.

The TLR will be sent from the traffic lights controller at a given time after the start of the clearance phase (the time delay is usually queue clearance time minus the gate delay).

Should the Traffic Light Response not be received a force must be sent to the traffic lights controller and the activation of the level crossing must be initiated at the expiry of the Train Demand Response Time.

11.3 Interface Controls

Interface controls should be arranged to accord to the agreed rail – road co-ordination scheme for the State concerned.

11.3.1 Rail Interface Control Unit

A Rail Interface Control Unit (RICU) shall be provided to manage the interface functions between the railway crossing system and traffic control system.

The interface functions between the railway crossing system and RICU shall consist of voltage-free contacts or relay contacts, which shall be monitored using an extra low voltage DC supply over an interface cable.

The design, installation and maintenance of the RICU is the responsibility of the Road Manager, unless agreed otherwise.

11.3.2 Interface Cable

An interface cable shall be provided between the railway crossing system and RICU, which shall have overvoltage and immunisation protection. In addition, all circuits through the interface cable shall be fused.

The cable shall consist of a twisted pair type cable with a minimum of 6-pairs and shall be approved for use on the ARTC network.

The cable route between the railway crossing housing and the traffic control cabinet shall be designed and constructed to ARTC Cable Route Construction Standard ESC-11-01. Interface pits shall be provided adjacent to the railway crossing housing.

11.3.3 Traffic Control Equipment Failure

Monitoring of traffic control equipment and roadside equipment (not connected to the railway crossing system) is the responsibility of the Road Manager, unless agreed otherwise. However, the RICU may issue a fault indication to the railway crossing monitoring system for the purposes of incident investigations. If provided, the railway crossing monitoring system shall log the status of this indication in the event recorder. But in the event of a fault indication being detected by the railway crossing monitoring system, no warning or alarms are to be issued to the Network Control Centre.

The tables below show the co-ordination schemes in use:

Rail to Road Controls

Function used in this standard	NSW name	VIC name	SA name	Description of function
Train Demand (normally open)	Train Demand (n/o)			Given as closed contact at the nominated Train Demand point prior to the crossing control point and is to remain until the train has cleared the crossing
		Call	Advance Warning	Given at the nominated Train Demand point prior to the crossing control point and is to remain until the train has cleared the approach section
Train Demand (normally closed)	Train Demand (n/c)			Given as open contact at the nominated Train Demand point prior to the crossing control point and is to remain until the train has cleared the crossing
Force	Crossing lights control (n/c)			Given as open contact at the crossing control point and is to remain until the flashing lights have ceased
		Force	Force to Red	Given as open contact following the call at the crossing control point and is to remain until the flashing lights have ceased. If given before call, the traffic lights are forced to flashing amber mode.
Release	Crossing lights control (n/c)			Given as closed contact when the flashing lights have ceased and is to remain until the flashing lights have commenced again

Function used in this standard	NSW name	VIC name	SA name	Description of function
		Release	Booms Rising	Given as closed contact when the flashing lights have ceased until the earlier of after the call has been applied or at the crossing control point whichever is sooner
Traffic Lights Response	Traffic Lights Response			Closed contact when TLR is received
Closed Loop		Closed Loop		Open circuit when co-ordination cable broken (traffic lights forced to flashing amber)

Road to Rail Controls

Function name	NSW name	VIC name	Description of function
Traffic Lights Response	Traffic Lights Response		Voltage free contact closure given when traffic lights are in clearance phase, dependent on Train Demand being present
		Traffic Lights Response	Voltage free contact closure given when traffic lights are in clearance phase, dependent on Train Demand being present. Not given when traffic lights are in flashing amber mode
Closed Loop		Closed Loop	Open circuit when co-ordination cable broken (traffic lights forced to flashing amber)

11.4 Manual Operation and Test Switch Operation

The operation of the Manual Operation or Test Switch is different for each co-ordination scheme.

The differences are shown below:

NSW

- When the level crossing is being operated by the Manual Operation or Test Switch the level crossing will not activate immediately.
- The Train Demand (TD) is applied.
- The level crossing is activated when the Train Demand Response Time period expires and the force is applied.
- The level crossing may also be activated by receipt of the Traffic Light Response from the road traffic signals, if the train is within the crossing area.

VIC

- When the level crossing is being operated by the Manual Operation or Test Switch the level crossing will not activate immediately.
- The Train Demand (TD) is applied and the level crossing is activated when the Train Demand Response Time period expires; at this time the Force is applied

- The level crossing may also be activated immediately if a Traffic Light Response from the road traffic signals is received.

The Clearance Phase commences at or before the time of level crossing operation and should not end until after the crossing operates. This is to prevent the queue from extending by more cars entering the crossing area. The actual end point may be extended by the Road Manager if a queue is detected. However, it will not be prior to the commencement of boom operation, where booms are provided. Cessation of the Clearance Phase is based upon the application of the Force Control.

11.5 Requirements for Boom Gates

When an interface with traffic lights is to be provided on a RX-5 crossing without boom gates, it will be necessary to install boom gates where the boom operation is an essential part of preventing a queue reforming over the crossing when the clearance phase on the traffic lights ahead is terminating. When separate traffic light installations exist on either side of a RX-5 crossing without booms, it may not be necessary to provide the booms where the traffic light interfacing ensures that vehicles will not come to a stand across the road – rail intersection. Individual sites should be risk assessed to ensure traffic queuing is prevented.

11.6 Other Co-ordination controls

The Road Manager may request other control functions from the rail interface to optimise control of the traffic lights system especially at road intersections.

These include:

- Booms down
- Crossing control relay energised.

12 Operation of Active Advance Warning Assemblies for Level Crossings

12.1 Introduction

This principle addresses the requirements for Active Advance Warning Assemblies (AAWA) for road traffic when integrated as part of the level crossing installation. There are two schemes in use:

- Firstly, those provided and maintained by the ARTC and wired directly into the level crossing control equipment. Such installations are now considered a legacy arrangement and are not to be provided, unless agreed otherwise with the Road Manager.
- Secondly, those provided and maintained by the Road Manager, which consist of a standalone traffic control system with an interface to the railway crossing system. This is the standard arrangement for new AAWA installations.

Also refer to Section 11 for the interface requirements between the railway crossing system and road traffic control system.

12.2 Local and Environmental Requirements

AAWA may be provided on agreement with the Road Manager on one or both road approaches to the level crossing where the motorist's view of the RX-5 assemblies is compromised by the road layout or by other un-correctable obstructions or where a risk assessment deems them appropriate. Figure 8 shows a typical roadside installation of an advance warning sign – see AS 1742.3 for details of the current sign design. Figure 9 shows a typical roadside application.

12.3 Sequence of Operation

If no train is approaching the level crossing then all warning lights shall be extinguished, any barriers shall be in the fully open position and the audible warning devices shall be silent.

If a train is approaching the level crossing, the AAWA shall operate before the RX-5 assemblies are activated. This is to allow vehicles travelling at the road speed limit after passing the AAWA while extinguished to pass through the crossing without the crossing operation commencing before the road vehicle arrives at the crossing.

After the time period has expired, the RX-5 assemblies will then activate and the level crossing will follow its prescribed sequence of operation as required by the particular equipment arrangement.

The AAWA shall extinguish when the RX-5 assemblies extinguish.

Under specific circumstances determined by the Road Manager, the AAWA may continue to operate until potential traffic queues have cleared. The length of extended operation may be determined through a calculated peak traffic volume queue length and time to clear, or through in-road sensors that detect the presence and movement of road vehicles.

12.4 Advance Warning Time Requirements

The AAWA normally operate for a defined amount of time before the railway crossing warning devices begin to operate (i.e. before the roadside railway crossing warning equipment operates). This advance warning time is typically referred to as the "pre-emption" time but may also be referred to as the "pre-start'' time.

The required pre-emption time for activating the AAWA before the level crossing operation shall be calculated using the method shown in AS1742.7 Clause 2.3.7 and Appendix E of the same document. The pre-emption timing calculations should be undertaken by the Road Manager or agreed with the Road Manager.

The approach section for the level crossing shall be extended to become the sum of the time required for the level crossing approach and the AAWA pre-start time.

An output from the railway crossing system is required to initiate the operation of the AAWA. The pre-emption output shall be initiated by one of the following methods:

- The addition of extra approach track circuits. Note that directional stick logic shall also be implemented for the advance warning lights control.
- Where provided, a holding section can be used by delaying this section of track.
- Timer functions (to delay the crossing operation) within a relay or computer-based interlocking (CBI) system.
- Timer functions (to delay the crossing operation) within a railway crossing predictor system or other suitable processor-based system.
- Pre-emptive output of a railway crossing predictor system

The method of extending the approach track lengths and delaying the crossing operation via a slow to drop relay shall be avoided due to the dangerous failure mode.

When the railway crossing is operated by the manual operation switch, test switch (if provided) or axle counter reset switch (if provided), the pre-emption output shall be initiated immediately but the level crossing operation shall be delayed until the nominated pre-emption time has elapsed.

12.5 Specific Requirements

Guidance for the use of AAWA together with recommended methods of locating these assemblies and setting their operational timing are provided in AS 1742.7.

Unless agreed otherwise, the railway crossing equipment shall not be used to control the operation of the AAWA. The operation of the AAWA shall be controlled by an Active Advance Warning Device (AAWD) as nominated by the Road Manager.

The railway crossing system shall issue a pre-emption output in the form of a voltage-free relay contact to the AAWD, which will initiate the operation of the AAWA.

Monitoring of the roadside AAWA equipment and AAWD control equipment is the responsibility of the Road Manager. However, the RICU may issue a fault function to the railway crossing monitoring system for the purposes of logging and incident investigations.

Figure 8 AAWA Example

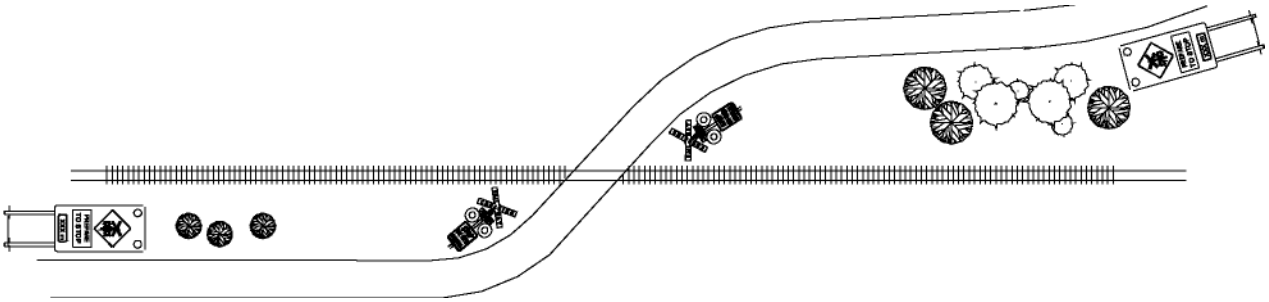


Figure 9 Application of AAWA