



AUSTRALIAN RAIL TRACK CORPORATION LTD

Discipline
Engineering Specification

Category
Track & Civil

Supplementary Appendix to ARTC Track & Civil Code of Practice

Establishing Minimum Protective Measures at Level Crossings

ETF-16-01

Applicability

ARTC Network wide	
New South Wales	
Western Jurisdiction	✓
Victoria	✓

Primary Source

(State Level Crossing Safety Committee, "Draft: Policy of Recommended Practices for Establishing the Minimum Protective Measures at Level Crossings in South Australia". South Australia (1998)/TCS-01)

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This document has largely been prepared by Statewide Operational Coordination Group in Transport SA, and amended to suit ARTC requirements.

1 Scope

This document refers to level crossings of roadways, footpaths and railways on the ARTC network. It provides guidance towards best practice, for the appropriate type of protection at level crossings. It is not intended as a prescriptive standard, as engineering judgement will typically be required.

Meeting of a guideline does not necessarily make an identified type of protection mandatory.

Note that ARTC may approach the relevant Road Authority on specific safety issues that may include, but not restricted to the following:

- Positioning of signs and signals at level crossings
- Positioning of approach signs (not ARTC responsibility)
- Provision of road markings (not ARTC responsibility)
- Improving visibility
- Accident statistics
- Road traffic densities
- Determination of sighting conditions (refer to ARTC Specification for Sight Distance Provisions at Passive Level Crossings).

Protective measures installed under a previous Rail Owner's policy will remain valid until a significant upgrading or review is undertaken.

2 Definitions

<i>Road Authority:</i>	that body (State or Local Government) vested with the care, control and management of the road concerned. Note that for private roads, the Road Authority is usually the licensee.
<i>Public Level Crossing:</i>	a level crossing provided to maintain continuity of a public thoroughfare. Public level crossings are available for the use of the general public.
<i>Private Level Crossing:</i>	a level crossing provided to permit access to private property or to extend access between parts of private property.
<i>Service Level Crossing:</i>	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.
<i>Left side crossing:</i>	one in which a motorist approaches a level crossing with an acute angle between the road and railway on his/her left side.
<i>Right side crossing:</i>	one in which a motorist approaches a level

	crossing with an acute angle between the road and railway on his/her right side.
<i>Exposure factor (VT):</i>	the value obtained by: multiplying the annual average daily traffic (nominally AADT) for road vehicles, by the average trains per week.
<i>Urban roads:</i>	roads within defined metropolitan areas or city/town speed limits.
<i>Rural roads:</i>	roads outside defined metropolitan areas or city/town speed limits.
<i>Multi-lane roadways:</i>	roadways comprising two or more traffic lanes in either direction.
<i>85th percentile (road) speed (V_{85} km/h):</i>	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.
<i>Primary set of flashing lights:</i>	the set of flashing lights that are aligned to provide long range viewing by approaching road traffic.
<i>Secondary set of flashing lights:</i>	the set of flashing lights that are aligned to provide short range viewing by approaching road traffic.

3 Functional Requirements

Level crossings are provided to enable a safe crossing, at grade, for road and pedestrian traffic.

A safe crossing should:

- Warn users (rail, road and pedestrian) of the existence of a level crossing.
- Warn road and pedestrian users of the approach of rail traffic in sufficient time for protective action to be taken.
- Allow for the passage of specified (size, mass and speed) road, pedestrian and rail traffic.

Sight distances at passive level crossings should comply with the ARTC Specification for Sight Distance Provisions at Passive Level Crossings.

4 Warning Signs, Signals and Road Markings

4.1 General

The installation of all signs, pavement markings and signals relating to road traffic should conform to the latest publication of Australian Standard AS1742.7, Manual of Uniform Traffic Control Devices - Railway Crossings.

Maintenance of crossings to an earlier publication of AS 1742.7 will be acceptable

under these guidelines until significant upgrading is required at a crossing at which time the latest publication of the Standard should be followed. Cooperation and coordination between ARTC and the Road Authority should be practiced.

4.2 Signs and Signals - ARTC Responsibility

The types of signs and signals listed in Table 1 should be provided (as appropriate), erected, maintained and managed by ARTC or its maintenance Contractor.

Table 1 Railway Owner Signs and Signals

ASSEMBLY	DESIGNATION
Railway Level Crossing Give-Way Assembly	RX-1
Railway Level Crossing Stop Assembly	RX-2
Railway Level Crossing Flashing Light Assembly (together with automatic gates where provided)	RX-5
Railway Level Crossing Gate Position Sign	RX-6
Standard Road Traffic Signals	refer AS1742.14

4.3 Road Authority Signs and Markings

The types of signs listed in

Table 2 should be provided, erected and managed on public roads by the Road Authority (as appropriate), in accordance with AS1742.7 and relevant road authorities and procedures.

The following pavement markings should be provided and managed on sealed public roads in accordance with AS1742.7 by the Road Authority, as appropriate:

- Holding and STOP lines
- Barrier lines
- RAIL X markings
- Yellow Box Markings

Table 2 Road Authority Signs

Sign	Sign number	Size mm	Used in Assembly
Stop Sign Ahead	W3-1A	600 x 600	
	W3-1B	750 x 750	
	W3-1C	900 x 900	
Railway Level Crossing Flashing Light Ahead	W7-4A	Not used	
	W7-4B	750 x 750	
	W7-4C	900 x 900	
Railway Level Crossing (passive control) Ahead - Symbolic Train	W7-7A	600 x 600	
	W7-7B	750 x 750	
	W7-7C	900 x 900	
Railway Level Crossing Ahead Diagrammatic - Right Angle Crossing - Oblique Crossing - Crossing on Side Road - Crossing on Cross Road	W7-8A, B, C	A-600 x 600	RX-3
	W7-9A, B, C	B-750 x 750	
	W7-12A, B, C	C-900 x 900	
	W7-13A, B, C		
RAILWAY GATE	W7-15A	600 x 600	RX-8
	W7-15B	750 x 750	
	W7-15C	900 x 900	
ON SIDE ROAD	W8-3A	600 x 400	RX-4
	W8-3B	750 x 500	RX-7
	W8-3C	900 x 600	RX-8
(distance).....m	W8-5A	Not used	
	W8-5B	750 x 250	
	W8-5C	900 x 300	
RAILWAY CROSSING	G9-32 & G9-33	2100 x 450	RX-9
Width marker	D4-3	450 x 900	RX-9
Chevron Alignment Marker	D4-6A	600 x 750	
	D4-6B	750 x 900	
	D4-6C	900 x 1100	

Note that RX-9 Signs are the responsibility of the Railway Owner in Victoria.

4.4 Private Crossings

Level crossings formed by private roads will be managed in accordance with the conditions of the licence between ARTC and the crossing licence holder.

5 Protective Measures to be used

When assessing the type of protection at a level crossing, the existing conditions (ie data and site information - see Clause 6 are usually best evaluated by considering the following order:

- Closure or relocation
- Grade Separation
- Flashing Lights

- Flashing Lights and Automatic Gates
- Give Way Signs
- Stop Signs

The minimum degree of protection should be the treatment type which best satisfies the existing conditions.

5.1 Private Crossings

Private crossings may be either for accommodation, that is those which provide access to the public road system from private dwellings, or occupational, that is those which provide access within a property.

The level of protection at private crossings will depend on the individual circumstances of the crossing. The options can vary from lockable gates through whistle boards to treatments provided for in AS1742.7, including a requirement for the licence holder to obtain a clearance from train control prior to using the crossing.

The ARTC modified RX-2 Stop Sign Assembly should be used unless a higher level of protection is indicated by a risk assessment. Special circumstances that may arise to require additional protection are: sighting problems, track geometry and speed, accident history, and potential use by the public.

The sighting distance provisions in the ARTC Specification for Sight Distance Provisions at Passive Level Crossings may be varied for private crossings subject to appropriate risk assessments.

It is the prime responsibility of the person(s) holding a crossing licence to ensure the adequate level of safety at private crossings. ARTC however retains the right to assess private crossings and require a nominated level of protection by the holder of the crossing licence.

6 Criteria for Control Devices

No new level crossing should be permitted where the angle between the road and rail alignments is:

- less than 35° in the case of a “left side crossing”, or
- less than 30° in the case of a “right side crossing”, as an absolute minimum where topography is a limiting criterion.

Preferred practice is to approach a crossing at 90° to the track from the appropriate viewing point (ie at a safe point on the approach and up to the stop line). Note that designing and constructing to the absolute minimum angles above would require active protection, as the necessary viewing angles cannot be achieved (refer Clauses 6.4.1, 6.4.2).

Guidelines used for determining the potential hazard at level crossings are based on the potential for conflict between road and rail traffic and is assessed on the basis of visibility, traffic volumes (road and rail) and traffic speeds (road and rail).

In the case of Give Way and Stop signs, various formulae are used to determine the visibility triangles necessary to provide an adequate level of protection, these formulae are described further in ARTC Specification for Sight Distance Provisions

at Passive Level Crossings.

An exposure factor (VT) to measure the degree of potential conflict for accidents is included in the appropriate criteria for protective measures (refer Clause 6.3.1).

Optional measures that may be applied to improve safety, as discussed in Clause 8, should be considered while assessing a level crossing.

6.1 Closure or Relocation

Where closure or relocation of the level crossing is considered to be the most appropriate protective measure, the situation is to be negotiated with the relevant road authority and local government body.

Closure or relocation of a level crossing should be considered under any of the following circumstances, along with any alternative options (eg improved signing, active protection, road realignment, and grade separation):

- where existing passive crossings have angles between the road and rail alignments of less than 35° for left side crossings and 30° for right hand crossings;
- where physical aspects render reliable and effective protection by passive signs or active warning devices difficult or impossible to achieve;
- at level crossings with active warning devices and a consistently high accident rate;
- at level crossings with an exposure factor (VT) of greater than 70,000 single line (60,000 for multiple track), together with a vehicle component of less than 500 per day (except for arterial roads);
- where the level crossing is part of a road and land use planning scheme whereby closure of the level crossing is or can be achieved; or
- where another level crossing exists in close proximity and traffic can be diverted by a cost effective traffic management plan.

Closure is not an option where there is not a convenient alternative.

6.2 Grade Separation

Level crossings that are already protected with boom gates, having high VT exposure levels, should be monitored, taking into account particular site characteristics and any accident record. Those considered to have top priority from a risk viewpoint should be brought to the attention of the appropriate funding bodies on an annual basis.

6.3 Active Warning Devices

6.3.1 Flashing Lights

Flashing lights and gong(s) should be provided where any of the following conditions apply:

- Conditions for stop signs are not met, or
- The exposure factor (VT) is greater than 70,000 for a single track or 60,000

for multiple tracks, or

- Where an identified additional risk exists, such as shunting over a level crossing, and the merits are considered appropriate, or
- Where a recognised accident prediction model provides a favourable cost benefit analysis.

Priorities for crossings falling within this group of criteria should be assessed between ARTC and the Road Authority. Flashing lights should then be installed in priority order at Road Authority cost.

In addition, active protection may be provided at crossings on highways or main arterial roads which do not meet the above criteria and as agreed between the Road Authority and ARTC (eg new crossings resulting from road realignment or route upgrades, at Road Authority cost).

6.3.2 Automatic Gates (Half Boom Barriers)

Automatic gates (half boom barriers) should be added to a flashing light and gong(s) installation where any of the following conditions apply:

- On a multiple line crossing where concurrent train movements can occur;
- On single and multiple line crossings when VT exceeds 1,000,000; or
- On single and multiple line crossings where speeds and operating conditions or accident records necessitate the provision of automatic gates to ensure safety to both rail and road users, where each case should be considered on its merits.

6.3.3 Standard Road Traffic Signals

Standard road traffic signals may be used in place of flashing lights as identified in Clause 6.3.1 where the crossing is:

- in an urban environment and speed zoned at 80 km/h or less, or
- on a branch line where train speeds do not exceed 50 km/h and the use of road traffic signals is consistent with road user expectations.

In these circumstances the W3-3 signs are to replace the W7-4 signs and dual-sided signal heads, facing both directions of road traffic flow, are to replace RX-5, flashing light assemblies. An appropriate sounding device (usually gongs) should also be installed with traffic signals. Note that State Government approval is required any traffic control device (stop signs, give way signs and flashing light assemblies).

For required warning times, see Appendix 'A'.

6.4 Passive Protection - Signs

The conditions to be met for the installation of Give Way Assemblies (RX-1) and Stop Assemblies (RX-2) are specified in Australian Standard AS 1742.7 Manual of Uniform Traffic Control Devices – Railway Crossings.

7 Additional Level Crossing Physical Aspects

7.1 Road Marking

The approaches to a level crossing are marked with barrier lines, provided by the Road Authority, which prohibits overtaking when a driver approaches a level crossing.

Additionally, appropriate road marking such as Yellow Box Marking over and in the vicinity of the crossing may be a beneficial treatment to be employed by the Road Authority.

7.2 Clearance of Vegetation

7.2.1 Along the railway reserve.

Vegetation shall be controlled by appropriate environment-sensitive methods to ensure that sight lines are maintained.

7.2.2 Along the road reserve.

Control of vegetation by appropriate environment-sensitive methods should be carried out on a regular basis by the Road Authority.

7.2.3 On private land in each sight triangle.

The cooperation of land owners should be sought jointly by the Rail Manager and the Road Authority, in the interest of improved safety.

7.3 At Crossings Protected by Active Warnings Devices

7.3.1 Position of Active Warning Devices

Flashing light assemblies (RX-5) should be installed so that:

- At least two sets of lights are displayed to road users when approaching the crossing on the major road.
- The primary set of lights should be located as near as practicable to the left side of the carriageway.
- The secondary set of lights for undivided 2-lane two way roads should be located on the right side of the road for approaching traffic, and mounted “back to back” with the primary lights for the other direction of road traffic, except as follows:
 - Where the pavement width is greater than 13 m, road approach speeds are typically 60 km/h or more, and overtaking manoeuvres are probable due to high traffic densities, the secondary lights should be positioned in a median strip at least 3 m wide, provided by the Road Authority for the purpose.
- On multi-lane roadways, lights should be positioned on the left side of the carriageway and in a median strip (provided by the Road Authority for the purpose if necessary) in such a way as to provide adequate coverage by primary and secondary lights for all traffic lanes.
- Overhead flashing lights may be used as an alternative in accordance with

the requirements of clause 8.7.

- Supplementary sets of flashing lights should be provided at crossings where the sighting of the primary or secondary unit is not adequate due to other factors such as: curves, vertical alignment, road-side obstructions, or road junctions in close proximity to the crossing.
- The final design of the layout of flashing lights is subject to engineering assessment for each location.

7.3.2 Warning Gong (Bell)

Warning gong(s) should be provided with each flashing light installation. Gongs should also be provided with each set of Standard Road Traffic Signals.

7.3.3 Automatic Gates (Half Boom Barriers)

When automatic gates are to be provided in compliance with Section 6.3.2, the gate mechanism should preferably be mounted on the primary flashing light assembly.

The length of each gate arm should not exceed 11.6 m and in cases where this dimension is insufficient, to cover all approach lanes, additional gate mechanisms should be used.

In cases where the gate arm is between 8 m and 11.6 m long, engineering judgement should be used to assess the need for additional gate mechanisms.

The second gate mechanism should be installed on a mast located in a centre of the road median strip. The median strip, to be provided by the Road Authority, will be at least 3 m wide. The mast should be located opposite the mast supporting the first gate mechanism.

Each gate arm should be fitted with at least three red lights illuminated when the flashing lights are activated as follows:

- Two lights (or two groups of lights) flashing red alternately and one light (near tip of the gate) displaying a steady red light. On longer gates, more lights may provide improved conspicuity but the weight limit on the gate arm needs to be considered.

8 Associated Safety Measures

8.1 White Flashing Light

The use of a white flashing light (eg a strobe light) positioned atop one or more RX-5 Assemblies may be considered where the road traffic speed limit is 80km/h and above.

8.2 Street Lighting

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

- trains standing on the crossing during the hours of darkness; and/or
- shunting or through movement over the crossing during the hours of darkness.

Each case is to be assessed separately in conjunction with the appropriate road authority and local government authority on issues of design and funding. Such lighting will be installed, operated and maintained at the Road Authority cost.

8.3 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.

8.4 Railway Crossing and Width Marker Assembly (RX-9)

These signs should be provided, erected and maintained by the Road Authority (except in Victoria where ARTC is responsible) where any of the following conditions applies:

- 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.

8.5 Size of Warning Signs

The selection of appropriate sign size should be as indicated in Table 1 of AS 1742.7-1993.

8.6 Size of Flashing Lights

Flashing lights having 200 mm diameter roundels is preferred practice.

8.7 Overhead Flashing Light Assemblies

Flashing lights should firstly be displayed from a position where road traffic would expect to view them, otherwise they may not be of much assistance. Therefore, after primary and secondary flashing lights, supplementary overhead (on cantilever or gantry) flashing light assemblies may be an option at active crossings where:

- due to road alignment or physical obstruction, safe stopping sight distance is difficult to achieve with normal active warning devices;
- the conspicuity of the normal active warning devices is adversely affected by physical background factors;
- on multi-lane roads where there is insufficient room for a median strip, wide enough to accommodate a flashing light assembly; or
- on roads with three or more approach lanes.

During any consideration, it should be borne in mind that overhead flashing lights are more difficult to service, they may not be practicable on over-dimension vehicle

routes, and require extremely rigid structures for reliable performance under windy conditions.

The costs associated with such assemblies shall be born by the Road Authority.

9 Pedestrian Crossings – Level of Protection

Section 9 of AS1742.7-1993 includes general considerations relating to the protection of pedestrians at level crossings.

An assessment is to be made on a case-by-case basis for the level of protection relevant to each situation.

When pedestrian maze (crib) crossings are required, a design based on Figure 13 in AS1742.7-1993 is recommended. Fencing should be constructed of materials that would not spear vehicle occupants in the event of a collision.

For typical application of protection types of pedestrian crossings, see appendix B. For details of definitions for rail traffic volumes, train speeds and pedestrian usage, see appendix C.

Pedestrian crossings are provided and upgraded at the cost of others than ARTC, such as local community groups, local Councils and Passenger operators.

Risk assessments should be carried out when a crossing is considered to have a lower level of protection than required.

9.1 Sighting Distance

For passive protection (types P1 and P2) to be acceptable, a pedestrian shall be able to sight any train from 2 metres outside the nearest running rail at a time before the train arrives sufficient to traverse the crossing and be safely clear. This time can be taken as 9 seconds under most conditions.

When assessing sighting distances, children eye levels, and the local railway environment, which may temporally reduce sighting distances for pedestrians should be taken into account. Local weather conditions, such as fog, should also be considered. (Appropriate Warning Boards may be required)

9.2 Usage Rate

The probability of pedestrians wishing to use the crossing when a train is approaching is to be assessed. The frequency of this train/pedestrian interaction will be a significant factor in the level of protection to be provided.

For rail traffic, use the highest train speed at the crossing.

9.3 Special User

Special consideration must be given to the class of protection to be provided at pedestrian crossings where, for example:

- The crossing provides the only access to a platform or platforms for which there are regularly scheduled rail services, particularly where the crossing is over double lines.
- The crossing provides access to a school, or for primary school children to reach a school bus, or transport to school etc.

- The crossing is used by a large number of aged persons or wheelchair users.

The crossing is not at a platform but has moderate or higher rail traffic volumes.

9.4 Crossing Environment

The environment surrounding the crossing can sometimes affect the type of protection to be provided or the operating modes of the protection.

With passive protection, fencing and cribs should be provided where it is apparent that pedestrians (or children on bicycles etc.) are likely to move onto the track without pausing to look both ways.

Where there are houses in close proximity to the crossing, audible warning devices will almost certainly generate complaint if operating through the night at high volume levels.

For a pedestrian crossing, however, it is only necessary that the audible device be loud enough to draw the attention of pedestrians' on the crossing and within 15 metres of the approach to the crossing.

9.5 Grade Separation

If rail traffic density is such that the crossing will be regularly closed to pedestrians and queuing of more than 25 people is a regular occurrence, then grade separation shall be given serious consideration.

9.6 Road Level Crossings Used by pedestrians

If a road level crossing is used by a significant number of pedestrians, the level of protection to be provided on the road should include assessment of the protection required as a result of the pedestrian usage.

10 References

- 1) Australian National, Working Draft - Policy of Recommended Practices for Establishing the Minimum Protective Measures at Level Crossings (Mainland) (1994).
- 2) Transport SA, Operational Instruction 7.1, "Rail Level Crossing Signing and Pavement Marking". Edition 1 Revision 1. (1999).
- 3) State Level Crossing Safety Committee, " Draft: Policy of Recommended Practices for Establishing the Minimum Protective Measures at Level Crossings in South Australia". South Australia (1998).
- 4) Level Crossing Warning Committee, Policy of Recommended Practices for Establishing the Minimum Protective Measures at Level Crossings in Tasmania. (1996)
- 5) Transport SA, Operational Instruction 7.1, "Rail Level Crossing Signing and Pavement Marking". Edition 1 Revision 1. (1999).
- 6) State Level Crossing Safety Committee, "Draft:: Policy of Recommended Practices for Establishing the Minimum Protective Measures at Level Crossings in South Australia". South Australia (1998)

- 7) Rail Infrastructure Corporation, Civil Engineering Standards - Right of Way - Level Crossings.
- 8) Australian Standard – AS 1742.7 – 1993, Manual of uniform traffic control devices Part 7: Railway Crossings

Appendix 1 - Warning Times for Level Crossings with Active Protection

The required warning times for active level crossings are:-

- 30 seconds for new installations.
- 25 seconds for existing installations.

For new installations, the predictor where used should be configured so that the allowable line speed may be increased by 30km/h without any additional work on the predictor installation.

Appendix 2 - Pedestrian Crossings - Typical Applications of Protection Types

Type P1	Warning Signs only	Single track, low volume, low to medium speed rail traffic, occasional pedestrian use, sighting meets minimum criteria, no special user criteria.
Type P2	Warning Signs Fencing and Crib	Single track, high speed rail traffic, low to moderate volume rail traffic, low peak rates of pedestrian use with no queuing, sighting meets or exceeds minimum criteria, no special user criteria.
Type P3	Warning Signs Fencing Lights and Audible Warning	Single track, moderate to high volume rail traffic, moderate peak rates of pedestrian use without regular queuing, minimum sighting criteria not met and/or special user criteria apply.
Type P4	Warning Signs Fencing Lights Audible Warning Boom Barriers	Double track, moderate to high volume rail traffic, moderate peak rates of pedestrian use.
Grade Separation	Underpass or Overbridge	More than two running tracks, or Single or Double track, high volume rail traffic and high peak rates of pedestrian use and/or special user criteria apply.

The cost of installing or upgrading protection at pedestrian crossings shall be determined on a case by case basis between ARTC and the other responsible party.

Appendix 3 - Pedestrian Crossing Definitions

<i>Rail Traffic Volumes</i>	<i>Low</i>	Up to 20 trains per day with intervals between trains usually exceeding 45 minutes.
	<i>Moderate</i>	20 to 50 trains per day with intervals between trains usually exceeding 30 minutes.
	<i>High</i>	More than 50 trains per day or regularly more than 4 trains per hour for the hours between 0600hrs and 2000hrs.
<i>Train Speeds</i>	<i>Low - Medium</i>	Less than 80kph.
	<i>High</i>	80kph or greater
	<i>Occasional</i>	Generally only one or two pedestrians at any one time, prolonged gaps between pedestrians, no noticeable peak usage.
<i>Pedestrian Use</i>	<i>Low</i>	Average peak usage 15 per hour or less.
	<i>Moderate</i>	Average peak usage 15 to 30 per hour.
	<i>High</i>	Average peak usage over 30 per hour or the crossing is subject to queuing at certain times of day such as after the arrival of a train.