Division / Business Unit:	Engineering and Systems
Function:	Signalling
Document Type:	Standard

Level Crossing Predictor Design Certification and Test

ESD-03-02

Applicability

ARTC Network Wide

SMS

Publication Requirement

Internal / External

Primary Source

Document Status

Version #	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
1.3	14 Apr 22	Standards	Stakeholders	Manager Signalling Standards	A/General Manager Technical Standards 28/04/2022

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	21 Oct 08		First issue
1.1	07 Oct 09		Disclaimer updated as per Risk & Safety Committee
1.2	13 Aug 10	All	Issued as final.
1.3	14 Apr 22		Document rebranded. Information included from ESN-06-01 and ESI-03-11 to merge in this document and other minor editorial changes.

Table of Contents

Table of Contents **2**
2 Overview **4**
2.1 How they operate 4
2.2 Use of level crossing predictors 5
3 Level Crossing Preliminary Design Requirements **6**
3.1 Signalling Design Proposal 6
3.2 Operations specification 6
3.3 Control Tables 6
3.4 Special characteristics 6
4 Design Deliverables **7**
5 Level Crossing Predictor Design Guidelines **7**
5.1 Introduction 7
5.2 Predictor Hardware and Software 7
5.3 Installation Design 7
5.4 Calculation of Approach Length 8
5.5 Acceleration Considerations (Positive Start Settings) 9
5.6 Control of acceleration by signage 11
5.7 General Site Setup Requirements 11
5.7.1 General *11*
5.7.2 Prediction Mode *12*
5.8 Selection of Frequencies 12
5.9 Crossing Controls for Multiple Tracks 13
5.10 Crossing Controls for Traffic Light Pre-Emption 13
5.11 Prediction Timeout Setting 13
5.12 Solid State Crossing Controllers 13
6 Layouts for Station Stops **13**
6.1 Train in a Platform Clear of the Positive Start Position 14
6.2 Train in a Platform with a Speed Limit for Stopping Trains 14
6.3 Train in a Platform is in the Positive Start Zone 15
6.4 Station with Mixed Approach Controls - Low Speed Approach 16
6.5 Station with Mixed Controls – High Speed Line 17
7 Layouts for Siding Situations **18**
7.1 Siding is Located Closer than 500m to the Crossing 18
7.2 Siding more than 500m from the Crossing 19

8 Specific Requirements for Safetran Grade Crossing Predictors (GCP) ... 20

9 Specific Requirements for HXP/XP4 Level Crossing Processors ... 22

9.1 Introduction ... 22

9.2 Positive Start Setting ... 22

9.3 Motion Detection Switchover ... 22

9.4 Surge Protection ... 22

9.5 Recording of set up values ... 22

9.6 XP4 Identification Management ... 23

9.6.1 Identification Rules ... 23

9.6.2 XP4 Identification Records ... 24

9.6.3 Action Steps ... 24

9.6.4 Flowchart ... 25

10 Check Design and Factory Test ... 26

10.1 Introduction ... 26

10.2 Checking Requirements ... 26

10.3 Design Check Report ... 26

10.4 Review of the Operational Specification ... 26

10.5 Check Design ... 26

10.6 Factory Test ... 26

11 Site Testing and Commissioning ... 26

11.1 Introduction ... 26

11.2 Inspection of the Track covered by the Level Crossing Predictor ... 26

11.3 Set to Work ... 27

11.4 Integrity Testing ... 27

11.5 Testing Personnel ... 27

1 Introduction

1.1 Purpose

The purpose of this standard is to provide the minimum requirements when designing an active level crossing that utilises a level crossing predictor system.

1.2 Scope

This standard covers the design and testing requirements for level crossing predictor systems.

1.3 Document Owner

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

Responsibilities

The Signal Project Manager/Project Engineer in conjunction with the corridor signal engineer are responsible for managing the process and implementation of this standard.

1.4 Reference Documents

ESD-03-01 - Level Crossing Design

ESC-03-01 - Level Crossing Construction

ESM-03-01 - Level Crossing Maintenance ESD0302F-01 - Request for ElectrologIXS XP4 level Crossing ID

Manufacturer's manual for Predictors

2 Overview

2.1 How they operate

Road/rail intersections (grade or level crossings) provided with level crossing predictors are intended to provide a relatively constant warning time for the crossing regardless of train speed with a minimum of interaction between signal control systems and the level crossing warning equipment. In addition to providing relatively constant warning time, they are intended to minimise the equipment provided for the level crossing warning system.

There are two types of level crossing predictors approved for use on the ARTC network: the Safetran systems (Siemens) GCP series and the HXP/XP4 series. Both systems employ two basic sensing means to control the warning systems.

An island track circuit covering the track through the roadway and a short section to both sides. This track circuit is usually a high frequency (3 – 10 kHz) AC overlay which causes the crossing control to be in the alarm state whenever it is occupied.

A motion sensing system is also used which uses lower frequency AC in the range of 56 to 990 Hz. The motion sensing and prediction system application treats the rail track as an electrical component by requiring that the rails are short circuited together (at the frequency used) at a predetermined distance from the crossing to which the predictor will have to monitor for the fastest speed authorised for the line. The effect of the short circuit is to make the track to either side of the crossing appear like a parallel resistance and inductance when measured from the level crossing feed point. The inductive component is mainly related to the length of rail between the feed point and the short circuit termination. By applying an AC current to the track at the crossing the voltage level and the phase angle to the voltage across the track can be monitored to determine when and how quickly a train is approaching the crossing.

During the setup phase, the voltage level and phase of the AC motion sense voltage is calibrated for the track clear condition and the length of the level approach sections. As the train approaches the crossing, the short circuit formed by the train wheels effectively moves the short circuit termination towards the crossing shortening the track circuit. This also reduces the impedance seen by the level crossing predictor equipment and lowers the voltage present at the feed point (as the feed current is constant). By the increase or decrease of feed voltage trains that are inbound and those that are outbound can be determined. Continuous measurement of the feed end voltage allows the level crossing predictor to determine how far the train is from the crossing and determine approach speed. Finally, a prediction calculation can be made by the equipment to provide the desired minimum warning time at the level crossing from the measured speed based on the rate of decline of the feed point voltage.

The outputs from the motion sensing and island systems are combined to make the crossing control alarm state which is used to operate the flashing lights, booms and audible warnings.

2.2 Use of level crossing predictors

Level Crossing Predictors are used where there is a requirement to be able to accommodate varying train speeds in prediction mode where there is sufficient tonnage though the level crossing to ensure correct shunting of the predictor’s track circuits so that a relatively constant warning time is provided for all train speeds. Road user confidence in the applicability of the warning to an approaching train is strengthened as excessive warning time is minimised.

Where the train speeds are relatively similar and there are no holding sections provided, a motion detection activated crossing may be used. This is to avoid the complications that arise countering train acceleration within the approach sections when prediction is used. To suit this arrangement the warning time of the slowest train to be encountered must not be longer than the design warning time + 10 seconds. The directional logic provided within the predictor may be used to ensure that tail ringing does not occur.

Level crossing predictors are ideally suited to open track conditions where trains stopping or shunting within the approach sections is not anticipated. Hybrid systems using level crossing predictors, fixed signals and track circuits designed to overcome problems cause by stopping or shunting are acceptable. The design must ensure that short warning times are eliminated and excessive operation of the level crossing minimised. Level crossing predictors may be chosen for level crossing warning systems except where the following applies.

- There are less than 500 gross tonnes per week in train use of the line
- There are complicated shunting movements and the controls for the level crossing to prevent excessive operation or short warning times could be more effectively and economically accomplished by the use of fixed signals with fixed approach length control
- Where trains regularly terminate or stand for periods greater than 1 minute and this is within the last 50% of the nominal level crossing approach section

The implementation of any level crossing predictor system requires prior infrastructure manager approval. The infrastructure manager may also require that a particular style of predictor is used in a specific area to aid maintenance support or that another type of level crossing control equipment is used.

3 Level Crossing Preliminary Design Requirements

This section covers the type of design information required by signal designers where a predictor level crossing is planned for installation.

3.1 Signalling Design Proposal

A Signalling Design Proposal needs to be generated for each new signalling project outlining the history of the site, outputs required from the signal design and any special requirements from ARTC which may facilitate maintenance, access or procurement of spares etc.

The proposal shall include a drawing of the track layout including any sidings, stations or any other infrastructure used in conjunction with the operation of trains to which the new level crossing protection system is to be applied. Signal designer will utilise this as a basis to produce a proposed signalling plan which includes the layout proposed for the control equipment including any new signals, gates, detectors or signage.

The signalling plan shall also detail the existing track circuits, including type and frequency as well as the locations of all insulated joints on the track to which the level crossing predictor is to be applied.

The type of track, rail weight and method of jointing (i.e. CWR or plated track) shall be documented for the area encompassed by the level crossing approaches.

3.2 Operations specification

An operational specification shall be developed for confirmation by the operations representative as an input to the design. The specification shall detail how the various train operating situations are to be handled and cover the issues of potential short or protracted crossing operation. It shall detail the following:

- A line speed table authorised for use on the line concerned shall be used to confirm the maximum speeds to be allowed for.
- The types of trains operating and their speed profiles through the area.
- Details of any trains movements to be allowed for which involve slowing, stopping or shunting within the notional level crossing approach sections.
- Details of any special train operating requirements allowed for.
- Details of any specific exclusion from the design.

3.3 Control Tables

All the requirements for the predictors are to be detailed in the control tables. Each level crossing shall have its own control table on a separate sheet or sheets. If multiple predictors are required for the level crossing, then these shall be included on the same control table sheet. The control table shall detail all the parameters to be set in the predictor configuration. It shall have a separate section for each approach path and for common configuration data. The approach distances shall be defined in terms of distances, warning time and respective train speed. Special requirements for logic of the predictor shall be detailed in the control table.

3.4 Special characteristics

The need for special controls or characteristics (such as traffic lights co-ordination or active advance warning lights) shall be documented for input into the design phase.

4 Design Deliverables

Following aspects of the design should be delivered as part of the Approved Design documentation for authorisation of construction for predictor system.

1. Signalling Scheme Plan including;
    - Position and type of Hard Wired Shunts (HWS), Narrow Band Shunts (NBS) and Wide Band Shunts (WBS),
    - Position and type of Simulated Track Inductors (STI),
    - Island track effective length and frequency
    - T1 effective length and frequency,
    - T2 effective length and frequency (if used),
    - Preempt timing information (if used),
    - DAX A-G timing and output control information (if used).
2. Boolean Logic Diagram
3. Control Table/s
4. Configuration files
    - Executive files for each system module
    - Configuration file for the CPU
5. Circuit Book including configuration package files
6. Copies of the Design Report and Factory Test Results

5 Level Crossing Predictor Design Guidelines

5.1 Introduction

This section addresses the common basic design requirements for a level crossing controlled by level crossing predictors.

5.2 Predictor Hardware and Software

The design hardware and software versions for all modules to be used must be recorded in the circuit book for later field verification prior to commissioning.

5.3 Installation Design

The design of installation must include the following features:

- The power supply for the operation of the level crossing shall be in accordance with ESD-09-01 and ESD-09-02.
- The housing of level crossing predictors must be arranged so that the maximum internal temperature of the housing is 70°C for the full range of environmental temperatures likely to be experienced at the location.
- The level crossing predictor housing is to be located as close as possible to the intended feed point of the level crossing predictor.

- The level crossing predictor must be designed to have lightning and surge protection meeting the requirements of ESC-09-02.
- The shunts and couplers used in the design shall be fixed frequency or value.
- The island track must not be less than 25m in length.
- Separation of similar audio frequency prediction tracks, audio overlays or island track frequencies is subject to the restrictions in the manufacturer's documentation.
- Level crossing predictors shall not be applied to dual gauge track.
- Level crossing predictors may be used over the top of steady energy DC track circuits, or DC coded track circuits with the appropriate filters fitted.
- Level crossing predictors may be used over high frequency audio track circuits in accordance with the manufacturer's recommendations.
- Level crossing predictors must not be used where DC traction return currents flow in the rail.
- The output relays driven from any level crossing predictor functions except gate driving shall be QS2 type housed in the same enclosure as the level crossing predictor.
- The outputs of a level crossing predictor shall not be used for vital track clear information.

5.4 Calculation of Approach Length

The approach length used shall be that calculated for a fixed approach section crossing in the same operating conditions with additional length based on calculation time allowances assuming the maximum permitted speed.

- For speeds below 130km/h an additional 5 seconds calculation time shall be added.
- For maximum speed above 130km/h an additional 6 seconds calculation time shall be added.
- Any other time allowance specified in the manufacturer's application guidelines shall be added.

In the case where holding sections are employed in double track situations these shall be added to the predictor approach length so that the length is the sum of the approach and holding section with a single allowance for calculation time included. The approach section lengths shall be calculated by using the maximum allowable train speed and the minimum warning time rounded up to the nearest second. The circuit book shall record the approach lengths in meters with the equivalent feet in parenthesis. See fig 5.4.1 for a layout which includes holding sections.

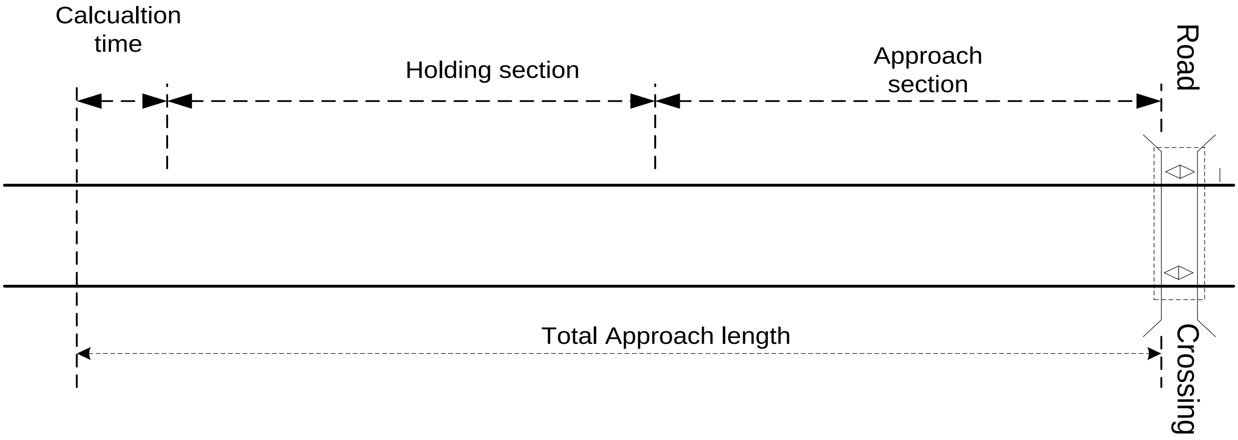


Fig 5.4.1 Approach and holding section layouts (one side only shown)

5.5 Acceleration Considerations (Positive Start Settings)

Level crossing predictor start calculations are based upon the train maintaining constant speed through the level crossing approach sections to achieve the specified minimum warning time. If acceleration occurs on the approach to a level crossing the approach warning time will be shortened. The acceleration rate of trains falls with speed and because the distance covered per second increases with speed, the effect on approach warning time is reduced when the train speed is higher at the time when the acceleration first occurs. Scenarios based on a rapidly accelerating short passenger train have been modelled and they show that accelerations at lower speeds of around 0.85 ms^2 are possible by these trains.

Manufacturer's recommendations are to increase warning time settings by up to 10 seconds to combat acceleration. This is only a partial answer and there is still a potential problem with light passenger trains accelerating in the last 50% or so of the level crossing approach.

Note that this effect is less of a problem with stationary trains as the standing start acceleration is longer than from a moving train assuming that a motion detection restart has been set for this situation. For trains from a standing start with motion detection restart set:

- provided the train is more than 250m from the level crossing the warning time should exceed 25 seconds,
- provided the train is more than 335m from the crossing the warning time should exceed 30 seconds.

Setting the warning time above the implemented approach distance increases the warning time for slow trains and counters acceleration but line speed trains still achieve the correct warning time.

Table 5.5.1 shows the effect of acceleration for crossings with line speeds of 110 km/h.

Approach section warning time	Notional approach dist inc 5 seconds calculation	Warning time set to approach section warning time	Warning time set to approach section warning time + 5 seconds	Warning time set to approach section warning time + 10 seconds
25 seconds	917m	No acceleration allowed within approach section	Acceleration within 505m of crossing may shorten warning time below required approach time	Acceleration within 365m of crossing may shorten warning time below required approach time
30 seconds	1069m	No acceleration allowed within approach section	Acceleration within 705m of crossing may shorten warning time below required approach time	Acceleration within 505m of crossing may shorten warning time below required approach time

Table 5.5.1 Effect of acceleration in approach sections

Within the approach distances shown in the table positive start must be set or acceleration controlled by signage to avoid shortening the warning time provided.

If the maximum acceleration can be limited to a particular speed increase by the use of signage the effect of shortening can be reduced so that the positive start point can be placed closer to the crossing. The table shows how limiting of the speed increase within the approach section can modify the mitigation for acceleration.

Approach section warning time	Notional approach dist inc 5 seconds calculation	Warning time set	Speed increase limited to 25 km/h	Speed increase limited to 20 km/h
25 seconds	917m	25	Acceleration within 505m of crossing may shorten warning time below required approach time	Acceleration within 420m of crossing may shorten warning time below required approach time
		30	Acceleration within 305m of crossing may shorten warning time below required approach time	Acceleration within 245m of crossing may shorten warning time below required approach time
30 seconds	1069m	35	Acceleration within 705m of crossing may shorten warning time below required approach time	Acceleration within 585m of crossing may shorten warning time below required approach time
		40	Acceleration within 420m of crossing may shorten warning time below required approach time	Acceleration within 335m of crossing may shorten warning time below required approach time

Table 5.5.2 Effect of max speed increase on acceleration in approach sections

Within the approach distances show in the table, positive start must be set. Acceleration controlled by the use of signage to avoid shortening the warning time provided.

5.6 Control of acceleration by signage

Where Predictors are installed within the ARTC network with acceleration signage, the signage is placed to warn drivers of the predictor-controlled level crossing they are approaching and the need to, as much as practical, to maintain a constant speed whilst occupying the level crossing approach. The signs shall be placed at the location of the furthest Track Shunt.

The sign in NSW is detailed in ANGE 216. The sign for SA/WA Jurisdiction is defined in the ARTC Addendum to the Code of Practice for the Defined Interstate Rail Network. The sign in Victoria is the same as for the SA/WA and is covered in the TA20.

Rail traffic must not accelerate between the trackside sign advising approach to a Type F level crossing fitted with predictor circuitry and the level crossing.

Figure ANGE 216-4

Example: Trackside sign before standard Type F level crossing with predictor

Fig 5.6.1 Signage for NSW

33.2 Level Crossing Predictor Warning Sign

The level crossing ahead is equipped with a predictor which calculates the speed of the approaching movement and governs the activation of the level crossing warning device to give a constant ring time before the movement is at the level crossing.

Meaning - The Driver of a movement shall not increase the speed of the movement from the point of passing the sign until the lead unit of the movement has passed over the level crossing.

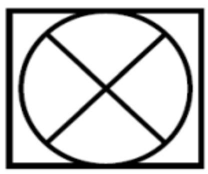


Fig 5.6.2 Signage for Vic/SA/WA

5.7 General Site Setup Requirements

5.7.1 General

The following setup values should be used unless a specific design requirement causes them to be varied:

- The approach section lengths shall be set in the predictor in feet rounded to the nearest 10 feet.
- The Island track frequencies shall be selected in accordance with the manufacturer's guidelines. The island track pickup time shall be set to 2 sec minimum.

Where predictor controlled level crossings overlap, the frequency separation must be at least 2 frequency steps for both the base and island track frequencies.

5.7.2 Prediction Mode

The following setup values should be used unless a specific design requirement causes them to be varied:

- The warning time setting for the crossing on the predictor shall be set for 5 or 10 seconds longer than that determined when the location of the approach sections is calculated. This is to ensure that even under train acceleration the warning time is always above the minimum warning time for the crossing.
- Motion sense zones should be set so they are not less than the length of the positive start zone.
- Positive start should be set for 55% of the approach distance or 500m minimum whichever is the greater unless acceleration mitigation has been applied or the design requires that another figure be used.

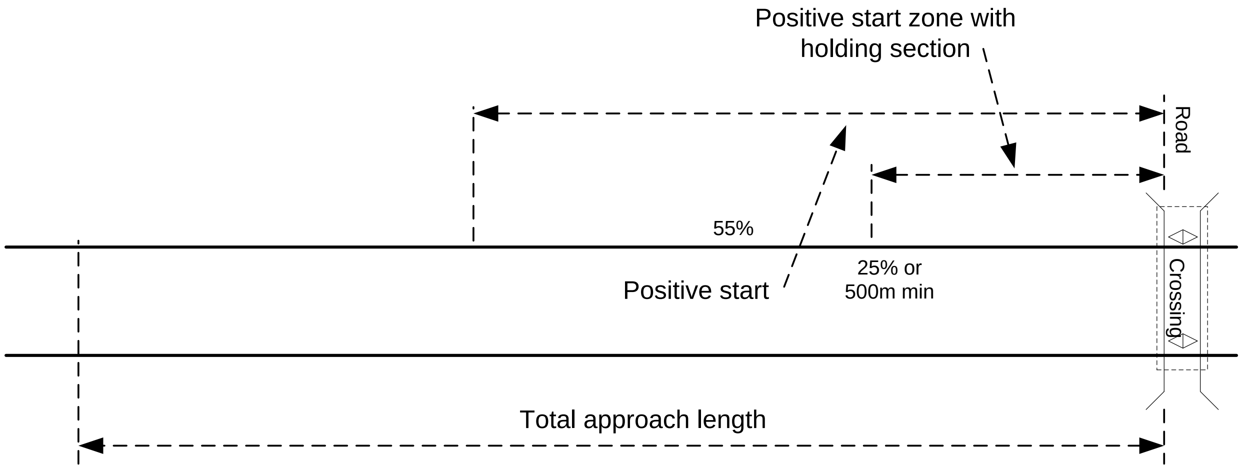


Figure 5.7.2 Setting of positive start - no acceleration control

5.8 Selection of Frequencies

The following frequencies available from the two manufacturers must not be used for level crossing predictors motion sensing system:

- 100Hz
- 151Hz

156HZ may be used subject to successful field trials at the location concerned.

In general, the frequencies used shall be the highest possible consistent with the manufacturers application guidelines but should not be higher than 600Hz without the approval of the infrastructure manager.

Selection of applicable frequency and ballast resistance should be based on the manufacturer’s requirement. Design proposal is required to be reviewed and accepted by corridor signal engineer for any local maintenance issues.

5.9 Crossing Controls for Multiple Tracks

The operation of the level crossing shall be maintained after the first train has cleared the crossing and a second approaching train is within the holding section for the crossing. In the case where train speeds are relatively constant the prediction for the second track may be switched by the level crossing activation function from the first track from prediction mode to motion detection mode when the level crossing is activated.

If the crossing approaches are located in an area where there are slower trains accelerating from passing loops or sidings an additional prediction function, set for the sum of approach and holding time, must be used to initiate the application of the holding function for the other track/s.

5.10 Crossing Controls for Traffic Light Pre-Emption

Traffic light pre-emption requires that a control be passed from the level crossing control equipment to the traffic lights controller in advance of when the level crossing warning equipment operates. This is so the traffic lights equipment can cycle to the correct phasing ensuring that road vehicles are not trapped within the rail/road intersection. The additional timing required is defined by the road authority for the particular project but is generally in the range of 25 to 35 seconds before the crossing warning equipment operates. Generation of this control must be by a prediction function whose time is set as the sum of the design crossing warning time and the additional time required by the road authority.

Where it is required to be used, the Pre-empt control output shall be used – no external timers shall be permitted.

5.11 Prediction Timeout Setting

The time for the predictor to recover and cancel the alarm state after a train has become stationary on the approach section outside the positive start zone must not be less than 15 seconds.

5.12 Solid State Crossing Controllers

Solid state crossing controllers may be used to drive the lights and the associated boom mechanism. A separate solid-state crossing control must be used for each side of the crossing. The lights battery shall be a nominal 12v and used to provide power for the level crossing predictor. In general, a separate battery backed up supply should be used to run the boom mechanisms via a QBCA1 gate control relay. The gates up indication must sense that the gate control relay is energised. The gates down indication must also sense that the gate control relay is de-energised.

6 Layouts for Station Stops

There are a number of possible layouts for stations stops. In the scenarios that follow the average acceleration of any passenger train is taken not to exceed 0.8 mS-2 av. from a standing start at the station to the crossing. This assumption should be verified for the particular train operating condition and the actual gradient of the track. In addition, it is taken that in the positive start scenario the train will not be held in the station to make up time or similar otherwise excessive operation of the level crossing will result.

Pre-emption is used to provide holding for a second train in multiple track territory. This shall be configured in accordance with the manufacturer’s guidelines.

There may be situations that require a train to stop within the approach to the level crossing. This may be a station platform, controlled signal or automatic signal or siding / points. The predictor system shall be configured for these conditions using the general configuration details as above and special logic as required. Where a train stops within the detection zone, the train will be limited to increasing speed to 25 kph until it passes the level crossing. Generally, in these situations the positive start zone is extended to include the station platform or 200 metres on the approach side of the signal to ensure that the required warning times are achieved. Additional logic may be required to ensure that the 15 seconds for boom gates to rise and fall is provided in cases of a second stopped train restarting within the detection zone.

6.1 Train in a Platform Clear of the Positive Start Position

When the train can stop at the station with the train either in the station platform or on the crossing side of the station and the station far enough away that motion sense restart can be used the following is required.

In this configuration:

- There is no particular speed limit placed on the stopping train between the station and crossing
- The distance from where the locomotive would stand to the nearest part of the roadway is greater than 0.5 x [maximum average accel. (0.8)] x [calculated warning time + 2 S]2
- Motion sense restart is set to activate when the predictor EZ or RX is 2 higher than the level as the train enters the platform.
- Positive start is set to a point closer to the crossing than the nearest station end
- Predictor/Motion sense switch over is set to a point closer to the crossing than the nearest station end.
- Acceleration control signage is used.

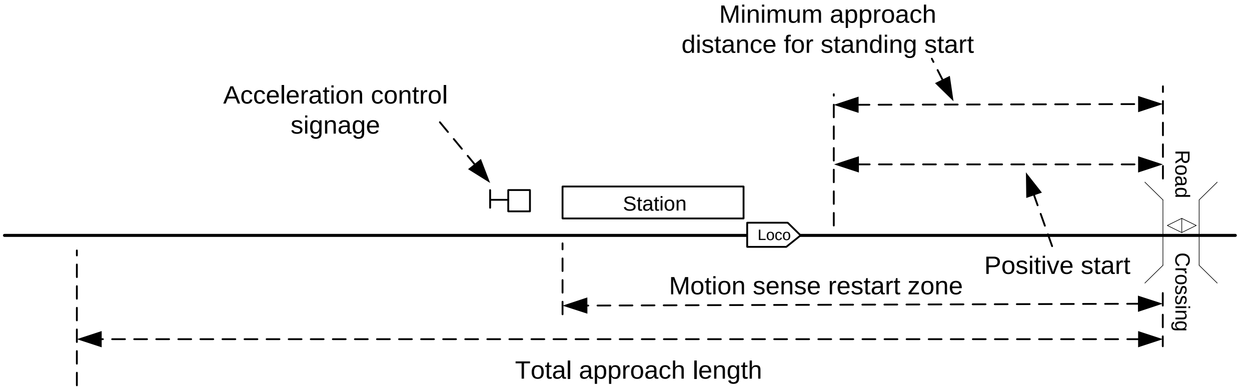


Figure 6.1 Station stop – Layout for motion sense restart

6.2 Train in a Platform with a Speed Limit for Stopping Trains

When the train can stop at the station with the train either in the station platform or on the crossing side of the station and the station is far enough away that motion sense restart can be used provided a maximum speed limit is imposed.

In this configuration:

- There is a particular speed limit placed on the stopping train between the station and crossing that is agreed with the manager infrastructure

- The distance from where the train would stand to the nearest part of the roadway is in excess of the calculated warning time plus 2 seconds when the time accelerating from a standing start to the stopping train speed limit plus the time to cover the remaining distance to the crossing are added.
- Motion sense restart is set to activate when the predictor EZ or RX is 2 higher than the level as the train enters the platform.
- Positive start is set to a point closer to the crossing than the nearest station end
- Predictor/Motion sense switch over is set to a point closer to the crossing than the point where the train would stand with an EZ or RX margin of 2.
- Acceleration control signage for through trains is used.

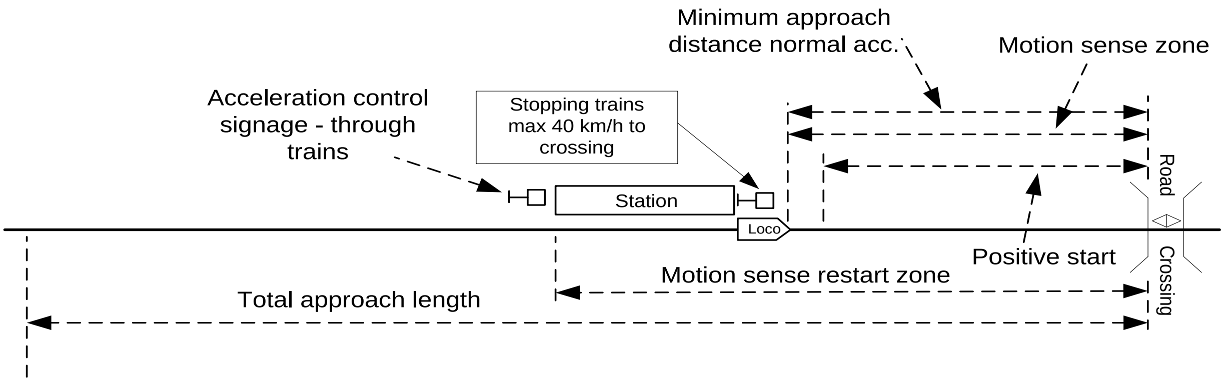


Figure 6.2Station stop - Layout for motion sense restart with speed limit

6.3 Train in a Platform is in the Positive Start Zone

When the train can stop at the station with the train either in the station platform or on the crossing side of the station and the station is not far enough away that motion sense restart could be used the following must be used.

In this configuration:

- The distance from where the train would stand to the nearest part of the roadway is in less than the calculated warning time plus 2 seconds and when the train leaves the station there would be insufficient warning time provided if a motion sense function with or without restart was used or
- The positive start point required for through trains falls in or before the station.
- Positive start is set to operate as the train enters the platform or as required to mitigate acceleration.
- Predictor/Motion sense switch over is set to the greater of the same point or a minimum of 25 % of the approach distance.

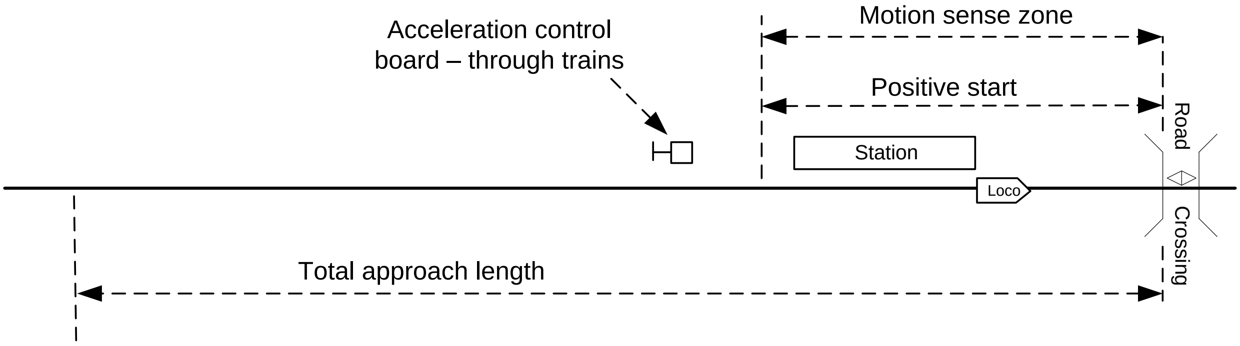


Figure 6.3 Station stop - Layout for positive start

6.4 Station with Mixed Approach Controls - Low Speed Approach

When the train can stop at the station with the train either in the station platform or on the crossing side of the station and the station has a relatively complicated layout a level crossing predictor with a portion of fixed length control may be used.

In this configuration:

- The distance from where the train would stand to the nearest part of the roadway is more than the calculated warning time considering the speed limit through the loop track. If the level crossing approach were to start at signal B there would be insufficient approach distance.
- The layout allows the train to stand in the platform until ready to depart.
- The level crossing predictor is remote from the crossing.
- Signal A prevents the operation of the warning system when it is at stop.
- Signal A cannot clear unless signal B is clear or there is a train between them.
- If signal A is cleared with the approach sections unoccupied it will clear immediately.
- If signal A is cleared with a train on any part of the approach section a time delay interlock will apply, the time depending on which track circuits are occupied. The timing will commence after the crossing warning cycle has started.
- On the loop line a positive start point is required to start the crossing if the signal is to be cleared with the train occupying the loop track.
- Motion sense restart is set so that the warning cycle will commence as the train leaves the platform.

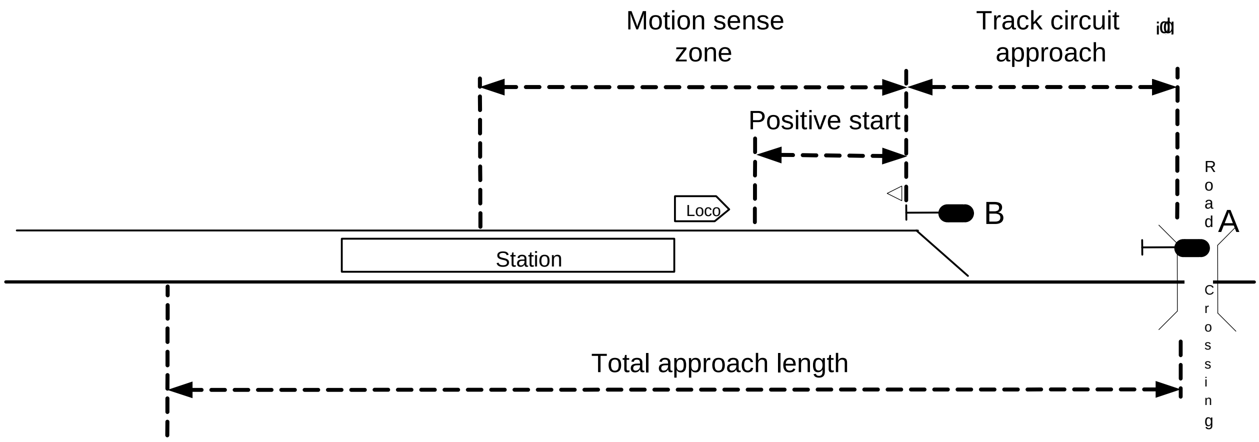


Figure 6.4 Station stop - Layout for positive start with low speed line

6.5 Station with Mixed Controls – High Speed Line

When a train on a high speed track (greater than 80 km/h) can stop at the station with the train either in the station platform or on the crossing side of the station and the station has a relatively complicated layout a level crossing predictor with a portion of fixed length control may be used as follows.

In this configuration:

- The distance from where the train would stand to the nearest part of the roadway is less than the calculated warning time considering the speed limit through the station. If the level crossing approach were to start at signal B there would be insufficient approach distance.
- The layout allows the train to stand in the platform until ready to depart.
- The layout shown includes a holding section for the level crossing.
- The level crossing predictor is remote from the crossing.
- Signal A prevents the operation of the warning system when it is at stop.
- Signal A cannot clear unless signal B is clear or there is a train between them.
- If signal A is cleared with the approach sections unoccupied it will clear immediately.
- If signal A is cleared with a train on any part of the approach section two interlocks will apply. A time delay interlock will apply, the time depending on which track circuits are occupied (timing will commence after the crossing warning cycle has started). A second interlock will ensure that the crossing is operating or that the holding time has expired.
- A positive start point is required to start the crossing if the signal is cleared with the train occupying the loop track and also to mitigate the warning shortening effect of accelerating trains approaching the crossing.
- Motion sense restart is set so that the warning cycle will commence as the train leaves the platform.
- An auxiliary start is required to provide the holding function; this is set with positive start so that the holding is occupied while the train is in the platform.
- Acceleration control signage will usually be required.

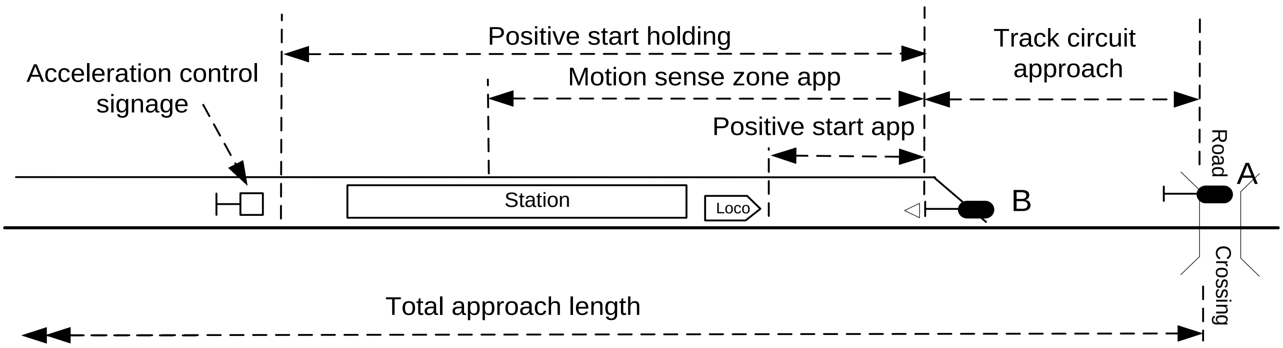


Figure 6.5 Station stop - Layout for positive start with high speed line

7 Layouts for Siding Situations

There are a number of possible layouts for siding situations as these alter with the location of the train and movement of the train.

7.1 Siding is Located Closer than 500m to the Crossing

When the train stops at a siding to shunt and the siding is closer than 500m to the level crossing, a fixed signal at the crossing must be provided to qualify the approach section or the crossing approaches taken out of effect by the release of the siding access. If the siding is further 500m from the crossing acceleration control signage and appropriate warning times may take away the need for modification of the approach section. The following is generally required.

In this configuration:

- If a fixed signal is provided this qualifies the approach section for the track concerned.
- As an alternative a siding release is used to qualify the level crossing approaches.
- In either scenario push buttons with signage are to be provided for movements across the crossing
- The distance from where the train would stand is less than 500m from the crossing
- Motion sense switch over is set to activate when the predictor EZ or RX is at least 2 higher than the level where the train would stand.
- Positive start is set to a point further from the crossing than where the train would stand so that the crossing will activate once the qualification of the signal or siding release is removed.

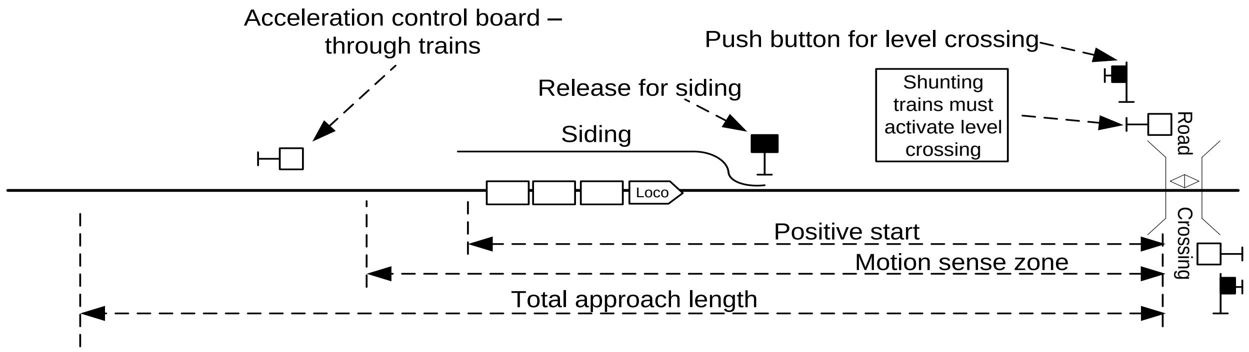


Figure 7.1 Siding within 500m of crossing

7.2 Siding more than 500m from the Crossing

When the train stops at a siding to shunt and the siding is more than 500m to the level crossing the following should be provided.

In this configuration:

- The distance from where the train would stand is more than 500m from the crossing
- Motion sense switch over is set to activate when the predictor EZ or RX is at least 2 lower than the level where the train would stand.
- Positive start is set to a point at least 350m from the crossing so that the crossing will activate if the shunting train approaches the crossing.
- A board is placed at the positive start point to require the train to occupy the crossing before setting back.
- Acceleration control for through trains must be applied

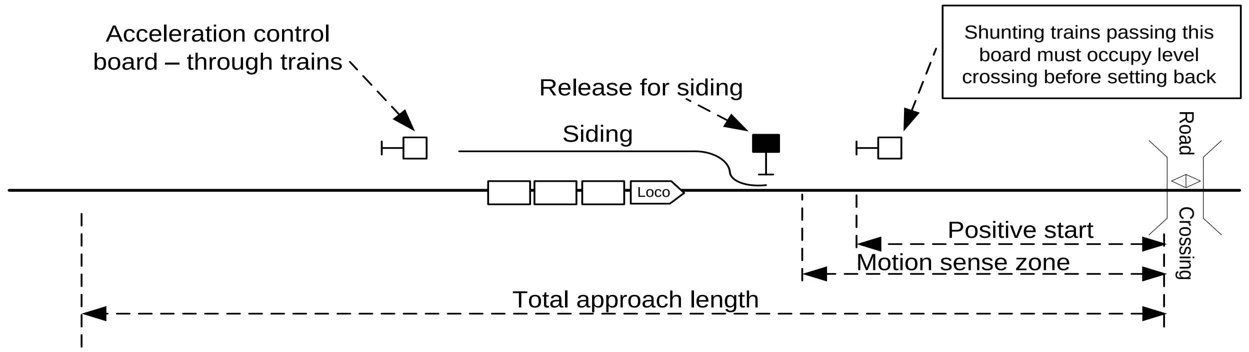


Figure 7.2 Siding more than 500m from crossing

8 Specific Requirements for Safetran Grade Crossing Predictors (GCP)

8.1 Introduction

This section addresses the requirements for application of Safetran systems level crossing predictors 4000 series.

8.2 System Configuration Requirements

The following configuration items are to be set in the GCP data:

- Time is to be set as Eastern Standard Time or Central Standard Time as applicable. Daylight Saving Time is not to be used or configured.
- The 25 Character Site Name is to be in the format - “Town, Street name”.
- The 6 figure crossing number is the same as applied for the level crossing monitor.
- The location is set in kilometres and metres as kkk.mmm
- The unit address is a unique ID allocated by ARTC. It includes the ARTC ID 047.

8.3 Site General Requirements and Approach Length Calculation

The system should normally be set with Enhanced Detection. This results in a 10 second allowance for the GCP to calculate a train. This is 5 seconds average for calculation of speed and 5 seconds average to allow calculation of changed track conditions. This time should be added to the required warning time for the level crossings equipment to determine the length of approach tracks based on the train speed at the location.

Motion Sense zone should be set in accordance with the conditions in the Safetran Application Guidelines. The value should normally be 25% of the approach distance. This may be varied between 20% and 30% depending upon the specific site conditions.

Positive Start zone should be set in accordance with the conditions in the Safetran Application Guidelines. The value should normally be 15% of the approach distance. This may be varied down to 10% depending upon the specific site conditions.

The approach requirements for all train paths to the level crossing shall be considered. Each approach path shall be recorded in the GCP Control Table. Station stop logic and trailing points logic may be required where special situations are encountered. The Safetran Application Guidelines shall be used to determine and implement this logic.

8.4 Overlay of 50Hz AC track circuits

GCPs may be used over 50Hz AC track circuits not fitted with impedance bonds.

8.5 Switching of GCP inputs

Back and front contacts must be used when using a control to switch external inputs to a GCP. The control must be held at battery potential or a ground, circuit arrangements where the input could float in one state are not permitted.

8.6 Recording of set up values

The correct time and date are to be set in each level crossing predictor and the following set up values are to be shown in the circuit book:

- Set Warning time
- Daylight saving time (N)
- Password enable/disable (E)
- Password
- Master slave operation (if required)

For each track controlled the following is to be given:

- Island Track frequency
- Island length
- Track name
- Length (ft)
- Prediction sense frequency
- Uni/Bidirectional
- Predictor/motion sense settings
- DAX offset (if applicable)
- UAX pickup delay (as required)
- ENA/UAX2 enable or pickup delay (as required)
- Switch to MS at EZ level (default 25)
- Enhanced detection (on/off)
- Positive start EZ level (default 10)
- Positive start timeout (0)
- Advanced pre-emption timer (off)
- EZ correction is to be disabled
- EX Limiting is to be disabled
- Any other special setup required for the application

9 Specific Requirements for HXP/XP4 Level Crossing Processors

9.1 Introduction

This section addresses the specific requirements for a level crossing fitted with HXP or XP4 series level crossing predictor.

HXP shall not be used for new works on ARTC.

9.2 Positive Start Setting

Unless otherwise advised XP4 level crossing processors must be set to provide at least 200m positive start zone when used in situations where shunting at sidings occurs. In the case of areas where it is anticipated that accelerating passenger trains may be encountered a minimum of 250m positive start zone must be used.

9.3 Motion Detection Switchover

Where the design requires a motion detection switch over function, other than by restart, this is to be accomplished by programming an AX output for positive start for the switchover point required and using this output via a relay to switch the MDR to the motion detector mode.

9.4 Surge Protection

Unless otherwise advised surge protection for the power leads and the track leads must be provided by using the GETS MDSA surge suppressor panel.

9.5 Recording of set up values

The correct time and date are to be set in each level crossing predictor and the following set up values are to be shown in the circuit book:

- Set Warning time
- Daylight saving time (N)
- Password enable/disable (E)
- Password
- Master slave operation (if required)
- Auto RX (disabled)

For each track controlled the following is to be given:

- Prediction track frequency
- Approach track length (ft (m))
- Uni/Bidirectional
- CW/MD mode (CW)
- Advanced pre-emption (default 0)
- CWE warning time (default 0)
- Island Track frequency
- UAX pickup delay (as required)

- Offset distance (ft (m))
- MD restart setting (RX value)
- Sudden shunt zone setting (default 75)
- Post joint detection Rx value (o)
- Post joint detection timer (0)
- Positive start value (default RX value for 250m)
- Positive start timer (99)
- Any other special setup required for the application.

9.6 XP4 Identification Management

XP4 addresses are managed by ARTC from a centralised database for all ARTC corridors to ensure that there are no overlaps between locations.

9.6.1 Identification Rules

There are number of Rules associated with the allocation of XP4 Addresses.

Each address comprises of a 'Chassis ID' and an 'Application ID' number.

1. Chassis ID to be allocated as '255' for all ARTC jurisdictions.
2. Application ID blocks to be allocated based on predetermined geographical areas; as per XP4 Master ID Register. Application IDs to be sequentially allocated as defined below:
    a. Application ID Number for North South Corridor to be allocated between 2001-2999
    b. Application ID Number for East West Corridor to be allocated between 3001-3999
    c. Application ID Number for Hunter Valley Corridor to be allocated between 4001-4999
3. No spare Application ID numbers shall be issued to the Requestor.
4. The Location Number is a four (4) digit number derived from the kilometrage of the XP4 installation. For example: 136.425 km will have a Location Number '1364'.
5. Record the required information in the database and show the:
    a. Corridor Jurisdiction
    b. Job Number
    c. Project Name
    d. Commissioning Date (Proposed)
    e. Location (Area/ Interlocking)
    f. Location (Road Name)
    g. Location (km)
    h. Circuit book number
    i. Requestor details
    j. within the Remarks column detail any specific comments/ notes.

9.6.2 XP4 Identification Records

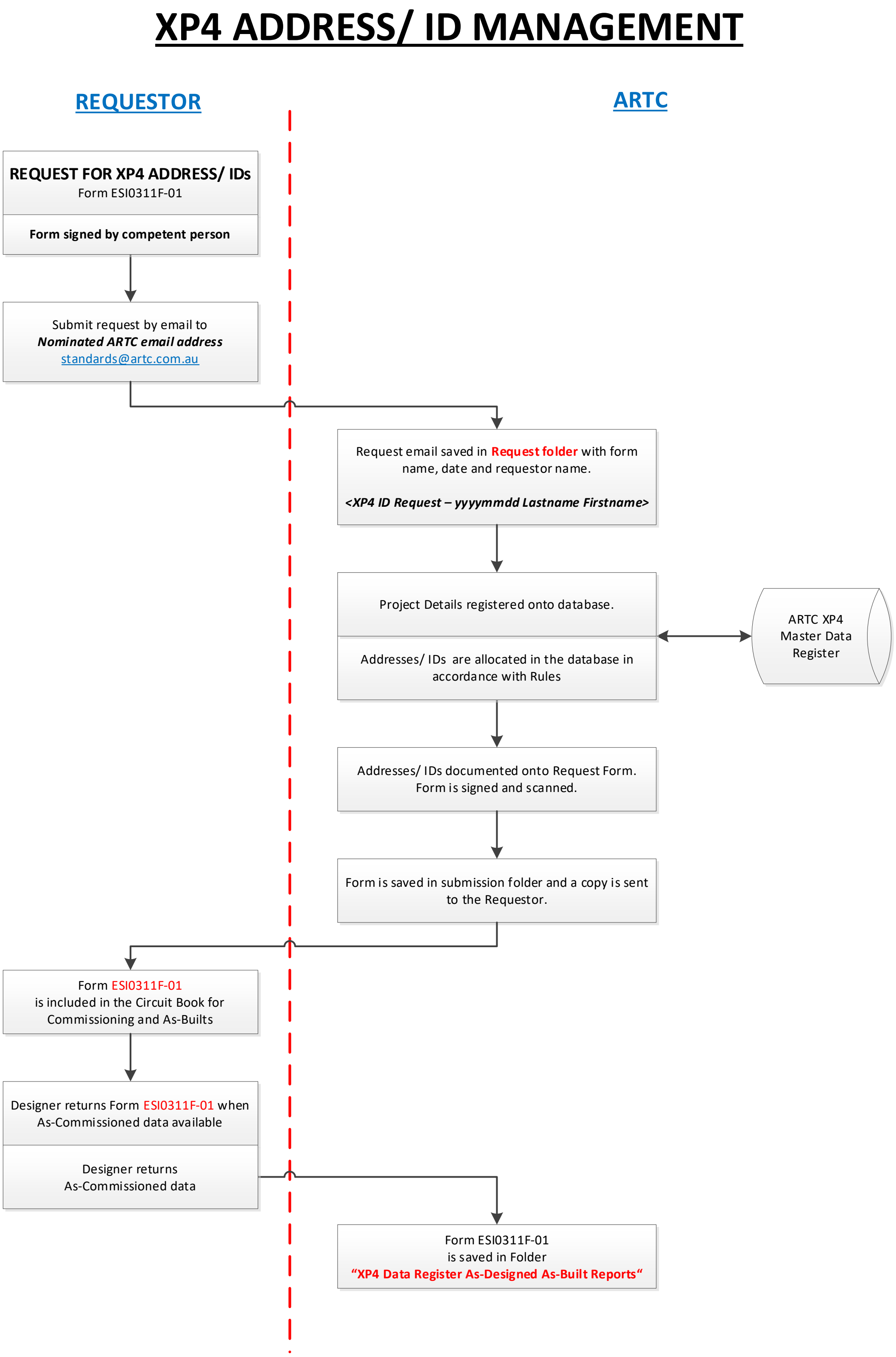
The XP4 Master Identification Register records all allocated and in-service Identification Numbers.

9.6.3 Action Steps

There are number of Action Steps associated with the allocation of XP4 Identification Numbers (see attached flowchart).

1. The Requestor submits an email with the signed Request for XP4 IDs Form ESD0302F-01
2. This is saved in the nominated request folder: ‘XP4 ID Form Requests’
3. The nominated ARTC representative shall check:
   a. that the requestor has signals competency; and
   b. all information has been provided on the form.
5. The nominated ARTC representative updates the XP4 Master ID Register with the new allocation.
6. The nominated ARTC representative details the Chassis ID Number, Application ID Number and Location Number onto the form and authorises ESD0302F-01.
6. ESD0302F-01 form is scanned and saved in the folder: ‘XP4 ID Form Authorised’
7. ESD0302F-01 form is sent to the Requestor

9.6.4 Flowchart



10 Check Design and Factory Test

10.1 Introduction

This section addresses the requirements for checking of the design and for factory testing.

10.2 Checking Requirements

The design shall be subject to checking by a suitably qualified checking engineer familiar with the application of the level crossing predictor used. The checking engineer shall take the developed scheme (signal track plan) and approved operations specification as the basic inputs to the verification process. All proposed train operational scenarios, acceleration and stopping assumptions shall be reviewed to assess the ability to control the level crossing without short warnings times or excessive operation.

The checking engineer shall produce a check report covering all of the issues where it is believed that the design needs adjustment. The report may be entirely written or be combination of marked up circuit book drawings as well as a written report referring to the drawings as required.

10.3 Design Check Report

The checking engineer shall produce a check report covering all of the issues where it is believed that the design needs adjustment. The report may be entirely written or be combination of marked up circuit book drawings as well as a written report referring to the drawings as required.

10.4 Review of the Operational Specification

The operational specification shall be reviewed following the completion of the checking report and any adjustments made. If significant adjustments are required the operations specification shall be submitted for and achieve approval prior to the update of the design.

10.5 Check Design

The submitted design shall be revised to form the check design which is to be signed by the checking engineer once all of the issues raised in the checking review have been closed out with the designer. This is the design to be used for the construction.

10.6 Factory Test

A factory test static simulation of the equipment configuration shall be set up to provide a factory test environment if required by the infrastructure manager. This test shall use all of the setup parameters proposed and use dummy loads and other equipment to simulate the track lengths to be used. The factory test shall be used to verify that all of the setup parameters are compatible and that external inputs or outputs correctly respond.

11 Site Testing and Commissioning

11.1 Introduction

This section addresses the set to work and testing requirements for Level Crossing Predictors.

11.2 Inspection of the Track covered by the Level Crossing Predictor

Prior to the commencement of the set to work the tester must walk so entire length of the approach sections and verify that:

- The track construction is relatively consistent through the length of each prediction track
- Any mechanical joints are correctly bonded out
- All required insulated joints are in place
- All couplers, shunts and dummy loads are in place and of the correct values
- There are no extraneous connections to track or between the rails.

11.3 Set to Work

All connections to the unit must be complete before setup is commenced.

It is important that no trains are present in the approach section during the setup procedure.

- The unit must be powered up and following a satisfactory self-test the software versions checked against those shown in the circuit book tabulation.
- Each of the items (in the order of the manufacturer's instructions) must be entered in turn for each track using the values shown in the circuit book tabulation.
- The location and road name must be entered.
- The time must be set as Eastern Standard Time, Central Standard Time or Western Standard Time depending on the local time zone; daylight saving time is not to be used.
- Following entry of all of the application programming data the crossing controls should be in the non-alarm state (crossing open for road traffic and no call placed on external traffic signals).
- Once this condition is reached the history card applicable to the crossing type is to be populated with the actual setup data.
- Note if the functions implemented are different to those designed the changes must be approved by the checking engineer.
- The minimum required warning time must be achieved for each test. Long warning times are to be investigated and adjustments in the design or settings made to minimise these occurrences.

11.4 Integrity Testing

Integrity testing must take place using a light locomotive to simulate all of the train movements anticipated at the location and documented in the operational specification.

When it is impractical to use a light engine for the testing, scheduled train services may be used.

The minimum required warning time must be achieved for each test. Long warning times are to be investigated and adjustments in the design or settings made to minimise these occurrences. All changes to the design or setup must be approved by the checking engineer.

11.5 Testing Personnel

Persons undertaking testing must be familiar with the application of the equipment being used and have current competency shown on their ARTC Statement of Competency for the specific equipment type. In addition, they must have a thorough understanding of the design and the associated operational specification.