AS 7705:2019

Level crossing monitoring systems

RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

Train control systems standard

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This Australian Standard® AS 7705 Level crossing monitoring systems was prepared by a Rail Industry Safety and Standards Board (RISSB) development group consisting of representatives from the following organisations:

Pacific National	BHP	MTM
ARC Infrastructure	Kiwi Rail	ARTC
WaveTrain Systems	Sydney Trains	Queensland Rail
PTA WA	Rio Tinto	Aurizon

This Standard was approved by the development group and the TCSSC Standing Committee in Select SC approval date. On Select Board approval date the RISSB Board approved the standard for release.

This Standard was issued for public consultation and was independently validated before being approved.

Development of this Standard was undertaken in accordance with RISSB's accredited process. As part of the approval process, the Standing Committee verified that proper process was followed in developing this Standard.

RISSB wishes to acknowledge the positive contribution of subject matter experts in the development of this Standard. Their efforts ranged from membership of the Development Group through to individuals providing comment on a draft of this Standard during the open review.

I commend this Standard to the Australasian rail industry as it represents industry good practice and has been developed through a rigorous process.

Paul Daly
Chief Executive Officer
Rail Industry Safety and Standards Board

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1 Introduction

1.1 Purpose

This Standard supports a consistent approach to discharging level crossing signals monitoring requirements. This is done within the context of the industry trend towards extending maintenance and inspection intervals.

1.2 Scope

This Standard provides mandatory and recommended requirements, primarily for the monitoring of level crossings that are fitted with active protection and warning systems.

The scope of this Standard includes the following:

(a) Equipment to monitor operation of level crossing active protection equipment.

(b) Condition monitoring in a healthy state.

(c) Correct sequence of operation.

(d) Remote alarming.

(e) Vehicle and pedestrian surveillance.

(f) Logging and recording of information.

(g) Obstruction detection.

(h) Accuracy and precision of recording events.

(i) Communication method and latency.

(j) Time synchronisation.

(k) Interface requirements.

1.3 Compliance

There are two types of control contained within Australian Standards developed by RISSB:

(a) Requirements.

(b) Recommendations.

Requirements – it is mandatory to follow all requirements to claim full compliance with the Standard.

Requirements are identified within the text by the term ‘shall’.

Recommendations – do not mention or exclude other possibilities but do offer the one that is preferred.

Recommendations are identified within the text by the term ‘should’.

Recommendations recognise that there could be limitations to the universal application of the control, i.e. the identified control cannot be able to be applied or other controls can be appropriate / better.

For compliance purposes, where a recommended control is not applied as written in the standard it could be incumbent on the adopter of the standard to demonstrate their actual method of controlling the risk as part of their WHS or Rail Safety National Law obligations. Similarly, it could also be incumbent on an adopter of the standard to demonstrate their method of controlling the risk to contracting entities, or interfacing organisations where the risk may be shared.

Controls in RISSB standards address known railway hazards as included in an appendix.

1.4 Referenced documents

1.4.1 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document:

(a) AS 7658 Level Crossings.

(b) AS 7703 Signalling Power Supplies.

1.4.2 Informative references

The following referenced documents are used by this Standard for information only:

(c) AS 7450 Rail Systems Interoperability.

(d) AS 7639 Track Structure & Support Systems.

(e) AS 7718 Signal Design Process Management.

(f) AS 7770 Rail Cyber Security.

(g) AS 15288 Systems Engineering – System Life Cycle Processes.

(h) RISSB CoP Rail Cyber Security in Train Control Systems.

1.5 Definitions

Level crossing: A location where the railway line and a road or pedestrian walkway cross paths on the same level.

Level crossing monitoring system: A system that monitors the condition of a level crossing and/or the activity at, or around a level crossing.

Rail infrastructure manager (RIM): The person who has effective control and management of the rail infrastructure, whether or not the person:

(a) owns the rail infrastructure; or

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

2 General

2.1 Monitoring systems

Level crossing monitoring systems detect and record the condition of a level crossing, typically those fitted with protections and warnings for vehicular and/or pedestrian traffic. This includes traffic booms and/or pedestrian gates, with visible and audible alerts.

Level crossing monitoring systems (hereafter referred to as *the monitoring system*) are deployed to comply with safety integrity requirements, or to support improved maintenance practices.

A monitoring system is used to comply with safety integrity requirements at actively controlled level crossings, by monitoring and recording the status of various components of the level crossing. The monitoring system may also be used for maintenance purposes.

Remote monitoring of level crossing status and live reporting of failure conditions should be provided, where it is reasonably practicable to implement a communications link.

As a minimum, a level crossing monitoring system shall monitor and record:

(a) operation of the level crossing;

(b) availability of primary power supply;

(c) primary power supply or battery voltage:

(d) timing and operation of visual and audible alerts and, where applicable, boom barriers and/or pedestrian gates;

(e) train detection systems and associated circuitry;

(f) controls that operate, override or test the level crossing system.

The monitoring system should have a facility to prevent false alarms being raised during maintenance tasks (also known as maintenance mode).

The monitoring system may include (but is not limited to) any of the following:

(a) Level crossing monitoring and communications hardware.

(b) Level crossing power supply and battery system.

(c) Level crossing obstruction detection system.

(d) Monitoring location system, e.g. GPS.

(e) Wayside monitoring systems.

(f) Environmental monitoring, e.g. temperature, rainfall, rock slip, etc.

Level crossings may also be remotely monitored via Closed-Circuit Television (CCTV) cameras. CCTV can be a component of the monitoring system or an independent system.

2.2 Design

The design process shall support the development of hardware and software configurations that provide the functionality and performance required for the monitoring systems.

When designing a monitoring system, RIM's should reference AS 7718 Signal Design Process Management.

As a minimum, the design shall:

(a) be feasible, fit for purpose, and safe;

(b) be efficiently configurable, installable, operable, testable, and maintainable;

(c) provide functionality as per specifications of the RIM; and

(d) detect, indicate, and log faults as per specifications of the RIM.

(e) minimise the risk of detecting and reporting incorrect status information;

(f) minimise the risk of interfering with the systems being monitored, including (but is not limited to):

i. power supplies;

ii. signal interlockings and interfaces;

(g) minimise the risk of unauthorised or unintended manipulation of the system;

(h) possess approvals from all applicable regulatory authorities;

(i) have been documented as per each RIM's requirements. These documents and records shall form part of the evidence supporting systems and safety assurance.

Designers of the monitoring system should consult the following standards: AS 7450, AS 7639, AS 7718, AS 7770, and AS 15288.

The monitoring system should support redundant methods of communication.

2.3 Environmental requirements

The monitoring system shall comply as per documented environmental specifications of the RIM, including (but is not limited to):

(a) ambient temperature thresholds;

(b) relative humidity tolerances;

(c) water and dust ingress;

(d) vibration tolerances;

(e) AC frequency range.

2.4 Integrity and reliability

2.4.1 Integrity

At level crossings where monitoring is specified as mandatory, the integrity of the monitoring system shall be within the prescribed limits of the system.

The monitoring system shall:

(a) detect all internal faults that indicate a system fault, including (but is not limited to):

i. firmware, memory, and data storage faults;

ii. processor faults;

iii. clock faults;

iv. input and output faults;

v. communication faults;

(b) be certified to operate correctly where its operating parameters are within its specifications, with supporting evidence; and

(c) be compliant as per safety and system integrity requirements of the RIM.

Faults with the operation of digital inputs shall be detected and indicated within limits prescribed in RIM's documented procedures for the operation of monitoring systems.

2.4.2 Reliability

RIM's shall specify and document the reliability requirements of monitoring systems. The monitoring system shall:

(a) incorporate equipment manufacturers specifications in the assessment of reliability; and

(b) be compliant as per reliability specifications of the RIM, including (but is not limited to) mean time between failures;

2.5 Records management

RIM's shall have documented process for the retention and management of records in relation to the following:

(a) design
(b) installation
(c) commissioning
(d) operation
(e) maintenance
(f) decommissioning

Records should be retained for a period of time no less than the legislated period of time required in each jurisdiction that the RIM operates under.

2.6 Interoperability

Monitoring systems used within the rail industry should have characteristics and attributes that contribute to interoperability between systems.

When applying new or updated monitoring systems, RIM's should consider:

(a) assessing technical harmonisation of all systems as one option for achieving interoperability;
(b) assessing future technology roadmaps and design changes to minimise any restriction of further development of systems;
(c) enabling open market competition and innovation in the design of future system development, additions or upgrades;
(d) developing a defined and publicly available design concept to allow interoperability of other systems and technology when required;
(e) ensuring that there is a route for migration from the legacy systems;
(f) use of proven industry standard communications protocols; and
(g) using common terminology and definitions in both system and operational interface;
(h) utilisation of an industry standard communications system.

An optimal technology outcome should be derived by:

(a) identifying targets for reliability, availability, maintainability and Safety;
(b) addressing cyber security protocols;
(c) supporting a consistent user information delivery interface;
(d) assessing the whole of life cost;
(e) assessing a technology roadmap and potential associated changes;
(f) assessing system obsolescence;
(g) identifying communication redundancy systems;
(h) assessing scalability for future expansion; and
(i) assessing the interface to other modes of transport.

Interoperability of technology should be focussed on the alignment of commonality regarding inputs and outputs.

When applying interoperability, RIM's should reference AS 7450 Rail Systems Interoperability.

2.7 Configuration management

RIM's shall have documented processes in place for configuration management. These processes shall be applied to the configuration management of monitoring systems.

Considerations for configuration management of a monitoring system may include (but is not limited to):

(a) configuration checksum;

(b) configuration files;

(c) configuration file backup;

(d) definition of what parameters are configurable and what their limits are; and

(e) how configuration is performed and controlled.

3 Functional requirements

3.1 Operation and self-checking

The level crossing monitor system shall:

(a) automatically start-up and commence monitoring on initiation of electrical power;

(b) automatically re-start if the software ceases to operate correctly;

(c) alarm if a defined number of re-starts that occur within a defined period is exceeded;

(d) check all configuration data on start-up and indicate a system fault if it is invalid;

(e) alarm if the power supply is out of limits for correct operation;

(f) continuously check that the software, and real time clock are operating correctly;

(g) logging of events with a time stamp; and

(h) alarm on loss of communication.

3.2 Correct sequence of operation

The correct sequence of operation will vary between systems and RIM's. In all cases, RIM's shall have documented processes in place that define the correct sequence of operation for each of their monitoring systems.

Operations being monitored may include (but are not limited to):

(a) exceedance of battery and lamp limits;

(b) train sequencing;

(c) sequence of digital inputs;

(d) approach warning time; and

(e) activation of the level crossing.

The level crossing monitor may also include additional functionality such as battery testing.

3.3 Digital inputs

Where the term digital input is used, this may be via a physical digital input, or via a supported serial/ethernet interface.

RIM's shall have documented matrices for the configuration of all monitoring system digital inputs.

RIM's should consider expandability when examining digital inputs requirements. The following non-exhaustive list is the types of digital inputs:

(a) Train detection systems and associated circuitry.

(b) The level crossing control and repeat relays.

(c) Test switch.

(d) Door switch.

(e) Gate and boom arm state.

(f) Lights, audible alert, gate and boom arm emergency switches.

(g) Power supply state indication.

(h) Battery voltage health indication.

(i) Any other function that qualifies the operation of the Level Crossing (for example approach signals).

(j) Audible alert state.

(k) Reset fault or warning.

(l) Output state of each flasher.

(m) Other relays/contacts of interest.

(n) Other wayside monitoring peripherals.

3.4 Digital outputs and indications

RIM's shall have documented matrices for the configuration of all monitoring system digital outputs.

RIM's should consider expandability when examining digital output requirements. The following non-exhaustive list is the types of digital outputs:

The current state of the outputs shall be indicated on the level crossing monitor. Depending on the type of monitoring system, the level crossing monitor outputs could include (but is not limited to):

(a) battery test;

(b) no fault;

(c) no warning;

(d) system fault;

(e) power fault;

(f) lamp problem;

(g) logic problem.

3.5 Analogue inputs

Analogue inputs shall be protected against reverse polarity connections and surges.

Where possible, all analogue inputs should be isolated between the monitoring system and operational system.

RIM's shall have documented matrices for the configuration of all monitoring system analogue inputs.

RIM's should consider expandability when examining analogue input requirements. The following non-exhaustive list is the types of analogue inputs:

The functionality of the analogue inputs may include:

(a) battery and/or power supply monitoring;

(b) lamp driver/flasher unit correct operation;

(c) individual lamp health; and

(d) audible alert monitoring;

The battery voltage should be considered to have changed when the voltage is more than the threshold for recorded values.

3.5.1 Sampling

RIM's shall have documented requirements for sampling.

At a minimum, the sample rates of the analogue inputs should be at a high enough rate to accurately reflect both the flashing and not-flashing states of the lamps.

The analogue inputs shall be continually monitored, regardless of the current state of the level crossing.

3.5.2 Power/battery monitoring

The power supply and battery shall be sampled to ensure the voltages are within range for correct operation of the level crossing.

3.5.3 Lamp health

Monitoring the health of the lamps will be dependent on the lamp types installed at site. The monitor shall that a lamp (or set of lamps) are drawing a current within normal operation ranges. If the current falls out of the normal range, the monitor shall raise a fault.

If a current is detected on a lamp when not expected, the lamp shall be assumed to be faulty.

The lamp driver should be monitored to ensure that:

(a) the flasher is operating with the correct flashing period between ON and OFF states; and

(b) the lamp current is within the correct operating parameters.

3.6 Status reporting

The level crossing monitor shall indicate its status. This may be locally and/or remotely.

RIM's shall have documented processes in place to generate reporting of the status of the monitoring system.

3.7 Vehicle and pedestrian surveillance

All active level crossings should be equipped to provide a level of vehicle and pedestrian surveillance. The extent of this provision will be dependent on regulatory requirements, and the specific requirements of the RIM.

The surveillance system should comprise of the following components:

3.7.1 Street lights

At least two diagonally located light poles should be provided to illuminate the level crossing. The poles shall be 8m in height. The installation shall have the following characteristics:

(a) The street lights should be capable of being switched off when sufficient level of daylight is available. This should be a configurable level, and the on/off function may be achieved using a photoelectric sensor.

(b) The lights may be installed on break-back poles for maintenance purposes. When broken, the movement of the broken part shall be parallel to the road and clear of railway track by at least 3.0 metres.

(c) To provide maximum coverage, the two poles should be located in opposite quadrants. Individual RIMs may choose to provide more than two light structures (for example, in each quadrant).

3.7.2 CCTV and/or recording system

All level crossing should consider installing a facility to record a visual overview of the level crossing. This system should consist of the following:

(a) Overview CCTV cameras.

(b) Digital video recorder.

Two CCTV cameras would be installed (located in opposite quadrants) to cover each end of the level crossing. If used, the cameras shall record all activity over the level crossing, and should:

(a) perform in day and night (minimum 0.5 lux illumination) conditions to capture viewable images;

(b) use communications systems (i.e. internet protocol) to provide video to the on-site digital video recorder; and

(c) be capable of vehicle number plate recognition, where required by the RIM.

The view functionality of the CCTV system shall cover the whole of the level crossing zone, including all extremities. This should be achieved by ensuring that the viewing area for each camera includes:

(d) stop line on the opposite side of the road is visible;

(e) boom mast with flashlight on the opposite side of the road is visible; and

(f) track panels and road section across the level crossing are visible.

A digital video recorder (DVR), capable of being connected to all cameras, should be installed at each level crossing where vehicle and pedestrian surveillance is required.

The DVR should:

(a) tag the video content for activation events of the level crossing;

(b) have a storage capacity consummate with the requirements of a specific RIM; and

(c) be remotely accessible and configurable.

In instances where the RIM chooses to use the CCTV recordings for legal reasons (for example, to pursue court proceedings), then it shall ensure that:

(a) the equipment installed meets the stipulated or regulatory system performance criteria for the given jurisdiction; and

(b) strict chain of custody rules are in place and complied with;

(c) the equipment is calibrated regularly in accordance with manufacturers specifications.

3.8 Obstruction detection

A system for detecting obstructions may be deployed at level crossings, in accordance with the specific requirements of the RIM.

If the system is used by the RIM, it shall detect still and moving objects using scanners (or similar equipment), on both sides of the railway corridor and across the diagonal of the road interface.

Where deployed, such systems should consist of at least two scanners, mounted in opposite quadrants, ensuring good coverage of the entire area of the road/rail interface for both single and dual rail track crossings.

The system shall be able to determine whether objects detected at a level crossing constitute an obstruction of the crossing, by using a small number of rules or algorithms. As a result, the passage of trains and road traffic through the crossing area under scrutiny shall not be flagged as obstructions.

The system should also be able to carry out a self-health check indicating that all the components in the system are functioning correctly. A range of critical and non-critical alarms shall be raised as required and directed to the train control system to ensure the safety of train movements for critical alarms, or alert maintenance teams for non-critical ones.

In certain circumstances, the nature of the obstruction can be verified by the Train Controller using the camera/lighting system referred to in Section 3.7, in order to determine the action(s) to be carried out.

3.9 Maintenance and testing

3.9.1 General

RIM's shall have documented maintenance and testing processes in place to ensure the integrity of the systems.

A facility shall be provided for level crossing maintenance staff to temporarily disable the status reporting whilst maintenance and/or testing is carried out. The maintenance staff shall not be required to have any equipment to use the temporary disable facility. This feature shall self-disable after a period of time as determined by the RIM.

3.9.2 Battery testing

Where RIM's require level crossing standby battery testing, the monitoring system shall have the facility for testing the current state of the level crossing battery and reporting the results to a remote location.

The process of testing the level crossing battery and the monitoring system when requested, may be as follows.

(a) Perform a thorough check of the operation of the monitoring system.

(b) Check battery voltage to determine if it is within limits.

(c) Check that the battery test current is less than prescribed limits.

(d) Check that the battery test cut-off indication functions correctly.

(e) Monitor that the Battery test current is greater than prescribed limits.

RIM's shall develop and implement documented processes for the battery testing of each monitoring system.

Where appropriate, RIM's should consider the interoperability of systems to streamline testing.

3.10 Logging requirements

The level crossing monitor shall detect changes in its analogue inputs, digital inputs and its digital outputs. Details of these changes shall be stored with their date and time (to the tenth of second) of occurrence. RIM's shall determine the minimum amount of time a level crossing monitor needs to retain logged information and the number of changes to be stored.

The log shall be maintained in a non-volatile storage medium. The log shall still be retrievable after the level crossing monitor has been removed from service, transported to another location, and left without power for at least 31 days.

The oldest event shall be automatically replaced by the next new event when the event log is full.

Changes to the state of the flasher inputs shall not be logged. This is solely to prevent wasting log space.

4 Interface requirements

4.1 Remote monitoring

For RIM's that utilise remote monitoring, an authorised operator may be able to:

(a) retrieve event logs and alarms;

(b) display historical trends of information;

(c) remotely download firmware and to remotely upload and download configuration parameters;

(d) view the status of the monitoring system;

(e) view logs containing the user actions.

4.2 Remote alarming

For RIM's that utilise remote alarms, the following should be considered:

(a) When the supervisory system receives an alarm message from monitoring system, the supervisory system shall provide an alert to operators with the appropriate user privileges.

(b) Suitable methods of alerting the operator shall be determined by the RIM depending on the criticality of the alarm, and may include:

i. visual alerts;

ii. audible alerts;

iii. digital messages (e.g. email, SMS, etc.);

iv. integration with 3rd party systems to handle alerts.

(c) Alerts shall remain active and be repeated and/or escalated until the underlying alarm has been acknowledged by an operator with the appropriate user privileges.

(d) The system may be capable of being configured to send alerts when the supervisory system receives certain configurable types of alarms.

In addition, RIM's should consider use of technology whereby the monitoring system rather than the supervisory system is utilised to issue digital alarming messages (e.g. email, SMS, etc.). This may be as the primary issuer, or as a redundancy in the event of communications failure with the supervisory system.

4.3 Time synchronisation

RIM's shall have documented requirements for periodical time and date synchronisation for monitoring systems. The methodology, length of time between periodical synchronisation of the time and date and type of on-board local clock shall be determined and documented by each RIM on a need's basis. The level of tolerable local clock drift and period of synchronisation with remote time standard shall be chosen dependant on vitality of data and its intended use. RIMs shall maintain their local time clock operation over the full temperature range and after loss of power for a minimum of 1 year after loss of external power.

4.4 Power supply

4.4.1 Power supply requirements

The level crossing monitor should operate from a reliable primary source of power. RIM's should determine the primary power supply source which best suits the application of the monitoring system. These could include (but is not limited to):

(a) electricity grid supplied mains power;

(b) solar supply;

(c) batteries.

Selection of the power supply source should also be fit for purpose and meet the manufacturers specification requirements.

The application of power supply requirements shall be consistent with the requirements of AS 7703.

RIM's should consider surge protection and isolation in power supply requirements.

To aid in graceful degradation of the level crossing, the minimum operating voltage for the monitor shall be lower than the minimum operating voltages for the level crossing control and warning subsystems; such that in the event of a loss of supply, the monitor shall still be able to report the critical failure of the level crossing.

4.4.2 Power supply redundancy

RIM's should consider power supply redundancy in the design of the system. Considerations for the power supply redundancy could include (but is not limited to):

(a) solar supply;

(b) batteries.

When assessing the redundancy of power supplies, the power supply source should also be fit for purpose and meet the manufacturers specified requirements.

RIM's shall ensure that the additional load of the monitoring system does not greatly impact on the standby/hold-up time for the level crossing battery.

The application of power supply requirements shall be consistent with the requirements of AS 7703.

Appendix A Hazard register extract

No.	Reference	Description
1	9.39	Level crossing failure
2	10.8.1.4.2	Incorrect management of rail traffic, crossing with failed protection
3	10.9.1.3.1	Wayside device failure
4	10.9.1.3.10	Unknown unsafe condition
5	10.11.1.4.1	Protection failure
6	10.11.1.4.2	Lost load on level crossing
7	10.11.1.4.3	Vehicle stalls on level crossing
8	10.11.1.4.4	Vandalism/trespass
9	10.11.1.4.5	Rail rule violation
10	10.11.1.4.6	Road rule violation

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Authors work with RISSB's Standards Development Managers and Development Groups to ensure that products are acceptable to industry. Standing Committees oversee this work and ensure that proper governance and process is followed. The products are exposed to the public and industry for comment and validated by an independent validator.

Once agreed by the Development Groups, Standing Committees and Validator, the drafts are passed to the RISSB Board for approval.

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