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RISSB Contact details:

Head office:

Phone:	Email:	Web:
(07) 3724 0000 +61 7 3724 0000	info@rissb.com.au	www.rissb.com.au

Standard Development Manager:

Name:	Phone:	Email:
Andrew Muscat	0456 939 768	amuscat@rissb.com.au

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SDM name	Andrew Muscat
SDM phone	0456 939 768
SDM email	amuscat@rissb.com.au

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Preface

This standard was prepared by the Railway infrastructure – Sighting Development Group, overseen by the RISSB Infrastructure Standing Committee.

Objective

Signs, signals, and indicators are used in the railway to present information to train crew, maintenance workers and other authorized persons working in the rail corridor. In order for this information to be comprehended by the user, the correct sighting of the stimulus is required.

The objective of this Standard is to provide a framework to assess optimal sighting arrangements in order to minimize risks as a consequence of poor sighting on the railway network.

The documentation can be used to facilitate the optimisation of sighting and detection-response which are considered important safety factors in the mitigation of railway safety risks associated with:

(a) the occurrence of an exceedance of authority from incorrectly placed signs or signals;

(b) the occurrence of reading the incorrect sign or signal, for example read-through and read-across errors; and

(c) the impacts of other rail corridor infrastructure obstructing signs or signals.

Whilst not the primary objective, this Standard can also be used to provide information regarding the sighting of:

(d) railway and contract personnel working in the rail corridor;

(e) authorized visitors to the corridor; and

(f) machinery and plant being used in the corridor.

If applied as intended, the framework provided in this Standard will enable the rail infrastructure manager (RIM) to overcome or minimize the safety risks associated with poor sighting arrangements; thereby increasing safety of operations and people.

Compliance

There are four types of provisions contained within Australian Standards developed by RISSB:

(a) Requirements.

(b) Recommendations.

(c) Permissions.

(d) Constraints.

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 recognize that there could be limitations to the universal application of the control, i.e. the identified control is not able to be applied or other controls are more appropriate or better.

Permissions – conveys consent by providing an allowable option. Permissions are identified within the text by the term ‘may’.

Constraints – provided by an external source such as legislation. Constraints are identified within the text by the term ‘must’.

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.

RISSB Standards address known hazards within the railway industry. Hazards, and clauses within this Standard that address those hazards, are listed in Appendix C.

Appendices in RISSB Standards may be designated either “normative” or “informative”. A “normative” appendix is an integral part of a Standard and compliance with it is a requirement, whereas an “informative” appendix is only for information and guidance.

Commentary

Commentary *C Preface*

This Standard includes a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by ‘C’ preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.

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Section 1 Scope and general

1.1 Scope

This Standard aims to provide a framework for the development and implementation of optimal sighting arrangements for visual stimuli in the rail corridor where it is critical that a person(s) perceives, interprets and acts upon a stimulus in a safe and controlled manner.

A stimulus can be a:

(a) sign;

(b) signal; and/or

(c) indicator, e.g., guard's indicator or station indicator.

For the purpose of this Standard, markings such as stop lines, platform markers, etc., are included as signs. Indicators such as guard's indicators are included as signals.

Where appropriate, this Standard is intended to be used in conjunction with:

(d) AS 7632 Railway Infrastructure – Signage; and

(e) AS 7721 Railway Signals, Indicators and Signage.

This Standard describes a number of environmental, physical and human factors considerations which will assist the RIM in the understanding of sighting processing, constraints and requirements.

This Standard is not specifically intended to cover heritage railways operating on private reservation, but items from this Standard can be applied to such systems as deemed appropriate by the relevant Rail Infrastructure Manager (RIM).

1.2 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 7630, *Railway infrastructure - Track classification*

(b) AS 7632, *Railway infrastructure - Signage*

(c) AS 7721, *Railway signals, indicators and signage*

(d) *National standard for health assessment of rail safety workers 2017*

NOTE:

Documents for informative purposes are listed in a Bibliography at the back of the Standard.

1.3 Defined terms and abbreviations

For the purposes of this document, the following terms and definitions apply:

1.3.1
dark adaptation
adjustment of the eye to low light intensities, involving reflex dilation of the pupil and activation of the rod cells in preference to the cone cells

1.3.2
depth of processing
adjustment of the eye to low light intensities, involving reflex dilation of the pupil and activation of the rod cells in preference to the cone cells

1.3.3
minute of arc
unit of angular measurement equal to one-sixtieth of one degree

1.3.4
detection-response
process that starts from the instant a stimulus is detected by one's sensory system and finishes when the required action to safely mitigate any hazards or risks by the stimulus are applied

1.3.5
detection-response time
time taken for a person to undergo the detection-response process

1.3.6
primary user
person or group who would most frequently need to sight and act upon the information shown on a sign or signal

1.3.7
RIM
rail infrastructure manager

1.3.8
response time
time elapsing between the beginning of the application of a stimulus and the beginning of a person's response to it

1.3.9
readability
ease with which the information shown on a sign or signal can be recognized and interpreted

1.3.10
sighting distance
sighting distance available from a point is the actual distance over which a person/s from a specified height or position at a particular speed has visibility of stationary or moving objects in order to safely perceive / react as necessary to those objects

1.3.11
SPAD
signal passed at danger

1.3.12
stimulus
sign or signal which requires a person to perceive, interpret and act upon to ensure continuation of safe and orderly working

1.3.13
visibility
state of being able to see or be seen, and the distance required to be in this state as determined by prevailing conditions

1.3.14
visual acuity
acuteness or clarity of vision; the relative ability of the eye to resolve and distinguish details and shapes of objects or to see fine detail. It depends on the:

(a) sharpness of the retinal focus within the eye;

(b) intactness and functioning of the retina; and

(c) sensitivity of the interpretative faculty of the brain.

General rail industry terms and definitions are maintained in the RISSB Glossary. Refer to: https://www.rissb.com.au/products/glossary/

Section 2 Sighting process

2.1 General

When approaching a visual stimulus, a person initially detects the presence of the stimulus, recognizes the stimulus, processes and interprets information in relation to that stimulus, decides how to respond and then undertakes the appropriate response. This is referred to as the detection-response process (see Appendix Figure A.1-1 in Appendix A).

Detection-response times are greatly affected by:

(a) the movement / activity / actions being undertaken at the time of sighting;

(b) poor visibility and sighting arrangements;

(c) the ease with which the one stimulus can be distinguished from other possible stimulus (e.g., distinguishing one sign from another sign);

(d) the depth of processing required; and

(e) the number and different types of actions (responses) to the stimulus, that could occur.

For a person, the overall detection response may be reduced if the person has had the opportunity to prepare for the stimulus. As they are expecting the stimulus, they will be more vigilant for its appearance.

2.2 Detection-response

The time taken to complete the detection-response process is defined as the required detection-response time.

The successful detection of and response to any stimulus will generally rely upon processing of the following components.

(a) Vigilance – the action or state of keeping careful watch for a possible stimulus.

(b) Detection – detecting surface features of a stimulus in the environment. This includes identifying the basic form of the stimulus and discriminating it from surrounding objects.

(c) Recognition – it is recognized as appropriate to the driver's route.

(d) Interpretation – the implication and meaning of the stimulus is understood.

(e) Response selection and action – the appropriate action is taken (i.e. rail traffic crew responds to sign).

Section 3 Sighting assessment

3.1 General

Sighting assessments are a critical component of assessing and maintaining the safe operation of a railway. The needs of the primary users shall form the key elements as part of the sighting assessment of detection-response time. The RIM shall establish a sighting assessment committee to conduct a sighting assessment when:

(a) new signs / signals are installed;

(b) alterations are made to existing signs / signals that impacts sighting;

(c) alterations are made to lineside infrastructure that impacts sighting;

(d) assessing sighting after an incident e.g., limit of authority overrun; and/or

(e) by mutual agreement of affected stakeholders.

The sighting assessment committee may be a permanently formed group, or formed on an as needs basis and disbanded once the work is complete.

The specific determination of sighting for line side signals, signs and indicators shall be in accordance with AS 7721.

3.2 Sighting assessment committee

3.2.1 Committee members

The sighting assessment committee is a specialist group managing a critical interface between wayside, other infrastructure, rail traffic crew and other external factors.

The sighting assessment committee allows for input from rail traffic crew representatives regarding the positioning of signals and signs.

The RIM shall have a process in place to identify and appoint a competent facilitator who has the necessary experience and expertise to manage the group and establish requirements for adequate signal sighting within the constraints of the design and existing infrastructure and environment.

The facilitator shall be responsible for identifying the representation of the signal sighting committee to achieve effective sighting of the signal / sign.

The sighting assessment committee composition should be as follows:

(a) Facilitator

(b) Infrastructure and/or signalling engineers

(c) Rail traffic crew representative/s

(d) Human factors representative

(e) Safeworking representatives

(f) Union representative

Where a sighting assessment committee is established as result of a SPAD or other incident then the working group shall include the appropriate person from the investigation team.

3.2.2 Sighting assessment committee duties – new construction

A sighting assessment committee should be established during the plan and design phase of any new installation project to review proposed locations of signals and signs.

As part of desktop assessment, the sighting assessment committee shall review the proposed design and provide comments on the proposed stimulus' positioning, configuration, and functionality. This assessment should also include safeworking requirements and installation issues within the rail network.

When the conceptual location and type of signal required for the design has been determined, a sighting assessment committee review shall take place to determine the best location, height and configuration of signal to provide optimal visibility to the rail traffic crew.

Prior to the issue of the proposed design for construction, an on-site sighting assessment should also be carried out to confirm that the desktop assessment is achievable.

To reduce the possibility of having to relocate signs and signals after installation sighting assessments for new or proposed signals / signs should be conducted using virtual modelling. Where a virtual assessment is conducted a final on-site sighting assessment shall also be carried out.

The sighting assessment committee shall carry out on-site inspections to verify the sighting of signals against the approved signal sighting checklists.

3.2.3 Sighting assessment committee duties – SPADs

Where a sighting assessment committee is established as result of a SPAD or other incident the approach view of rail traffic crew shall be assessed, as well as the signalling arrangements and site engineering requirements.

3.3 Factors to be assessed

Factors which can affect visibility and viewing conditions and subsequently interfere with detection and sighting, shall be included in a sighting assessment. For example, the assessment can include:

(a) obstructions obscuring the line of visibility;

(b) reading through or reading across, i.e. the driver will be misled by sighting past a sign or signal to another brighter or more obvious signal or sign;

(c) variability in lighting conditions;

(d) risks of reducing intensity or contrast due to dirt, dust, fog and/or other air pollution;

(e) potential glare causing dazzle or visual bleaching. This can be a result of:

  (i) sunlight;

  (ii) potential interference from ambient lighting such as street lighting or active advertising displays; and

  (iii) car or headlight glare from road traffic or other rail vehicles.

(f) alignment of track or access road which could prevent required continuous and uninterrupted view;

(g) lineside or corridor clutter (both temporary and permanent) which could prevent continuous and uninterrupted view; and

(h) topographical constraints such as gradients and curvature.

3.3.1 Line of visibility

The line of visibility can be obstructed by, but not limited to:

(a) natural ground level or topographical features;

(b) vegetation;

(c) structures (bridges, stations, lineside cabins, posts.) and/or any protruding parts to those structures (e.g., station furniture);

(d) overhead line electric traction power system;

(e) other rail traffic; rail traffic on an adjacent track will obscure the signal, notably on curved tracks;

(f) cab design;

(g) background lighting, such as traffic lights, streetlights, floodlights, active advertisement displays; and

(h) people on a platform.

3.3.2 Variability in light conditions

Site conditions shall be assessed for any variability in lighting conditions, such as adjustment in light levels and changes in light intensity.

Variability in lighting conditions includes the effect of sun entering and exiting any structure, cutting or other area which is long enough, exposed or shaded in such a manner to cause an adjustment in light level and sudden change in light intensity (e.g., exiting a tunnel long enough to cause changes in light levels).

Following exposure to very intense illumination the eye will experience a greatly elevated visual threshold that takes significant time to return completely to normal. This phenomenon is termed dark adaptation.

3.3.3 Attention / parallel distraction factors

Elements which can cause attention / parallel distraction and interfere with sighting shall be assessed. For example:

(a) reading through or reading across, i.e. the driver will be misled by sighting past a sign or signal to another brighter or more obvious signal or sign;

(b) the effect of multiple reminder aids and/or other items displayed;

(c) any potential distraction due to cab clutter;

(d) any potential distraction caused by complex track layouts and/or horizontal or vertical alignments (e.g., rising or falling gradients on approach);

(e) the effect of parallel lines or sidings creating risks of responding to an incorrect stimulus such as a sign or signal intended for users of an adjacent track;

(f) the effect of background interference on detection; and

(g) the effect of ambient lighting from highways running parallel to the railway.

Shielding from ambient lighting may be achieved by the installation of foliage or suitable manmade barriers in the median strip between the two transport corridors.

3.3.4 Glare

Glare can be:

(a) relative glare caused by excessive contrasts between different parts of the visual field (e.g., driver of a rail vehicle viewing a VDU placed in front of brighter light from the vehicle window);

(b) absolute glare caused by excessively bright light sources, such that the eye cannot adapt to the level (e.g., driver of a rail vehicle experiencing high beam headlight glare from vehicles approaching on adjacent highway; or

(c) adaptive glare, for example dark adaption when entering a tunnel after being exposed to bright sunlight, temporarily decreases visual acuity while the eye adapts to different light levels.

The risks of glare and subsequent impact on the detection-response times shall be included in assessing optimal sighting arrangements.

Section 4 Sighting of railway signs and signals

4.1 General

For the design, placement and maintenance of railway infrastructure signs, this section should be read in conjunction with AS 7632.

The design, placement and maintenance of lineside signals, indicators and signal signage shall be in accordance with AS 7721.

Where it is noted that changes in environmental or other circumstances post installation could impact on the sighting of a stimulus, a risk assessment shall be undertaken to ascertain whether detection or visibility has been compromised.

To optimize sighting and arrangement of railway signs and signals, the impact of each component of the detection-response time shall be assessed.

Prior to the determination of sighting requirements for railway signs and signals, the target primary user and any secondary users (as appropriate) shall be identified.

The impact of any relevant characteristics of the primary user (such as activities being performed, or situational awareness expectations) which could affect their detection-response time shall be, wherever practical, identified and incorporated into any sighting assessments.

Sighting requirements for railway signs and signals shall be assessed for the following primary users as appropriate:

(a) Rail traffic crew.

(b) Drivers of maintenance, inspection and other vehicles on railway access roads or within the corridor.

When reviewing and setting sighting requirements for railway signs and signals a route-based approach shall be applied.

This approach should, wherever practical, ensure that:

(c) sighting considerations along a route addresses;

  (i) railway safety requirements;

  (ii) environmental constraints and conditions;

  (iii) proximity, location and number of other signs, signals and infrastructure;

(d) railway signs and signals are positioned in the optimum position for sighting by the primary user; and

(e) a consistency in the positioning of signs and signals is maintained along the route.

To optimize sighting where required, railway signs and signals may be placed in an elevated position such as on a gantry or cantilever.

Where there is lack of or poor sighting along a particular route section, the hierarchy of hazard control shall be applied to minimize or eliminate any exposure to hazards identified during sighting assessments.

Mitigation measures may include realignment, speed restrictions or other risk mitigation measures as appropriate.

4.2 Detection-response for railway signs and signals

4.2.1 General

When considering detection-response components for railway signs and signals, the following shall be assessed:

(a) Will the signage be of known permanent status and message (e.g., signs expected to be known with route knowledge)?

(b) Will the signage be of known permanent positioning but with alternating messages (e.g., permanent signs or digital message signs)?

(c) Is the stimulus such that it may not be expected (i.e. where a person may have to change mental set to a new situation before being able to prepare and make a response)? This includes temporary signs, including emergency stop signs, temporary speed signs, etc.

4.2.2 Rapid change in light conditions

If railway signs or signals are required to be placed in a situation where the primary user will be exposed to darkness after brightness, greater distance should be implemented to allow for the human eye's slower adjustment to variability of darkness after brightness.

Due to the potential variability in lighting on exiting a tunnel, signals and signs shall be positioned at a distance as recommended by the sighting assessment and approved by the RIM. The positioning of such railway signs and signals should be the subject of a risk assessment.

4.2.3 Visibility

The following factors could interfere with detection and should be avoided or mitigated when developing optimum sighting arrangements for signals and signs:

(a) Signals and signs which are non-standard height with respect to the line of sight of the rail traffic crew.

(b) Inconsistencies in height, lateral location or longitudinal placement of signals and signs.

Where required for the safety of the application, measures shall be taken to limit the visibility of the sign, so that it is primarily only visible to the line of sight of the intended users.

Railway signs and signals facing due east or west can be affected by sunlight conditions and should be avoided where possible. Where this is not possible, mitigation measures may be taken to ensure that clear visibility is achieved in all sun light conditions.

If there are close viewing requirements for railway signs or signals, these shall be reviewed.

4.2.4 Attention / parallel distraction factors

Railway signs and signals positioned close to other signs and/or signals shall not display confusing or conflicting information.

Signs proposed to be installed within the sighting distance of a sign or other signal intended for a primary user shall not compromise the sighting of that signal or other sign for that primary user.

In the case of signs provided in support of a signalling requirement, all aspects of that sign shall be subject to the recommendations of the signal sighting assessment and comply with AS 7721.

Assessments of attention / parallel distraction factors should include the effects of potential excessive visual workload, which could contribute to a reduction in the primary user's functional field of view or concentration.

4.2.5 Peripheral vision

Given the limitations of peripheral vision, especially in the ability to distinguish colour and shape, operational and safety critical signs should be designed to fall within the area of accurate vision.

Railway signs and signals intended for rail traffic crew should be placed within the 10-degree cone of vision, assessed from the location the rail traffic crew would normally be expected to react to that stimulus.

4.2.6 Recognition with track layout factors

The following route / line factors could affect recognition and should be assessed when considering optimum sighting arrangements:

(a) Whether railway signs and signals are located on the consistent side of the line.

(b) Location of railway signs and signals in relation to parallel tracks or sidings e.g., relative visibility of sign, where a sign is less obvious than an adjacent sign or signs further ahead, leading to the wrong sign being read.

(c) Irregular spacing in relation to railway signs and signals.

The arrangement (spacing and lineside) of signals shall be in accordance with AS 7721.

4.2.7 Colour and symbol recognition

Signs on a route which are depicting the same or similar intent should have similar colours for text, symbol types and background relative to previous signs.

When using colour coding for recognition, light levels shall be sufficient to differentiate between the colours.

Signs on a route should have similar configuration relative to previous and following signs.

Colours used on signs should be in accordance with AS 7632.

4.2.8 Criticality and depth of processing required

To maximize readability of railway signs and minimize the depth of cognitive processing and detection-response time required, text should be kept to a minimum to convey the message.

Text used shall be familiar and RIM approved pictorial representations used.

Where sighting factors have been identified which interfere with readability and the minimum detection-response times required, appropriate mitigation measures to overcome these factors shall be implemented. This can include:

(a) removal of sources of obstruction;

(b) alteration of sign height to improve visibility;

(c) relocation of the sign ensuring that the risk is not transferred elsewhere; and

(d) briefings to increase user awareness.

4.3 Minimum detection-response time

Recommended minimum detection-response times provided should be:

(a) 4 seconds for signs of known permanent status and fixed message, dependent on line speed. Sign should be used only to confirm route knowledge - viewer has already taken action to achieve requirement;

(b) 8 seconds for signs or signals with variable messages. Location should be known from route knowledge - viewer has already taken some action to achieve requirement;

(c) 8 seconds for unexpected signs:

  (i) 8 seconds plus time for vehicle to change to requirement, considering previous requirements and characteristics of expected traffic, including line speed;

  (ii) unexpected signs include temporary signs.

(d) the minimum sighting distance of a sign to satisfy these times for different line speeds is tabulated in Appendix B.

The times above shall be increased to allow for any site-specific sighting constraints.

Minimum sighting distances for signals shall be in accordance with AS 7721.

If the visibility of a railway signal or sign is affected by sighting obstructions or other constraints to detection-response requirements, the required sighting distance of the railway sign or signal should be extended as one of the mitigation measures.

Visibility and readability shall be maximized. To facilitate this the detection-response and sighting process of railway signs and signals the following factors should include the assessment of:

(e) visibility factors and viewing conditions (environmental factors and light intensity);

(f) criticality and depth of processing required;

(g) attention / parallel distraction factors;

(h) approach and the task that the primary user may be involved in during the approach;

(i) detection factors;

(j) association with route / line factors;

(k) readability factors including the impact of nearby signs and signals; and

(l) interpretation factors.

Where appropriate, the RIM should approve appropriate mitigation measures to overcome all or a combination of these factors.

4.4 Non-compliance

Where it is necessary to position railway signs or signals in a manner which do not comply with the sighting requirements in this Standard:

(a) the risk implications of each non-compliance shall be assessed;

(b) appropriate control measures shall be implemented to reduce the risks to a level so far as is reasonably practicable; and

(c) appropriate control measures shall be implemented to ensure no intolerable risks remain.

Section 5 Sighting hazards

5.1 General

A hazard is an unexpected stimulus to which an observer cannot react before changing their mental set to accommodate the new situation. It is therefore unreasonable to determine sighting requirements for unexpected hazards.

In the railway environment, certain areas where vehicles, people or animals could cross the track with or without authority can be classified as hazard locations.

Where hazard locations are identified, the appropriate risk assessment for sighting should be undertaken to maximize the detection-response time for personnel that could encounter hazards.

The factors specified in Section 3 to optimize sighting arrangements on the approach to hazard locations should be considered.

Any risk identified from the consideration of these factors should be mitigated such that optimum sighting conditions are provided to enable safe and controlled appropriate responses wherever possible.

Whilst undertaking sighting assessments, it is noted that the depth of processing and preparation required for a response to an unexpected stimulus could be greater than the response to a known permanent status stimulus, and as such could require greater detection-response time.

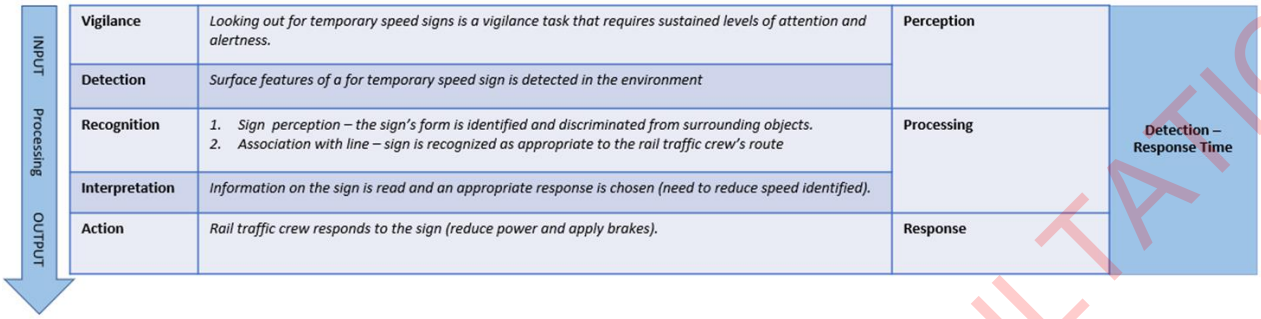
In the case of known permanent hazards such as limited clearance structures, the considerations for visibility and sighting of warning and information signs should include the relevant factors as defined in Section 3.

Appendix B contains a guideline table demonstrating calculation of the sighing time required on the approach of rail traffic. The table provides minimum sighting distances and shall be read in conjunction with this Standard.

Appendix A Sighting processes and factors (Informative)

A.1 Detection - response

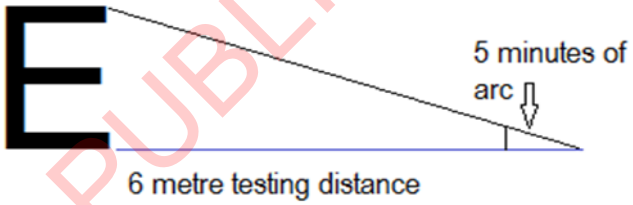
Appendix Figure A.1-1 is an example of the application of the detection-response processing stages framework as related to a driver processing the identification and reading of a signal or sign.



Appendix Figure A.1-1: Sequential processing for rail traffic crew

A.2 Visual acuity factors

Visual acuity refers to how well a person can see. Assuming daylight with high contrast text (black on white) and unlimited time, normal vision is defined as the ability of a person to recognize a letter (or an object) of approximately 8.8 mm size (or at a subtended angle of 5 minutes of arc as shown in Appendix Figure A.2-1) from a distance of 6 m. A person with normal vision is said to have 6/6 vision (or 20/20 (imperial)).



Appendix Figure A.2-1: Visual acuity

A person with 6/12 (20/40) vision is said to have poorer vision as they require letters that subtend twice this angle (10 minutes of arc) and are twice the height.

If the visual acuity is 6/30 (20/100), the letter size has to be increased by five times (or the angle subtend to 25 minutes of arc) to achieve the equivalent 6/6 (20/20) performance. Or alternatively, a five-time magnifier or telescope with five-time magnification has to be used, or the letters have to be brought five times closer.

Therefore on approach, a person with 6/6 (20/20) vision can barely read letters that are 2.5 cm tall at a distance of 17 m, and letters that are 5.4 cm tall at a distance of 38 m, and so forth (see Appendix B for example of calculations).

Visual acuity is affected by contrast and brightness of the object, and the relative speed between the object and the driver.

When undertaking a sighting assessment using the subtended angle of arc and required visual acuity, it shall be noted that actual conditions often vary from ideal conditions.

Any sighting consideration shall use National Health Standards and organisational visual acuity primary eligibility criteria in place for the primary user.

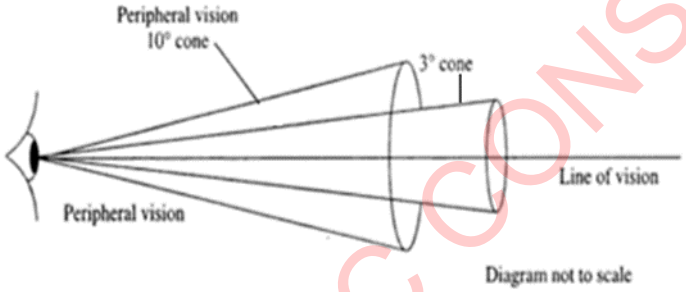
The calculation of the text size for any sign-based stimulus shall be based upon the visual acuity required of the primary user group as defined in the National standard for health assessment of rail safety workers. See Appendix B for calculations of text height.

A.3 Field of vision

Visual acuity reduces with the angle of vision.

The area of accurate vision (in which for normal vision, visual acuity is at least 6/6 or 20/20) for the human eye includes a cone of approximately 3 degrees from the focal point (see Appendix Figure A.3-1 below). The rest of the visual field is termed the peripheral vision.

Clarity of vision is reasonable within a 10-degree cone of peripheral vision. Beyond that, until about 160-degree cone, everything falls into peripheral vision and visual acuity deteriorates rapidly (Appendix Figure A.3-1).

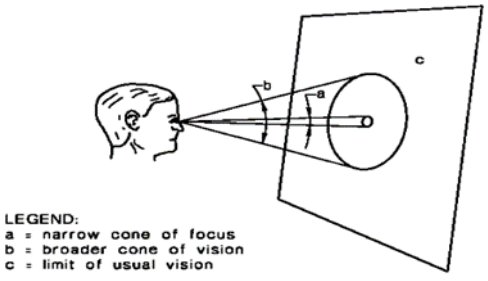


Appendix Figure A.3-1: Peripheral vision cone

The peripheral vision constraints of the primary user shall be included in optimising sighting arrangements, taking note of the following (see Appendix Figure A.3-2):

(a) A middle visual field broader cone with a visual angle of some 40 degrees. A stimulus within this cone is not clearly seen, but contrast and movement within the cone are discernible.

(b) An outer field visual angle beyond 40 degrees and up to 70 degrees. In this cone, a stimulus is not seen until it moves.



Appendix Figure A.3-2: Visual cone constraints

A.4 Colour detection

Types of colours and colour combinations are not equally discernible.

Light colours on dark backgrounds or dark colours on light backgrounds are usually considered as the more visual and discernible to the human eye.

Types of colours and colour combinations for all relevant railway infrastructure shall align with regulatory safety requirements and relevant standards and guidelines. For example, railway infrastructure signs shall comply with AS 7632.

A.5 Glare

The iris in the human eye acts as a diaphragm in a camera, opening wider to permit more light to enter the pupil in low-light conditions, and closing to reduce the amount of light entering in bright sunlight.

When the iris constricts (becomes smaller in diameter), relative refractive errors in the lens are reduced and visual acuity increases. However, if light levels are increased to excessively high levels then, the risk of glare is increased and visual acuity will be reduced.

A.6 Interpretation

Physical changes in simple stimuli are coded faster than symbolic information, and symbolic or pictorial information is typically processed faster than verbal or semantic information, as long as the symbols used are highly familiar and legible.

A.7 Recognition

Route / line factors can improve object recognition. These factors may include:

(a) consistency;

(b) spacing;

(c) colours; and

(d) symbols.

The above factors should be taken into account when considering optimum sighting arrangements.

Where circumstances are such that non-consistent sign and signal locations need to be considered, a risk assessment shall be undertaken as part of the design and installation process.

A.8 Vigilance

When faced with a stimulus, there are factors that can compromise the vigilance performance of a primary user. These factors include:

(a) in the case of the primary user being rail traffic crew, any in-cab checks that could need to be done on the approach (e.g., at the train / platform interface);

(b) lineside and surrounding distractions.

The sighting assessment of detection-response time shall include identifying distractions that might affect the primary user when the stimulus appears. For example:

(c) known use of equipment which causes additional activity and distraction;

(d) starting against a stop signal in a station when checking the safety of the train and any persons remaining on the platform.

A.9 Response selection

The length of time available for a response affects the quality of that response, especially in circumstances where several responses are expected to be available.

If high accuracy is required then, where possible, measures should be implemented to maximize given detection-response times as appropriate.

Response time is dependent on numerous factors including but not limited to:

(a) what the person/s are doing at the instant of visibility;

(b) physical and mental characteristics of the person/s viewing the object or stimulus;

(c) environmental and physical conditions surrounding the person/s viewing the object or stimulus.

A.10 Visual aids and auxiliary devices

Visual aids and auxiliary sighting devices include:

(a) safety sunglasses, hats and visors used to reduce glare or filter light;

(b) torches or night lights to enhance visual acuity in dim light or darkness;

(c) mirrors on rail or road traffic vehicles where the driver's view can be restricted from their position in the driver's seat; and

(d) reversing cameras on rail or road vehicles.

Where it is known that sighting is restricted, such appropriate devices can be used to remedy hazards arising from inadequate direct vision.

The use of appropriate visual aids and auxiliary devices shall be determined by risk assessment in conjunction with the manufacturer's instructions, relevant standards, and National Rail Safety Regulations.

In the assessment of optimal sighting arrangements, risks associated with the potential mis-function or constraints of such devices shall be assessed.

The hierarchy of controls shall be applied to minimize or mitigate any identified hazards arising from such mis-functions.

Appendix B Calculation of sight distance chart (Normative)

B.1 Sighting distance chart

Table B1 provides recommended sighting distances to calculate the minimum time for the clear sighting of signals and signs. The chart is provided as a guideline only and should not be used for safe working purposes.

See clause 4.3 for more information.

Appendix Table B.1-1: Sight distance chart

Line Speed (km/hr)	Time (s)													
	4	5	6	7	8	9	10	15	20	25	30	35	40	45
	Required Sighting (m)													
5	6	7	8	10	11	13	14	21	28	35	42	49	56	63
10	11	14	17	19	22	25	28	42	56	69	83	97	111	125
15	17	21	25	29	33	38	42	63	83	104	125	146	167	188
20	22	28	33	39	44	50	56	83	111	139	167	194	222	250
25	28	35	42	49	56	63	69	104	139	174	208	243	278	313
30	33	42	50	58	67	75	83	125	167	208	250	292	333	375
40	44	56	67	78	89	100	111	167	222	278	333	389	444	500
50	56	69	83	97	111	125	139	208	278	347	417	486	556	625
60	67	83	100	117	133	150	167	250	333	417	500	583	667	750
70	78	97	117	136	156	175	194	292	389	486	583	681	778	875
80	89	111	133	156	178	200	222	333	444	556	667	778	889	1,000
90	100	125	150	175	200	225	250	375	500	625	750	875	1,000	1,125
100	111	139	167	194	222	250	278	417	556	694	833	972	1,111	1,250
110	122	153	183	214	244	275	306	458	611	764	917	1,069	1,222	1,375
120	133	167	200	233	267	300	333	500	667	833	1,000	1,167	1,333	1,500
130	144	181	217	253	289	325	361	542	722	903	1,083	1,264	1,444	1,625
140	156	194	233	272	311	350	389	583	778	972	1,167	1,361	1,556	1,750
150	167	208	250	292	333	375	417	625	833	1,042	1,250	1,458	1,667	1,875
160	178	222	267	311	356	400	444	667	889	1,111	1,333	1,556	1,778	2,000

As the chart provides minimum sighting times, in reading the chart, potential constraints that could impact or influence the detection-response time of the primary user shall be assessed. For example, visibility factors and viewing conditions, visual acuity factors and glare.

B.2 Example calculation

What is the clear sighting distance to give a 10-second sighting on a route with line speed 80 km/hr?

A speed of 1 km/hr = 0.278 m/s (that is 1000/(60x60)

For:

Line speed 80 km/hr:

Distance in 1 second

= 80 x 0.278

= 22.22222 m

For:

10-second sighting, clear line of sight required:

= 22.2 x 10

= 222 m (see Appendix Table B.1-1)

Appendix C Hazard Register (Informative)

Hazard number	Hazard	Heading number(s)
5.3.1.3	Bodily impact, harm to persons	
5.7.1.17	Deficient worker procedures, insufficient high visibility clothing, etc., causing harm to persons on the track, path infringement	
5.9.1.25	Poor driver eyesight causing the driver to incorrectly interpret signals so that the driver effectively 'ignores' signals, Signal passed at danger	
6.10.1.1	Infrastructure infringing rolling stock kinematic gauge, path infringement	
6.12.1.2	Headlight illumination inadequate, poor cab vision	
6.12.1.9	Glare from sun through windscreens or off consoles, poor cab vision	
6.22.1.12	Persons on tracks, persons being crushed	
6.22.1.2	Persons being crushed between wheels and rails	
6.26.1.2	Impact with parts of trains, bodily impact	
6.26.1.22	Moving trains, persons being crushed	
6.26.1.5	Persons beside trains (on tracks or platforms), persons being crushed	
6.5.1.3	Persons being crushed, harm to persons	
6.6.1.15	Operational failure, harm to Track and civil Infrastructure by Rolling Stock	
6.6.1.16	Wayside structures infringing the rolling stock kinematic envelope, harm to Track and civil Infrastructure by Rolling Stock	
6.6.1.3	Hitting a wayside structure, harm to Track and civil Infrastructure by Rolling Stock	
7.1.1.12	Loss of situational awareness, derailment or collision	
7.1.1.13	Poor ergonomic design, derailment or collision	
7.1.1.15	Poor equipment layout, derailment or collision	
7.1.1.3	Miscommunication, derailment or collision	
7.1.1.5	Poor resources and/or excessive workload, derailment or collision	
7.1.1.9	Environmental conditions, derailment or collision	
7.2.1.12	Loss of situational awareness, harm to persons	
7.2.1.13	Poor ergonomic design, harm to persons	
7.2.1.15	Poor equipment layout, harm to persons	

Hazard number	Hazard	Heading number(s)
7.3.1.12	Loss of situational awareness, damage to rolling stock and/or infrastructure	
7.3.1.13	Poor ergonomic design, damage to rolling stock and/or infrastructure	
7.3.1.15	Poor equipment layout, damage to rolling stock and/or infrastructure	
7.3.1.3	Miscommunication, damage to rolling stock and/or infrastructure	
7.3.1.5	Poor resources and/or excessive workload, damage to rolling stock and/or infrastructure	
7.3.1.9	Environmental conditions, damage to rolling stock and/or infrastructure	
7.4.1.9	Environmental conditions, harm to the environment	
8.4.1.1	Being Struck by train, injury or death of an employee	
8.5.1.1	Being Struck by train, injury or death of a third party	
9.10.1.3	Failure to consider signal sighting, signals failure (design)	