Australian STANDARD®

Driving Cabs

RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

Rolling Stock Standard

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This Australian Standard® AS 7533:2021 Driving Cabs was prepared by a Rail Industry Safety and Standards Board (RISSB) Development Group consisting of representatives from the following organisations:

ARTC	Torrens Connect	Department of Transport (Vic)
Viva Health Group	John Holland Group	TfNSW
RTBU	UGL	Metro Trains
Pacific National		

The Standard was approved by the Development Group and the Enter Standing Committee Standing Committee in Select SC approval date. On Select Board approval date the RISSB Board approved the Standard for release.

Choose the type of review

Development of the 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 the 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 the 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.

Deb Spring
Exec. Chair / CEO
Rail Industry Safety and Standards Board

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Driving Cabs

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This Standard was prepared by the Rail Industry Safety and Standards Board (RISSB) Development Group AS 7533:2021 Driving Cabs. Membership of this Development Group consisted of representatives from the organisations listed on the inside cover of this document

This Standard supersedes AS 7533.1:2013 - Australian Railway Rollingstock - Driving Cabs - Locomotives , AS 7533.3:2013 - Australian Railway Rollingstock - Driving Cabs – Passenger, and AS 7533.4:2013 - Australian Railway Rollingstock - Driving Cabs - Infrastructure Maintenance

Significant technical changes to previous editions include:

a) combining the previous three-part publication into a single Standard to include locomotive rolling stock, passenger rolling stock and infrastructure maintenance rolling stock;
b) clause numbering changes throughout to support the restructured document;
c) addition requirements added to section 9 Exterior vision.

Objective

The objective of this Standard is to describe requirements for the design of:

a) driving cabs in locomotives and passenger trains;
b) driving cabs/stations in infrastructure maintenance rolling stock (i.e., vehicles intended for use on rails).

The main purpose of the requirements is to provide a safe and operable driving cab.

The application of this Standard relies upon the adoption of the Human Factors principles outlined in AS 7470.

Compliance

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

1. Requirements.
2. 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 is not able to be applied or other controls are more appropriate or 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 are addressed in an appendix A.

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, it does not form part of the requirements and recommendations of this Standard.

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Appendix Contents

1 Scope and general

1.1 Scope

This document applies to the design of new locomotives, passenger and infrastructure maintenance rolling stock. The document recognises the importance of a structured approach to human factors integration, through the application of appropriate knowledge, processes, and techniques, in order to enhance both safety and overall system performance.

The interior environmental requirements for driving cabs/stations are not covered in this document – refer to AS 7513.

The structural requirements for driving cabs/stations are not covered in this document - refer to AS 7520.

The interior crashworthiness of driving cabs is not covered in this document - refer to AS 7521.

The access & egress requirements for driving cabs/stations are not covered in this document - refer to AS 7522.

Operation of rolling stock in regard to network safe working rules and route standards is not covered.

Remotely operated rolling stock are not covered.

This Standard is not specifically intended to cover rolling stock used on light rail, cane railways and monorail networks, but items from this Standard may be applied to such systems as deemed appropriate by the relevant Railway Infrastructure Manager (RIM).

Road rail vehicles (RRVs) are within the scope, however only for their operation on the rail network. RRVs operating on public roads are out of scope – refer to AS 7502 and the Australian Design Rules (ADRs).

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:

- AS 7470 Human Factors Integration in Engineering Design – General Requirements.
- AS 7501 Rolling stock compliance certification.
- AS 7513 Rolling stock interior environment.
- AS 7520 Body structural requirements.
- AS 7521 Interior crashworthiness.
- AS 7522 Access & egress.
- AS 7531 Lighting & Visibility.
- AS 7631 Railway Infrastructure – Sighting.

1.3 Terms, abbreviations, and definitions

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

1.3.1
alarm
visual or auditory indication that the value of a monitored parameter, component, system, or function is outside the specified acceptable range and immediate action is required. For the purposes of this document alarm is interchangeable with alert.

1.3.2
anthropometrics
is a reference to the data used in anthropometry.

1.3.3
console
the desk arrangement that forms part of the driving position/workstation in the drivers' cab. As it appears directly in front of the driver it is an ideal location to place critical, hand-operated controls and is also a convenient location for display screens.

1.3.4
control
device located in the cab used to regulate or operate the train, communications, or other equipment.

1.3.5
HFIP
human factors integration plan.

1.3.6
HMI
human machine interface.

1.3.7
operator
the person or body responsible by reason of ownership, control or management, for the provision, maintenance or operation of trains, or a combination of these, or the end user acting on its behalf.

1.3.8
rear view device
rear view mirrors, video cameras or other vision assisting devices.

1.3.9
work closure
section of railway track closed off to normal traffic and undergoing maintenance, construction or inspection.

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

2 Human factors integration plan

2.1 A HFIP shall be developed for all cab design projects which is compliant with the Human Factors integration process outlined in AS 7470.

C2.1 Commentary

For projects such as the procurement of new rolling stock or the modification of existing rolling stock, the development of a HFIP early in the project i.e. prior to producing the technical specification, will facilitate the identification of what human factors work will be required to be undertaken during the project. It will also provide assurance that the needs of all users of the vehicle (or train when used as part of a consist) have been considered in the design for safe operations.

A HFIP is a plan for human factors activities which will be carried out during project delivery. It identifies human factors issues, constraints on the integration of human factors (e.g., pre-selected or legacy equipment), the activities that will be undertaken, dependencies and interactions with other project activities, and the process/means for considering human factors trade-offs. Human factors issues should be captured, tracked and managed in a human factors issues register (HFIR).

The HFIP could include the appropriate human factors activities related to rail cab design, including the following but not limited to:

(a) Driver's responsibilities and tasks.
(b) Crew positions.
(c) Visibility of signals (signal sighting requirements).
(d) Visibility of Persons on Track and Work Area (sighting requirements).
(e) Rear vision.
(f) Glare and internal lighting.
(g) Interior vision.
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(p) Emergency systems.
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(r) Cab colour scheme.
(s) Train coupling.
(t) Train crew amenities.
(u) Driver supervisory systems.
(v) Maintenance activities.
(w) Other user considerations (e.g., cleaners, trainers, other observers).
(x) Driver only operation (DOO).
(y) Non-driver crew that may be present.
(z) Interior noise levels.
(aa) Firefighting equipment locations.
(bb) Entry/exit access.
(cc) Interior cabin temperature.

C.2.1 Commentary (continued)

The HFIP may be used to identify (but is not limited to) the following specific studies:

(dd) Analysing conditions for optimal driver workload – this takes into consideration the use of tools such as task analyses or formal usability analyses to address monotony, underload, overload (especially in emergency or error recovery situations), opportunity for error and possibility for stress / strain injuries.

(ee) The identification of performance shaping factors, potential human errors and approaches to managing them.

(ff) User trials with a representative sample of end users.

(gg) Review of proposed designs with user groups/specialists (including drivers cab committees) to identify potential issues.

(hh)Review of emergency degraded and abnormal mode procedures.

(ii) Training needs analysis.

2.2 A human factors lead shall be appointed to be responsible for the integration of human factors into the design of the train cab - where this person is not a human factors specialist they shall ensure adequate input from appropriately qualified and experienced human factors professionals.

C.2.2 Commentary

Training may be provided to the project team regarding human factors to enable them to be aware of relevant issues throughout the project and seek additional support where required.

Useful human factors references can be found in Appendix C.

3 General requirements

3.1 A process which involves the use of 3D design review, a series of mock-ups and end-user involvement should be adopted early in the design phase of any cab design project.

C3.1 Commentary

The intent of this Clause is to facilitate stakeholder engagement early in the design phase of a cab design project to identify potential issues which the design will need to address. Some examples include:

(a) requirements for access and egress;

(b) visibility requirements;

(c) positioning of cab equipment in relation to structural elements such as collision posts and other interior crashworthiness considerations;

(d) other areas which could lead to either significant rework or a compromised solution for the overall design if not considered early in the project.

Historically mock-ups have provided valuable input into the design phase, by highlighting potential issues which need to be addressed. The mock-up process can often start with low fidelity mock-ups, and progress through to a higher fidelity mock-up as the design matures. RISSB Guideline - Integration of Human Factors in engineering design, provides additional information regarding the use of mock-ups.

3.2 Provision for disinfecting all surfaces that workers have direct contact with shall be provided.

C3.2 Commentary

The intent of this Clause is to provide adequate means of disinfecting the work area between users. Typically this would include, but not be limited to:

(a) door operating mechanisms;

(b) cab desk controls; and

(c) cab seats.

The method(s) of disinfecting could vary with surface types, for example vinyl seats can generally be wiped clean relatively easily, however cloth seats have the tendency to absorb perspiration which may lead to additional cleaning requirements.

4 Anthropometric Data

4.1 The design shall be appropriate for at least the size range of 5th percentile (P5) to 95th percentile (P95) of the clothed Australian adult population for male and female people.

C4.1 Commentary

Careful consideration is required in the selection of anthropometric sources, as there is no current comprehensive dedicated Australian data set.

The available data may not be entirely appropriate for the intended population of drivers, and therefore any limitations or justifications for the use of the data sets need to be acknowledged.

SAA HB59 is a common reference, however the data is now considered dated and is based on older U.K data. Penn State provides a public access database which can be found at the following address: https://www.openlab.psu.edu/design-tools-anthropometric-databases/

It is however important to note that a direct dependence on overseas anthropometric data used in Australian studies can be misleading to the designer because of Australia's multicultural population.

4.2 The design shall be appropriate for the range of forces that can be applied by the 5th percentile (P5) females of the Australian adult population.

C4.2 Commentary

This static measurement ultimately provides a limiting force, however this can be supplemented by 3D anthropometric data and to consider functional movement patterns and duration of use for example.

5 Interior dimensions

5.1 Cabs shall be sized to provide clearance for 95th percentile of the intended user population.

5.2 Operating positions should be such that a person's eyes are not located closer than 400 mm to a windscreen.

C5.2 Commentary
To mitigate the risk of the operator's head impacting the windscreen when the train is in motion.

5.3 Where the driver could be required to stand to operate the vehicle, it shall have a ceiling height at the driving position which is sufficient to accommodate the 95 percentile (P95) clothed Australian male.

C5.3 Commentary
Clothed includes a suitable allowance for shoes, which can typically be 30-40mm.

5.4 Where the driver could be required to stand to operate the vehicle, it should have a ceiling height at the driving position of at least 2000 mm.

6 Crew positions

6.1 Driving positions/workstations shall be provided in all driving cabs such that the driver is able to safely control the train/vehicle.

C6.1 Commentary
Where the design considers the physical, cognitive and psychosocial engagement with the driver, control of the train can be optimized for performance and human interaction.

6.2 When seated in the driving position, the driver shall be able to operate and see all driving task required controls, instruments and monitors within the cab, including having the exterior vision required to operate the rolling stock.

6.3 If multiple driving positions are available in a driving cab, then all driving positions shall allow the driver to safely control the train/vehicle/equipment from those positions.

6.4 Where the signal sighting in the network is based upon a specified driver position (e.g., left hand side of the vehicle) this driver position should be adopted in the cab design, except where it can be demonstrated that alternative seating positions are appropriate for the required signal sighting.

6.5 Where a second worker in addition to the driver is also required to be in the cab, a position with associated controls, vision and communications arrangements necessary to meet the requirements of the role shall also be provided.

C6.5 Commentary

Roles for second workers in the cab vary, for example this could include trainers, trainee drivers and workers with inspection tasks. The intent of Clause 6.5 is to provide the additional position in the cab, in such a way that the second worker can fulfill their duties whilst seated and eliminate the need for the second worker to move around within the cab.

The design should also address vision, communication and decision making with consideration to systems interfaces and the effects of distributed situational awareness.

7 Seating

7.1 Seating shall be adjustable to allow 5th percentile (P5) female to 95th percentile (P95) male driving crew to meet sighting requirements specified in Sections 4 and 5, and to reach and operate all required controls from the driving position.

C7.1 Commentary

Comfortable seating for driving crew will help to maintain operator effectiveness and alertness.

7.2 Seat adjustments should include:

(a) height (except for driving positions in road rail vehicles);

(b) seat back angle;

(c) seat pan tilt for locomotive and passenger rolling stock;

(d) seat back tilt for infrastructure maintenance rolling stock (except for driving positions in road rail vehicles);

(e) fore-aft position;

(f) swivel (except for driving positions in road rail vehicles);

(g) armrest height, where provided (except for driving positions in road rail vehicles);

(h) lumbar support;

(i) suspension.

7.3 The following key seat dimensions shall be evaluated when selecting a seat:

(a) Seat height.

(b) Seat width.

(c) Back support width.

(d) Back support height.

C7.3 Commentary

The following seat dimensions are suggested:

(a) Seat height, adjustable in the range 390 - 540 mm from the expected heel resting point (which may be the floor or the footrest/Vigilance pedal).

(b) Seat width: minimum 440 mm at the back and 480 mm at the front of the seat.

(c) Back support width: 360 - 440 mm.

(d) Back support height: minimum 450 mm (measured from the seat pan to the top of the back rest).

(e) Suspension - 100mm vertical stroke and should be adjustable to compensate for variations in the weight of different occupants.

7.4 The adjustment mechanisms shall be operable by the user in a seated position including 5th percentile female to 95th percentile male users.

7.5 Seating shall be located such that it allows a 95th percentile clothed person of the intended user population access to the exit or exits.

C7.5 & C7.6 Commentary

Locating seating with sufficient clearances to allow access, swivelling, and adequate legroom will promote comfort and avoid drivers banging into sidewall and other equipment.

Provision of appropriate seat suspension can also be considered to promote driver comfort.

7.6 Where the design incorporates a standing driving position, seating shall be positioned to permit the driver to stand and operate the controls without impediment or discomfort.

7.7 When rolling stock is operated outside of a work closure and not travelling between work closures, seats shall be provided for the driver or drivers.

C7.7 Commentary

When the driver or drivers are required to travel between work closures whilst standing, for example where it may not be practical to load / unload rolling stock on the rail, considerations include the:

(a) distance between work sites;

(b) time travelling between work sites; and

(c) impact on the driver or drivers ability to maintain the safe operation of the rolling stock.

7.8 Seating should be provided for additional worker(s) and/or trainer/inspector, appropriate for the intended use as required.

7.9 Any additional seat where provided shall be of reasonable size and appropriate for the intended use of inspectors and trainers.

C7.9 Commentary

Where additional seats are intended for use of inspectors or trainers it is considered that the roles require ergonomic and sighting considerations comparable to those provided for the driver. As inspectors and trainers can often spend a considerable amount of time seated in the additional seat(s), an understanding of the expected duration of use of the additional seat(s) can directly contribute to the adoption of an appropriate solution.

7.10 Any additional seat intended for the use of inspectors and trainers where provided shall not be a folding seat.

7.11 Any additional seat intended for the use of inspectors and trainers where provided should be designed to provide as far as practicable the ergonomic characteristics of a drivers seat.

7.12 The trainers/inspectors seat shall have visibility of the track ahead from their seated position as per section 9 and section 10 of this Standard.

C7.12 Commentary

AS 7470 defines end users and provides HF design requirements. Design considerations include the impact of the seat design and placement on the primary user (Driver).

Clause 7.12 is not intended to cover infrastructure maintenance rolling stock working inside/travelling between work closures.

7.13 No equipment in the cab shall impede access to or from the driver's and any additional workers seat, where provided.

7.14 The person in any additional seat shall not impede the drivers view.

8 Consoles/workstations

8.1 The console or workstation shall be designed for use whilst seated and/or standing as required.

8.2 The console shall allow, and not impede, drivers to reach any foot controls, the traction/brake controller and other required controls.

8.3 The console shall not have sharp edges that could cause harm to driver or other persons in the driving cab.

8.4 The console shall allow the driver to see the information presented on dials/displays.

8.5 The workstation should be designed as far as practical so that the driver operates the controls with shoulders relaxed, upper arms hanging and elbows at 90 degrees or more.

> *C8.5 Commentary*
> *Solutions provided for seating as per the requirements of Section 7, can when considered in conjunction with Clause 8.5 contribute to meeting this requirement for a Driver whilst seated.*

9 Exterior Vision

9.1 General requirements

9.1.1 The external view from the driving position shall be sufficient to ensure the driver can perform safely and effectively the operation tasks for which the rolling stock was designed.

> *C9.1.1 Commentary*
> *The production of an exterior vision requirements evaluation (as per Clause 9.1.2) can be used to assist with demonstrating the requirements of Clause 9.1.1 have been met.*

9.1.2 An exterior vision requirements evaluation shall be produced which documents:

(a) the type of rolling stock;

(b) the role of the driver or operator;

(c) the network(s) the rolling stock is intended to operate on;

(d) any applicable operational restrictions;

(e) details specific to the design; and

(f) state any non-compliance with the:

i. human factors requirements of AS 7470;
ii. interior environmental requirements outlined in AS 7513;
iii. structural requirements for driving cabs/stations outlined in the AS 7520 series;
iv. crashworthiness requirements of AS 7521;
v. access & egress requirements for driving cabs/stations outlined in AS 7522;
vi. lighting and visibility requirements of AS 7531; and
vii. sighting process outlined in AS 7631.

9.1.3 Where new or modified rolling stock requires certification under AS 7501, the exterior vision requirements evaluation produced in accordance with Clause 9.1.2 shall be appropriately detailed as outlined in AS 7501 for documents used in the application of AS 7501 this shall include one or more of the following:

(a) Data register

(b) Standards compliance register.

(c) Derogation risk assessment.

C9.1.2 Commentary
The intent of this clause is to assist with rolling stock compliance certification sort through the application of AS 7501. This facilitates consultation with key stakeholders early in procurement phase of a project.

9.1.3.1 Direct visibility shall take precedence over visibility via camera where sighting controls and safety critical infrastructure.

9.1.4 Where cameras are used to supplement sight lines, RTOs shall provide an assessment of the camera and its display or HMI which details the:

(a) Technical specification of the camera, display/HMI including:

i. resolution;
ii. response time;
iii. refresh rate;
iv. viewing angles;
v. susceptibility to glare; and
vi. its performance under varied lighting conditions.

(b) Limitations for its use, which could include:

i. specific lighting conditions;
ii. minimum/maximum sighting distances; or
iii. duration of its use.

(c) Impacts on operation, where images are delayed, frozen (i.e. not in real time) or degraded, which could be:

i. reduction of train speed;
ii. using alternative safeworking methods; or
iii. cease of work.

Details of this assessment shall be documented in accordance with the exterior vision requirements evaluation produced under Clause 9.1.1.

C9.1.5 Commentary

The following needs to be considered when designing a CCTV system:

(a) Visibility of the screen when the driver is seated in the normal driving position.

(b) Providing a field of view in the immediate vicinity of the rear of the vehicle.

(c) Providing a field of view sufficient to be able to stop clear of any signals when travelling at maximum travel speed.

(d) Providing the driver with a true representation of the scene.

(e) Ensuring the system can distinguish between signal colours under all lighting conditions.

9.2 Signal sighting principles

9.2.1 The signal sighting principles described in section 9.2 are considered to be applicable to all rolling stock types on all networks. Detailed worked examples of how these principles have been previously applied is given in Appendix B, the examples given in Appendix B are focussed on specific rolling stock types and specific networks. they can be adapted to other rolling stock types and networks, where deemed appropriate by the applicable RTO(s) and RIM(s).

9.2.2 The design criteria shall provide drivers or operators of all self-propelled vehicles a clear and unobstructed view of trackside signals from their driving positions.

9.2.3 Signal visibility testing shall be caried out to determine if the requirements of Section 9.1, Clause 9.2.1 and Clause 9.2.2 have been met.

9.2.4 In operating situations where the signal sighting requirements cannot be fully complied with (e.g., with cab trailing on a single cab locomotive), appropriate controls shall be put in place to ensure safe operation.

C.9.2 Commentary

If direct visibility is not practical, then suitable operational controls would need to be in place to protect other workers or equipment.

9.2.5 Details of all appropriate controls adopted by the application of Clause 9.2.4 shall be documented in accordance with the exterior vision requirements evaluation produced under Clause 9.1.1.

9.3 Visibility of persons on track

9.3.1 General

9.3.1.1 The forward-facing view from both the sitting and standing driving position (where the design includes a standing driving position) should allow the sighting of the head of a 5th percentile fully clothed adult female person standing at 5 metres ahead of the vehicle within the danger zone.

C.9.3.1.1 Commentary

If direct visibility is not practical then suitable operational controls would need to be in place to protect other workers or equipment.

9.3.2 Infrastructure maintenance rolling stock

9.3.2.1 The operator should have visibility of the work area and the functions under their control (either direct visibility or via cameras).

9.3.2.2 The operator should have visibility of workers and other track machines normally in close proximity to the track machine while working on track (either direct visibility or via cameras).

C9.3.2.2 Commentary

The definition of normally in close proximity will vary with operational context, therefore it is expected that workers and other track machines carrying out planned work would be doing under safe working practices as determined by risk management process and plant hazard assessment of the work to take place.

9.3.2.3 Whilst operating outside of a work closure, the direct visibility should take precedence over visibility via camera.

9.4 Rear vision

9.4.1 General

9.4.1.1 Rear view devices, where fitted, shall be adjustable to enable the operator to view the necessary parts of the vehicle consist from the normal driving position.

9.4.1.2 Rear view devices, where fitted, shall be designed such that they do not exceed the rolling stock outline, or be capable of being folded inwards when they exceed the rolling stock outline.

9.4.1.3 Rear view devices, where fitted, shall provide a steady and clear view of the vehicle(s) without the need for further adjustment at all speeds that rear vision is required.

9.4.1.4 Rear view devices, where fitted, shall provide a clear view under all weather conditions.

C9.4.1.4 Commentary

Considerations for the selection of review devices includes the performance of the device in severe weather conditions such as fog, frost, heavy rain and direct sunlight.

9.4.2 Locomotive and passenger rolling stock

9.4.2.1 Where there is an operational risk of injury or death due to reversing or door-closing, appropriate rear view devices (e.g. mirrors, CCTV screens etc) giving a field of view towards the rear of the train consist, shall be fitted at each driving cab.

9.4.3 Infrastructure maintenance rolling stock

9.4.4 Rear view devices (e.g., mirrors), giving a field of view towards the rear of the train consist, shall be fitted to both sides of vehicles at each driving cab.

9.4.5 Rear view devices shall be adjustable to enable the driver to view both sides of the vehicle consist from the normal driving position.

9.4.6 Rear view devices shall be designed such that they do not exceed the rolling stock outline or be capable of being folded inwards when they exceed the rolling stock outline.

9.4.7 Rear view devices shall provide a steady and clear view of the vehicle(s) without the need for further adjustment at all speeds that rear vision is required.

9.4.8 Where rear visibility is insufficient, a rear-vision mirror, or colour CCTV system which allows the operator to view the track at the other end of the vehicle shall be provided.

10 Interior vision

C10 Commentary

(a) Providing the ability to control illumination levels on the cab controls may be useful in managing sources of glare from inside the cab.

(b) Refer to AS 7531 for further information on cab general lighting.

10.1 Display screens shall be free from glare such that the information presented is legible by the driver during both day and night conditions - taking into account the light controls and other mitigations in place to manage the interior environment.

10.2 All cab controls, instruments and switches shall be illuminated when required such that their position or function is visible by the driver during both day and night conditions.

C10.2 Commentary

Instruments such as speedometers or gauges could be analogue devices, which require backlighting or digital devices i.e. displayed on a HMI.

10.3 When driving under night-time conditions, sources of illumination provided from inside the cab shall not produce glare/reflection that prevents the driver from sighting objects outside of the cab.

11 Glare

11.1 Means such as blinds, visors, tinted windows and non-reflective surfaces shall be provided where necessary to minimise glare while maintaining the required external visibility.

11.2 Reflectance of surfaces should increase from floor to ceiling.

> *C11.2 Commentary*
> *Desirable reflectance ratios/values for surfaces are generally the lowest for floors and increase for consoles/ work surfaces, followed by walls/structures and then upper walls and ceiling.*
>
> *As lighting conditions and types of surface finishes will vary, careful consideration for the targeted reflectance ratio/values can avoid undesirable effects such as a reflections of the ceiling in gauges or screens.*

11.3 Tinting film shall not be applied to the identified viewing area(s) of windscreens or cab side windows where the viewing of the platform is required.

11.4 Where window tinting or other film is permitted, it shall not change the colour perception of signals.

11.5 Blinds should be adjustable, providing adjustments in at least 25 mm intervals.

11.6 Blinds should have a positive locating and retaining device.

11.7 Any device within the cab fitted glazing, screens or other reflective materials should have an anti-glare treatment appropriate to the material of the device.

12 Controls and indicators

12.1 A process involving 3D design review, mock-ups and end-user involvement should be followed with new cab control arrangements to check that controls and indicators (including instruments, switches, HMIs etc) are designed and located based on sound ergonomic principles and human factors guidelines; maximise operator comfort, effectiveness and alertness; and minimise operator errors and fatigue.

12.2 Where controls are used in high fidelity mock-ups, they should be the actual controls with regard to movement, operating force, texture and shape.

C.12.2 Commentary

Some important principles to consider are listed below:

(a) Controls may be located so that operators can maintain the correct alignment of activating body part (and avoid twisting or excessive bending of limbs) when using them.

(b) Controls may be shaped to suit activating body part.

(c) Functionally related controls and displays be located close to each other and arranged in functional groups, e.g., power, status, and test.

(d) Controls be located within reach of 5th percentile female users to 95th percentile male users from the driving position; this may place controls within the static or dynamic reach envelopes depending on the frequency and importance of controls (see C.12.2(f)).

(e) Controls be located within the sight envelopes for 5th percentile female users to 95th percentile male users.

(f) Controls be located so that important and frequently used controls are located closer to the user than those which are less important or used less frequently.

(g) Controls be located so that they are consistent with the expected sequence of use.

(h) Controls be located and operate in a consistent fashion to other (similar) rolling stock that a driver will use - deviations from similar rolling stock be justified and the impact on the driver considered.

(i) Controls that could be accidentally activated be identified and be located in areas where they are less likely to be activated accidentally or are protected from accidental activation.

(j) Each control be distinguishable from others in at least two ways (e.g. visually by colour or labelling, or by tactile means such as location, size, or shape).

(k) Any text or symbols be appropriately sized, legible and unambiguous, with all text written in the English language using a 'sans serif' font. In some applications capitalized text is preferred to improve legibility.

(l) Allowance be made for varying size, strength, vision, hearing and knowledge of the operators.

(m) Minimise the operating forces for frequently used controls. Further information regarding operating forces can be found in US MIL-STD 1472F.

12.3 Where possible, driving controls should be standardised across cabs to support drivers who transfer from one cab to another.

13 Speed indicating device

13.1 Locomotive and passenger rolling stock shall have at each driving position an operative speed indicating device that is visible to the driver and trainer at their designated position.

13.2 Infrastructure maintenance rolling stock shall have at each driving position on rail bound equipment capable of travelling greater than 15km/h an operative speed indicating device that is visible to the driver at that driving position.

13.3 The speed indicated to the driver shall not at any time indicate a speed below the actual speed.

13.4 The speed indicated to the driver should not at any time indicate a speed greater than 3 km/h above the actual speed.

C13.4 Commentary
This can be challenging for legacy rolling stock with inaccurate data sources.

13.5 The speed indicating device shall be legibly marked.

13.6 The maximum authorised design speed of the vehicle should be marked in red and be clearly in view of the driver in the normal operating position.

13.7 The speed indicating device shall read in km/h.

13.8 Rolling stock shall be capable of indicating speeds 25 % in excess of the maximum design speed.

13.9 Locomotive rolling stock speed should still be indicated while the locomotive is switched off-line.

14 Alarms

14.1 Alarm philosophy

14.1.1 An alarm philosophy that describes the alarm system and its underpinning principles, including coding systems used to convey urgency and the priorities of all alarms should be developed in accordance with AS 7470.

> *C14.1.1 Commentary*
> *When developing an alarm philosophy, the operational context for the rollingstock will need careful consideration, for example for driver only operation may significantly impact the design features for alarms (see Section 14.3).*

14.1.2 The alarm should be functionally tested with the intended user population to verify the design is effective, including discrimination of interpretation of alarms and masking (i.e., ensuring that alarms do not mask other alarms, especially higher priority alarms).

14.1.3 The alarm philosophy of infrastructure maintenance rolling stock should consider the different modes of operation (i.e., travel and work).

14.2 Application of alarms

14.2.1 Alarms (and the associated set points) should be raised to the driver as described in the alarm philosophy developed in accordance with Clause 14.1.1, so the driver can monitor and respond in a timely manner.

> *C14.2.1 Commentary*
> *If an alarm cannot be provided in a time for the driver to respond then it is superfluous. Alarms are only required where operator action is required. Alarms could be prioritised to communicate to the driver which alert to attend to first and to ensure that alerts are designed such that they do not interfere with higher priority alerts/alarms.*
>
> *It is desirable that higher priority alarms subdue lower priority alerts and following the higher priority alerts being acknowledged the lower priority alarms then return so they can be acknowledged by the driver.*
>
> *AS 7470 provides detailed requirements for the human factors requirements for alarms and alerts.*

14.2.2 The total number of auditory alarms used in the cab should not exceed twelve.

> *C14.2.2 Commentary*
> *The auditory element of an alarm can be removed following acknowledgement, but a visual indication can remain until it is either deleted or addressed.*
>
> *AS 7470 provides HF requirements for alarms alerts.*

14.3 Design features of alarms

14.3.1 General

14.3.1.1 Only events requiring immediate attention should use a continuous aural element.

14.3.1.2 Only events requiring immediate attention should use a flashing indicator.

14.3.1.3 The alarm system should be distinctively coded with a 'Low', 'Medium' or 'High' priority, with the applied coding priority for an event reflecting the safety or operational urgency of the situation.

C14.3.1.3 Commentary

Consideration needs to be given to ensuring the alarms that a driver is presented with always appear in the same form in the same location with the same required response in all driving cabs as far as practical.

14.3.2 Auditory

14.3.2.1 Each auditory alarm should:

(a) have a frequency component between 500 and 750Hz;

(b) have three (3) or more components in the 300-3000Hz range;

(c) align in terms of urgency of sound and urgency of the situation;

(d) use a modulated signal to give best discrimination from normal sounds;

(e) use signals that have different frequency to background noise;

(f) use moderate sound levels if multiple alarms are used;

(g) use independent horns/bells/loudspeakers;

(h) co-locate alarm source near any associated controls in the cab e.g. vigilance alarm source near the vigilance acknowledge pushbutton.

14.3.2.2 The alarm level for critical alarms should be between background noise plus 10dB(A) (minimum) and a sound level of 105dB(A) (maximum) but should not exceed the background noise by more than 25dB(A).

C14.3.2.2 Commentary

Considerations of background noise conditions of the cab typically take into account all of the following conditions:

(a) Air conditioning / fans running at maximum speed with maximum cooling / heating.

(b) Vehicle operating at maximum design speed.

(c) Vehicles operating at maximum power / braking settings.

(d) Vehicle operating on track conditions as encountered on the network.

(e) Windows / doors open.

AS/NZS 1269.0 provides general requirements for occupational noise management and an overview of the AS/NZS 1269 series.

14.3.2.3 Alarms shall be tested using “A” weighted spectrum with the measuring instrument set to fast response and located at ear height of a seated driver in each driving station.

C14.3.2.3 Commentary
AS 2377 sets out methods for the measurement of A-weighted railbound vehicle noise, which includes components generated by the vehicle and its operation. AS/NZS IEC 61672.1 provides the performance specifications for sound level meters capable of undertaking these measurements.

14.3.2.4 The measuring instrument shall be located on the centreline of the driver's seat.

C.14.3.2.4 Commentary

The alarm system can minimise startle reactions through the use of the following points:

(a) The increase in sound level during any 0.5 sec period is not greater than 30 dB(A).

(b) The first 0.2 sec of an alarm sounding is not presented at maximum intensity and this includes the use of square topped waveforms, or present abruptly rising waveforms.

14.3.2.5 Aural alarms should have an associated visual alarm.

14.3.2.6 Critical alarms should continue until silenced by the operator (or as per the alarm philosophy).

14.3.3 Visual

14.3.3.1 Visual alarm indications should be located within 60 degrees on either side of the line of sight of the operator's normal working position.

14.3.3.2 High priority visual alarm indications should be located within 30 degrees of the normal viewing angle (i.e., 15 degrees below horizontal in front of the operator).

C.14.3.3.2 Commentary

An alarm philosophy (as per Clause 14.1.1) can detail operational specific requirements to assist with assigning suitable positions and priorities to visual alarms. Examples include:

(a) Infrastructure maintenance rolling stock can have multiple operating stations i.e. for carrying out work or travelling where lines of sight can vary.

(b) Driver only operations, where in some cases it can be preferable to locate visual alarms in a central position in the cab as opposed to one side.
Use clear terminology in alarm text that suggests remedial action where possible - avoid using coded alarm identifiers that are not meaningful for users.

14.3.3.3 Other non-alarm sources of illumination should be located away from alarm displays to avoid them being mistaken for, or masking, an alarm.

14.3.3.4 Symbols and characters should be large enough to subtend a viewing angle of no less than 20 minutes of arc measured from the design eye position (where one degree is equal to 60 minutes of arc).

C14.3.3.4

In some applications capitalized text is preferred to improve legibility.

14.3.3.5 Alarm text should be written in English.

Appendix A Hazard register

The following table shows hazardous events and publishable consequences that can be controlled by this Standard. The effectiveness of control should be assessed by the user.

Publishable Consequence	Hazardous Event
Collision between Train and projectile	Non-Passenger-Train collision with projectile
Collision between Train and projectile	Passenger-Train collision with projectile
Collision in Yard between Train and Member of Public/Trespasser	Non-Passenger-Train collision with Member of Public/Trespasser in Yard (not including suicides)
Collision on Running Line between Train and Member of Public/Trespasser	Non-Passenger-Train collision with Member of Public/Trespasser on Running Line not at a level crossing not at a station platform (not including suicides)
Collision on Running Line between Train and Member of Public/Trespasser	Passenger-Train collision with Member of Public/Trespasser on Running Line not at a level crossing not at a station platform (not including suicides)
Maintenance Vehicle collision with other train/MV on Running Line (Where collision was caused by other train/MV)	Maintenance Vehicle collision with other train/MV on Running Line (Where collision was caused by other train/MV)
Maintenance Vehicle collision with worker on Running Line not at a level crossing	Maintenance Vehicle collision with worker on Running Line not at a level crossing
Rolling Stock collision with Buffer Stop in Yard including gates and other stops but not including derailers	Rolling Stock collision with Buffer Stop in Yard including gates and other stops but not including derailers
Rolling Stock derailment in Yard	Rolling Stock derailment in Yard
Train Collision with Buffer Stop in Yard	Non-Passenger-Train collision with Buffer Stop in Yard including gates and other stops but not including derailers
Train Collision with Buffer Stop on Running Line	Non-Passenger-Train collision with Buffer Stop on Running Line
Train Collision with Buffer Stop on Running Line	Passenger-Train collision with Buffer Stop on Running Line
Train Collision with infrastructure on Running line	Non-Passenger-Train collision with infrastructure on Running Line (permanent structures like platforms, signs, loaders) not including obstructions (e.g. temporary signs and other temporary equipment)
Train Collision with infrastructure on Running line	Passenger-Train collision with infrastructure on Running Line (permanent structures like platforms, signs, loaders) not including obstructions (e.g. temporary signs and other temporary equipment)
Train collision with Road User at Public Road Level Crossing	Train collision with Road User at Public Road Level Crossing
Train collision with Rolling stock in Yard	Non-Passenger-Train collision with Rolling Stock in Yard

Publishable Consequence	Hazardous Event
Train collision with an animal in Yard	Non-Passenger-Train collision with an animal in Yard
Train collision with an animal on Running Line	Non-Passenger-Train collision with animal on Running-Line
Train collision with an animal on Running Line	Passenger-Train collision with animal on Running-Line
Train collision with derailed other train/MV on running line	Non-Passenger-Train collision with derailed other train/MV on Running Line
Train collision with derailed other train/MV on running line	Passenger-Train collision with derailed other train/MV on Running Line
Train collision with infrastructure in Yard	Non-Passenger-Train collision with infrastructure in Yard not including obstructions, i.e. permanent structures like platforms, signs, loaders however not including temporary signs and other equipment
Train collision with obstruction at Level Crossing	Non-Passenger-Train collision with obstruction at Level Crossing of any type (Not Road User or Pedestrian)
Train collision with obstruction at Level Crossing	Passenger-Train collision with obstruction at Level Crossing of any type (Not Road User or Pedestrian)
Train collision with obstruction in Yard	Non-Passenger-Train collision with obstruction in Yard not at a level crossing
Train collision with obstruction on Running Line	Non-Passenger-Train collision with obstruction on Running Line not at a level crossing
Train collision with obstruction on Running Line	Passenger-Train collision with obstruction on Running Line not at a level crossing
Train collision with other train in Yard	Non-Passenger-Train collision with other train/MV in Yard
Train collision with other train on Running Line	Non-Passenger-Train collision with other train/MV on Running-Line
Train collision with other train on Running Line	Passenger-Train collision with other train/MV on Running Line
Train collision with other train/MV on Running Line (Where collision was caused by other train/MV)	Non-Passenger-Train collision with other train/MV on Running Line (Where collision was caused by other train/MV)
Train collision with other train/MV on Running Line (Where collision was caused by other train/MV)	Passenger-Train collision with other train/MV on Running Line (Where collision was caused by other train/MV)
Train collision with passenger/member of public at a platform/station	Non-Passenger-Train collision with passenger/member of public at a platform/station not due to slip, trip, or fall (not including suicide attempts)
Train collision with passenger/member of public at a platform/station	Passenger-Train collision with passenger/member of public at a platform/station not due to slip, trip, or fall (not including suicide attempts)
Train collision with worker in Yard not at a level crossing	Non-Passenger-Train collision with worker in Yard not at a level crossing

Publishable Consequence	Hazardous Event
Train collision with worker on Running Line not at a level crossing	Non-Passenger-Train collision with worker on Running Line not at a level crossing
Train collision with worker on Running Line not at a level crossing	Passenger-Train collision with worker on Running Line not at a level crossing
Train derailed or load dropped at loader/unloader in Yard	Non-Passenger-Train derailment or load dropped in Yard while loading/unloading
Train derailment in Yard	Non-Passenger-Train derailment in Yard
Train derailment on Running Line	Non-Passenger-Train derailment on Running-Line
Train derailment on Running Line	Passenger-Train derailment on Running-Line

Appendix B Signal sighting - worked examples (normative)

B.1 General

B.1.1 The content sections B.2 through B.3 provide worked examples where the signal sighting requirements of Clause 9.2 have previously been achieved. Any solutions adopted from the examples provided from the shall be detailed in the exterior vision requirements evaluation as per the requirements of Clause 9.1.1. The detail shall include how the rolling stock will interface the current network specific infrastructure and rules of the network(s) intended for use.

> *CB.1.1 Commentary*
> *As network specific rules and infrastructure can change, the exterior vision requirements evaluation will provide the detail as to how the current network specific criteria is intended to be met.*

B.2 New South Wales standard gauge network

B.2.1 All rolling stock

B.2.1.1 Where a vehicle operates outside a work closure (or is otherwise required to drive according to signals), the driver shall have direct line of sight to low level signals:

(a) The driver shall have direct line of sight to dwarf post and ground mounted signals located at rail height to a height of 2.5 metres above rail level, at all distances greater than 13 metres from the driver's eye position while in the seated position. This field of view shall be seen to a width of 2.5 metres from the adjacent rail running face on either side of the track. This is illustrated in figure B:1.

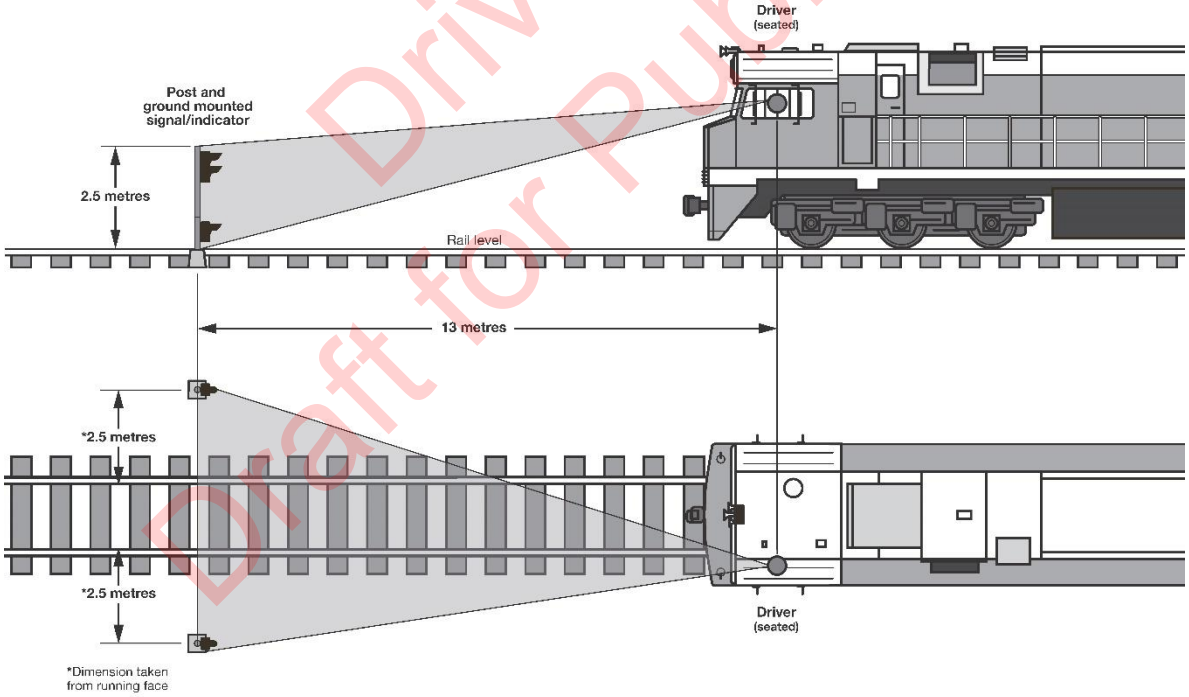

Figure B:1 – Sighting low level signals on NSW network –driver sitting

(b) The driver shall have a direct line of sight to ground mounted signals, located at rail level to a height of 1 m above rail level at all distances greater than 4 m from the driver's eye position while in the standing position. This field of view shall be seen to a width of 2.5 m from the adjacent rail running face on either side of the track. This is illustrated in Figure B:2.

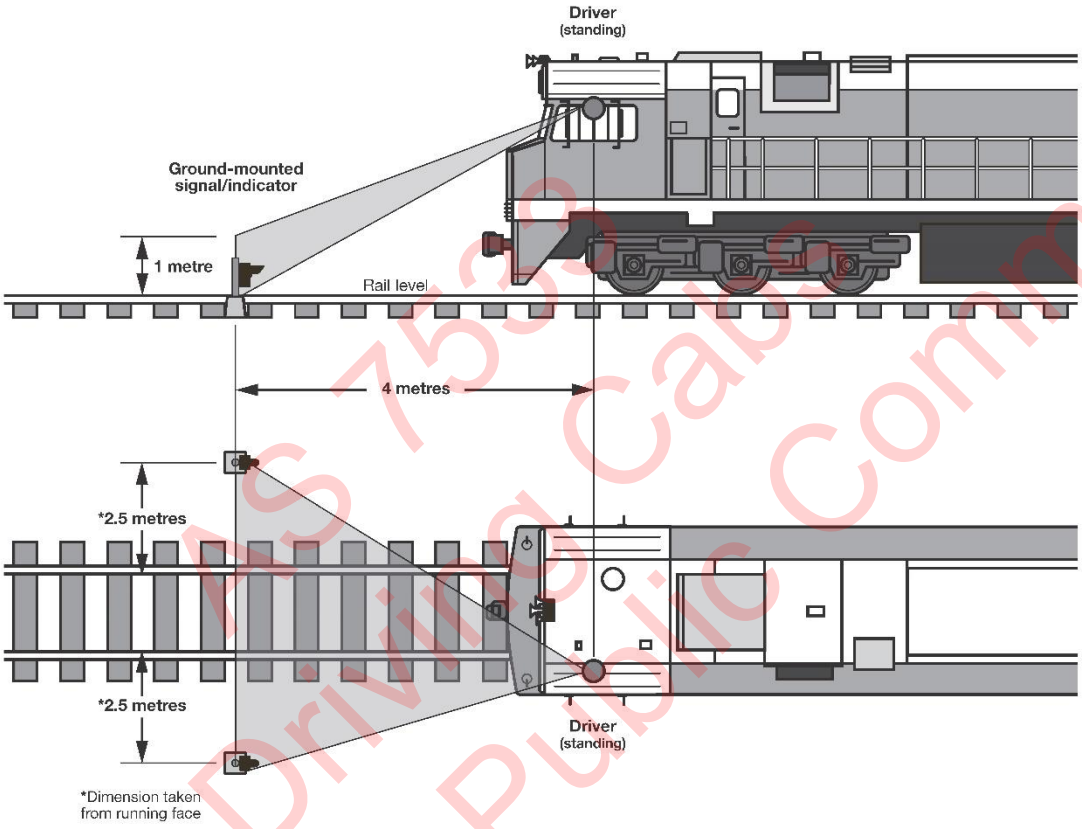

Figure B:2 - Sighting low level signal on NSW network – Driver standing

(c) The driver shall have a direct line of sight to standard or high post signals and gantry mounted signals located at a height of 2.5 m above rail level to a height of 6.7 m above rail level, at all distances greater than 13 m from the driver's eye position while in the seated position. This field of view shall be seen to a width of 5 m from the adjacent rail running face on either side of the track. This is illustrated in Figure B:3.

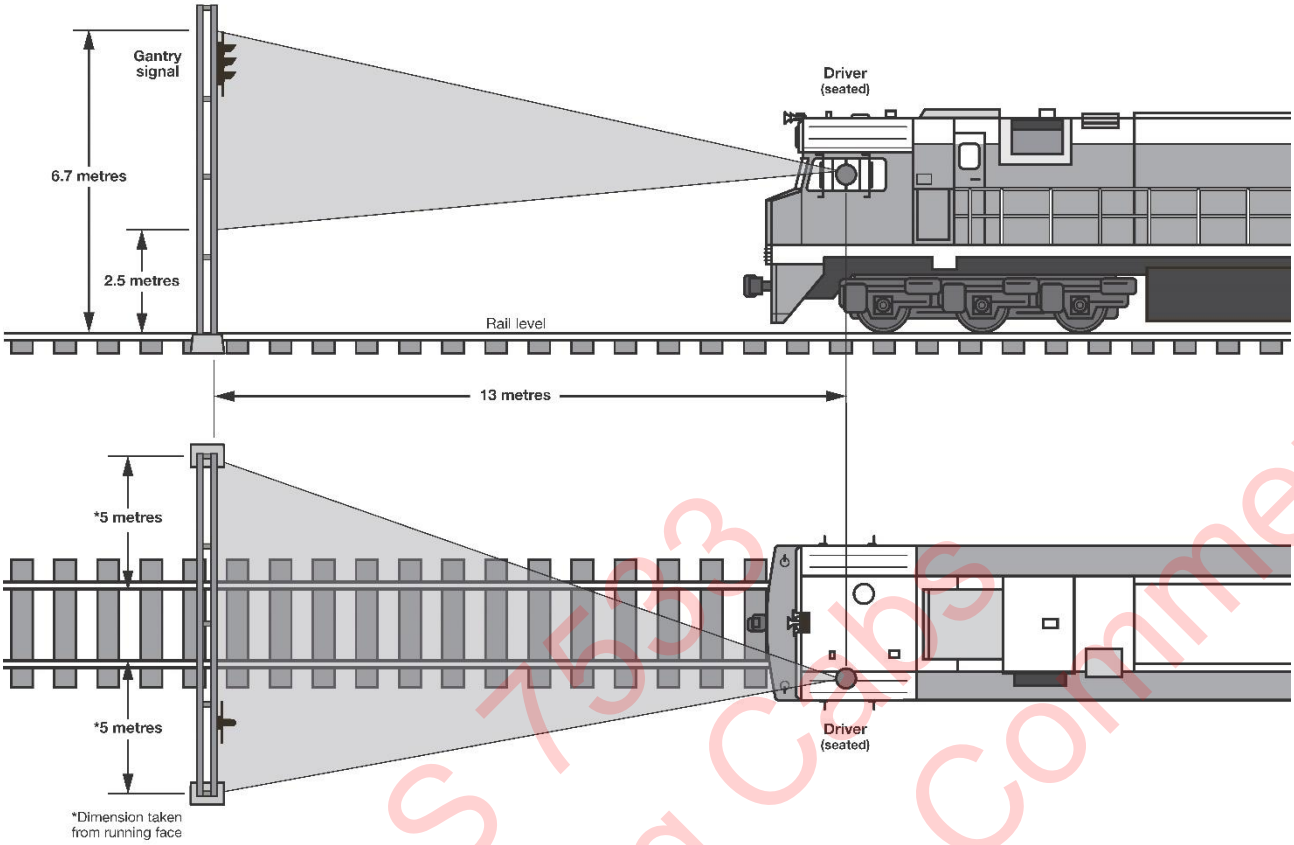

Figure B:3 - Sighting high level signals on NSW network – driver sitting

B.2.2 Additional signal visibility requirements for EMU and DMU passenger rolling stock

B.2.2.1 For EMU and DMU type rolling stock, the driver shall have a field of view as explained in Clauses B.2.2.2, B.2.2.3 and B.2.2.4, including a direct line of sight to the items described in this section. These requirements are in addition to those specified in Section B.2.1.

B.2.2.2 EMU (only) passenger rolling stock sighting requirements for tunnel signals. The driver shall have a direct line of sight to tunnel signals located 1.3 m above rail level to a height of 3.3 m above rail level, located at all distances greater than 4 m from the driver's eye position while in the seated position. This field of view shall be seen to a width of 1.25 m from the adjacent rail running face on either side of the track. This is illustrated in Figure B:4.

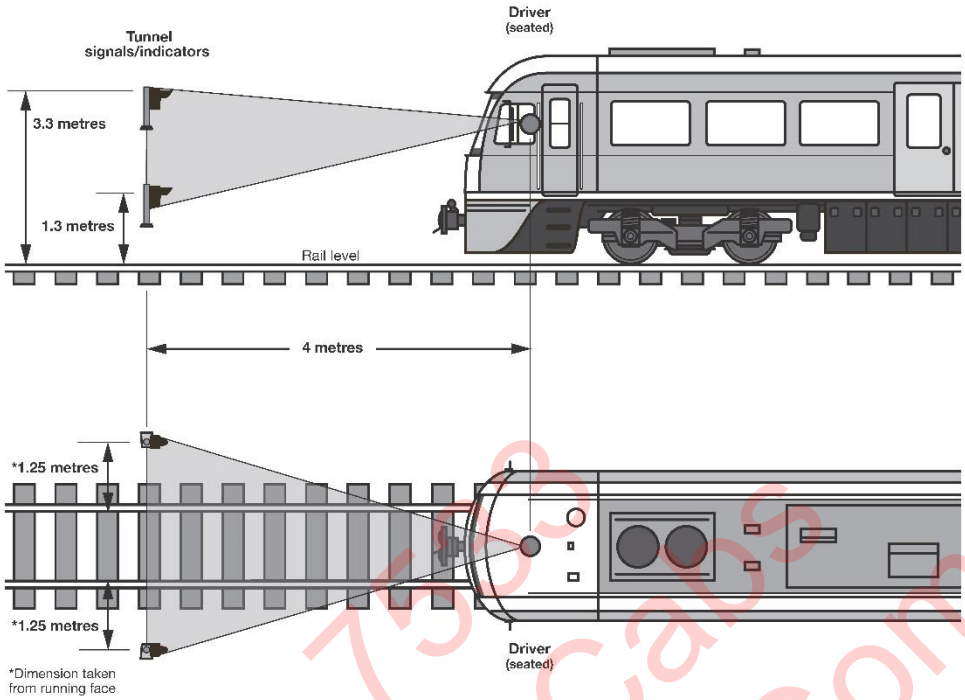

Figure B:4 – EMU (only) seated tunnel signal visibility

B.2.2.3 EMU and DMU passenger rolling stock sighting requirements for ground mounted signals. The driver shall have a direct line of sight to ground mounted signals located at rail level to a height of 1 m above rail level, at all distances greater than 2.5 m from the driver's eye position while in the standing position. This field of view shall be seen to a width of 1 m from the adjacent rail running face on either side of the track. This is illustrated in Figure B:5.

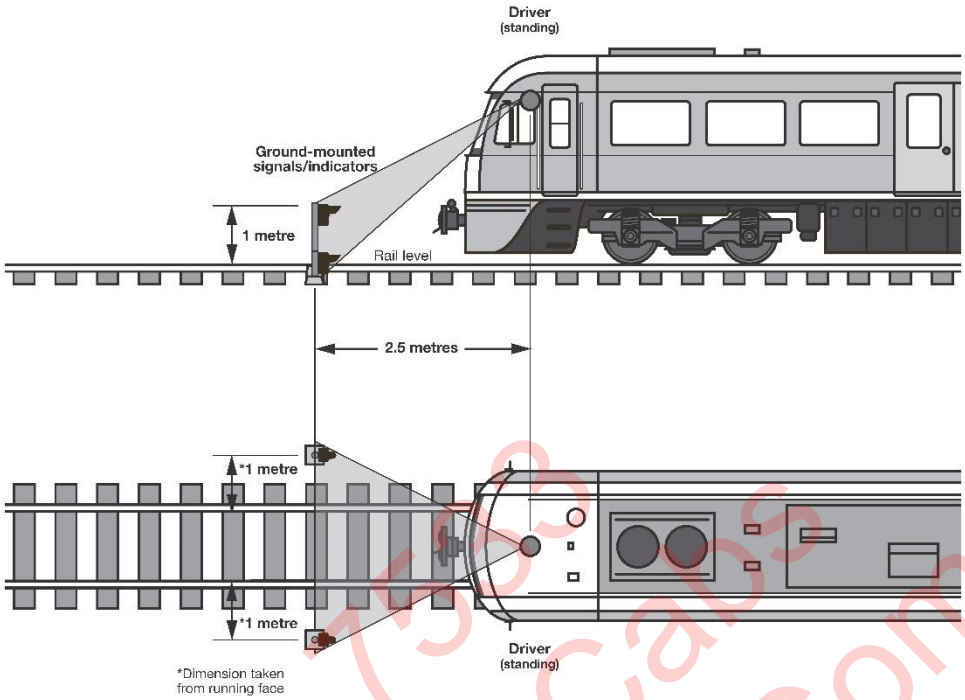

Figure B:5 – EMU and DMU standing mounted signal visibility

B.2.2.4 EMU and DMU passenger rolling stock sighting requirements for post mounted signals. The driver shall have a direct line of sight to post mounted signals located 1.3 m above rail level to a height of 5.6 m above rail level, located at all distances greater than 4 m from the driver's eye position while in the seated position. This field of view shall be seen to a width of 2.5 m from the adjacent rail running face on either side of the track. This is illustrated in Figure B:6.

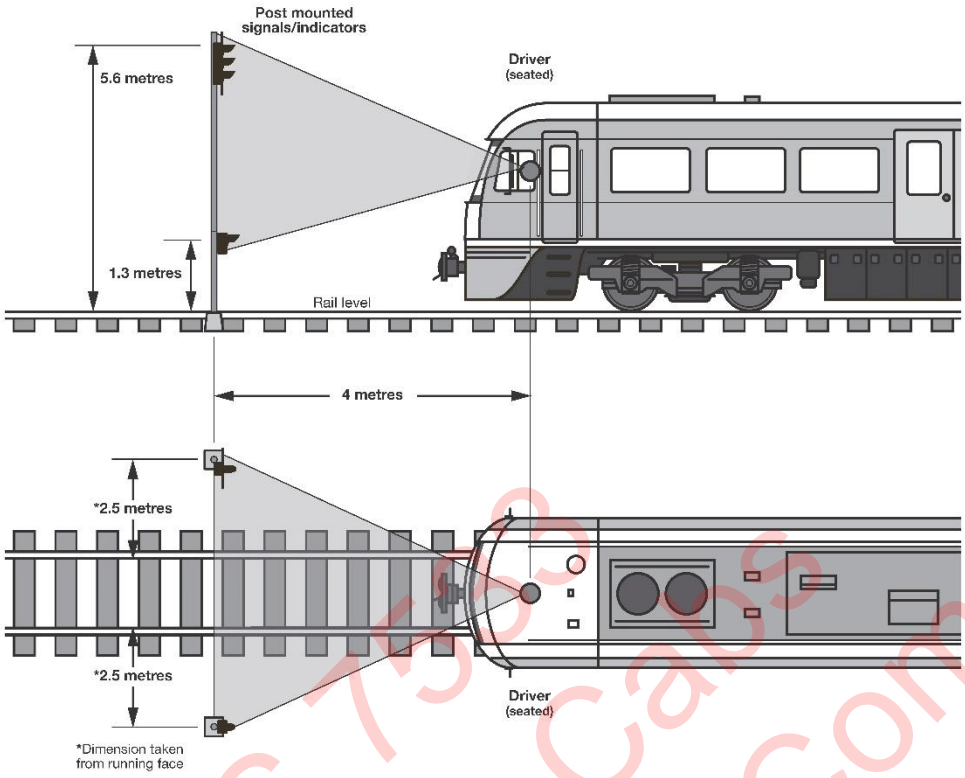

Figure B:6 – EMU and DMU seated post mounted signal visibility

Driving cab side windows of EMU and DMU passenger rolling stock

B.2.3 Allowance for driver head movement

B.2.3.1 Clauses B.2.1.1(a) and B.2.1.1(c) are considered normal driving sighting requirements and shall not apply any allowance for head movement as described in Clause B.2.3.2.

B.2.3.2 All sighting requirements should be met without any movement in the point of origin for the sightlines defined in sections B.2.1 & B.2.2.In order to provide some flexibility in defining the point of origin for the sightlines defined in Clauses B.2.1.1(b) , B.2.2.2 B.2.2.3 and B.2.2.4 consistent with the degree of head movement expected of a driver, the point of origin of the sightlines shall be taken as anywhere within an oblate spheroid (with a horizontal radius of 200 mm and a vertical radius of 100 mm) centred at the point of origin as shown in Figures B:2, B:4, B:5, and B:6.

> *CB.2.3.2 Commentary*
> *The allowance for head movement is provided for the above stated Clauses and associated figures, as these are considered focus driving actions normally associated with departure from platforms when stationary.*

B.2.3.3 The requirements of B.2.3.2 shall be deemed to be met if the sighting requirement can be met at any point (but not necessarily all points) within the oblate spheroid specified.

B.2.4 Driving cab side windows of EMU and DMU passenger rolling stock

Driving cabs in existing NSW passenger trains are fitted with cab side windows adjacent to the drivers seated position on both sides of the vehicle. The main purpose of the cab side windows is to provide the train crew with visibility of platforms and car markers in order to align the train at the correct position when stopping at platforms, and for general peripheral vision. Suitable means shall be provided to achieve this requirement.

B.3 QLD narrow gauge network:

B.3.1 Locomotive, passenger and infrastructure maintenance rolling stock

Where a vehicle operates outside a work closure, the driver shall have a direct line of sight to signals viewed on approach where the forward facing view from the driver's eye position should allow the sighting of a 4 metre high signal lamp that is located 3 metres laterally to either side of a tangent track centreline and 5 metres ahead of the vehicle.

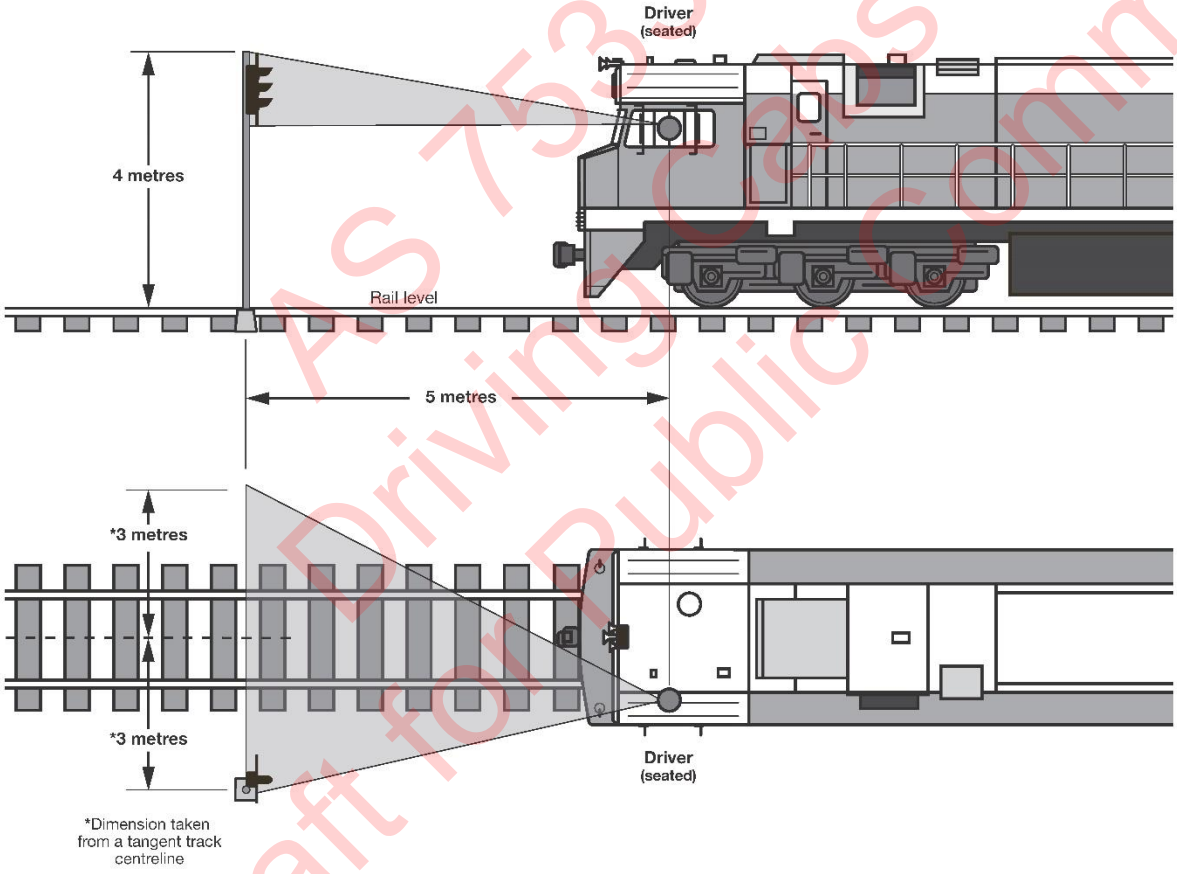

Figure 14:4 - Sighting for signals on QLD network

Appendix C Bibliography

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

(a) AS 2377 Acoustics- Methods for the measurement of railbound vehicle noise.

(b) AS 4024.1 Safety of machinery.

(c) AS 4292 Railway safety management.

(d) AS 7502 Road rail vehicles.

(e) AS 7510 Brakes.

(f) AS 7511 Onboard train protection systems.

(g) AS/NZS 1269.0 Occupational noise management overview and general requirements.

(h) AS/NZS IEC 61672-1 Electroacoustics - Sound level meters - Part 1: Specifications

(i) ISO 1503 Spatial orientation and direction of movement [of controls and displays] – Ergonomic requirements.

(j) ISO 6385 Ergonomic principles in the design of work systems.

(k) ISO 6682 Earth-moving machinery – Zones of comfort and reach for controls.

(l) ISO 9241 Ergonomic requirements for office work with visual display terminals (VDTs).

(m) ISO 9355 Ergonomic requirements for the design of displays and control actuators.

(n) ISO 11581 Information technology – User system interfaces and symbols – Icon symbols and functions.

(o) ISO 13407 Human-centred design processes for interactive systems.

(p) ISO 18152 Ergonomics of human-centred system interaction – Specification for the process assessment of human-system issues.

(q) ISO 18529 Ergonomics of human-centred system interaction – Human centred lifecycle process descriptions.

(r) ARTC Standard ESD-32-01.

(s) DEFSTAN 00-250 2008 Human Factors for Designers of Equipment.

(t) MIL-STD 1472F US Department of Defence Design Criteria Standard Human Engineering.

(u) NUREG-0700 Rev.2 2002, Human-System Interface Design Review Guidelines.

(v) People size 2008 Pro, anthropometric data.

(w) SAA Handbook HB59 Ergonomics - The human factor - A practical approach to work systems design.

(x) US Department of Transportation, FAA, 2003, Human Factors Design Standard (HFDS) For Acquisition of Commercial off-the-shelf Subsystems, Non-Developmental Items, and Developmental Systems.

(y) US Department of Transportation, FRA HF-Guideline-03.

(z) RISSB Guideline - Integration of Human Factors in engineering design.

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