AS 7531:2022

Australian STANDARD®

Lighting and visibility

RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

Rolling Stock Standard

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This Australian Standard® AS 7531 Lighting and visibility was prepared by a Rail Industry Safety and Standards Board (RISSB) Development Group consisting of representatives from the following organisations:

RTBU	Transport for NSW	TTM Rail
Department of Transport (Vic)	Yarra Trams	Department of Infrastructure & Transport (SA)
Metro	Queensland Rail	NSW Trains
KiwiRail	Pacific National	ARTC
BRAEMAC	J.W.Speaker	

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

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

Development of 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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AS 7531:2022

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Document details

First published as: Enter first publication identifier (AS XXXX:yyyy)

ISBN Enter ISBN.

Document history

Publication Version	Effective Date	Reason for and Extent of Change(s)
2022	Select Board approval date	
PC Draft	01/04/2022	Draft for Public Comment

Approval

Name	Date
Rail Industry Safety and Standards Board	Select Board approval date

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This Standard was prepared by the Rail Industry Safety and Standards Board (RISSB) Development Group AS 7531 Lighting and visibility. Membership of this Development Group consisted of representatives from the organisations listed on the inside cover of this document.

Objective

The objective of this Standard is to provide requirements for lighting and rolling stock visibility.

Significant technical changes from previous editions of this Standard include:

(a) Additional content provided for LED lighting.

(b) Revised methodology for head light and visibility light aiming.

Compliance

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

1. Requirements.
2. Recommendations.
3. Permissions.
4. 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 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.

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 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.

Contents

Appendix contents

1 Scope and general

1.1 Scope

This document applies to new and existing locomotive, freight, passenger, and infrastructure maintenance rolling stock.

This document is applicable for rolling stock operating up to 160 km/h nominal maximum speed. The document covers the design, construction, and maintenance of rolling stock.

Operation of rolling stock is not covered.

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

Where it is not reasonably practicable for tourist and heritage rolling stock to comply with a requirement of this Standard then alternative means of controlling the risks needs to be applied.

For avoidance of doubt, risks to safety must be eliminated so far as is reasonably practicable in accordance with the Rail Safety National Law.

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 1680.2.1 Interior lighting - Circulation spaces and other general areas.
- AS 1680.2.2 Interior lighting - Office and screen-based tasks.
- AS 1680.2.4 Interior lighting - Industrial tasks and processes.
- AS 2700 Colour standards for general purposes.
- AS 7722 EMC Management
- AS/NZS 1906.1 Retroreflective materials and devices for road traffic control purposes - Retroreflective sheeting.
- AS/NZS 1906.2 Retroreflective materials and devices for road traffic control purposes - Retroreflective devices (non-pavement application).
- AS/NZS 1906.4 Retroreflective materials and devices for road traffic control purposes - High visibility materials for safety garments.
- AS 7502 Road Rail Vehicles.
- APTA standard SS-PS-004-99 Standard for low-location access path marking.
- Australian Government Australian Design Rules for road vehicles (ADR).
- BS EN 13272 Railway applications — Electrical lighting for rolling stock in public transport systems.
- Disability Standards for Accessible Public Transport (DSAPT).

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

1.3 Terms, definitions, and abbreviations

For the purposes of this document, the terms and definitions given in RISSB Glossary: https://www.rissb.com.au/products/glossary/ and the following apply:

1.3.1
chromaticity
an objective specification of the quality of a colour regardless of its luminance, that is, as determined by its hue and colourfulness (or saturation, chroma, intensity, or excitation purity).

1.3.2
EMC
electromagnetic compatibility

1.3.3
emergency lighting
lighting powered from a separate source (e.g. battery) to the vehicle's main power source, providing illumination for evacuation purposes.

1.3.4
EMI
electromagnetic interference

1.3.5
ETM
end of train marker
a device that is fitted to the trailing end of a train or vehicle to denote the end of the train.

1.3.6
illuminance uniformity
ratio of the least favourable illuminance to the average illuminance within the specified measurement surface. The least favourable illuminance may be either the minimum or maximum illuminance over all the measurement points.

1.3.7
LED
light emitting diode.

1.3.8
luminance
photometric measure of the luminous intensity per unit area of light travelling in a given direction, i.e. the amount of light that passes through or is emitted from a particular area.

1.3.9
maximum illuminance uniformity
ratio of the maximum illuminance and average illuminance on the surface being considered.

1.3.10
PWM
pulse width modulation

1.3.11
spectral power distribution
spectral power distribution (SPD) is a description of the power per unit area for each frequency of light across the range of frequencies emitted by a/of a source of illumination.

1.3.12
visibility
conspicuity.
The ability of rolling stock to be seen.

2 Headlights

2.1 General

Locomotive, self-propelled passenger, and infrastructure maintenance rolling stock shall have one white headlight arrangement fitted at each leading end.[1]

The headlight shall produce light with a colour temperature of between 2800 K and 4500 K.[2]

If multiple headlights are fitted, they shall be symmetrical about the centreline of the rolling stock profile.

Headlight arrangements on locomotive and self-propelled passenger rolling stock, and on Infrastructure maintenance rolling stock able to travel at speeds greater than 60 km/h or weighing in excess of 20 tonnes gross train/consist mass, shall have a high intensity beam of at least 200,000 candela luminous intensity when on the bright setting.

The maximum aggregate luminous intensity of the headlight arrangement should not be more than 520,000 candela.

Each headlight on high beam setting shall produce at least 3,000 candela at an angle of 7.5 degrees and at least 400 candela at an angle of 20 degrees from the centreline of the rolling stock when the light is aimed parallel to the running rails.

Note that light levels produced by headlights will degrade over time in service and this needs to be allowed for in the specification of headlight units.

The peak intensity requirement shall also be met if devices to protect / diffuse the headlights are fitted while in service.

Headlights on new and modified locomotives, self-propelled passenger rolling stock and infrastructure maintenance rolling stock should be at least 2.3 m above rail.

The centreline of each headlight beam shall be aimed at a point 1 metre above top of rail at centre of track at least 240 m and not more than 260 m ahead and in front of the headlight.

[1] Sometimes operators use two headlights for redundancy.
[2] As colour temperatures increase there is increased likelihood that other rail or road users will experience nuisance glare

Operators need to consider the affect the intensity of the headlights has on approaching trains and road users when determining which lighting will be utilised when in the vicinity of other trains or when travelling parallel to roadways. This may include user acceptance testing when new lighting systems are introduced.

C2.1 Commentary
The purpose of the headlight is to provide illumination in mesopic conditions of the track ahead of the vehicle sufficient for the driver to detect and respond to warning signs, signals, and obstructions on the track.

2.1 Locomotive and passenger rolling stock

For locomotive and passenger rolling stock headlight arrangements with a high intensity beam of 200,000 candela or above shall also have a low intensity beam, or the ability for the high intensity beam to be dimmed, giving a maximum luminous intensity of 80,000 candela in the dimmed state.

2.2 Infrastructure maintenance rolling stock

For Infrastructure maintenance rolling stock, irrespective of gross train/consist mass or maximum speed, consideration should be given to fitting headlights with a high intensity beam of at least 200,000 and not more than 260,000 candela luminous intensity when on the bright setting.

Headlight arrangements on Infrastructure maintenance rolling stock unable to travel at speeds greater than 60 km/h and weighing less than 20 tonnes gross train/consist mass shall produce a peak intensity of at least 100,000 candela.

Headlight arrangements with a high intensity beam of 100,000 candela or above shall also have a low intensity beam, or the ability for the high intensity beam to be dimmed, giving a maximum luminous intensity of 75,000 candela in the dimmed state.

Infrastructure maintenance rolling stock with a driving station at each end shall have one headlight arrangement fitted at each leading end.

Headlights on self-propelled road rail vehicles shall comply with the applicable Australian Design Rules for road vehicles.[3]

The headlights on road rail vehicles shall be suitably interlocked with the direction control to provide clarity of direction of travel while on track and also to avoid contravention of Australian Design Rules regulations while on road.

2.3 LED headlights

LED headlights and their system components such as drivers, controls/indicators and system interfaces shall comply with the EMC management requirements outlined in AS 7722.

Any arrangement used to adjust or control the luminous intensity of the headlight shall not cause a shift in the spectral power distribution of the light produced by the headlight.

C2.3 Commentary
If PWM is used by the headlight designer to adjust or control the luminous intensity of the headlight, the switching frequency of pulses needs consideration to avoid causing shutter roll or other interference with digital cameras or video monitors.
Typically this can be avoided by good design where constant current is supplied to the LEDs using pulse-width modulation and varying the duty cycle to the LED.

[3] https://www.infrastructure.gov.au/

3 Tail and marker lights

3.1 Tail lights

New and modified locomotives, self-propelled passenger rolling stock and self-propelled track machines shall have red tail and white marker lights fitted as high and wide as practical, at both sides of each end.

For infrastructure maintenance rolling stock, consideration should be given to duplicating the tail light arrangement on both ends in scenarios where the vehicle could be required to reverse for some distance while on track.

If duplicated, the tail lights on road rail vehicles shall be suitably interlocked with the direction control to provide clarity of direction of travel while on track and also to avoid contravention of ADR regulations while on road.

Road rail vehicles shall be fitted with tail and marker lights that comply with the applicable Australian Design Rules for road vehicles.[4]

If operating in a network where the safeworking system allows permissive working then each tail light shall have a luminous intensity of at least 100 candela.

Consideration should be given to installation of duplicate marker light(s) and taillight(s) to RRVs where operational constraints give rise to a likelihood of having to travel a distance in reverse of the normal operational direction.

C3.1 Commentary
For further information regarding Australian Design Rules for road vehicles visit:
https://www.infrastructure.gov.au/
AS 7502 provides the requirements for RRVs.

3.2 End of train marker

Every operational train shall have an end of train marker fitted at any trailing end of the train unless the rolling stock is fitted with functioning red tail lights.

The primary function of the end of train marker is to alert approaching rail traffic, in any weather or lighting condition (includes tunnels), to the presence of a vehicle that could be obstructing the path of the approaching vehicle.

The end of train marker should be a light.

The lit surface of the light should be between 8,000 mm^2 and 12,000 mm^2.

Any light used as an end of train marker shall produce red light as per the requirements for high visibility colours detailed in AS 2700.

The end of train marker shall be fitted such that it is visible from the rear of the train. The method of securing the end of train marker assembly shall be sufficiently rigid so as to ensure the assembly remains vertically aligned and that the centre of the beam remains directed to the rear of the train in line with the longitudinal axis of the vehicle.

The luminous intensity of the end of train marker light shall be not less 100 candela and should be not be greater than 250 candela when measured at the centre of the beam.

The light used as an end of train marker should flash.

[4] https://www.infrastructure.gov.au/

If the end of train marker is fitted with a flashing feature, the rate of flashing shall be not less than 40 flashes per minute and not more than 180 flashes per minute.

The design and construction of any light used as an end of train marker and its associated power supply shall have sufficient energy storage capacity and be sufficiently robust to ensure that it performs its intended function for the required duration.

The end of train marker should include reflective delineators constructed from Class 1A reflective material compliant with AS/NZS 1906.2 or class 1W reflective material compliant with AS/NZS 1906.1.

The colour of reflective delineators shall be white or red. The reflective delineators should have an area of not less than 14,000 mm^2 and a minimum dimension of not less than 90 mm.

The end of train marker may incorporate other features to monitor functions such as train integrity and brake pipe pressure and voltage.

Appendix B has information on how these requirements can be incorporated into an operational setting.

C3.2 Commentary
Considerations include cleaning / routine maintenance requirements.

4 Visibility lights

New and modified locomotive, self-propelled passenger and infrastructure maintenance rolling stock shall have two white visibility lights fitted at each leading end.

Consideration should be given to duplicating the visibility light arrangement on both ends in scenarios where the vehicle could be required to reverse for some distance while on track.

The lights shall produce warm white light with a colour temperature of between 2800 K and 4500 K.

Visibility lights should:

(a) enhance the visibility of the leading end of the rolling stock from the perspective of a driver of a motor vehicle, or a pedestrian approaching a level crossing;

(b) enhance the visibility of the leading end of the rolling stock from the perspective of track workers; and

(c) illuminate turnout components and other trackside installations.

For road rail vehicles the normal road headlights may be used as visibility lights when travelling in the forward direction.

The visibility lights on road rail vehicles shall be suitably interlocked with the direction control to provide clarity of direction of travel while on track and also to avoid contravention of ADR regulations while on road.

Each visibility light shall produce a peak intensity of at least 20,000 candela.[5]

[5] This is well below the US 49 CFR 229.133 requirements of 200,000 candela for ditch or crossing lights. The lower output allows use of lights that can stay illuminated without causing glare/discomfort to oncoming trains and road vehicles.

Each visibility light should produce at least 3,000 candela at an angle of 7.5 degrees and at least 400 candela at an angle of 20 degrees from the centreline of the rolling stock when the light is aimed parallel to the tracks.

Visibility lights shall be at least 600 mm above the top of the rail.

Visibility lights should be no more than 1200 mm above the top of the rail.

Visibility lights shall be laterally separated by at least 900 mm if they are mounted more than 1500 mm below the headlights.

Visibility lights shall be laterally separated by at least 1500 mm if they are mounted less than 1500 mm below the headlights.

Visibility lights shall be aimed at a point that is not less than 25 metres and not more than 30 metres in front of the vehicle at top of rail.

Figure 4:1 - Side view of visibility light aiming

Visibility lights shall then be aimed / turned cross-eyed so that they intersect at a point not less than 4 metres and not more than 6 metres in front of the vehicle.[6]

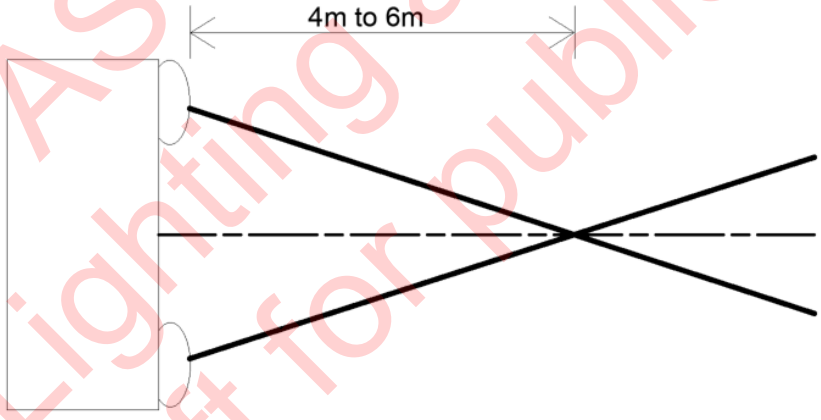

Figure 4:2 - Top view of visibility light aiming

Visibility lights shall alternately flash on and off when the horn is sounded.

Visibility lights should alternatively flash on and off when the vehicle changes direction.

If visibility lights are fitted with a flashing feature, the rate of alternate flashing shall be at least 40 flashes per minute and shall be at most 180 flashes per minute.

If visibility lights are fitted with a flashing feature, the flashing shall continue for a period of at least fifteen seconds after the horn has been sounded.

[6] To improve side on visibility of the vehicle.

If required the period for flashing should be increased to ensure that flashing continues as the vehicle traverses a level crossing, having regard to the vehicle speed and relevant track infrastructure.

C4 Commentary
Note that in some jurisdictions the terms "crossing lights", "ditch lights" and "fog lights" are used. Those terms are not used in this Standard.

5 Number lights

Locomotives shall be fitted with two forward-facing, internally illuminated number boxes at each leading end where the safeworking system requires observance of locomotive numbers by other trains.

6 Flashing beacons

An amber or orange flashing beacon shall be fitted to self-propelled infrastructure maintenance rolling stock.

The beacon shall be mounted on the top of each vehicle, or in suitable locations, so that beacon light is visible around the vehicle.

More than one beacon could be required on some vehicles in order to meet the clause above.

Each beacon shall have a luminous intensity of at least 18,000 candela. The flashing light shall be visible to a person standing 4 metres, in any direction, from the vehicle on level ground.

The flash rate of beacons shall be at least 40 flashes per minute and shall be at most 180 flashes per minute.

A white flashing beacon may be fitted to the leading vehicle of a train to enhance visibility in the forward direction. If fitted the beacon shall not detract from the effectiveness of the requirements of this Standard.

7 Stop lights

Road rail vehicles shall be fitted with stop lights that comply with the applicable Australian Design Rules for road vehicles.[7]

Consideration should be given to duplicating the stop light arrangement on both ends in scenarios where the vehicle could be required to reverse for some distance while on track.

If duplicated, the stop lights on road rail vehicles shall be suitably interlocked with the direction control to provide clarity of direction of travel while on track and also to avoid contravention of ADR regulations while on road.

Self-propelled track machines able to travel at speeds greater than 15 km/h shall be fitted with a red stop light at any trailing end.

Rail mounted trailers shall be fitted with a red stop light at the trailing end if the brake lights of the towing vehicle are obscured.

[7] https://www.infrastructure.gov.au/

Stop lights on infrastructure maintenance rolling stock shall have a luminous intensity of at least 60 candela per light.

Stop lights on new and modified track machines should be fitted with a flashing feature having a flash rate of at least 40 flashes per minute and at most 180 flashes per minute.

8 Normal interior lights

Normal (non-emergency) lighting levels inside the locomotive cab should comply with the following:

(a) Cab general: Minimum 50 lux (illuminance uniformity 0.5 to 2.5).

(b) Driver's desk: Minimum 75 lux at desk level (illuminance uniformity 0.7 to 1.3).

(c) Timetable light: Minimum 160 Lux at 150mm (illuminance uniformity 0.7 to 1.3).

(d) Driver's reading light: Minimum 150 lux (illuminance uniformity 0.7 to 1.3).

(e) Kitchen and other working areas: Minimum 300 lux (illuminance uniformity 0.7 to 1.3).

Normal (non-emergency) lighting levels inside the passenger car cab should comply with the following:

(a) Cab - general: Minimum 50 lux (illuminance uniformity 0.5 to 2.5).

(b) Drivers desk: Minimum 75 lux at desk level (illuminance uniformity 0.7 to 1.3).

(c) Drivers reading light: Minimum 150 lux (illuminance uniformity 0.7 to 1.3).

(d) Kitchen and other working areas: Minimum 300 lux (illuminance uniformity 0.7 to 1.3).

Normal (non-emergency) lighting in passenger areas shall comply with the requirements of the Disability Standards For Accessible Public Transport (DSAPT).[8]

Normal (non-emergency) lighting levels inside infrastructure maintenance rolling stock should comply with the appropriate task lighting levels as recommended by AS 1680.2.1, AS 1680.2.2 and AS 1680.2.4.

9 Emergency interior lights

Spaces (cabins, rooms, vestibules, aisles etc.) on locomotives, passenger rolling stock, and infrastructure maintenance rolling stock where people can be enclosed in during operation, shall have emergency lighting.

Emergency lighting on new and modified locomotives and infrastructure maintenance rolling stock, shall be able to operate for at least 90 minutes after main power is removed.

Emergency lighting on new and modified passenger rolling stock, shall be able to operate for at least 180 minutes after main power is removed.

Emergency lighting on new and modified locomotives and infrastructure maintenance rolling stock, shall provide at least 0.2 lux illuminance at floor level along exit paths.

[8] https://www.ag.gov.au

Emergency lighting on new and modified passenger rolling stock shall provide at least 1.0 lux illuminance at floor level along exit paths.

Where power supply permits, emergency lighting on new and modified passenger rolling stock should provide at least 5.0 lux illuminance at floor level along exit paths.

The minimum illuminance uniformity ratio of the emergency lighting, measured along the centre line of the escape route should be 0.2.

The maximum illuminance uniformity ratio of the emergency lighting, measured along the centre line of the escape route should be 5.0.

Refer to BS EN 13272 for further information on the method of measuring illumination.

Emergency lighting shall provide at least 20 lux illuminance at floor level at all doors on new and modified locomotives.

Emergency lighting on new and modified passenger rolling stock shall provide at least 20 lux illuminance at floor level at emergency exit doors.

Emergency lighting on new and modified locomotives and passenger rolling stock shall provide at least 20 lux illuminance on any equipment necessary to provide emergency egress.

Emergency lighting on new and modified infrastructure maintenance rolling stock should provide at least 20 lux illuminance on any equipment necessary to provide emergency egress.

On new and modified passenger rolling stock where emergency lighting is powered by the trains normal battery supply or mounted near the ceiling, the vehicle shall have in passenger-accessible areas another method of illuminating emergency exit paths and exit equipment that is crash-tolerant and mounted near the vehicle floor.[9]

Refer to APTA SS-PS-004-99 Standard for Low-Location Access Path Marking for a specification describing passive (e.g. photo luminescent) and active (electrically powered) means of achieving the Clause above.[010]

10 Livery

New and modified locomotives and the lead vehicle of a passenger train that is loco hauled or has power cars shall have a livery applied that has areas of high visibility colour applied to the ends and sides of the vehicle.

A forward facing area of high visibility colour shall be applied each leading end of existing locomotives and self-propelled passenger rolling stock.

Infrastructure maintenance rolling stock shall have livery applied that has high visibility colour applied to at least 50% of the available area on the front and sides of the vehicle.

The colour of the high visibility areas on locomotives and passenger rolling stock should be one of yellow, orange, orange-red or red within the CIE chromaticity co-ordinates of Table 10.1, or white.

The colour of the high visibility areas on road rail vehicles should be one of yellow within the CIE chromaticity co-ordinates of Table 10:1, or white.

[9] To provide illumination in the event of fire and/or loss of main batteries
[10] https://www.apta.com/

The colour of the high visibility areas on infrastructure maintenance rolling stock should be one of yellow within the CIE chromaticity co-ordinates of Table 10:1.

	Chromaticity coordinates of high visibility of colour space using CIE standard D65 illuminant			
x	0.375	0.346	0.524	0.690
y	0.625	0.492	0.319	0.310

Table 10:1 – CIE chromaticity limits

The colour of the yellow, orange, orange-red or red high visibility areas should have a minimum luminance factor, when new, as detailed in Table 2.3 of AS/NZS 1906.4.[11]

Suitable AS 2700 high visibility colours include:

(a) Yellow: Y11 to Y15, Y22, Y23, Y26

(b) Orange: X11, X12, X13, X24

(c) Red: R11, R12, R13, R22, R23

(d) White: N14

The forward facing area of colour on locomotives and passenger rolling stock shall be not less than 1 square metre in area with a minimum continuous height or width of 0.6 m.

The forward facing area of colour may be divided by the features of the front of the rolling stock if necessary.

Each section of a divided colour surface shall have an uninterrupted area of 0.4 square metres with a minimum continuous height or width of 0.6 m.

If the front of the rolling stock slopes from vertical or is rounded, the area of the coloured surface and its vertical and/or horizontal dimensions shall be increased in order to produce the equivalent required areas and dimensions when looking at the front of the vehicle from the centre of the track at a height of 1500 mm above rail level and 25 m from front of vehicle.

An area of high visibility colour or contrasting colours (one of which should be high visibility) should be extended down the sides of the vehicle from the front as far as possible.[12]

Fluorescent colours compliant with AS/NZS 1906.1 should be considered for use in order to improve day time visibility while giving due consideration to the environment in which the rolling stock operates.

11 Reflective delineators

Reflective delineators shall be fitted to vertical surfaces on each side of all rolling stock.

Reflective delineators should be mounted between 800 mm and 2000 mm above rail.

Each reflective delineator shall have a minimum height of 75mm and a minimum width of 350mm.

[11] This defines a colour space enclosing all the high visibility colour spaces shown in Figure 2.1 of AS/NZS 1906.4.
[12] The extension of the high visibility colours down the sides of the vehicle is to be determined using a risk assessment which takes into consideration the vehicle design and environmental factors.

At least two delineators per side shall be fitted, with one mounted near each end of the vehicle to highlight the extremities of the vehicle.[13]

Additional delineators should be fitted every 2.5 to 5 metres between the end-mounted delineators for locomotives, freight and passenger rolling stock, and track machines.

Delineators should be fitted to outer extremities of the headstock on both ends of each vehicle. Each reflective delineator should have a minimum height of 75mm and a minimum width of 350mm.

Class 1A reflective material compliant with AS/NZS 1906.2 or class 1W reflective material compliant with AS/NZS 1906.1 shall be used.

The colour of reflective delineators shall be white or yellow.

For road rail vehicles refer to AS7502.

12 Access lighting

Lighting shall be provided on locomotives to illuminate exterior walkways and steps, ladders and the ground below ground-access steps and ladders.

A minimum illumination level of 150 lux on the access treads shall be achieved on new and modified passenger rolling stock, or a minimum illumination level of 80 lux for new and modified locomotives and infrastructure maintenance rolling stock.

Care needs to be taken in the positioning of the step light to avoid casting of shadows on step rungs or the ground below.

13 Coupler lighting

Lighting shall be provided on new and modified locomotives and passenger rolling stock to illuminate the area around couplers which can be separated during service operation.

Lighting should be provided on new and modified infrastructure maintenance rolling stock to illuminate the area around couplers which can be separated during service operation.

The top and sides of the coupler head, and any coupler manual release point should have a minimum illumination level of 20 lux.[14]

14 Work lighting

Infrastructure maintenance rolling stock working in conditions of poor visibility shall have lighting to illuminate areas that are hazardous to workers on or around the vehicle.

Conditions of poor visibility include working in tunnels or at night when no or inadequate wayside lighting has been provided.

[13] Near is considered to be within 25% of the end of the vehicle.
[14] An example of a manual release point is an uncoupling handle.

15 Maintenance

For locomotives, passenger rolling stock and infrastructure maintenance rolling stock, lighting arrangements shall be inspected and maintained to preserve their illumination and alignment properties.

For freight rolling stock, tail light arrangements shall be inspected and maintained to preserve their illumination and alignment properties.

The high visibility colour areas on locomotives, passenger rolling stock and infrastructure maintenance rolling stock shall be cleaned and maintained to prevent obscuring or fading.[15]

Refer to appendix A of AS/NZS 1906.4 for a method of measuring luminance factor.

Reflective delineators shall be inspected and maintained to preserve their fitment and reflectance properties.

[15] Measuring luminance outside of laboratory conditions is difficult and impractical. However, the aim of maintenance is to preserve the visibility of the vehicle.

Appendix A ARRM risk table

Publishable	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 rain 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
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

Publishable	Hazardous event
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
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

Publishable	Hazardous event
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 Typical arrangements for end of train markers (EOTM)

The arrangement for end of train markers can be tailored to the specific requirements of the rail operator and the type of train. The information below give examples of how these different operational requirements can be met.

Type of EOTM	Portable tail lamp	Sense and brake unit (SBU) EOTM	ECP EOTM
Function	Provides a flashing red light in low light conditions	Provides a flashing red light in low light conditions plus increased safety and brake pipe monitoring	Provides flashing light when the ambient light is low plus monitoring of critical ECP parameters
Features	Simple, basic device that can be easily removed and replaced as required	Battery backup, charged by a brake pipe generator Remote air pressure supplied to the lead HEU via radio The ability to trigger a brake pipe dump via remote switch on the lead HEU	• Battery back-up, charged by the trainline power • Trainline air pressure and electrical monitoring back to the lead HEU • End of train information – air pressure, voltage, via test button on the side • Second generation shows EOTM ID on the lead locomotive and can show as a marker in cross talk logs
Flash rate	Between 40 and 180 flashes per minute with typical value 120 per minute and flash duration 25 ms.	Between 40 and 180 flashes per minute	Between 40 and 180 flashes per minute
Brightness	100 Candela measured at the centre of the beam	100 candela measured at the centre of the beam	100 candela measured at the centre of the beam
Service interval	Each unit is inspected on roll by to determine functionality.	12 - 18 months	Three yearly
Battery life	10,000 hours with 2 50 Ahr alkaline batteries.	Nominal 10,000 hrs	Nominal 10,000 hrs
Maintenance requirements	Repair or battery replacement as indicated by condition monitoring and inspection program	Servicing completed in accordance with AAR specifications by OEM. LED lights are checked for functionality and flashing frequency while in service.	Service, maintenance, and calibration is completed by OEM in accordance with AAR recommended practices. Each EOTM is also cleaned, and a full functional test completed. Spare EOTM's are kept on charging racks ready for use at most depots.

Appendix C Bibliography

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

(a) AAR Standard S-5515 – Led lighting for locomotives.

(b) AAR Standard S-5516 – Led headlights and auxiliary lighting for locomotives.

(c) UK RSSB standard GM/RT 2483 Visibility requirements for trains.

(d) US Code of Federal Regulations 49 CFR 221.14 Rear end marking device – Passenger, commuter & freight trains.

(e) US Code of Federal Regulations 49 CFR 229.125 Headlights and auxiliary lights.

(f) US Code of Federal Regulations 49 CFR 229.133 Interim locomotive conspicuity measures - Auxiliary external lights.

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