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Data entry – draft starts next page

Standard number	AS 7521
Version year	2026
Standard name	Interior Crashworthiness
Standing Committee	Rolling Stock
Development group member organisations	Metro Trains Melbourne, PTA WA, Transport for NSW, Queensland Rail, UGL Ltd
Review type	Targeted
First published	AS 7521:2018
ISBN	TBD
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Development draft history

Draft version	Draft date	Notes
0	5/01/2026	Draft 0 generated from the most recently published version
1	20/01/2026	Updated after DG meeting 1
2	11/02/2026	Updated after DG meeting 2
3	24/02/2026	Final Draft after DG meeting 3
4	6/03/2026	Updates in 4.2.1 and 4.5

Preface

This document was prepared by the Interior Crashworthiness Development Group, overseen by the ARISO Rolling Stock Standing Committee.

Objective

The objective of this document is to set the minimum requirements for the interiors of rolling stock to minimize the risk of injury during derailments, collisions and accidents.

This document contributes to the management of the following risks:

- (a) Individual striking or being struck by surfaces, structures or objects.
- (b) Contact with hot, electrical, chemical or hazardous substances.

Compliance

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

- (a) Requirements.
- (b) Recommendations.
- (c) Permissions.
- (d) Constraints.

Requirements – it is mandatory to follow all requirements to claim full compliance with the Standard. Requirements are identified within the text by the term ‘shall’.

Recommendations – do not mention or exclude other possibilities but do offer the one that is preferred. Recommendations are identified within the text by the term ‘should’.

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

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.

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’.

ARISO Standards identify known hazards relevant to the railway industry. Appendix A provides a non-exhaustive list of hazards relevant to the scope of this Standard.

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

Commentary

Commentary C Preface

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

Table of Contents

Section 1	Scope and general	5
1.1	Scope	5
1.2	Normative references	5
1.3	Defined terms and abbreviations.....	5
Section 2	General and common requirements	8
2.1	Secondary Impact Assessment.....	8
2.2	Other rolling stock considerations	8
Section 3	Secondary structural elements	8
3.1	Glazing.....	8
3.2	Windscreens.....	8
3.3	Bodyside windows.....	8
3.4	External vehicle doors	9
3.5	Inter-vehicle gangways.....	9
Section 4	Rail vehicle interface with occupants	9
4.1	Vehicle interior crashworthiness	9
4.2	Seats	9
4.2.1	Passenger seats	10
4.2.2	Personnel seats and train crew seats.....	10
4.3	Fixed tables	10
4.4	Folding seat back tables	10
4.5	Occupant constraint.....	10
4.6	Interior doors and glazing	10
4.7	Loose items	11
4.8	Grab handles, poles and rails	11
4.9	Interior fixtures and fittings	11
4.10	Luggage stowage.....	11
4.11	Cabs.....	12
4.12	Gangways	12
Appendix A	Hazard Register (Informative)	13
	Bibliography (Informative)	15

Section 1 Scope and general

1.1 Scope

This document applies to all rolling stock (including locomotives and rail bound track maintenance machines) intended to carry passengers as well as individuals carrying out their duties or resting.

This document applies to rolling stock:

- (a) entering service after the published date of this document; or
- (b) interior components undergoing major modifications or replacement with new designs after the published date of this document.

This document does not apply to heritage rolling stock and rolling stock operating on cane railways, light rail vehicles, and road rail vehicles.

The requirements for car body structural crashworthiness are detailed in AS 7520 (all parts).

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 2080:2019, *Safety glazing for land vehicles*
- AS 2208:1996, *Safety glazing materials in buildings*
- AS 7489:2024, *Passenger and Seating Appointments*
- AS 7520.1:2025, *Rolling Stock Body Structural Requirements – Part 1: Locomotive*
- AS 7520.3:2023, *Rolling Stock Body Structural Requirements – Part 3: Passenger*
- AS 7520.4:2023, *Body Structural Requirement – Part 4: Infrastructure Maintenance*
- AS 7531:2023, *Rolling Stock Lighting and Visibility*
- GM/RT2100 Iss 6.1:2021, *Rail Vehicle Structures and Passive Safety*
- Title 49, Code of Federal Regulations (49 CFR), U.S. Department of Transportation, Federal Railroad Administration
- Disability Discrimination Act 1992 (Cth)

NOTE:

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

1.3 Defined terms and abbreviations

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

1.3.1

bay seating
facing seats
club seating
carré seating
confronting seats
opposite seats
transfer seats

vis-a-vis seating

face-to-face seating

seats with the fronts or faces toward each other

1.3.2

bodyside windows

windows other than windscreens and interior glazing

1.3.3

crashworthiness

ability of the vehicle structure and interior to minimize harm to the occupants during a collision or derailment

1.3.4

double glazed windows

two or more panes of glass separated by an air gap fitted to reduce the transmission of heat, sound, etc.

1.3.5

free flight distance

distance a person is thrown from moment of collision up to point of impact on surfaces in direction of flight

1.3.6

interior glazing

all glazing not facing exterior of vehicle

Note 1 to entry: examples include screens, partitions, luggage racks, glazing in internal doors, intercar doors and internal passenger information displays.

1.3.7

laminated glass

safety glass that holds together when shattered

Note 1 to entry: In the event of breaking, laminated glass is held in place by an interlayer, typically of polyvinyl butyral or ethylene-vinyl acetate, between its two or more layers of glass.

1.3.8

occupant

any person occupying the train at any time, including passengers, maintainers and train crew

1.3.9

passive safety

systems which reduce the consequences of an accident should it occur

1.3.10

secondary impact

impacts which occur as a consequence of the primary impact, such as occupants impacting other occupants or impacting interior features of the vehicle

1.3.11

secondary structural elements

elements of a rail vehicle interfacing directly with occupants

1.3.12

supplier

organisation that has responsibility for supplying the railway vehicle to satisfy the regulations and functional requirements of the operator

1.3.13

windcreens

windows in the front and the rear of the rail vehicle facing outside

General rail industry terms and definitions are maintained in the ARISO Glossary. Refer to:

<https://www.ariso.org.au/glossary/>

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Section 2 General and common requirements

2.1 Secondary Impact Assessment

This document is primarily concerned with secondary impacts arising from a collision or derailment. For passenger rolling stock, the requirements for the collision energy management strategy as detailed in AS 7520.3 should be integrated with the design of interior elements.

All areas of a vehicle interior which are accessible to passengers, personnel or traincrew in normal service shall be subject to a secondary impact assessment, in addition to any specified proof or ultimate loads and impact testing requirements. The secondary impact assessment should be in accordance with GM/RT2100

Where dynamic testing is replaced or augmented by computer simulation, the simulation methodology, validation and acceptance criteria shall comply with GM/RT2100 (current issue). Explanation of the original test data can be found in GM/GN2687 and shall be applied when using computer simulations and calculations.

2.2 Other rolling stock considerations

In the event of a collision or derailment, electrical equipment, hot surfaces or stored energy should not cause harm to occupants.

Section 3 Secondary structural elements

3.1 Glazing

Safety glazing for new or replacement windows, including all forward-facing glazing, shall be fitted and labelled in accordance with AS 2080:2019. All interior glazing shall comply with AS 2208:1996

Windows shall be designed so that they do not become a hazard when damaged. This includes the selection of materials for the windows and surrounding structure.

Windows for emergency egress in accordance with AS 7522 shall be designed to be easily and safely removed in an emergency allowing occupants an escape path.

Windows for emergency egress shall be clearly labelled, with operating instructions located nearby.

All window upgrades shall meet the requirements of this document.

3.2 Windscreens

All vehicle windscreens and forward facing glazing shall comply with the relevant part of AS 7520.1:2025, AS 7520.3:2023 and AS 7520.4

Fittings attached to the glass of windscreens shall not have a mass greater than 15 kg. The windscreen with those fittings shall meet the testing procedures applicable to windscreens.

3.3 Bodyside windows

All exterior bodyside windows in occupant accessible areas shall have at least one pane of laminated safety glass. An alternative material with equivalent properties complying with AS 7520 may be used if the alternative is proven to provide equivalent protection for occupants against spalls and shards. Equivalence shall be demonstrated by test, analysis, or documented similarity, and accepted by the rolling stock operator or their delegated engineering authority.

Where windows are double glazed, laminated safety glass shall be installed on the interior pane of the window. The exterior pane of the window shall be toughened or laminated safety glass.

Exterior windows (including those with fittings) shall meet the requirements of GM/RT2100 for strength and impact resistance.

All exterior side windows shall be tested in accordance with Type II test of 49 CFR Part 223. The exterior windows should also be pendulum tested as per Appendix D of AS 2208:1996. The exterior windows shall remain unbroken and intact within the frame for all drop heights up to and including 1,200 mm and pass at a drop height of 1,500 mm.

All exterior window replacements should meet the requirements of this document for new vehicles.

3.4 External vehicle doors

Door windows shall meet all the requirements for exterior windows.

The design of external vehicle doors shall be in accordance with GM/RT2100

Door leaves shall resist penetration by the impacting objects specified with Type II test of 49 CFR Part 223.

NOTE:

The intent of this clause is that it is to be demonstrated either by analysis, testing or similarity with previously tested samples that the structural make-up of the non-glazed areas of a door will meet the requirement.

3.5 Inter-vehicle gangways

Inter-vehicle gangway elements shall not interfere with coupler collapse, anti-climber engagement or structural crush zones. Mountings clamped on couplers shall not interfere with radial expansion required for energy absorption.

See Clause 4.12 for requirements for passengers in gangways.

Section 4 Rail vehicle interface with occupants

4.1 Vehicle interior crashworthiness

Surfaces, objects, etc. which are likely to be impacted by persons during a collision, derailment or accident shall be free of sharp corners, edges or projections, and shall not form sharp edges or fragments when damaged.

Furnishings (e.g., seats, tables, etc.) shall be designed to absorb impact and not break away or detach during a collision or derailment, with precedence given to dynamic test loads over proof loading conditions.

Particular attention should be given to the geometry and material design choices for all interior elements, to reduce injury to people from secondary impacts.

The material for internal glazing shall be assessed, with toughened glass the minimum requirement.

Means to secure loose items in the cabin required for train operation (e.g., tools, instruments) shall be provided.

Hot surfaces (i.e. >60°C) shall be insulated or separated from occupants and crew by a physical barrier.

4.2 Seats

Seats, including tip-up seats, shall comply with the requirements of GM/RT2100.

Seating shall be dynamically tested to the requirements of GM/RT2100, but acceleration pulse levels may be based on the collision scenarios in AS 7520.3:2023

While containing no additional requirements for crashworthiness, AS 7489 should be read in conjunction with this document in the context of design.

4.2.1 Passenger seats

Reversible seats shall include locks or dampers to minimize the risk of occupants being propelled out of the seat by the inertia of the movable back rest.

Unidirectional transverse seating provides less risk of injury than bay or longitudinal seating. Where longitudinal seating is used, the layout and structure shall incorporate appropriate constraint or interior elements (e.g., grab rails, grab poles, barriers) to reduce occupants' free flight distance and mitigate injury risk.

The height of transverse seat backs should be as high as is practicable without compromising visibility. GM/RT2100 suggests at least 840 mm high to minimize injuries.

4.2.2 Personnel seats and train crew seats

The height of transverse seat backs should be as high as is practicable.

The headrests fitted to cab seats should not be considered part of the seatback.

4.3 Fixed tables

Fixed tables shall meet the requirements of GM/RT2100

4.4 Folding seat back tables

Arrangement of folding tables should reduce the risk of injury in a contact with occupant.

Dynamic testing for folding seat back tables shall comply with GM/RT2100

4.5 Occupant constraint

Potential occupants' free flight distance in collisions shall be constrained with armrests, seat backs from the front seats, bulkheads, stanchions, handrails or partitions.

Occupant constraints shall be designed so that the number of constraints is minimized, and the size of the constraints is maximized.

NOTE:

An example of the intent is to favour longer, continuous handrails rather than multiple shorter rails, and not to create potential points of entrapment between rails.

Beds for occupant or crew use should have a means of restraint to minimize injury in the event of a collision or derailment.

Impact loading used for testing occupant constraints shall be based on an occupant weighing 110 kg. Permanent deformation is acceptable for impact load of 80 kg, as long as the constraint is not breached.

The design of handrails, handholds, etc., shall be integrated to minimize hazard or injury impact of those elements.

4.6 Interior doors and glazing

All interior doors shall be manually openable after collision or derailment, or an alternative means of access or egress shall be provided.

Proof load for interior doors and partitions shall comply with the loading in GM/RT2100

Safety glass shall be utilized on all interior glass mirrors.

4.7 Loose items

Interior loose items being part of the train equipment shall be able to be securely fastened to the rolling stock structure.

Means shall be provided to conveniently stow and secure loose items such that they are unlikely to be a hazard under collision conditions.

Stowage areas shall be designed to prevent loose items breaking away and becoming projectiles during normal train operations or collisions.

Hazardous materials, including those which are corrosive, poisonous or flammable, or materials which are hotter than 45°C, shall be stored so that they do not cause harm to persons in the event of a collision or derailment.

4.8 Grab handles, poles and rails

Design for grab handles, poles and rails shall comply with GM/RT2100

Grab handles and handrails shall be designed as an integral part of the seats, luggage stowage and partitions within their original dimensions wherever possible. The secondary impact assessment shall demonstrate they are not a hazard to occupants during collision or derailment.

Attachments of handrails, handholds, etc., to the primary structure shall withstand impact loading.

4.9 Interior fixtures and fittings

Any internal equipment cubicle doors and access panels shall remain closed during normal train operation, collision or derailment. Additional securing fastenings (e.g., safety catches or straps) shall be provided when the doors are located in occupant areas or can block or restrict an exit during an emergency.

The design of additional securing fastenings on doors shall be in accordance with GM/RT2100

Barriers or partitions shall be provided to restrain uncontrolled movement of wheelchairs applicable to people with disabilities as defined by the Disability Discrimination Act 1992 (Cth).

Toilet compartments shall be designed in accordance with the principles in this document and not be considered as unoccupied.

All internal fittings including information displays, interior lighting and CCTV systems shall be designed to remain integrated into the interior to minimize the risk of causing harm to occupants and train crew during a collision or derailment.

Interior lighting shall be designed to ensure adequate emergency lighting for egress as specified in AS 7531:2023

Provision shall be made for the secure storage of catering equipment including trolleys when not in use.

Catering equipment proof loadings shall comply with GM/RT2100

Security and location of fire-fighting equipment design shall be in accordance with GM/RT2100

4.10 Luggage stowage

Where on board luggage stowage is provided, it shall be designed to contain luggage to minimize projectile risk to passengers during operation, collision or derailment.

Open transverse luggage stowage arrangements should be avoided or minimized if practicable.

The design of luggage stowage shall provide access in accordance with GM/RT2100

Luggage racks shall be designed to withstand loading of 100 kg per m².

Overhead luggage racks shall be designed to comply with GM/RT2100

4.11 Cabs

Secondary impact assessment in areas occupied by individuals carrying out their duties or resting shall be undertaken to consider the potential for injury.

For passenger trains, dynamic testing shall be conducted for the driver seat zone as set out in GM/RT2100. A reduced scope or alternatives to testing may be considered for locomotives and maintenance vehicles ordered in smaller quantities.

4.12 Gangways

The safety of passengers travelling on or passing through inter-vehicle gangways shall be assessed, particularly when these are collapse zones. Accordingly, it may be necessary to discourage passengers from standing in this area.

Specifications shall make clear whether the inter-vehicle gangway is to be treated as a standing area when calculating standing capacity.

Appendix A Hazard Register (Informative)

Hazard number	Hazard
5.3.1.1	Electric shock
5.3.1.2	Hazardous substances
5.3.1.3	Bodily impact
5.3.1.7	Persons being crushed
5.3.1.12	Drowning due to derailment into water
5.3.1.15	Sharp edges, burrs or cuts
5.3.1.43	Harmful exposure to released pressured gas or fluid
5.36.1.21	Falls from bunk bed as a result of inadequate side restraints (Vertical drop)
5.36.1.35	Door/lock strength being inadequate causing persons to fall out the doors onto tracks (Vertical drop)
5.36.1.37	Guard rail, hand rail or hand hold strength being inadequate
5.40.1.16	Standing persons on overcrowded trains being crushed by other persons in a collision or derailment
5.40.1.17	Seated persons in facing seats being crushed by other persons in collision or derailment
5.40.1.18	Seated persons in longitudinal seats being crushed by other persons in collision or derailment
5.44.1.1	Impact with interior surfaces (Impact caused by excessive accelerations)
5.44.1.8	Compartment breaches or openings large enough for persons to pass through resulting in persons being thrown out of the vehicle during collision or derailment (Impact with wayside structure or other rolling stock)
5.44.1.9	Compartment breaches or openings large enough for persons to pass through resulting in persons being thrown out of the vehicle during collision or derailment (Impact with ground / floor)
5.44.1.10	Inadequate means of restraining persons inside vehicles resulting in persons being thrown out of the vehicle during collision or derailment (Impact with wayside structure or other rolling stock)
5.44.1.11	Inadequate means of restraining persons inside vehicles resulting in persons being thrown out of the vehicle during collision or derailment (Impact with ground / floor)
5.44.1.13	Parts of the body being outside vehicles' doors (Impact with wayside structure or other rolling stock)
5.44.1.14	Parts of the body being outside vehicles' windows (Impact with wayside structure or other rolling stock)
5.44.1.15	Being trapped or held by exterior doors resulting in parts of bodies being outside vehicles (Impact with wayside structure or other rolling stock)

Hazard number	Hazard
5.44.1.21	Impact with unrestrained sliding or hinging door as a result of accelerations during train operations (Person inside train - Impact with part of train)
5.44.1.26	Objects coming loose during collision or derailment (Impact with loose objects)
5.44.1.27	Heads being hit on low interior features (Person inside train - Impact with part of train)
5.44.1.28	Body parts being hit on protruding interior features (Person inside train - Impact with part of train)

Bibliography (Informative)

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

- AS 1940, *The storage and handling of flammable and combustible liquids*
- AS 7470, *Human factors integration in engineering design, General requirements*
- AS 7501, *Railway rolling stock, Rolling stock certification*
- AS 7520.1, *Railway rolling stock, Body structural requirements, Part 1: Locomotive rolling stock*
- AS 7522, *Access and egress*
- AS 7635, *Track geometry*
- AS/NZS 1664, *Aluminium structures*
- AS/NZS 2865, *Safe working in a confined space*
- AS/NZS 3711 (all parts), *Freight containers*
- AS/NZS 3788, *Pressure equipment, In-service inspection*
- EN 12663, *Railway applications, Structural requirements of railway vehicle bodies*
- EN 1993-1-9, *Eurocode 3: Design of steel structures, Part 1-9: Fatigue*
- BS 7608, *Code of practice for fatigue design and assessment of steel structures*
- AAR Manual of Standards and Recommended Practices Section C, Part II:2023, *Design, fabrication and construction of freight cars*
- RSSB GM/GN2687, *Guidance on rail vehicle interior structure and secondary structural elements*