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T MU RS 01000 ST

Standard

Structural Integrity and Crashworthiness of Passenger Rolling Stock

Version 1.0

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Standard governance

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Document history

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Preface

The Asset Standards Authority (ASA) is an independent unit within Transport for NSW (TfNSW) and is the network design and standards authority for defined NSW transport assets.

The ASA is responsible for developing engineering governance frameworks to support industry delivery in the assurance of design, safety, integrity, construction, and commissioning of transport assets for the whole asset life cycle. In order to achieve this, the ASA effectively discharges obligations as the authority for various technical, process, and planning matters across the asset life cycle.

The ASA collaborates with industry using stakeholder engagement activities to assist in achieving its mission. These activities help align the ASA to broader government expectations of making it clearer, simpler, and more attractive to do business within the NSW transport industry, allowing the supply chain to deliver safe, efficient, and competent transport services.

The ASA develops, maintains, controls, and publishes a suite of standards and other documentation for transport assets of TfNSW. Further, the ASA ensures that these standards are performance based to create opportunities for innovation and improve access to a broader competitive supply chain.

This standard sets out the requirements for passenger rolling stock structural integrity and crashworthiness over its whole of asset life. It aims to allow for the adoption of internationally proven solutions for crashworthiness, leading to increased industry participation in the supply of rolling stock, while maintaining safety for occupants.

The ASA developed this standard in consultation with other TfNSW agencies and the rolling stock industry through national and international rolling stock manufacturers, following the development of a position paper on crashworthiness.

This standard is the first issue.
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1. **Introduction**

Structural integrity and crashworthiness requirements for passenger vehicles ensure that structural and passive safety features provide a safe environment for occupants over the design life of the asset, and control the risk of injury to occupants in the event of abnormal conditions such as heavy shunts, derailments, and collisions.

ASA has predominantly adopted the requirements in this standard from nationally or internationally accepted practice as set out in AS 7520.3, GM/RT 2100, and applicable European Norms.

2. **Purpose**

This standard sets ASA requirements for passenger rolling stock structural and passive safety features to allow for the adoption of internationally proven solutions and increased industry participation in the supply of rolling stock, while maintaining safety for occupants. This standard ensures that passive safety features take into account the intended operation of rolling stock and the current performance of other rolling stock while, where appropriate, adopting internationally accepted standards and practices.

2.1. **Scope**

This standard covers the minimum structural and crashworthiness requirements that the passenger rolling stock shall continue to meet over its design life. Requirements include the structural performance of car body and secondary structural elements, the ability to protect occupants during its operation, and for scenarios involving derailment or collision or both.

This standard also sets requirements for rolling stock assets protection in the event of heavy shunts and minor collisions.

2.2. **Application**

This standard applies to the specification, procurement, design, supply, introduction, operation, or modification of heavy rail, rapid transit, and light rail passenger rolling stock that is to operate on the TfNSW rail network.

3. **Reference documents**

**International standards**

49 CFR 223 Safety glazing standards-Locomotives, passenger cars and cabooses

AAR Manual of Standards and Recommended Practices (MSRP), Section S-III, S-106 – Coupler, E Type, No. 10-A Contour and Detail of Pivot Pin Hole
4. Terms and definitions

For the purpose of this standard the following terms and definitions apply.

**occupant** any person occupying the train at any time, including passengers, maintainers, and train crew (reference EN 15227)

**Operator** organisation that has responsibility for defining the technical requirements for the railway vehicle so that it will perform the intended operation and meet the acceptance criteria (reference EN 15227)

**passive safety** systems which reduce the consequences of an accident should it occur (reference EN 15227)

**secondary structural elements** for the purposes of this document, secondary structural elements are considered those elements of a vehicle that interface directly with occupants. Secondary structural elements should include:

a) windscreens (see Part 5 of GM/RT2100)

b) windows (see Part 5 of GM/RT2100)

c) doors (see Part 5 of GM/RT2100)

d) gangways (see Part 5 of GM/RT2100)

e) interiors, for example seats, tables, panelling, partitions, and so forth (see Part 6 of GM/RT2100)
supplier organisation that has responsibility for supplying the railway vehicle to satisfy the regulations and functional requirements of the Operator (reference EN 15227)

5. Crashworthiness and structural performance of rail vehicle bodies

5.1. General requirements

All passenger rail vehicles shall comply with the requirements of the following European Norms:

- EN 12663-1:2010 Railway application – Structural requirements of railway vehicle bodies – Part 1: Locomotive and passenger rolling stock (and alternative method for freight wagons)
- EN 15227:2008 Railway Application – Crashworthiness Requirements for Railway Vehicle Bodies

The operator shall specify the vehicle category used for EN 12663 based on the intended configuration and operation of the rolling stock. In general, this will be P-I for locomotive hauled carriages, P-II for vehicles formed into heavy rail multiple unit trains, P-III for vehicles formed into rapid transit multiple unit trains operating on dedicated lines, and P-V for light rail vehicles.

The operator shall specify the crashworthiness design category used for EN 15227 based on the intended operation of the rolling stock. In general, this will be C-I for heavy rail operations, C-II for rapid transit trains operating on dedicated systems, and C-IV for light rail vehicles.

For mixed traffic operations including heavy rail operations, the design of rolling stock shall consider collisions with freight wagons in accordance with EN 15227. The relevant collision scenario shall consider a wagon without side buffers and fitted with a coupler conforming to AAR Manual of Standards and Recommended Practices (MSRP), Section S-III, S-106 in place of the wagon specified in Appendix C.1 of EN 15227.

For category P-II vehicles operating on the heavy rail network, a compressive proof load of 2 MN shall be withstood by the vehicle body rather than 1.5 MN as stated in EN 12663. The supplier may use EN 12663 without adopting this modified requirement if the supplier can assure through risk assessment or other appropriate means or both that there is a neutral or beneficial net safety impact in doing so based on the intended operation of the fleet.

5.2. Consideration for other rolling stock

The crashworthiness design of rolling stock shall consider, where reasonably practicable, the interface and performance of crashworthiness features of other rolling stock with which it is intended to interoperate. Consideration to other rolling stock shall include the following:

- maintaining override prevention performance in the event of a collision
- maintaining collision energy management performance in the event of a collision
- ensuring alignment and engagement of anti-climb devices in the event of a collision
- ensuring alignment and engagement of coupler systems in the event of a collision

Refer to Figure 1, Appendix A for an indicative location of anti-climbers on other heavy rail passenger trains operating in NSW.

5.3. Roofing

Heavy rail rolling stock shall provide a location on the roof of each vehicle where emergency services may cut through to gain access to the interior of a vehicle that has rolled onto its side. This space shall be clearly labelled to enable emergency services to identify immediately the appropriate space and cut lines. The location shall be adequate to enable a stretcher borne patient to be removed from the train. The region to be cut shall be devoid of any cables, pipes, or other equipment that may impede access.

For light rail and rapid transit rolling stock, the supplier shall perform a risk assessment to determine whether emergency roof access is required. The assessment shall take into account the risk of rolling stock rolling onto its side following collision or derailment, the level of other emergency access / egress facilities available, and the practicality of providing roof access.

5.4. Vehicle body missile protection

Roofs and forward facing areas shall comply with the missile protection requirements in Part 3 of GM/RT2100.

Vehicle bodysides and roof over areas that are freely accessible to occupants shall provide an equivalent or better level of protection to occupants as the bodyside glazing.

Further requirements for missile protection are provided in Section 7 of this standard.

These requirements do not apply to light rail rolling stock assets.

5.5. Requirements for equipment attached to vehicle bodies

Excepting expendable items as defined in T HR RS 00100 ST RSU 110 (heavy rail only) all exterior components shall be attached with the use of secondary restraints, redundant fixings, or secondary latches as appropriate to ensure that no single point of failure can cause equipment to either physically detach or protrude out of gauge. Examples of items requiring secondary restraints include side skirts and roof hatches.
6. **Structural requirements for bogies and suspension**

6.1. **Bogies and running gear**

For heavy rail applications, the bogies shall meet the applicable requirements in T HR RS 00000 ST; T HR RS 00100 ST; T HR RS 00200 ST and T HR RS 00600 ST.

6.2. **Body to bogie attachments**

Body to bogie attachments shall comply with EN 12663 -1:2010 *Railway application – Structural requirements of railway vehicle bodies – Part 1: Locomotive and passenger rolling stock (and alternative method for freight wagons).*

In addition to the requirements set out in EN 12663 for category P-I and P-II vehicles, the body-to-bogie attachments for P-I and P-II vehicles shall withstand the following loads without significant permanent deformation.

- longitudinally, the respective bogie mass subjected to a 5 g longitudinal acceleration in either direction
- laterally, the greater of half the body design mass under exceptional payload (as defined in EN 15663), or the respective complete bogie mass subjected to a 1.1 g acceleration in either direction
- vertically, the greater of half the body mass under exceptional payload (as defined in EN 15663) or the respective complete bogie mass subjected to 2 g acceleration over and above gravitational acceleration in either direction

Alternatively, the supplier may adopt the relevant requirements in EN 12663 without adopting these additional requirements, if the supplier can assure the operator through risk assessment or other appropriate means that there is a neutral or beneficial net safety effect in doing so based on the intended operation of the fleet.

6.3. **Equipment attached to bogie frames and axleboxes**

The design of equipment attached to bogie frames and axleboxes shall follow practice described in Part 4 of GM/RT2100 or Annex D of EN 13749.

The design load cases for equipment attached to axleboxes, and the attached equipment's mountings shall be appropriate for the intended operation of the rolling stock, considering both normal operation and collision or derailment scenarios and recovery.
7. Secondary structural elements

For heavy rail and rapid transport rolling stock, the performance of secondary structural elements shall comply with Part 5 of the GM/RT2100 standard. Windscreens shall meet all requirements of EN 15152.

7.1. Heavy rail rolling stock only

In addition to the requirements set out in GM/RT2100 Part 5, bodyside windows shall meet the testing requirements of FRA Type 2 Specification described in 49 CFR 223 Appendix A.

In addition to the requirements set out in GM/RT2100 Part 5, windscreens shall meet the testing requirements of FRA Type 1 Specification described in 49 CFR 223 Appendix A.

8. Crashworthiness and structural performance of interiors

Crashworthiness and structural performance of interiors shall comply with the Part 6 of the GM/RT2100 Issue 5, June 2012 Requirements for Rail Vehicle Structures standard.

If fitted, it shall be possible to open interior doors manually and for these doors to remain in an open position in the event that rolling stock has rolled onto its side or roof.

If fitted, interior doors shall remain able to be opened following collision scenarios considered in demonstrating compliance with EN 15227.

9. Asset protection

Rolling stock shall provide sufficient integrity to limit damage during heavy shunts. The level of provision in design shall be proportional to the level of risk associated with the intended operation of the rolling stock.

Where practicable, energy-absorbing devices shall be easily replaceable in the event of minor collision.

Unless stated otherwise by the Operator, the supplier shall consider features that improve resilience to damage and reparability after heavy shunts or minor collision to minimise asset life cycle cost, based on a risk-based review of the anticipated frequency of heavy shunts and minor collisions.

The Operator shall set further requirements for the ability of rolling stock to withstand heavy shunting, minor accidents, minor collisions, and minor derailments based on the specific operational and contractual arrangements under which the rolling stock is to be supplied and operated.
Appendix A – Anti-climbers

Figure 1 - Indicative location of anti-climbers on Waratah, OSCar, and Millennium Trains