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Preface

This standard was prepared by the Railway Rolling Stock – Body Structural Requirements – Part 2: Freight Rolling Stock Development Group, overseen by the ARISO Rolling Stock Standing Committee.

Objective

The objective of this document is to prescribe the minimum structural integrity level of the freight vehicle to ensure safe performance under normal and extreme operating conditions.

This document describes requirements for the structural strength of freight vehicles.

This document is intended to compliment the rolling stock compliance certification process outlined in AS 7501.

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.

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.

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 document 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 document.

Table of Contents

Section 1	Scope and general	6
1.1	Scope	6
1.2	Normative references	6
1.3	Defined terms and abbreviations.....	6
Section 2	General	9
2.1	Interpretation of vehicle structural requirements.....	9
2.2	Human factors integration	9
2.3	Inspection access.....	9
2.4	Marking and identification of rolling stock	9
2.5	Drawgear height.....	9
Section 3	Design verification	9
Section 4	Construction	10
4.1	General.....	10
4.2	Welding and fabrication.....	11
4.3	Mechanical fastening	11
4.4	Bonding	11
4.5	Corrosion protection	11
Section 5	Maintenance	11
5.1	General.....	11
5.2	Body-mounted equipment.....	13
Section 6	Structural rating	13
Section 7	Proof loads	13
7.1	Longitudinal proof loads	13
7.1.1	Compressive loads.....	13
7.1.2	Tensile loads.....	14
7.2	Vertical proof loads	14
7.2.1	Live loads.....	14
7.2.2	Combined vertical and longitudinal loads.....	14
7.2.3	Lifting and jacking.....	14
7.2.4	Coupler vertical loads.....	14
7.2.5	Twist	15
7.3	Impact load.....	15
7.4	Lateral loads	15
7.4.1	Rollover	15
7.4.2	Coupler lateral component	15
7.4.3	Load case summary	15
7.5	Additional requirements	16
Section 8	Fatigue loads	16
Section 9	Loading hatches, loading doors, discharge doors and crew access doorways ...	17

Section 10	Towing fixtures	17
Section 11	Body-mounted equipment	18
11.1	General requirements	18
11.2	Shock/minor impact loading	19
11.3	Modal analysis and fatigue	19
Section 12	Intermodal rolling stock	20
12.1	Corner fitting securing system – General requirements.....	20
12.2	Corner fitting securing system – Design loads	21
12.3	Rail vehicle requirements.....	21
Section 13	Tanks and fitting on rail tank cars.....	21
13.1	Rail tank car classification	21
13.2	General tank car requirements	21
13.3	General tank requirements	22
13.4	Detailed requirements for tank cars, tanks and attachments	22
Appendix A	Hazard Register (Informative).....	24
Appendix B	Container Restraint Spigot (Informative)	25
Appendix C	Rail Tank Car Classification Requirements	27
	Bibliography (Informative)	30

Figures

Figure 1	Example emergency towing fixture	18
Appendix Figure B1	Spigot centreline spacing.....	25
Appendix Figure B2	Spigot design loads	26

Tables

Table 1	Load Cases for Investigation	15
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Section 1 Scope and general

1.1 Scope

This document applies to new and modified freight rolling stock.

The requirements in this document do not retrospectively apply to any existing vehicles other than vehicles which are being modified in areas covered by this document, so far as reasonably practicable.

The document covers the design, construction and maintenance of freight rolling stock.

This document excludes roadrailer trailers, the operation of rolling stock, or rolling stock used on cane railways. Items from this document can be applied to such systems as deemed appropriate by the relevant RTO.

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 1210:2010, *Pressure Vessels*
- AS 4100:2020, *Steel structures*
- AS 4991:2004, *Lifting devices*
- AS 7503:2023, *Rail vehicle identification and markings*
- AS 7522:2025 *Access and Egress*
- AS 7524:2019 *Coupler and Drawgear*
- AS/NZS 1554.1:2014, *Structural steel welding, Part 1: Welding of steel structures*
- AS/NZS 1665:2004, *Welding of Aluminium Structures*
- AAR M-1002, *Specifications for Tank Cars (Manual of Standards & Recommended Practices Section C, Part III:2024)*

NOTE:

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

1.3 Defined terms and abbreviations

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

1.3.1

AAR

Association of American railroads

1.3.2

API

American Petroleum Institute

1.3.3

critical design stress

either the yield stress (0.2% proof limit), 80% of the ultimate stress or 80% of the critical buckling stress whichever is less

1.3.4

DOT

Department Of Transport (USA)

1.3.5

EN

Euronorm, official European standard

1.3.6

freight vehicle

hailed vehicles designed and used for carrying payloads which do not include people

1.3.7

heavy duty freight vehicle

freight vehicle suitable for freight and heavy haul with three or more locomotives head end.

1.3.8

light duty freight vehicle

freight vehicle used for example in light duty freight operations, with a maximum head end tractive effort of 600 kN

1.3.9

medium duty freight vehicle

freight vehicle used in intrastate main and branch line operations, restricted to around 1200 kN tractive effort at head end, typically hauled by 2 AC or 3 DC locomotives, and with indexer (if used) load no more than 600 kN.

1.3.10

modifications

changes to a railway vehicle body structure or components which affect its original structural integrity or safety in areas covered by this standard

1.3.11

NNI

National Network for Interoperability

1.3.12

rail infrastructure manager (RIM)

1.3.13As defined by Rail Safety National Law.

RSO

rolling stock operator as defined by Rail Safety National Law

1.3.14

RTO

rail transport operator as defined by Rail Safety National Law

1.3.15

ullage

difference between the volume of a container and the volume of its content. It can be expressed as an absolute volume or as a percentage of the container volume

1.3.16

underframe

metal framework carrying the main body structure of a vehicle usually located under the floor level

1.3.17

underframeless tank car

tank having end assemblies welded or otherwise attached directly to the tank

Note 1 to entry: The tank portion of the car acts as a load bearing member to directly withstand dead and live loads and the forces generated by train action in transit.

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

2.1 Interpretation of vehicle structural requirements

The requirements in this document primarily relate to freight vehicles (i.e. a single vehicle), however the design, construction and maintenance of the vehicles specified in this document shall include incorporation of all interfaces between vehicles that make up a train.

2.2 Human factors integration

Human factors should be incorporated into the design process in accordance with AS 7470.

Common physical interfaces include access ladders and steps, couplers, cocks and pneumatic equipment, hand brakes, doors and hatches among others. Items accessed during maintenance should be considered as well as those used regularly in service.

NOTE:

The intent is to avoid early structural design choices which can cause human interface problems if these are only considered later.

2.3 Inspection access

The design of the freight vehicle car shall assess areas of critical importance which will require inspection throughout the operating life of the vehicle. Appropriate access to such areas shall be included as part of construction if it is practical to do so.

2.4 Marking and identification of rolling stock

The marking and identification of freight vehicles shall be in accordance with AS 7503:2023, with additional identification marking for light, medium and heavy rated vehicles to ensure their rated draw load is not exceeded.

2.5 Drawgear height

Coupler draft pockets shall be designed to AS 7524:2019 coupler height requirements. The draft pocket height may be varied to suit an offset coupler as per AS 7524.

Drawbar pockets may be offset from the coupler pocket. The compressive load case as per Clause 7.1.1 shall not generate 10% unloading of the vehicle gross load.

NOTE:

Shorter wagons such as iron ore cars generally need fixed drawbars aligned to the same height as the coupler.

Section 3 Design verification

Verification of compliance with the requirements of this document shall be undertaken by engineering analysis, calculation, inspection, comparison with other vehicles or test.

Commentary C3-1

Examples of engineering analysis include finite element analysis (FEA), fatigue analysis, hand calculations and vibration analysis.

Verification of compliance with the requirements of this standard shall account for the full range of variations in vehicle condition that are likely to be experienced.

The stress criteria used in this document shall be the critical design stress unless otherwise noted.

Where this document references a prescribed load case from another standard (i.e. AAR), then the stress criteria proposed in that particular standard shall be used.

If demonstration of compliance with this document is undertaken using finite element analysis, high localised stresses exceeding critical design stress may be acceptable if one of the following conditions is fulfilled:

- (a) they are associated with model singularities, or
- (b) they would not result in significant permanent deformation being experienced by the vehicle structure when the load is removed.

Commentary C3-2

Methods used to demonstrate that there is no significant permanent deformation include:

- (a) use of non-linear analysis to determine the magnitude of plastic deformation after a load application/removal cycle; and
- (b) correlating the results of physical tests to analysis results.

AAR Manual Section C-II provides further guidance on the acceptability of calculated stresses.

Where testing is undertaken, a correlation between the analysis and test results should be carried out.

The extent of testing shall be defined by the purchaser prior to contract award.

Subject to appropriate commercial agreement, the vehicle purchaser may request the vehicle supplier to provide all stress and fatigue analysis reports, model validation report, and physical test reports, concerning the structural integrity of the vehicle.

Commentary C3-3

The reports could include all necessary information to enable the vehicle purchaser or RSO to conduct due diligence, including but not limited to the following:

- (a) Structural representation – 2D and 3D drawings and models to fully define the primary vehicle structures for FEA analysis, including detailed cross-sectional areas and critical dimensions of individual structure members, subassemblies and general assemblies;
- (b) Design concepts – detailed description of the structural design concept including the main load paths in normal operating scenarios;
- (c) Structural connections – details of connections between structural members such bolted, riveted and welded connections including details of webbing and flanges; and
- (d) material properties – details of the materials used including strength and fatigue properties.

The primary purpose of the vehicle supplier providing the above information is to allow the vehicle purchaser to undertake repairs and make potential modifications to the rolling stock in the future and/or manage a change of operations.

Section 4 Construction

4.1 General

Construction shall be in accordance with relevant Australian or international standards applicable to the material.

Commentary C4.1

This document largely assumes construction from steel, complying with Australian or recognised, equivalent international standards. Where alternative materials such as aluminium or ferritic stainless steels are used, extra care is required in design for fatigue, and in the selection and application of weld procedures.

The quality of the workmanship in construction shall ensure that the actual structure meets the structural requirements of this document.

The construction of the freight vehicle shall be verified in accordance with the design documentation.

4.2 Welding and fabrication

Metallic welding including repair and rectification shall be in accordance with AS/NZS 1554.1:2014 for carbon and stainless steel and AS/NZS 1665:2004 for aluminium, or equivalent international standard.

4.3 Mechanical fastening

Mechanical fastenings (e.g., bolted joints, rivetted joints, etc.) shall be in accordance with AS 4100:2020, or an equivalent international standard.

4.4 Bonding

Adhesive bonding shall be in accordance with an appropriate international standard.

4.5 Corrosion protection

Materials should be corrosion and environment resistant to survive a nominal 25-year design life. Loss of material thickness due to corrosion should be considered unless prevented by protective coatings.

Where dissimilar materials such as steel and aluminium are in contact, protective measures shall be provided to prevent galvanic corrosion.

Flat areas where water could accumulate and promote corrosion should be adequately drained.

Crevices and traps where water or other substances could accumulate and promote corrosion shall be sealed.

Refer to AS/NZS 2312 for protection of structural steel. If renewal of the protective coating is required during design life, this should be included in the maintenance plan.

Section 5 Maintenance

5.1 General

The structural integrity of freight rolling stock shall be maintained over the asset service life.

The vehicle designer should incorporate the output from fatigue assessments into the vehicle maintenance manual to guide the operator and maintainer on what critical areas of the vehicle structure should be inspected to ensure structural integrity.

Any changes to operating conditions and/or parameters during the asset service life should be assessed in terms of any effect on the rolling stock structural integrity.

Commentary C5.1-1

The weld categories in AS/NZS 1554.1 for carbon and stainless steel and AS/NZS 1665 for aluminium can be used as guidance for determining critical areas that could require inspection during the asset service life.

NOTE 2:

Secondary structural elements can be designed to last the life of the vehicle and are not typically replaced or overhauled unless damaged or are no longer fit for service. However, aging and degradation due to operating and environmental factors such as water ingress, extended exposure to solar radiation and minor collisions can affect the required functionality and performance of these elements. In some circumstances destructive testing could be required to sufficiently demonstrate compliance with original requirements.

Structural condition assessment and testing to detect deterioration of strength due to impact damage, cracking, erosion, and corrosion that can negatively impact the theoretical remaining fatigue life and structural safety of the freight vehicle should be performed when the freight vehicle:

- (a) is subjected to a collision, derailment or other incident (e.g., high shunting loads);
- (b) has a major overhaul or upgrade;
- (c) is subject to potential degradation from corrosion, minor collisions or other causes;
- (d) the designated design life could be affected by a change in operating parameters;
- (e) as defined in the technical maintenance plan.

For freight vehicles that have reached the designated design life and are to have their asset life extended, structural condition assessment to detect deterioration of the original strength due to asset operation should be performed to determine the theoretical remaining fatigue life.

If required, structural damage to a rolling stock body shall be repaired in such a way that the structural integrity is restored to the extent required by the RTO and maintainer.

Any structural repairs carried out shall be assessed for the effect on the structural integrity of the surrounding areas.

Where a structural repair introduces design features that are different from the original design, the structural integrity of these features shall be demonstrated to meet the requirements of this document so far as is practicable, either absolutely or by comparison with other local design features.

Commentary C5.1-2

AS 1940 provides guidance on the gas-freeing procedure for rail tank cars.

AS 2865 provides requirements for working inside rail tank cars.

AS/NZS 3788 provides general inspection requirements for rail tank cars.

A structural review to identify issues before they affect operations, and to enable a targeted inspection process for aged rollingstock should be conducted (i.e. at half-life) for the vehicle class during the asset service life.

The review should include NDT inspection on a sample set of vehicles to identify structural damage and material corrosion/erosion.

5.2 Body-mounted equipment

Fasteners, brackets and supports associated with equipment mounted to the exterior of the body shall be maintained to prevent the equipment from detaching from the vehicle or encroaching upon the kinematic envelope.

When determining appropriate maintenance procedures, material type, component serviceable life, failure modes of mounting system components and the effects of corrosion on structural integrity should be assessed.

Commentary C5.2

This requirement recognises that inadequate maintenance of exterior-mounted equipment can lead to failure of mounting systems, creating hazards such as detached components or infringement of the vehicle kinematic envelope.

Section 6 Structural rating

Freight vehicle designs shall comply with the appropriate structural rating given in this document based on the intended mode of operation and the likely loads the vehicle will experience in service.

Three main structural rating categories are given in Clause 1.3 of this document:

- (a) Heavy duty freight vehicles
- (b) Medium duty freight vehicles
- (c) Light duty freight vehicles

Commentary C6

For guidance, these categories align approximately with the following draw capacities in RIM vehicle information packs:

- (a) Heavy: draw capacity of 2.2 MN or greater
- (b) Medium: draw capacity of 1.8 MN.
- (c) Light: draw capacity less than 1.3 MN

Section 7 Proof loads

7.1 Longitudinal proof loads

7.1.1 Compressive loads

Freight vehicle structures should be designed to withstand a compressive longitudinal load applied along the centre line of the draft gear at each end of the body without exceeding the critical design stress of the following applicable magnitude:

- (a) 4,450 kN for heavy duty freight vehicles
- (b) 3,500 kN for medium duty freight vehicles
- (c) 2,000 kN for light duty freight vehicles

Commentary C7.1.1

The compressive load specified in Clause 7.1.1(a) is derived from the AAR Manual of Standards and Recommended Practices, Section C-II, which specifies a 1,000,000 lb longitudinal end load for freight vehicle structures.

7.1.2 Tensile loads

Freight vehicle structures should be designed to withstand a tensile longitudinal load, applied along the centre line of the draft gear at each end of the body without exceeding the critical design stress of the following applicable magnitude:

- (a) 3,375 kN for heavy duty freight vehicles
- (b) 2,700 kN for medium duty freight vehicles
- (c) 1,500 kN for light duty freight vehicles

Commentary C7.1.2

The tensile longitudinal load specified in Clause 7.1.2(a) is derived from the 500,000 lb draft load defined in the AAR Manual of Standards and Recommended Practices, Section C-II, with an applied load factor of 1.5.

7.2 Vertical proof loads

7.2.1 Live loads

To allow for live loads, freight vehicle structures, when loaded to their maximum service mass on rail (i.e. dead load), shall be capable of supporting the effects of a load factor of 1.8 without exceeding the critical design stress.

7.2.2 Combined vertical and longitudinal loads

Freight vehicle structures shall be capable of supporting the following combined loads without exceeding the critical design stress:

- (d) Compressive end load (see Clause 7.1.1) and vertical load due to maximum mass.
- (e) Tensile longitudinal load (see Clause 7.1.2) and vertical load with a load factor of 1.8

7.2.3 Lifting and jacking

Rolling stock shall be designed to allow for jacking and lifting during maintenance or after derailment.

Sufficient space should be provided underneath and around each jacking and lifting point to allow installation of rerailling and lifting devices both during maintenance and rescue/recovery.

Fully loaded vehicles complete with bogies shall withstand the loads arising from lifting and jacking in the following situations:

- (a) Lifting or jacking from either end, on or near the draft gear carrier plate and coupler, with the vehicle supported by the other bogie without exceeding the critical design stress.
- (b) Lifting or jacking on jacking pads, or lifting brackets where fitted, without exceeding 0.6 x critical design stress.

The supplementary requirements of AS 4991 may be used for the design of lifting devices used to lift railway vehicles.

7.2.4 Coupler vertical loads

Freight vehicles shall be designed to withstand a vertical load of 220 kN applied at the coupler pull line, both upwards and downwards, without exceeding the critical design stress.

7.2.5 Twist

Freight vehicles shall be designed to withstand the twist arising from the more onerous of:

- a) The vertical load on one bogie is supported by only one side-bearer with centre plate unloaded; or
- b) The case of complete wheel unloading on one side of one bogie without exceeding the critical design stress (more likely to be critical on narrow gauge).

7.3 Impact load

Freight vehicles shall be designed to withstand the reaction and inertial forces arising due to a single ended impact through the coupler imparting a peak acceleration of 4 g, without exceeding the critical design stress.

7.4 Lateral loads

7.4.1 Rollover

This load case need only be considered for freight vehicles which operate where high cross winds are known to be a problem, such as articulated container wagons and car carriers. Such freight vehicles should be designed to withstand the reactions arising at the point of rollover with complete wheel unloading on one side of the vehicle, without exceeding the critical design stress.

7.4.2 Coupler lateral component

This load case need only be considered for freight vehicles which operate in hilly territory with grades 2% or greater and curves of 160 m radius or less. Such vehicles shall be designed to withstand the reactions arising due to the lateral component of the draw load in the coupler when the vehicle is on a minimum radius curve on a grade, without exceeding the critical design stress. The minimum curvature encountered on the NNI is 160 m, but 100 m radius curves can be found on the Queensland narrow-gauge network.

For tensile coupler force F this component is approximately $FL/2R$, where L is the coupled length, and R is the curve radius.

This lateral force is applied at each coupler pin, and is reacted at the bogie centre pivot, with a roll component if there is a difference in height.

This lateral load should be assessed combined with the tensile load in Clause 7.1.2 and the vertical load in Clause 7.2.1.

7.4.3 Load case summary

Table 1 provides a summary of the load cases which should be investigated.

Table 1 Load Cases for Investigation

Load case	Allowable stress
1.8x dead load	critical design stress
draft Load + 1.8x dead load	critical design stress
compressive end load + dead load	critical design stress
impact load + 1.8x dead load	ultimate tensile stress

Load case	Allowable stress
lifting at coupler + dead load	critical design stress
lifting at jacking pads +dead load	0.6 x critical design stress
coupler vertical loads + dead load	critical design stress
twist load + dead load	critical design stress

7.5 Additional requirements

The following loads are not applicable to all freight vehicles, but should be assessed where they are relevant to the vehicle design or intended operation:

- (a) Roof loads (e.g., support maintainer and tools).
- (b) Pressure loads from bulk materials, which could be asymmetrical, for example when unloading hoppers with sequentially opening doors.
- (c) Floor loads when loading.
- (d) Fork truck wheel loads.
- (e) Longitudinal loads on end walls, bulkheads and diaphragms.
- (f) Lateral leaning loads on sidewalls.
- (g) Asymmetrical partial load cases, such as a container on one end of a wagon.

Commentary C7.5

Some of the load cases listed above are described in further detail in the AAR Manual of Standards and Recommended Practices, Section C, Part II Sub-section 4.1 which provides indicative loading data for certain freight vehicle types and operating scenarios.

Section 8 Fatigue loads

A fatigue assessment should be performed for all new freight vehicle designs in accordance with the following process:

- (a) The fatigue loading spectrum is determined from direct measurement, simulation, from other standards, or sinusoidal approximation.
- (b) The designer identifies all locations that are subject to fatigue loading.
- (c) A standard such as BS7608, EN 1993-1-9 or DVS-1612 is used to determine the relevant classification and associated allowable stress at 10^7 cycles for non-welded details and fusion welded fabrications.
- (d) Miner's rule is used to add cumulative damages from each load case at each critical location.
- (e) Mean - 2 standard deviation data (i.e. 97.7% probability of survival) is the minimum level of confidence for fatigue life acceptance. (Note: This is already included in most fatigue standards).

Commentary C8

AAR Manual of Standards, Section C, Part II contains REPOS tables with fatigue spectra for North American operations, which could be relevant to some Australian operations as follows.

- (a) Heavy duty vehicles: Table 7.57 Fully loaded ARC-5 Car—articulated connector longitudinal load (kip),

(b) Medium duty cars: 60% cycle count Table 7.57 Fully loaded ARC-5 Car—articulated connector longitudinal load (kip), AAR MSRP C-II-321.

However, many Australian routes have higher loadings for twist than the USA due to the number of curves and greater superelevation.

An example of sinusoidal approximate is EN 12663 loads for locomotives of ± 0.2 g vertical for 10^7 cycles and ± 0.25 g lateral for 10^7 cycles

Section 9 Loading hatches, loading doors, discharge doors and crew access doorways

Loading hatches, loading doors and discharge doors shall be fitted with a system to ensure against accidental or malicious opening.

Commentary C9

Refer to AS 7522 for requirements on crew access doorway systems.

All bottom discharge doors of bulk commodity wagons shall be designed to minimise leakage, as far as practicable, of the commodity onto the track.

Section 10 Towing fixtures

Two (2) emergency towing fixtures shall be fitted at each end of a freight vehicle, evenly spaced laterally on either side of the coupler.

NOTE 1:

Figure 1 shows an example of a suitable towing fixture fitted to the headstock.

NOTE 2:

The purpose of the towing fixtures is to allow chain attachment between vehicles in the event of coupler failure so the train can clear the section at low speed.

NOTE 3:

The towing fixture shown on Figure 1 has a 25 kN in-line and 15 kN at 45 degrees nominal load rating.

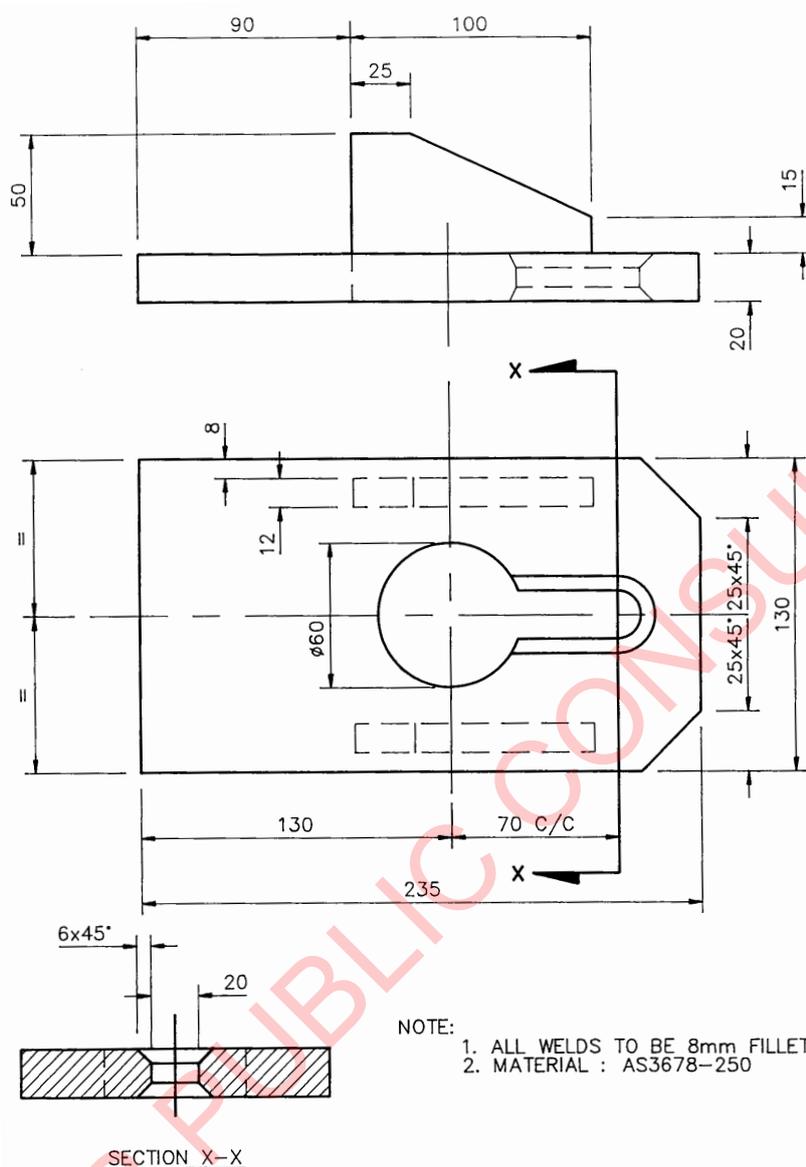


Figure 1 Example emergency towing fixture

Section 11 Body-mounted equipment

11.1 General requirements

Body-mounted equipment shall be designed to be retained within the kinematic envelope.

To meet the requirements of this section, especially in the case of equipment which could fall onto the track if fasteners work loose, or where equipment is frequently removed, one of the following methods should be used:

- (a) Over design of fasteners and attachments.
- (b) High strain energy fasteners.
- (c) Secondary restraints.

Body mounted equipment that could cause a derailment if it detaches and falls to the track should be instrumented during type testing to confirm the design analysis.

NOTE:

Particular attention is warranted to the mounting and support of underframe equipment that is frequently removed.

11.2 Shock/minor impact loading

The following accelerations applied individually to components and their mountings to the body should not cause the critical design stress to be exceeded in any member:

- (a) Longitudinally $\pm 4g$
- (b) Laterally $\pm 2g$
- (c) Vertically $\pm 2g$

The accelerations defined above shall also be combined with the load due to 1 g vertical acceleration (i.e. gravity).

The accelerations quoted above shall be applied to the centre of inertia of the equipment.

Deflection should also be assessed if it could result in components coming into contact and causing the failure of pipework or electrical short circuiting in critical equipment.

These requirements do not apply to the corner fitting securing systems on freight vehicles for which Clause 14.2 and Clause 14.3 apply.

11.3 Modal analysis and fatigue

Body-mounted equipment and slender members should be assessed for vibrational modes under 40 Hz.

Commentary C11.3-1

In a vehicle of structural steel construction and with AAR freight bogie wedge suspensions, the above section is conservative. In such vehicles, vibration fatigue risk is prevented for frequency above 30 Hz.

This is due to two factors:

- (a) AAR Friction wedges are unable to transfer high frequency due to the wedge bounce resonance limit; and
- (b) In structural steels infinite fatigue life effects means high frequency strains are unable to fatigue steel.

Commentary C11.3-2

In vehicles with viscous damping suspensions, the designer will likely need to consider frequencies to 50 Hz (to the bogie frame vibration limits).

Commentary C11.3-3

In an alternate material construction (i.e. aluminium), the review of flex modes will need to allow for higher cycle accumulation to 5×10^7 cycles in the absence of infinite life fatigue properties of structural steels.

Commentary C11.3-4

Problem vibrations can be instrumented during performance testing to confirm the vibration frequency and cycle counts accumulating per 100 km so the design can review the vibration fatigue service risk.

If present, vibrational modes under 40 Hz should be reviewed for fatigue from 0.1 g excitation in any axis for 10^7 cycles.

The modal fatigue model should include a static gravity pre-loaded geometry.

Validation testing shall be performed to verify the vibration frequency and calibrate the pre-stress state for the flex mode.

Commentary C11.3-5

Thin wall hopper and gondola wagons can be prone to wobble modes in compressive loaded upper walls. Fatigue damage of the cant rail weld has been experienced. This is due to a combination of the live load and manufacture weld stresses of the cant rail.

Whilst modes of +30 Hz are unlikely to fatigue, manufacturing variation does affect the connection stiffness of attachments and requires the designer to review 30–40 Hz flex modes for fatigue or stiffening.

Section 12 Intermodal rolling stock

12.1 Corner fitting securing system – General requirements

The corner fitting securing system of freight containers (refer to AS 3711) shall provide longitudinal, lateral and vertical restraint at the four lowest corner fittings.

Longitudinal and lateral restraint of the container or removable structure shall be provided by either:

- (a) engagement by a spigot with the aperture in the base of each corner fitting; or
- (b) corner brackets (restraining curbs) at each corner or vertical sides of a well.

The longitudinal distance between corner bracket or well end walls shall be the nominal container or removable structure length plus between 10 mm and 20 mm.

The lateral distance between corner bracket or well inner sides shall be the nominal container or removable structure width plus between 6 mm and 12 mm.

Wells should be tapered at the top as follows:

- (c) The longitudinal length at the top of the inside of the well should be at least 100 mm greater than the longest container.
- (d) The lateral width at the top of the inside of the well should be at least 2,540 mm.

Lateral spacing of securing devices shall be symmetrical about the longitudinal centre line of the vehicle.

Lateral and longitudinal spacing of spigot centrelines shall comply with Appendix Figure B1 for the illustrated container sizes.

Vertical restraint of the container or removable structure shall be provided by either of:

- (e) a rotating spigot engaging the inner surface of each corner fitting base;
- (f) a horizontal peg or key that engages through each corner fitting and an aperture in the vertical face of the spigot or corner bracket; or
- (g) vertical internal sides of each corner bracket or well taller than 240 mm.

For any combination of four securing devices located to restrain a freight container, the support surface of any device shall lie within 5 mm of the plane through the support surfaces of the other three.

Manually operated vertical restraint spigots, pegs or keys shall be fitted with a positive locking mechanism.

The locked position of manual or automatic locking devices shall be identifiable by visual inspection.

See Appendix B for information about spigot design and spacing.

12.2 Corner fitting securing system – Design loads

When installed in the normal operating conditions, all securing devices shall withstand the following loads as shown in Appendix Figure B2 without exceeding the critical design stress in any component:

- (a) A longitudinal load of 630 kN applied in either direction at a point 15 mm above the container seating surface.
- (b) A lateral load of 315 kN applied in either direction at a point 15 mm above the container seating surface.
- (c) A total vertical downward load of 560 kN applied to the horizontal support face of the securing device.
- (d) A vertical downward load of 315 kN applied to the centre of the rotating spigot providing vertical restraint in both the locked and unlocked position.
- (e) A total vertical upward load of 315 kN applied to the underside of the restraining face of the rotating spigot providing vertical restraint.

For automatic twistlocks and interbox connectors the exit force per device shall be between 4.5 kN and 10 kN.

For automatic twistlocks and interbox connectors the maximum entry force per device shall be 3.56 kN.

12.3 Rail vehicle requirements

The part of the vehicle structure supporting the securing devices should be designed to withstand the loads arising from the following accelerations when the vehicle is loaded to its maximum capacity without exceeding the critical design stress:

- (a) Longitudinally 2g
- (b) Laterally 1g
- (c) Vertically up 1g
- (d) Vertically down 1g

The resultant forces in each individual case should be assumed to be taken by two securing devices only.

Section 13 Tanks and fitting on rail tank cars

13.1 Rail tank car classification

Rail tank cars are classified in groups as non-pressure (filled at atmospheric pressure) and pressure (filled at a pressure greater than atmospheric).

Individual classes of tanks with required features, design parameters, AAR and United States DOT equivalents are given in Appendix C. Cryogenic vessels or vessels with pressures greater than 500 kPa are outside the scope of this document.

Rail car tanks fitted with equipment for heating the contents are identified by the lower-case suffix 'h' added to the tank class letter.

13.2 General tank car requirements

The design and construction of a tank car shall meet the requirements of this standard for its class and type or the requirements of the United States DOT or AAR M1002 as identified in Appendix C.

The tank car shall incorporate all safety equipment as prescribed in Appendix C.

For underframeless tank cars, the end assemblies, comprising headstock, bolster and draft sills, shall be attached to the tank in such a manner that the longitudinal compressive and tensile loads specified in

this standard are safely transmitted into the tank without unduly over-stressing any members involved in the connection.

13.3 General tank requirements

Tanks shall be circular in section, fusion welded with heads dished convex outwards, fitted with an inspection entry and such other features as described in clause 15.4.

Tank shells and fittings shall be designed and constructed to comply with the requirements of AS 1210:2010 and AAR M-1002

Inspection entries shall be provided in one end or on top of each compartment of a tank with provision for the locking of each entry.

Inspection entries should be hinged to the tank and designed to prevent opening while the interior of the tank is subjected to a pressure above the atmospheric pressure.

The joint between the cover and ring shall be sealed against vapour pressure.

A means of achieving the desired level of sealing is to use a gasket in this joint.

The minimum inspection entry diameter should suit service / emergency personnel with breathing apparatus.

All tank cars should be fitted with a measuring device accessible at ground level to determine the loaded condition of the tank.

When an ullage bar is used as a liquid load indicator it shall be permanently attached to the shell, inside each tank compartment immediately below the manhole opening.

Where used, the ullage bar shall be positioned such that the percentage of volume of the tank shell above the ullage bar is equivalent to that specified in Appendix C.

Where bottom loading of the tank is permitted, API or AAR standard fittings shall be used and automatic overfill protection shall be provided.

When the interior of the tank is divided into compartments, each compartment shall be complete with all features such as the inspection entry, fitting and expansion dome (if fitted) as prescribed for a single tank.

13.4 Detailed requirements for tank cars, tanks and attachments

On underframeless tank cars and where the side sills have been omitted, suitable boundary members should be provided with a minimum width of 2600 mm, or 2540 mm for narrow gauge.

Ladders, handholds and inspection or filling platforms in accordance with AS 7522:2025 should be fitted to the tank car to enable access to the inspection entries, expansion domes and other tank fittings.

All attachments to the tank including ladders, steps and handholds shall be made using attachment pads in accordance with AS 1210:2010

Holes, loops and other devices may be fitted to the tank car to enable towing, propelling or lifting.

When an expansion dome is fitted it shall be circular in plan.

When an expansion dome is fitted it shall have a minimum capacity when measured from the inside top of the shell of the tank to the top of the ports in the skirt of the safety valve, in accordance with the requirement identified in Appendix C.

Tank heater installations shall comply with the requirements of AS 1210:2010 and the applicable AAR standards.

When ends of steam coils are not attached to a manifold or steam jacketed chamber, they shall be attached to pads or tank reinforcements.

Outside pipe connections to steam coils shall not be an integral part of the interior coils.

Outside pipe connections to steam coils shall be welded to the outside of pads or reinforcements.

Inlets and outlets of heater pipes shall be equipped with a valve, cock, cap, plug or other closure.

Caps, plugs or other removable closures shall be secured by a steel chain with a link material not less than 5 mm diameter.

When flame tubes are used, the outlet end shall be fitted with an efficient spark arrester.

Fitting of a heater which uses the shell or ends of the tank as part of the flame duct is prohibited.

Discharge outlets and valves shall meet the requirements of the AAR or API standards.

Protection against damage shall be provided for fittings mounted directly on the tank and not contained inside an expansion dome.

It is acceptable for side discharge pipes to be attached to form part of the bottom discharge outlet.

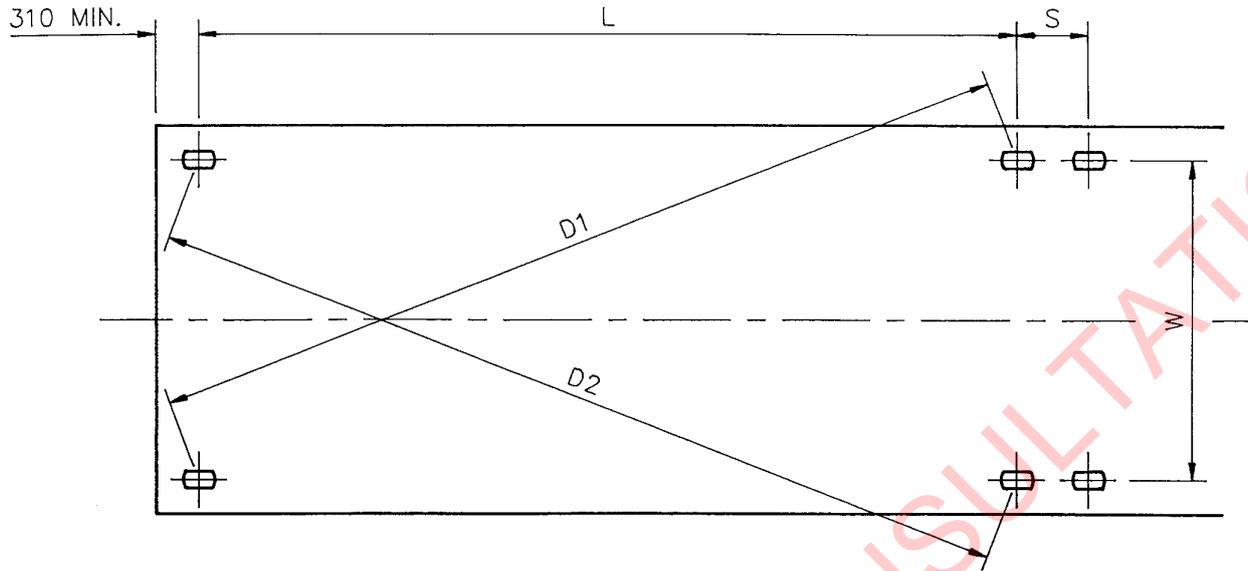
Air operated valves may be used for the top vent and bottom liquid outlet.

Any vessel venting equipment shall discharge away from operators.

Appendix A Hazard Register (Informative)

Hazard Number	Hazard
5.1.1.33	Collision causing accidental spills
5.2.1.7	Out of gauge trains causing collision with wayside structures
5.2.1.8	Objects dropping down / falling off trains causing collision with wayside structures
5.2.1.32	Out of gauge trains causing dewirement (harm to overhead power systems)
5.4.1.5	Inadequate couplers, draft gear or structure strength which are unable to withstand train forces
5.4.1.25	Spilled corrosive waste products
5.4.1.30	Unsealed steel crevices from poor design and manufacture resulting in excessive corrosion
5.4.1.31	Undrained areas from poor design and manufacture resulting in excessive corrosion
5.4.1.32	Contact of incompatible materials from poor design and manufacture resulting in excessive corrosion
5.4.1.33	Inadequate protective coating from poor design and manufacture resulting in excessive corrosion
5.4.1.35	Inadequate jacking / lifting points such that rolling stock is unable to jacked up or lifted without damage
5.4.1.36	Inadequate structure strength -such that rolling stock is unable to jacked up or lifted without damage
5.7.1.13	Objects off passing trains colliding with the sides of trains
5.8.1.7	Out of gauge trains causing side swipe by another train

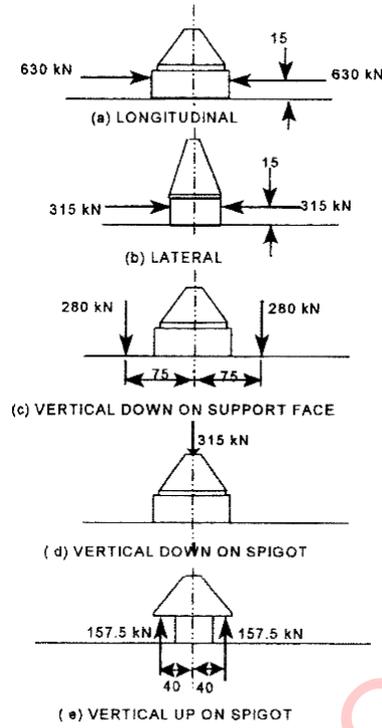
Appendix B Container Restraint Spigot (Informative)



NOMINAL LENGTH OF CONTAINER ,m	L	W	D1-D2 OR D2-D1	S	
				EITHER	OR
12.20	11986±6	2261±2	10	510	280
9.13	8919±6	2261±2	8	510	280
6.10	5853±6	2261±2	8	510	280
3.05	2787±6	2261±2	6	510	280

NOTE: DIMENSION "S" :510mm ALLOWS SUFFICIENT CLEARANCE BETWEEN CONTAINERS FOR TOP LIFTING EQUIPMENT WITH CENTREING GUIDES.
 :280mm MAINTAINS THE NOMINAL I.S.O. CLEARANCE OF 76mm BETWEEN ADJACENT CONTAINERS.

Appendix Figure B1 Spigot centreline spacing



Appendix Figure B2 Spigot design loads

Appendix C Rail Tank Car Classification Requirements

Tank Car Class	A	B	C	D	E	F	G	H	J	K
Material	Steel, Al	Steel, Al, S.S.	Steel, Al	Steel	S.S.	Steel, S.S.	Steel, Al, S.S.	Steel, S.S.	Steel, S.S.	Steel, Al, S.S.
Insulation	Optional	Optional	Optional	N/A	N/A	Optional	N/A	Optional	Required	Optional
Cladding	N/A	N/A	N/A	N/A	N/A	Optional	N/A	N/A	N/A	N/A
Lining	N/A	N/A	N/A	Rubber	N/A	Optional	N/A	N/A	N/A	N/A
Heater	N/A	Bh	Ch	Prohibited	N/A	Prohibited	N/A	Optional	N/A	Optional
Burst pressure (kPa)	As per AAR	As per AAR	As per AAR	As per AAR	As per AAR	As per AAR	As per AAR	As per AS 1210	As per AS 1210	As per AAR
Dome	Optional	Optional	Optional	Optional	Optional	Optional	Prohibited	Prohibited	Prohibited	Optional
Expansion capacity	2%	1%	1%	1%	1%	1%	1%	N/A	N/A	2%
Filling pressure (kPa)	Atmospheric	Atmospheric	Atmospheric	Atmospheric	Atmospheric	Atmospheric	As per AAR	500 - 3100	As applicable	Atmospheric
Test pressure (kPa)	420	420	420	420	420	420	As per AAR	As per AS 1210	As per AS 1210	250
Safety vent	Prohibited	Required	Required	Required	Prohibited	Required	Optional	Prohibited	Inner & Outer	Prohibited

Tank Car Class	A	B	C	D	E	F	G	H	J	K
Safety relief valve	Required	Prohibited	Prohibited	Prohibited	Required	Prohibited	Optional	Required	Inner Tank Only	Required
Relief pressure (kPa)	240	420	420	420	240	240	As per AAR	As per filling pressure +/- 3%	As per filling pressure +/- 10%	Min. 50
Retest	Required	Required	Required	Prohibited	Required	Prohibited	Required	Required	Required	Required
Bottom outlet	Optional	Required	Prohibited	Prohibited	Prohibited	Optional	Optional	Prohibited	Prohibited	Optional
Bottom sump	Optional	Optional	Optional	Optional	Optional	Prohibited	Optional	Prohibited	Prohibited	Optional
Side outlet	Optional	Pipes Optional	Prohibited	Prohibited	Prohibited	Pipes Optional	Pipes Optional	Prohibited	Prohibited	Optional
Top outlet	Optional	Prohibited	Required	Required	Required	Optional	Prohibited	Required	Required	Optional
Fire protection	N/A	Optional	Optional	N/A	N/A	Optional	N/A	Required	Required	N/A
Dangerous goods class	3 & 6	3 & 8	3 & 8	8	8	8	-	2.1, 2.3 & 6	2.2	N/A

Tank Car Class	A	B	C	D	E	F	G	H	J	K
Typical application	General, flammable & Poisonous Liquids	General, Combustible & Corrosive Liquids	General, Combustible & Corrosive Liquids	Highly Corrosive Liquids	Very Highly Corrosive Liquids	Corrosive Liquids, Food Stuffs & Pure Chemicals	Dry Bulk & Granular Materials	Chlorine, L.P.G., Anhydrous Ammonia & Highly Toxic Liquids	Cryogenic Liquids	General (non-dangerous) liquids only
US DOT Class	103W, ALW, 104W, 111A**W*	103A-ALW, 103CW, EW, 111**ALW1, W1, W3, 115A**W*	103AW, *ALW, 111* *ALW2, W2	103BW, A*ALW	103CW, EW, 117A*W7	103CW, EW		105A, S**W, 107A**, 109A**ALW, W, 112A, J, S & T**W, 114J, S & T**W	105J**W, 113***W	-
AAR Class	203*W, 211A**W*	203DW, 211A**W6, 211A**ALW	203DW, 211A**W6, 211A**ALW	203DW, 211A**W6, 211A**ALW	211A**W7		207A**W*		204W	-

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