



Engineering and Asset Management
Interoperability Standard
M-ST-RS-8101
Rail Vehicle
Interoperability

Document Control

Document No.	M-ST-RS-8101	Issue No.	1.1
Date Effective	12/03/2026		
Prepared (P)	(P)/(A) A. Raue	Checked and Approved By	Engineering & Asset Management – Professional Heads
Reviewed (R)		Authorised for Release By	Professional Head – Interoperability
Amended (A)			

This is a 'living' document, that will be updated every five years or earlier if KiwiRail determines that changes to the document are required.

If changes arise from the review this document will be reissued, however, if no changes arise from the review, the current version of this document will remain in force.

Copyright

The information in this document is protected by Copyright and no part of this document may be reproduced, altered, stored or transmitted by any person without the prior consent of KiwiRail.

The original version is held on KiwiRail EDMS, and controlled copies are available through SharePoint and the KiwiRail external website www.kiwirail.co.nz. All other electronic copies and all printed versions are uncontrolled.



Table of Contents

1. Purpose	7
2. Scope	7
3. Associated Documents	7
3.1 Withdrawn, closed and superseded	7
4. Acronyms and Definitions	8
5. Application	11
6. New Rail Vehicles	11
6.1 Provisional Running Rights	11
6.2 Interim Running Rights	11
6.3 Full Running Rights	12
6.4 Temporary Running Rights	12
7. Existing Rail Vehicles	13
7.1 Modification of Existing Rail Vehicles	13
7.2 Extending Running Rights	13
8. Rail Vehicles Outside of Controlled Network	14
9. Independent Competent Person	14
10. Derogation Process	14
11. Innovative Solutions	14
12. Data Register	14
13. Change of Rail Operator	15
14. Audit Inspections	15
15. Route Authorisation	15
15.1 Clearances	15
15.2 Vehicle Mass & Axle Loads	16
16. Maximum Speed	17
17. Track Forces and Stresses	17
18. Dynamics & Curve Negotiation	18
18.2 Horizontal Curves	19
18.3 Vertical Curves	19
18.4 Longitudinal Forces in Curves	19
18.5 Resistance to Roll-Over in Gales	20
19. Wheelsets	21
19.1 Compliance to External Standards	21
19.2 Wheel Material	21
19.3 Wheel Diameter	22

19.4	Rim Width	22
19.5	Wheel Profile	23
19.6	Wheelset Back-to-Back	23
20.	Braking	24
20.1	Stopping Brake	24
20.2	Parking Brake	24
20.3	Dynamic Brake	25
20.4	Brake Command	25
20.5	Brake Requirements - Rescue	28
20.6	Braking Performance	29
20.7	Wheel-Rail Adhesion	31
20.8	Wheel Slide Protection	31
20.9	Jerk Limitation	32
20.10	Brake System Thermal Capacity	32
21.	End Couplers	32
22.	Leading Ends & Frontal Impact	33
23.	Visibility	35
23.1	Leading End Lighting Arrangement	35
23.2	Headlights	36
23.3	Ditchlights	36
23.4	Tail Lights	37
23.5	Leading End Livery Colour	38
23.6	Reflective Delineators	39
24.	Audibility	39
24.1	Horns	39
24.2	Yard Warning Devices	40
25.	Signalling System Compatibility	41
25.1	Signal Viewing	41
25.2	Permitted Acceleration	42
25.3	Track Circuit Detectability	42
25.4	Track Circuit Interference	43
25.5	Sanding	43
25.6	On Board Wheel Flange Lubrication & Adhesion Modifiers	44
25.7	Axle Configuration	44
25.8	Axle Counter Compatibility	45
26.	Instruments & Monitoring Equipment	46
26.1	Speed Indicating Device	46
26.2	Vigilance System	46
26.3	Event Recorder	47
27.	Vehicle Markings	47

27.1	Vehicle Identification.....	47
27.2	Functional & Safety Labelling	47
28.	Electrified Areas.....	48
28.1	Vehicles that Operate in Electrified Areas	48
28.2	Electric Vehicles	49
29.	Tunnel Operation	51
29.1	Gas Emissions.....	51
29.2	Running Capability in Case of Fire	51
30.	Rail Ferry Compatibility.....	51
31.	Environmental Restrictions.....	52
32.	Rail Vehicle Electrical Power Systems.....	53
32.1	Electrical Safety & Compatibility.....	53
32.2	Electrical Energy in Emergency.....	53
33.	Radio System	54
34.	Remote Control Systems	54
35.	Electromagnetic Compatibility.....	55
36.	On Board Equipment	55
36.1	Railway Track Signals	55
36.2	Fire Extinguishers	56
37.	Position Reporting.....	56
38.	Wayside Monitoring System Compatibility	56
38.1	Automatic Equipment Identification Tags	56
Appendix 1	Route Parameters.....	58
Appendix 1.1	North Island Routes.....	59
Appendix 1.2	South Island Routes	62
Appendix 2	Standard Static Vehicle Gauge.....	64
Appendix 3	Hi-Cube Static Vehicle Gauge	65
Appendix 4	Comparative Gauging – AS 7507 Method.....	66
Appendix 4.1	Reference Vehicle 1 (UK Wagon)	67
Appendix 4.2	Reference Vehicle 2 (IAB Wagon)	68
Appendix 5	Absolute Gauging – Static Outlines.....	69
Appendix 6	Service Brake Performance Curves	71
Appendix 7	Maximum Permitted Acceleration Performance Curve.....	73
Appendix 8	Electrified Areas – Basic Parameters	75
Appendix 9	Automatic Equipment Identification Tags	76
Appendix 9.1	AEI Tag Positioning.....	76

Appendix 9.2 AEI Tag Programming Requirements 80

Document History 85

List of Figures

Figure 1: Base Vehicle, Short (IPA-Class Wagon) 19

Figure 2: Base Vehicle, Long (EF-Class Locomotive) 20

Figure 3: Base Vehicle, Rescue (DM-Class Locomotive)..... 20

Figure 4: Wheel Taping Line Datum 22

Figure 5: KiwiRail Standard Wheel Profile Dimensions 23

Figure 6: Wheelset Back-to-Back Dimension 24

Figure 7: Anti-Climb Device Requirements, Side View (mm) 34

Figure 8: Leading End Lighting – Positioning Requirements 35

Figure 9: Viewing Envelope Dimensions for Ground Signals (metres)..... 41

Figure 10: Viewing Envelope Dimensions for Running Signals (metres) 42

Figure 11: Warning Labels 15024439 (Horizontal) & 15024440 (Vertical) – 20 mm Text, Red Symbol/Text on White Background..... 48

Figure 12: Static Clearance Assessment in ClearRoute (example) 70

Figure 13: Service Brake Performance Curves, Tangent Level Track 71

Figure 14: Maximum Permitted Acceleration Curve, Level Track..... 73

Figure 15: AEI Tags - 2-Axle Vehicles 77

Figure 16: AEI Tags – 4-Axle Bogie Wagons / Carriages (mm) 77

Figure 17: AEI Tags – 6-Axle Bogie Wagons / Carriages (mm) 78

Figure 18: AEI Tags – 6-Axle Locomotives (Co-Co, etc.) (mm) 78

Figure 19: AEI Tag – 4-Axle / 6-Axle Locomotives (Bo-Bo-Bo, etc.) (mm)..... 79

List of Tables

Table 1: Chromaticity Limits, CIE 1931, for Red Tail Lamps 37

Table 2: Chromaticity Limits, CIE 1931, D65, for Yellow Front Ends 38

Table 3: Standing Surface Dimensions for Live Parts Clearance Assessment 50

Table 4 : Route Parameters – North Island 59

Table 5: Route Parameters – South Island..... 62

Table 6: Static Clearance & Speed Restrictions – Above Vehicle Floor Level..... 69

Table 7: Clearance & Speed Restrictions – Below Vehicle Floor Level 69

Table 8: Service Brake Performance Values, Tangent Level Track 72

Table 9: Minimum Acceleration Distance (metres), Level Track 74

Table 10: EPC Memory Encoding Scheme 80

Table 11: 6-Bit Encoding of Alphanumeric Characters – EPC Memory 81

Table 12: Example Class & Running No. Coding – EPC Memory ("DXR8007")..... 82

Table 13: User Memory Encoding Scheme 83

Table 14: Example Class & Running No. Coding – User Memory ("DXR8007")..... 84

1. Purpose

This standard sets technical requirements for rail vehicles to be interoperable with the National Rail System. Compliance with this standard is required for KiwiRail as Access Provider to grant Running Rights to Rail Operators for New or Modified Rail Vehicles.

2. Scope

This standard specifies technical requirements for new rail vehicles on the Controlled Network. These requirements are intended to ensure technical interoperability between rail vehicles and the infrastructure of the National Rail System, and are a prerequisite to Running Rights being granted to Rail Operators' rail vehicles by KiwiRail as the Access Provider.

Existing rail vehicles that undergo modification are required to meet this standard, so far as applicable to the sub-system(s) being modified. Existing rail vehicles should not otherwise be presumed to fully comply with all requirements of this standard.

This standard does not provide a comprehensive set of design requirements for rail vehicles. Rail Operators are responsible for ensuring rail vehicles they operate are designed, constructed, maintained, and operated to a standard that supports their Safety Case. In general, certifying rail vehicles to this standard will form only part of a wider certification process.

Interoperability between rail vehicles is not fully addressed in this standard. However, some basic requirements are included for rescue by KiwiRail locomotives, anti-climber dimensions for collision scenarios between rail vehicles, and mainline coupling.

3. Associated Documents

Level	Number	Title	Relationship
1	M-PR-GE-8001	Rail Vehicle Interoperability Principle	Superior Document: Clarified / Extended
2	M-ST-RS-8102	Wheelset Dimensional Limits	Companion Document
2	T-ST-DE-5200	Track Design	Companion Document
2	T-ST-DE-5212	Clearances	Companion Document
2	OM94001	Hi-Rail Vehicle Code	Supporting Document
2	OM94002	Trolley Code	Supporting Document
2	OM94003	Mobile Track Maintenance Vehicle Code	Supporting Document
2	APIS 11	Heritage Vehicle and Train Management	Companion Document

3.1 Withdrawn, closed and superseded

Old Reference	Title	Replaced by
NRSS / 6	Engineering Interoperability Standards	M-ST-RS-8101

4. Acronyms and Definitions

Acronym	Definition
AAR	American Association of Railroads
AEA	Auckland Electrified Area
AEI	Automatic Equipment Identification
ARISO	Australian Rail Industry Standards Organisation (formerly RISSB)
ARL	Above Rail Level
CIE	Commission Internationale de l'éclairage (International Commission on Illumination)
CIMW	Continuous In-Motion Weighing
EMC	Electromagnetic Compatibility
EMU	Electric Multiple Unit
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
HVAC	Heating Ventilation and Air Conditioning
ICP	Independent Competent Person
KMC	Kupe Mobile Controller
LA	Line Availability
LAVEN	Line Availability Vehicle Evaluation Number
MRSRP	(AAR) Manual of Recommended Standards and Practices
NIMTEA	North Island Main Trunk Electrified Area
OHLE	Overhead Line Equipment
ppm	Parts Per Million
PSR	Permanent Speed Restriction
RCD	Residual Current Device
RFID	Radio Frequency Identification
RIM	Railway Infrastructure Manager. A term used in ARISO standards. In New Zealand this is the Access Provider
RISSB	Rail Industry Safety and Standards Board (Australasia). Historic name, now replaced by ARISO
RORO	Roll-On/Roll-Off
RSSB	Rail Safety and Standards Board (United Kingdom)
TEM	Train End Monitor
TSR	Temporary Speed Restriction
UHF	Ultra-High Frequency
WEA	Wellington Electrified Area
WSP	Wheel Slide Protection

Term	Definition
Access Provider	A licensed party or person who controls the use of a railway line by rail operators. Per Railways Act 2005. This means KiwiRail in all contexts for this document.
Bogie	A structure incorporating suspension elements and fitted with wheelsets, used to support rail vehicles and capable of rotation in the horizontal plane.
Carriage	Hauled rail vehicle designed for carrying passengers.
Controlled Network	All track where occupancy and movement by rail vehicles is under the control of the Access Provider (KiwiRail). This means track controlled by KiwiRail's National Train Control Centre and local signal boxes.
Data Register	Collated set of data and information for a rail vehicle describing key technical parameters relevant to interoperability. See 12.
Driving Position	Place(s) from which a rail vehicle can be operated. Typically the driver's seated position for conventional rail vehicles.
Existing Rail Vehicle	A rail vehicle with running rights on the National Rail System. See 7.
Grandfathered Running Rights	Applies where vehicles have an established and continuous commercial operating history on the National Rail System, but where original certification standard is unclear (i.e., pre-NRSS/6).
Hi-Cube	Denotes intermodal containers with nominal height of 2.9 m (or 9'6").
Hi-Rail Vehicle	Highway-Rail Vehicle. Road vehicles and off-road vehicles (e.g., excavators) fitted with deployable rail wheels for travel on rail.
Independent Competent Person	An experienced and knowledgeable person responsible for certifying rolling stock. Must be acceptable to the Access Provider and independent of from the rolling stock acquisition, design, and construction. See 9.
Lead Unit	Any rail vehicle intended for operation at the leading end of a train.
Locomotive	Self-propelled rail vehicle used for hauling or propelling other rail vehicles.
Multiple Unit	Self-propelled passenger train, typically made up of several semi-permanently coupled rail vehicles. Includes electric multiple units, diesel multiple units, and hybrid or alternatively powered types.
National Rail System	The rail network comprising the Controlled Network and Operator Controlled Territory. It includes all track unless specifically defined as unavailable for rail activity, owned or managed by the Access Provider (KiwiRail), including private sidings and all retained track. Excludes private railways. Excludes private or leased sidings not connected to the Controlled Network.
New Rail Vehicle	A rail vehicle without existing running rights or an operating history on the National Rail System. See 6.

Operator Controlled Territory	All parts of the National Rail System that are not the Controlled Network and where a Rail Operator or other Rail Participant is responsible for the occupancy and movement of Rail Vehicles. This includes where KiwiRail as a Rail Operator is responsible for occupancy and movement of Rail Vehicles. This includes yards, sidings workshops, rolling stock maintenance depots, and similar.
Rail Operator	A licensed party or person that operates a rail vehicle. Per Railways Act 2005.
Rail Participant	Any organisation or person responsible for the provision or maintenance of rail services. Includes Access Providers and Rail Operators.
Rail Vehicle	Any flange-wheeled vehicle which operates on or uses a railway line. Includes hi-rail vehicles when operating on rail.
Railcar	A self-propelled passenger rail vehicle. Generally, refers to a single non-articulated vehicle with driving positions at both ends.
Railway Track Signal	Small explosive device affixed to the rail head for the purpose of providing audible warning when a rail vehicle wheelset passes over. Commonly referred to as a Detonator.
Running Rights	Written authority issued by KiwiRail as the access provider to allow operation of a rail vehicle (or class of rail vehicles) on the controlled network.
Train	A locomotive or other self-propelled rail vehicle, alone or coupled to one or more rail vehicles.
Wagon	Hauled rail vehicle designed for carrying freight. Includes various types – container flat wagons, bulk hopper wagons, tank wagons, etc.
Wheelset	An assembly consisting of axle, wheels, bearings, and where applicable associated components such as brake discs, traction gears, traction motor support bearings, gearbox, etc.

5. Application

Each third-level numbered clause (e.g., 15.1.1) in this document is a technical requirement for rail vehicles to be assessed against.

Clauses that use the term “shall” indicate a mandatory requirement. Clauses that use the term “should” indicate a recommended practice, but are not mandatory. Clauses that use the term “may” indicate an allowed practice.

Rationale and guidance notes are provided for select clauses to aid in the application of this standard in rail vehicle design and certification.

6. New Rail Vehicles

New rail vehicles are rail vehicles without existing running rights and without an operating history on the National Rail System. This includes newly built rolling stock and imported rolling stock with an operating history on other networks.

Introduction of new rail vehicles into service shall follow a conformance assessment and certification process such as AS 7501 or an equivalent standard. KiwiRail, as the Access Provider, act as the Rail Infrastructure Manager (RIM) in this context.

Conformance assessment and certification shall be endorsed by an Independent Competent Person (ICP per AS 7501 definition, alternatively referred to as the Certifying Engineer). Detailed compliance evidence shall be retained, and made available to KiwiRail Infrastructure Engineering upon request.

All Running Rights must be formally sought by Rail Operators and, if granted, will be issued in writing by KiwiRail’s Professional Head – Interoperability or their delegate. Requests shall be made in writing to running.rights@kiwirail.co.nz

KiwiRail as the Access Provider reserves the right to revoke Running Rights where non-compliance to this standard is found to exist, or where significant safety or operational issues exist.

6.1 Provisional Running Rights

Provisional Running Rights may be sought by Rail Operators, or their proxies, where assurance of infrastructure compatibility is required for project progression.

Provisional Running Rights do not allow rail vehicles to be operated on the Controlled Network, but may be issued to confer agreed route compatibility (e.g., gauging assessment) or agreed derogation from specific requirements of this standard. Application for Provisional Running Rights should be endorsed by the ICP where one has been engaged.

For large or complex rolling stock projects, it is strongly recommended that Provisional Running Rights are sought prior to construction beginning.

6.2 Interim Running Rights

Interim Running Rights will be issued for restricted-use operation of rail vehicles, typically to support any on-track test and commissioning programme. Restrictions will vary on an individual basis, but will typically limit operation to non-passenger,

non-revenue services. Specific restrictions will be stated on written Running Rights issued by KiwiRail as the Access Provider.

Applications for Interim Running Rights shall, at a minimum, include:

- An interim Data Register (refer Section 12),
- A design compliance certificate (issued by the Independent Competent Person),
- A test certificate for completed static tests (and dynamic tests performed elsewhere, if applicable),
- Type and routine test plans.

Interim Running Rights may also be issued where new or rebuilt infrastructure requires vehicle tests to be completed as part of its commissioning (e.g., new routes, altered signalling systems, route electrification, etc.)

6.3 Full Running Rights

Following a successful type test programme, Full Running Rights will be issued to allow full-use of rail vehicles on the Controlled Network. This requires written Running Rights issued by KiwiRail as the Access Provider, and may include operating restrictions (allowed routes, loading limits, maximum operating speed, etc.).

Applications for Full Running Rights shall, at a minimum, include:

- A complete Data Register,
- a list of routes and/or lines for which running rights are requested,
- a design compliance certificate,
- a construction compliance certificate,
- a test compliance certificate,
- derogation risk assessment(s), where applicable.

Routine on-track testing as part of series commissioning for a new rail vehicle fleet will generally be covered within Full Running Rights.

Full Running Rights are in all cases conditional on rail vehicles maintaining compliance with the interoperability standard they were certified to (i.e., this document).

6.4 Temporary Running Rights

Temporary Running Rights may be sought by Rail Operators for specific rail vehicle access on the Controlled Network in instances where rail vehicles do not meet all requirements of this standard and activities are limited. This may include moving rail vehicles from one storage location to another, specialist infrastructure maintenance rail vehicles entering the Controlled Network on a temporary basis, or for overweight and oversize loads.

Temporary Running Rights will be considered on an individual basis and should be supported by appropriate risk assessment. Written Temporary Running Rights issued by KiwiRail as the Access Provider are required before rail vehicles are placed onto the Controlled Network.

7. Existing Rail Vehicles

Existing rail vehicles include all those with running rights issued by KiwiRail as the Access Provider under this standard or any predecessor document (e.g., NRSS/6 Engineering Interoperability Standards). This includes grandfathered running rights granted under previous interoperability standards.

Requirements within this standard do not retroactively apply to existing rail vehicles. Correspondingly, existing vehicles should not be presumed to comply with all requirements in this standard.

Existing rail vehicles are required to maintain the same level of interoperability as their original certification (including grandfathered running rights).

Where changes occur to the National Rail System or industry regulation there may be requirements that shall apply retroactively to existing rail vehicles. In these special instances the requirements and compliance timeline will be promulgated to affected Rail Operators by KiwiRail as the Access Provider.

Heritage rail vehicles are considered existing rail vehicles, but are also covered by APIS-11 Heritage Vehicle and Train Management and M-ST-RS-8103 Heritage Rail Vehicle Interoperability.

7.1 Modification of Existing Rail Vehicles

Modifications to rail vehicles with existing running rights shall comply with the requirements of this standard where they relate to vehicle sub-systems being modified. The existing compliance level for the remainder of the rail vehicle shall be at least maintained, but does not require full reassessment or full compliance.

Modifications that alter the information recorded in a rail vehicle's Data Register shall in all cases be notified to KiwiRail as Access Provider, and be assessed and endorsed by an ICP. Depending on the scope of modification the staged Running Rights process used for new rail vehicles, as described in Section 6, may be adopted for modified rail vehicles.

Modifications that do not relate to requirements in this standard and do not alter a rail vehicle's Data Register may be carried out without notification to KiwiRail as the Access Provider.

7.2 Extending Running Rights

Extension to existing vehicles' running rights – e.g., to allow access to additional routes – must be formally sought by Rail Operators and, if granted, will be issued in writing by KiwiRail as the Access Provider.

Extending running rights requires ICP certification/endorsement, unless waived by KiwiRail as the Access Provider.

8. Rail Vehicles Outside of Controlled Network

Running rights are not required for rail vehicles that operate exclusively outside of the Controlled Network. An example is light electric shunt vehicles that operate only within the boundaries of rolling stock maintenance depots.

9. Independent Competent Person

The Rail Operator shall nominate an ICP acceptable to KiwiRail as the Access Provider.

The ICP shall meet the requirements specified in AS 7501, and specifically shall possess knowledge of the New Zealand rail environment.

10. Derogation Process

Non-compliance to any mandatory requirement in this standard must be supported by an approved derogation from KiwiRail as the Access Provider.

Derogations shall be requested by Rail Operators, and require:

- sound justification of why compliance cannot be practicably achieved or why the requirement is not applicable to a rail vehicle's operating context,
- a risk assessment with supporting mitigations,
- endorsement of the ICP.

Approved derogations will be recorded in written Running Rights issued by KiwiRail as the Access Provider.

11. Innovative Solutions

Future technological advances in rail vehicles may create situations of non-compliance with this standard or incompatibility with existing assessment methods, but otherwise represent modernisation of the railway system.

Where such a situation exists, rail vehicle designers or their representatives may make a proposal to KiwiRail as the Access Provider for the acceptance of an innovative solution. Proposals shall set out how a solution deviates from or complements the requirements of this standard, and how the solution ensures interoperability with the National Rail System. KiwiRail will assess proposals, involving other Rail Participants as required.

Where assessment of an innovative solution is positive, this standard will be updated to integrate the solution(s).

12. Data Register

A Data Register shall be compiled for rail vehicles, either on an individual vehicle basis or vehicle class basis, endorsed by the ICP, and provided to KiwiRail as the Access Provider as part of Running Rights application.

Data Register content shall include all relevant parameters for the rail vehicle type and its interfaces with the National Rail System. KiwiRail Infrastructure form

M-ST-RS-8101-FO1 provides a template suitable for most rail vehicle types. It may be adapted as required to suit specific vehicle types, or alternative formats used. AS 7501 Appendix B also provides guidance for Data Register content.

13. Change of Rail Operator

Running Rights are issued to licensed Rail Operators for rail vehicles or fleets of rail vehicles and are non-transferrable between Rail Operators.

Running Rights may be reissued for existing rail vehicles where there is a change of Rail Operator, but the cascade of aged rail vehicles may require operational restrictions and must be supported by the individual Rail Operator's Safety Case.

14. Audit Inspections

As the Access Provider, KiwiRail (or its agents) may inspect rail vehicles, facilities, and processes to ensure compliance with this standard.

Rail Operators shall provide complete information and cooperate fully during audit or inspection. This includes making staff available and facilitating test running of rail vehicles where required.

KiwiRail as the Access Provider is not liable for assuring compliance to this standard, or for ensuring broader safety of rail vehicles. It is the responsibility of Rail Operators to ensure compliance to this standard and their own Safety Case.

15. Route Authorisation

Loading gauge (clearance) and load capacity of track and structures differs throughout routes on the Controlled Network. These values are set out in Appendix 1.

Running Rights issued by KiwiRail will detail route authorisation for rail vehicles or vehicle classes, depending on their route-specific interoperability.

15.1 Clearances

The Controlled Network can be broadly split into two clearance standards.

- Standard clearance – nominally compatible with the static vehicle gauge in KiwiRail drawing 15036046. See Appendix 2
- Hi-cube clearance – nominally compatible with the static vehicle gauge in KiwiRail drawing 15035046. Equivalent to the standard static vehicle gauge, extended for 9'6" (2.9 m) containers. See Appendix 3

Guidance: Note 2b in both static vehicle gauge drawings can be simplified to $B \leq 12.384$ m (IAC-class wagon centre-throw) and $H^2 - B^2 \leq 105.821$ (UK-class wagon end-throw), where B is distance between bogie centres and H is distance between headstocks (in metres).

Guidance: An Excel-based tool to adjust static gauges for vehicles that exceed these throws is available on request.

Applicable clearance standards for all routes are defined in Appendix 1.

15.1.1 Rail vehicles that are demonstrably compatible with the standard static vehicle gauge (Appendix 2) shall be allowed to run on standard and hi-cube routes.

15.1.2 Rail vehicles that are demonstrably compatible with the hi-cube static vehicle gauge (Appendix 3), but do not comply with clause 15.1.1, shall be allowed to run on hi-cube routes only.

Guidance: Longer vehicles, with greater throws than those accounted for in the static vehicle gauge drawings (standard and hi-cube), may be deemed compatible if vehicle width is reduced by a corresponding degree (e.g., tapered ends for large end-throw vehicles). A minimum curve radius of 90 m may be assumed for these purposes.

15.1.3 Compatibility with static vehicle gauges shall be recorded in the rail vehicle Data Register.

15.1.4 Rail vehicles that are not compatible with static vehicle gauges (per Appendix 1 and Appendix 3) may still be allowed access to parts of the Controlled Network, provided clearance is demonstrated by one of the following methods:

- Comparative gauging to existing vehicles with running rights on same route(s) per AS 7507 – refer to Appendix 4 for details and KiwiRail reference vehicles applicable to this method.
- Absolute gauging with static vehicle outlines (see Appendix 5).
- Absolute gauging with kinematic vehicle models.

Guidance: KiwiRail perform regular laser scanning of the network and have the capability to perform absolute gauging with static vehicle outlines. A future intention is to expand this to kinematic vehicle models.

15.1.5 Rail vehicles running in electrified areas shall ensure minimum passing clearance to live overhead equipment is maintained (see 28.1.3).

15.2 Vehicle Mass & Axle Loads

15.2.1 Vehicle mass conditions shall be defined by either the AW system in AS 7501 Appendix E, EN 15663 definitions, or a suitable equivalent that captures the full range of vehicle mass conditions in service. These shall be recorded in the rail vehicle Data Register.

Guidance: At least the minimum and maximum operating masses must be defined.

15.2.2 Static axle loads for each vehicle mass condition shall be calculated and recorded in the rail vehicle Data Register.

15.2.3 Static axle loads for a vehicle shall not exceed the maximum permitted limit on the routes of the Controlled Network for which it is intended. These limits are defined in Appendix 1.

Guidance: Minimum axle loads also apply for train detection compatibility. See 25.3.2.

- 15.2.4 Additional to load limits for individual axles, underline bridge loading as a result of axle spacing arrangement shall be assessed to determine a rail vehicle's LA (Line Availability) rating. This assesses the maximum shear and bending stresses over differing span lengths. A rail vehicle's LA rating shall not exceed that of routes of the Controlled Network for which it is intended. These limits are described in Appendix 1.

Guidance: KiwiRail Structures' LAVEN tool is available for assessing LA rating based upon axle loads and spacing. This rating is based upon AS 5100.2 design loads. See KiwiRail Standard B-ST-AS-3121, Rail Bridge Assessment.

Guidance: New underline bridges are designed to 210LA, but this does not reflect the status of existing underline bridges. Existing 18 tonne axle lines are typically 170LA.

- 15.2.5 Static wheel load imbalance for any axle shall not exceed 10%, under all load conditions.

Guidance: Imbalance shall be calculated as per AS 7508, Equation 3.3

- 15.2.6 Rail vehicle centre of mass shall be no higher than 2000 mm ARL, in all loading conditions.

Rationale: This is a consideration for vehicle dynamics – see 18.

16. Maximum Speed

- 16.1.1 Maximum operating speed(s) shall be recorded in the rail vehicle Data Register.

Guidance: Current traffic on the National Rail System is typically limited to 110 km/h (passenger EMUs in Auckland and Wellington metro areas), 100 km/h (locomotive-hauled passenger trains), and 80 km/h (freight trains). All rail vehicles are limited to the line speed for a route, as well as permanent and temporary speed restrictions (PSRs / TSRs).

Guidance: AS7501 Appendix D provides guidance on test verification for maximum operating speed. Generally, a 10% overspeed test would be conducted during vehicle type tests to demonstrate safe margin for vehicle stability, etc.

17. Track Forces and Stresses

- 17.1.1 Track forces and stresses shall be assessed against AS 7508 or an equivalent standard that covers:

- Rail contact stresses,
- Vertical dynamic (P2) forces,
- Lateral track shifting forces,
- Lateral wheel to rail force,
- Bogie side L/V ratio.

KiwiRail Rolling Stock Engineering Specification 401 *Dynamic Performance* §4.1 provides guidance on applying AS 7508 to the National Rail System conditions. Similar adaptations shall be made if an alternative standard is applied.

- 17.1.2 For rail contact stress, P/D ratio shall not exceed 147 kN/m.

Guidance: This is 30 kg/mm on a per-axle basis, the established limit for the National Rail System (i.e., previously expressed this way in NRSS/6). Wheel diameter shall be measured at the tapping line (see Figure 4).

17.1.3 Vertical dynamic (P2) force shall not exceed 200 kN, calculated with the following inputs:

- Included angle of dip, $2\alpha = 0.014$ rad
- Equivalent track stiffness, $K_t = 50$ MN/m
- Equivalent track damping, $C_t = 52$ kNs/m
- Equivalent track mass, $M_t = 135$ kg

Guidance: Per AS 7508, where calculated P2 force exceeds 180 kN (i.e., 90% of limit) physical type testing with strain gauges on the rail web should be undertaken.

17.1.4 The lateral wheel to rail force shall not exceed 50 kN. Calculation for cant excess shall consider a lateral acceleration value of 0.73 m/s².

Rationale: This is the AS7508 value and equates to 85 mm of cant excess on 1,067 mm gauge track (functionally equivalent to KiwiRail 1,068 mm). KiwiRail track design standards allow a maximum design value of 70 mm for applied cant, but this can be exceeded within maintenance tolerances.

18. Dynamics & Curve Negotiation

18.1.1 Rail vehicle dynamic behaviour shall be assessed against AS 7509 or an equivalent standard that covers:

- Hunting,
- Base ride accelerations,
- Horizontal and vertical curve negotiation (see 18.2 and 18.3),
- Transition curve negotiation,
- Rollover,
- Negotiation of isolated track irregularities,
- Negotiation of cyclic track irregularities,
- Longitudinal forces in curves (see 18.4),
- Wind loading considerations (see 18.5).

KiwiRail Rolling Stock Engineering Specification 401 *Dynamic Performance* §4.2 provides guidance on applying AS 7509 to the National Rail System conditions. Similar adaptations shall be made if an alternative standard is applied.

18.2 Horizontal Curves

Horizontal Curve Negotiation

- 18.2.1 Rail vehicles shall be capable of negotiating a simple R70 m curve, from tangent track without transition.
- 18.2.2 Rail vehicles shall be capable of negotiating a reverse curve of R90 m – 4 m – R90 m, i.e., two opposing R90 m curves separated by a 4 m section of tangent track.

18.3 Vertical Curves

- 18.3.1 Rail vehicles shall be capable of negotiating a circular vertical curve of R300 m, both concave and convex.

Guidance: This is a vehicle design value. The track design limit is R700 m, but tighter vertical curves may exist in practice. Typically, there is no need for additional clearance margin when using the R300 m design value.

18.4 Longitudinal Forces in Curves

- 18.4.1 For rail vehicles that may operate coupled between other vehicles, bogie L/V ratio shall be calculated according to AAR MSRP M-1001 Chapter 2, cl. 2.1.6.4 and 2.1.6.5. Evaluation conditions may be determined by specific operating conditions a vehicle will experience in service, but for general use vehicles the following evaluation conditions shall be considered:

- Longitudinal force of 600 kN,
- Curve radius of 150 m,
- Assessed vehicle in its minimum mass condition (per 15.2),
- Base vehicle as per either Figure 1 or Figure 2, depending on which produces the greater bogie L/V ratio.

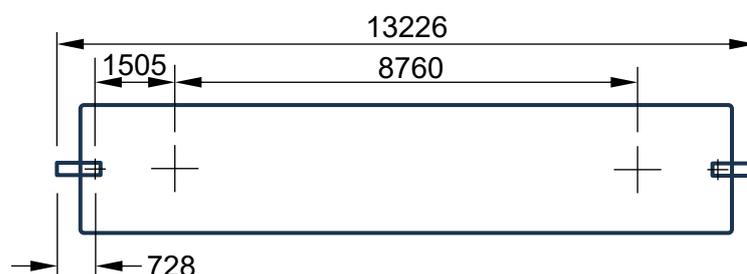


Figure 1: Base Vehicle, Short (IPA-Class Wagon)

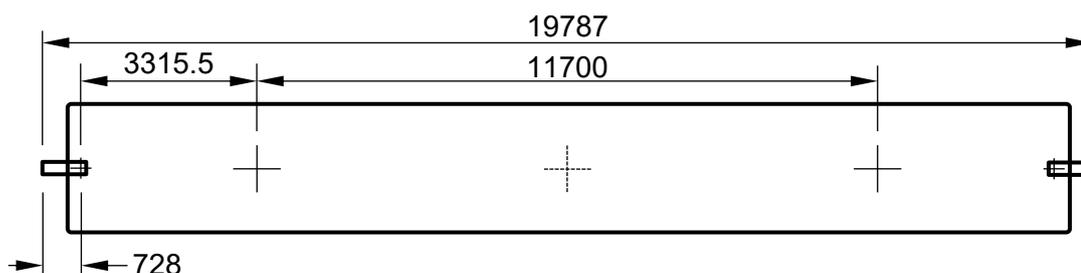


Figure 2: Base Vehicle, Long (EF-Class Locomotive)

Rationale: This methodology is also prescribed by AS 7509, Section 10.3. These base vehicles represent the expected worst-case for L/V ratio calculation in current service.

Guidance: Generally, long vehicles will exhibit greater L/V ratios when assessed against a short base vehicle and vice versa. Coupling geometry can be complex however, so evaluating against both base vehicles is recommended.

18.4.2 Rail vehicles where evaluation conditions are specific to their operation (i.e., differ from above cases) shall consider rescue with the base vehicle in Figure 3.

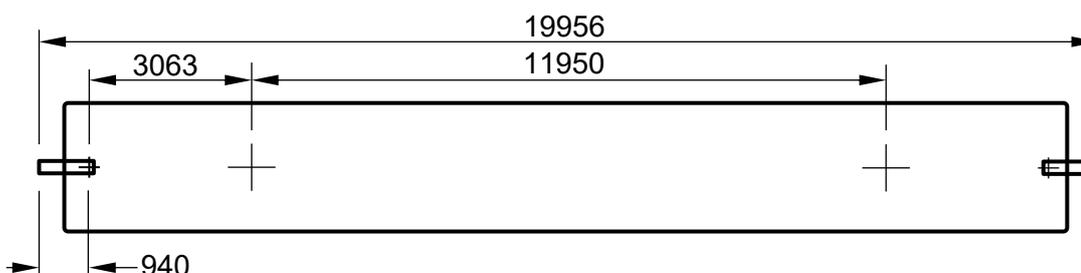


Figure 3: Base Vehicle, Rescue (DM-Class Locomotive)

Rationale: EF class locomotives, while generating larger coupler angles, are confined to the NIMT electrified area (Palmerston North – Hamilton). The DM class represents the largest coupler angle of locomotives likely to be used in recovering stranded trains throughout the full National Rail System.

18.4.3 Bogie L/V ratio (R_{LIM}) shall not exceed 0.71, provided coupler height is nominally 760 mm ARL (see 21.1.1, 21.1.3).

Rationale: This reduces the likelihood of “jack-knife” or “stringline” derailments, caused by the lateral component of train longitudinal forces acting on lightly loaded vehicles.

18.5 Resistance to Roll-Over in Gales

Intrinsic roll-over wind speed, calculated per the methodology described in RSSB standard GM/RT2142, shall be at least:

- 36.5 m/s, for vehicles that carry persons (crew or passengers),
- 22.2 m/s, for vehicles that do not carry persons.

Guidance: Freight wagons with safe ride positions for low-speed operation (e.g., Remote Control Operators in yards) can be excluded as person-carrying vehicles for this purpose.

Guidance: Curve speed limits on the National Rail System apply to all vehicles and are within conventional cant deficiency as it is applied in GM/RT2142.

19. Wheelsets

This section defines wheelset design requirements. For in-service wheelset limits see KiwiRail Standard M-ST-RS-8102, Wheelset Dimensional Limits.

19.1 Compliance to External Standards

19.1.1 Wheelsets shall be manufactured to a recognised standard(s), and have this information recorded in the Data Register.

19.1.2 Wheelsets should comply with the following standards.

- AS 7514 *Wheels* (see 19.2 for specific wheel profile requirements)
- AS 7515 *Axles*
- AS 7516 *Axle Bearings*
- AS 7517 *Wheelsets* (see 19.6 for specific wheelset back-to-back requirements, and 19.3 for specific wheelset tread diameter difference requirements)
- ARISO Wheel Defects Code of Practice

Guidance: This standard, Rail Vehicle Interoperability, only considers rigid wheelsets. Discussion with KiwiRail should be sought if considering vehicles with independently rotating wheelsets.

Guidance: The re-lubrication colour schedule for freight axleboxes described in AS 7516 is not generally used in New Zealand and is not mandatory.

19.2 Wheel Material

19.2.1 Brinell hardness of wheel treads shall not exceed 363 HB, except by specific agreement with KiwiRail as the Access Provider.

Rationale: This aligns with the upper limit for AAR M-107 / M-208 Grade C wheels and is a consideration for rail wear rates. It is not within the scope of this document to prescribe manufacturing standards for wheels, or to preclude alternative standards being applied (e.g., EN 13262).

Guidance: This requirement reflects current practice. A derogation can be sought where vehicle design or operating context warrants harder wheel materials (e.g., AAR Grade D).

19.3 Wheel Diameter

- 19.3.1 Wheel tread diameter, measured at the taping line (see Figure 4), shall be a minimum 330 mm.

Rationale: Smaller wheel diameters are not reliably detectable by axle counters used for signalling purposes on the Controlled Network.

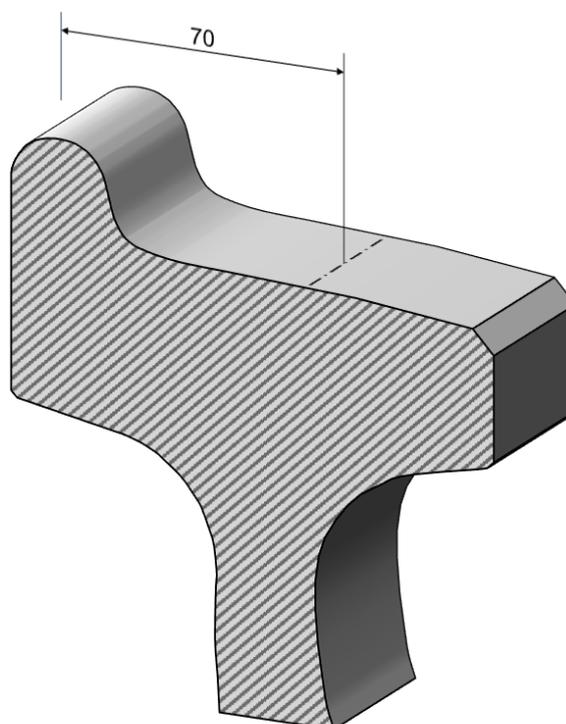


Figure 4: Wheel Taping Line Datum (mm)

- 19.3.2 Wheel tread diameters for a wheelset shall not differ by more than 0.5 mm. This limit applies when wheelsets are newly manufactured and following re-profiling.

Guidance: This standard does not set an in-service limit for wheel diameter difference, however where it exceeds 1.0 mm the source of asymmetry in tread wear should be investigated.

- 19.3.3 Wheel tread diameter limits (condemning diameter, maximum difference between wheelsets within a bogie, vehicle, etc.) shall be recorded in the Data Register.

19.4 Rim Width

- 19.4.1 Wheel rim width shall be within the range 127.0 mm – 140.0 mm.

Guidance: 145.0 mm wheel rim widths exist for some in-service vehicles but are superfluous to performance requirements. Where genuine requirement exists for wider rims, a derogation against this clause shall be sought from KiwiRail as the Access Provider.

Guidance: Prior to 2002, narrower wheel rim widths were commonplace for New Zealand rail vehicles (e.g., 114 mm, 117 mm). These wheels are allowed to remain in use but shall continue to be phased out wherever practicable.

19.5 Wheel Profile

- 19.5.1 Rail vehicles should use a standard KiwiRail wheel profile, as defined in KiwiRail Wheelset Manual M6000-101 and meeting the dimensions detailed in Figure 5. Preference is for TLA or TRA series wheel profiles.

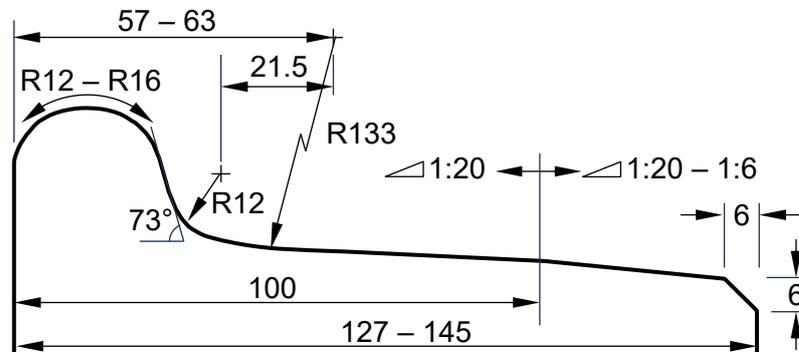


Figure 5: KiwiRail Standard Wheel Profile Dimensions

Rationale: A significant running history exists for these wheel profiles on New Zealand railways. Changes to the wheel-rail interface may have complex outcomes, and so this requirement seeks to preserve the existing interface insofar as is reasonably achievable.

Guidance: Figure 5 covers A, B, C, J, and H series wheel profiles, along with their contemporised TLA and TRA series wheel profiles. D, E, and F series profiles are also covered, but were historically used for tyred wheels that have been phased out of use.

Guidance: G-series, S1, P8, and P8-modified wheel profiles do not comply with Figure 5 dimensions and are only permitted for specific existing vehicles. These wheel profiles should generally not be used for new vehicles.

- 19.5.2 Alternative wheel profiles shall only be permitted with explicit agreement from KiwiRail as the Access Provider.

Guidance: It is recognised that further development of wheel profiles may achieve improvements to the wheel-rail interface. Such developments require KiwiRail’s involvement as an interfacing party, and be supported with dynamic modelling, test, etc. A derogation against this clause shall be sought from KiwiRail as the Access Provider in these instances.

19.6 Wheelset Back-to-Back

- 19.6.1 Wheelset back-to-back dimension shall be within the range 994.0 mm – 996.0 mm.

Rationale: The National Rail System is 1068 mm narrow gauge.

Guidance: A nominal back-to-back dimension of 995.0 mm is reduced from the historic norm of 997.0 mm in 2017 to increase flangeway clearance; reducing wear on wheels and rails, decreasing track forces, and improving wheelset stability.

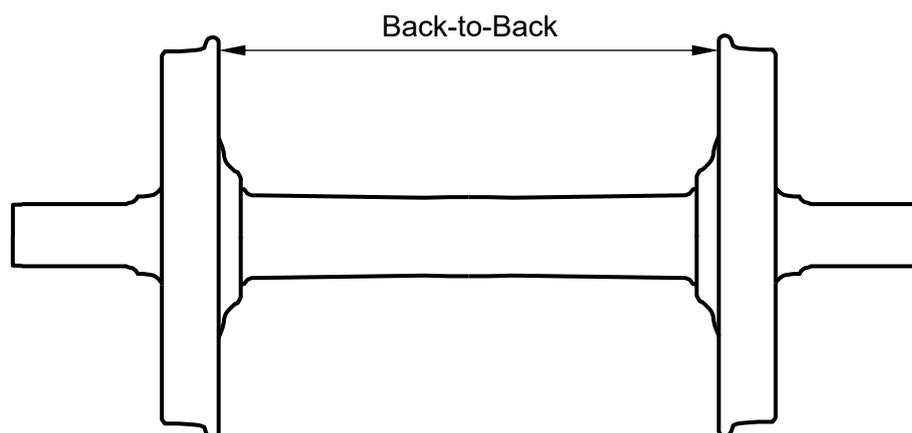


Figure 6: Wheelset Back-to-Back Dimension

20. Braking

20.1 Stopping Brake

20.1.1 All units shall be fitted with a stopping brake function, used for service and emergency braking.

20.1.2 The stopping brake shall be continuous, such that braking command is transmitted throughout the whole train by a control line.

20.1.3 The stopping brake shall be automatic, such that disruption of the control line anywhere throughout the train leads to brake application on all vehicles of the train.

20.1.4 In case of unintentional train separation, the stopping brake shall operate automatically to bring both train portions to a stop and then hold each train portion stationary.

Guidance: A two-hour period should be considered for holding time on each separated train portion with available on board energy, consistent with Clause 20.6.9.

20.1.5 On board stored energy for the stopping brake shall be distributed along the train in a manner consistent with the brake system design.

Guidance: For pneumatic systems, brake supply reservoirs should generally be arranged so that parting between vehicles does not reduce braking capability and that loss of braking force due to ruptures or leaks is as localised as practicable.

20.1.6 The design of the stopping brake function shall consider exhaustibility of the brake through successive application-release cycles.

Guidance: For pneumatic systems this will include air compressor output, reservoir capacity, and air consumption. Special consideration for wheel slide protection should be given, due to its typically high rates of air consumption.

20.2 Parking Brake

20.2.1 All rail vehicles shall be fitted with a parking brake function, used for holding the train stationary without available energy on board.

Rationale: Park brakes must be capable of holding vehicles stationary for an indefinite and unlimited period, and therefore must remain effective as on board energy depletes – e.g., compressed air, electrical energy, etc.

20.3 Dynamic Brake

20.3.1 A braking function linked to the traction system (dynamic brake), to complement the stopping brake function, may be fitted.

20.4 Brake Command

Service Brake Command

20.4.1 Driving positions shall be fitted with a brake controller that allows the driver to adjust braking force throughout the train to control the speed of the train, including stopping and holding stationary.

20.4.2 It shall be possible to isolate the brake controller(s) so that only one active service brake controller is present within a train.

20.4.3 In the absence of an active brake controller within a train, the stopping brake shall apply braking force to at least a level sufficient for holding the train stationary on maximum gradient (see 20.6.9).

20.4.4 The brake controller shall be hand-operated.

20.4.5 The brake controller may be combined with the traction controller.

20.4.6 The brake controller shall allow the driver to control service brake force with no fewer than six steps between minimum-application and full-service (inclusive).

Guidance: Continuously variable brake force control without any discrete steps meets this requirement.

20.4.7 For Passenger Trains, the service brake command shall allow graduated release of brake force.

Guidance: Direct release brake control is permissible for Freight Trains.

Independent Brake Command

20.4.8 For locomotives, an independent brake controller shall allow the driver to adjust braking force on the locomotive(s), independent of the braking control signal transmitted to other rail vehicles throughout the train.

Guidance: Locomotives operating in multiple will generally have common control of independent brakes.

Emergency Brake Command

20.4.9 The emergency brake command shall activate a single-step application of braking force throughout the full train.

Guidance: It should only ever be possible for the emergency brake to be set to fully released or fully applied. Partial application of the emergency brake should not be possible.

20.4.10 The emergency brake command shall be interlocked with the vehicle(s) traction system so that all tractive effort is cut-off as quickly as possible following its activation.

20.4.11 The brake controller shall have an Emergency position beyond its Full-Service position. A detent, or equivalent feature, should be fitted to avoid inadvertent application of the Emergency brake.

Rationale: Moving the brake controller to its maximum limit in the 'brake apply' direction is the expected driver reaction in response to an emergency requiring the shortest achievable stopping distance.

20.4.12 Driving positions shall be fitted with a red mushroom pushbutton that allows the driver to activate the emergency brake in a simple and single action from their normal driving position.

20.4.13 For driving cabs with an assistant position, an additional red mushroom pushbutton shall be fitted at the assistant position that allows the emergency brake to be activated in a simple and single action.

20.4.14 All emergency brake activation devices shall be mechanically self-locking and require a deliberate action to unlock.

Guidance: For mushroom pushbuttons this will typically be a twist-to-release or pull-to-release feature.

20.4.15 All emergency brake activation devices within a driving cab shall remain functional when the driving cab is made non-active.

20.4.16 The brake system design shall allow for emergency brake activation by other on-board systems. These may include:

- On board signalling systems (ETCS, etc.),
- Vigilance and operator enable systems,
- Passenger emergency alarm activation,
- Loss of passenger door interlock,
- Overlay systems (e.g., KiwiRail's eProtect and Interceptor systems).

Guidance: This will typically be implemented as a brake pipe dump valve, or an interlocked emergency brake loop electrical circuit.

20.4.17 For passenger trains it should be possible for the driver to override an emergency brake application, by deliberate action, if it is activated by:

- Passenger emergency alarm activation,
- Loss of passenger door interlock.

Rationale: The Controlled Network features several long single bore tunnels and bridges / viaducts without walkways. In the event of an emergency on board it is important the driver can continue the train to a place of relative safety.

Guidance: Suspending driver override during platform departure for passenger trains is recommended, depending on operating context. Platform dragging events require the train to be brought to a stop as quickly as possible and stations should in all instances be a place of relative safety. If driver override is suspended for platform departure a reliable technical solution to distinguish platform departure from normal running should be implemented.

20.4.18 Where fitted, driver override of an emergency brake application (per 20.4.17) shall be available for a maximum period of 10 seconds.

Hill Start Command

20.4.19 For lead units, a hill start function shall allow for the driver to apply traction power while braking force is applied.

Guidance: Where traction and braking are separately operated by standalone controls this requirement will generally be met by default. For combined traction / brake controllers a separate control (e.g., pushbutton) or automatic operation for holding brake will generally be required.

20.4.20 The hill start function shall be capable of starting a train on a 1 in 25 inclined gradient without rolling backwards.

Guidance: This requirement relates only to the holding capability of the brake system. Tractive capability may be a limiting factor for starting trains on steep gradients but does not need to be considered for this requirement.

20.4.21 Measures should be taken to prevent brakes remaining applied for an extended period after forward motion is fully established.

Rationale: Sustained braking under traction may exceed the thermal capacity of friction brake equipment.

Parking Brake Command

20.4.22 Vehicle parking brakes shall be commanded by one of the following.

- Manual application (lever, handwheel, etc.)
- Controls at the driving position(s)
- Automatic application with depletion of on-board energy, in tandem with brake function

20.4.23 For controls at the driving position(s), the parking brake shall apply automatically when there is no active driving position.

20.4.24 Where the operator is required to apply parking brakes, the status of the parking brake – i.e., released or applied – shall be readily apparent to the operator.

Dynamic Brake Command

20.4.25 For locomotives, dynamic brake may be commanded independently or together with the stopping braking function (blending).

20.4.26 For all other vehicle types, dynamic brake shall be automatically blended with the stopping brake function.

20.4.27 For automatically blended dynamic brake, total brake force per wheelset shall be controlled so as to not exceed the wheel-rail adhesion limits defined in 20.7.

20.5 Brake Requirements - Rescue

Brake Release & Isolation

20.5.1 It shall be possible to release and isolate all brakes from locations accessible within the rail vehicle(s) and/or at track level.

Guidance: Vented isolating cocks for brake cylinders and manual release levers for spring-applied parking brakes should be positioned where they can be accessed during rescue of stranded trains.

Compatibility with Brake Pipe Control

20.5.2 For rescue purposes, rail vehicles shall be equipped with a pneumatic brake system compatible with a single pipe direct-release brake system connected with an AAR FP-5 glad hand coupling.

Guidance: This coupling is defined in AAR S-491 and is also shown in Appendix A of AS 7510.2:2014 (A1.5 to A1.7).

20.5.3 AAR FP-5 glad hand couplings, or compatible couplings, shall not be used at vehicle ends for any purpose other than brake pipe connection.

Rationale: Use of non-compatible pneumatic couplings ensures non-brake pipe lines are not erroneously coupled to the brake pipe.

20.5.4 Brake control shall be compatible with KiwiRail brake pipe settings as follows.

- Release = 550 kPa
- Brake Minimum = 510 kPa (40 kPa reduction)
- Full Service = 400 kPa (150 kPa reduction)
- Emergency = 0 kPa

Rationale: This clause relates to the rescue of a stranded train by a KiwiRail mainline locomotive, allowing the network to be cleared for other traffic.

Guidance: Rail vehicles that use brake pipe control for normal service operation will meet this requirement by default.

20.5.5 An interface device may be used to achieve brake pipe control compatibility. Such devices may be battery-powered but shall not rely on energy from the rescued rail vehicle.

20.5.6 Reduced braking performance in rescue conditions is permitted but shall be accompanied by operational restriction and shall be recorded in technical and operational documentation.

Guidance: Releasing spring-applied parking brakes with Brake Pipe pressure may be appropriate for rescue purposes but reduced braking performance shall be accounted for by speed restriction, etc.

- 20.5.7 Separation of the rescued train from the rescuing train shall result in automatic application of brakes on both the rescuing and rescued trains.

Guidance: For the rescuing train, it is sufficient to demonstrate that train separation will guarantee venting of the brake pipe.

20.6 Braking Performance

Service Braking Stopping Performance

Trains must meet the following requirements in all loading combinations and for all wheel diameters from new to fully worn. These performance requirements relate to the maximum service brake command and apply from the point of the braking command (i.e., brake controller being put into its Full-Service position) to the point of the train coming to a complete stop, on dry, straight, and level track.

- 20.6.1 All trains shall not exceed the stopping distances defined by Appendix 6, Curve B.

Rationale: For initial speeds 60 km/h and greater, this curve correlates to minimum signal spacing distances on level track as defined in S.26251-1 (Minimum Freight Intermediate Signal Spacing) with a 10 per cent safety margin applied.

Guidance: Under special circumstances, trains exceeding Curve B may be granted running rights with differential line speed restrictions enforced.

- 20.6.2 Individual freight vehicles may demonstrate compliance with 20.6.1 by a break-away test from 80 km/h not exceeding a stopping distance of 650 m.

Rationale: This reflects the established method for checking freight vehicle brake performance by break-away tests that determine stopping distance for an emergency brake application. Historically, NRSS/6 prescribed this same requirement. Trains comprising fully of vehicles meeting this requirement will generally meet the requirements set out by 20.6.1.

Guidance: This method is generally sound for brake pipe controlled vehicles where brake effort is equal for full service and emergency brake, and where emergency brake build-up time is around 20 seconds. More complex vehicles and brake systems are generally not suitable for this method. Rail Operators must establish suitable limits for train lengths and cut-out brakes for trains to maintain compliance to 20.6.1.

- 20.6.3 Locomotive-hauled passenger trains shall not exceed the stopping distances defined by Appendix 6, Curve C.

Rationale: This curve preserves the historic NRSS/6 requirement for locomotive-hauled passenger trains to be able to stop within 750 metres from 100 km/h.

Guidance: Adherence to this curve does not assure compliance to S.26251-2 (Minimum Passenger Intermediate Signal Spacing), so does not allow trains to continue at line speed when passing a signal displaying a 'Flashing Yellow' aspect.

- 20.6.4 Locomotives operating as single rail vehicles, or locomotives in multiple without a hauled load, shall not exceed the stopping distances defined by Appendix 6, Curve C.

Rationale: This is a readily achievable performance level for modern locomotives while limiting the impact “light loco” movements on the Controlled Network have on passenger timetables.

- 20.6.5 Passenger trains intended to travel at line speed after passing a signal displaying a ‘Flashing Yellow’ aspect shall not exceed the stopping distances defined by Appendix 6, Curve D.

Rationale: This curve correlates to minimum signal spacing distances on level track as defined in S.26251-2 (Minimum Passenger Intermediate Signal Spacing) with a 10 per cent safety margin applied.

Guidance: Historically, this performance was typical of railcars operated on the National Rail System.

- 20.6.6 Multiple units for operation in Auckland and Wellington Metro areas shall not exceed the stopping distances defined by Appendix 6, Curve E.

Rationale: This curve represents nominal 9%g (0.9 m/s²) full-service braking capability, achievable by modern electro-pneumatic brake systems fitted with wheel-slide protection. This does not correlate to signal spacing on the existing Controlled Network but allows for increased differential line speeds to be employed in future and for closer train spacing under ETCS.

Guidance: Existing Auckland Metro multiple units achieve a nominal 10%g (1.0 m/s²) full-service braking performance.

Emergency Brake Stopping Performance

- 20.6.7 For all trains, stopping distances for emergency brake applications shall not exceed the equivalent full-service brake application.

Rationale: For safety, the emergency brake shall always represent the shortest achievable stopping distance available to the operator.

Guidance: Equal performance of service and emergency brakes is acceptable.

- 20.6.8 Multiple units shall have enhanced emergency braking capability, nominally 30% increased braking force over full-service braking and not less than 15%.

Main Brake Holding Performance

- 20.6.9 The main brake, in its Full-Service setting, shall be capable of holding a rail vehicle in its maximum loading condition on a minimum gradient of 1 in 25 (4‰) for at least two hours following the loss of braking energy supply.

Guidance: For conventional pneumatic brake systems this requirement relates to reservoir sizing and air leakage rates, accounting for increase in leakage throughout the vehicle maintenance cycle.

Parking Brake Performance

- 20.6.10 Parking brakes shall be capable of holding a rail vehicle in its maximum loading condition on a gradient of 1 in 25 (4‰) for an indefinite and unlimited period, and without available energy on board.

- 20.6.11 For manually applied parking brakes, the assumed application force shall not exceed 500 N (applied to lever, handwheel, etc.). It may be assumed this force is applied over a full-service application of the main brake.

Rationale: This allows for the crew of an immobilised train to apply park brakes while the main brake system still has on board energy available. Parking brake holding capability must still be assessed under conditions where on board energy is depleted and the main brake is fully released.

- 20.6.12 Automatically activated parking brakes (e.g., spring applied) may work in conjunction with the main brake in a bleed-on/bleed-off manner, provided minimum holding performance is maintained throughout the full transition in both directions.

Guidance: Pneumatic brake actuators with combined main brake and spring-applied parking brake functions will generally maintain braking force as on-board air pressure depletes, provided both chambers are at equal pressure throughout. System design must ensure that restoring air pressure to a dead train does not release the spring-applied park brakes, unless equivalent main brake force is applied to compensate.

20.7 Wheel-Rail Adhesion

- 20.7.1 For rail vehicles equipped with wheel slide protection (WSP), demanded wheel-rail adhesion shall not exceed 0.15 in Service and Emergency braking under all load and wheel wear combinations.
- 20.7.2 For rail vehicles not equipped with WSP, demanded wheel-rail adhesion shall not exceed 0.12 in Service and Emergency braking under all load and wheel wear combinations.
- 20.7.3 For parking brakes, the assumed wheel-rail adhesion for holding performance shall not exceed 0.12.

20.8 Wheel Slide Protection

Wheel slide protection (WSP) is a system designed to make best use of the available wheel-rail adhesion by reducing and reapplying brake force so that uncontrolled wheel slide is prevented. This minimises stopping distance extension in low adhesion conditions and limits damage to the wheel and rail surfaces.

WSP Design & Performance

- 20.8.1 For rail vehicles fitted with WSP, its performance shall be verified by test to a suitable standard such as BS EN 15595:2018+A1:2023.

Guidance: Verification by other methods may be agreed, provided these demonstrate adequate effectiveness and safety of the WSP system being assessed.

- 20.8.2 WSP systems, where fitted, should allow per-axle braking control except where significant technical barriers preclude it.

Guidance: Drive systems with mechanically linked wheelsets is an example of a significant technical barrier.

- 20.8.3 Design of WSP systems shall consider the depletion of on-board stored braking energy and shall prevent the release of braking force if sufficient energy is not available to fully reapply it.

20.9 Jerk Limitation

- 20.9.1 At speeds above 5 km/h, jerk caused by braking shall not exceed 4 m/s³.

Guidance: Jerk is effectively the rate at which braking force is applied (e.g., brake cylinder filling rate). High levels of jerk should be avoided for the safety and comfort of passengers and crew.

20.10 Brake System Thermal Capacity

- 20.10.1 The braking system shall be designed to withstand the dissipation of braking energy. This may be demonstrated by a combination of test, previous experience, and calculation, considering the two below scenarios.

- Two successive emergency brake applications from maximum speed and in the maximum loading condition on level track, with the time interval between applications equivalent to the time for the train to accelerate to maximum speed.
- The maximum descending line gradient, associated length, and operating speed for which the vehicle operating context requires, while in the vehicle's maximum load condition. Assumed values (line gradient, associated length, and operating speed) shall be recorded in the Data Register.

For the second scenario, instead of deriving a vehicle-specific case the following may be used as a reference case: a maintained speed of 80 km/h, on a constant descending 1 in 55 grade, over a distance of 32 km, and in the maximum load condition.

Rationale: This reference case approximates the descent from Arthurs Pass to Jackson on the Midland Line. This is a conservative estimate, as 80 km/h is not possible throughout the entirety of this section.

21. End Couplers

- 21.1.1 Rail vehicles intended for coupling to dissimilar vehicles in normal operation should be fitted with automatic knuckle couplers, conforming to the following requirements.

- No. 10A contour, as defined in AAR S-106
- 11" knuckle face vertical dimension (nominal)
- Centreline is nominally 760 mm ARL in the vehicle's minimum operating mass condition (per 15.2.1)

Guidance: These requirements are compatible to couple to AAR Type E and Type E/F couplers, but neither type is mandated. Coupler shank arrangements are typically different in New Zealand rolling stock, and there is no requirement to adhere to AAR Intermodal Interchange Rules.

- 21.1.2 Automatic knuckle couplers should feature a bottom interlocking shelf.

Rationale: Interlocking shelves prevent vertical disengagement of knuckle couplers, mitigating the risk of train partings and improving crashworthiness. It is recognised these are not practicable for all vehicles.

- 21.1.3 For general use rail vehicles, automatic knuckle couplers and their support structures should be designed for 1.6 MN static force, tensile and compressive.

Rationale: This reflects the current standard for KiwiRail's own general freight fleet.

Guidance: Maximum trailing mass is to be defined and included in the Data Register where this requirement is not met.

- 21.1.4 Rail vehicles may be fitted with alternative end couplers, provided that:

- A rescue coupler adapter is provided so that it can be coupled to an automatic knuckle coupler as described in 21.1.1, of sufficient strength to allow rescue of a maximum length train in maximum operational mass condition (per 15.2.1)
- Centreline is nominally 760 mm ARL in the vehicle's minimum operating mass condition (per 15.2.1)

Rationale: End couplers, in general, are an essential component in crash energy management. A consistent nominal height across different vehicle types improves the effectiveness in different collision scenarios and simplifies requirements for infrastructure buffer stops.

Guidance: Hook and pin couplers (also referred to as "Norwegian" or "chopper" couplers) were previously standard for New Zealand rolling stock. These are nearing completion of phase-out and should not be fitted to new or modified vehicles.

Guidance: A drawgear force of 370 kN can be considered for typical KiwiRail rescuing locomotives.

- 21.1.5 Rescue coupler adaptors should be kept on board rail vehicles or, if appropriate, stored at strategic network locations.

22. Leading Ends & Frontal Impact

This standard does not attempt to fully prescribe crashworthiness requirements for rail vehicles, but rather define parameters related to interoperability between vehicles and infrastructure or other vehicles. Appropriate crashworthiness standards should be applied in vehicle design (e.g., AS 7520, EN 15227) in support of Rail Operator Safety Cases.

Cow Catcher / Lifeguards

- 22.1.1 Leading ends of lead units shall be fitted with a cow catcher meeting the requirements for an obstacle deflector in Section 6.5 of EN 15227:2020.

Guidance: EN 15227:2020 uses the term 'Obstacle Deflector,' whereas the ARISO preferred term is 'Cow Catcher.' Both terms should be taken to mean the same.

Guidance: Static longitudinal load at a lateral distance of 565 mm from centre line is appropriate for New Zealand's 1,068 mm track gauge (750 mm is for a 1,435 mm track gauge).

22.1.2 Cow catchers shall be maintained at a maximum height of 175 mm ARL, accounting for all loading conditions.

Guidance: Compliance to static gauge profile, KiwiRail drawings 15035046 and 15036046, sets an effective lower limit of 100 mm ARL for cow catchers as non-bogie items. Negotiation of concave vertical curves must also be considered, see 18.3.

22.1.3 Lifeguards may be fitted in front of leading wheelsets and, where fitted, should meet the requirements in Section 6.6 of EN 15227:2020.

Guidance: Lifeguards, if mounted to axle box or bogie frame, shall be considered bogie items and may be mounted to a minimum 30 mm ARL in compliance with the static gauge profile, KiwiRail drawings 15035046 and 15036046.

Anti-Climb Device

22.1.4 Leading ends of lead units shall be fitted with an anti-climb device, meeting the following requirements:

- Feature at least 3 shelves,
- A minimum engagement depth of 25 mm for each shelf,
- Positioned so that it is prominent of other body features (end coupler excluded),
- Occupy at least the vertical space 1390 – 1550 mm ARL (tare conditions, new wheel diameter),
- Extend across the fullest practicable width of the vehicle front.

Figure 7 below illustrates these anti-climb device requirements.

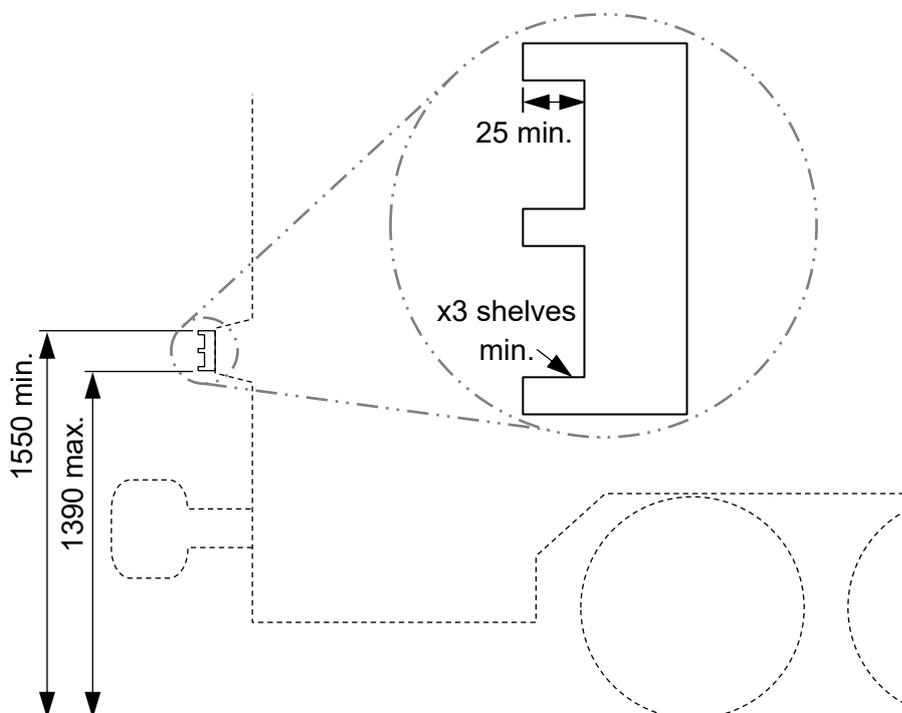


Figure 7: Anti-Climb Device Requirements, Side View (mm)

Rationale: Anti-climbers mitigate the risk of vehicles overriding during collisions. By standardising anti-climber height across vehicle types operating on the National Rail System, the likelihood of proper engagement and effectiveness is improved for various collision combinations. KiwiRail drawing 15018063 details existing anti-climb devices on KiwiRail's mainline locomotive fleet.

Guidance: AS 7520 series standards provide suitable proof load cases for anti-climb devices, but suitable alternatives may be used.

- 22.1.5 Anti-climb devices should be fitted to non-leading vehicles where their operating context puts them at increased risk of vehicle-vehicle collision. E.g., trailing ends of locomotive-hauled passenger sets.

23. Visibility

23.1 Leading End Lighting Arrangement

- 23.1.1 Headlights and ditchlights shall be fitted to the leading end(s) of all lead units, positioned so they form a triangle as shown in Figure 8.

- **V** – height of headlights ARL, shall be at least 2300 mm
- **Y** – height of ditchlights ARL, shall be at least 900 mm
- **V-Y** – vertical offset between headlights and ditchlights, shall be at least 600 mm
- **X** – horizontal spacing of ditchlights, shall be at least 1500 mm

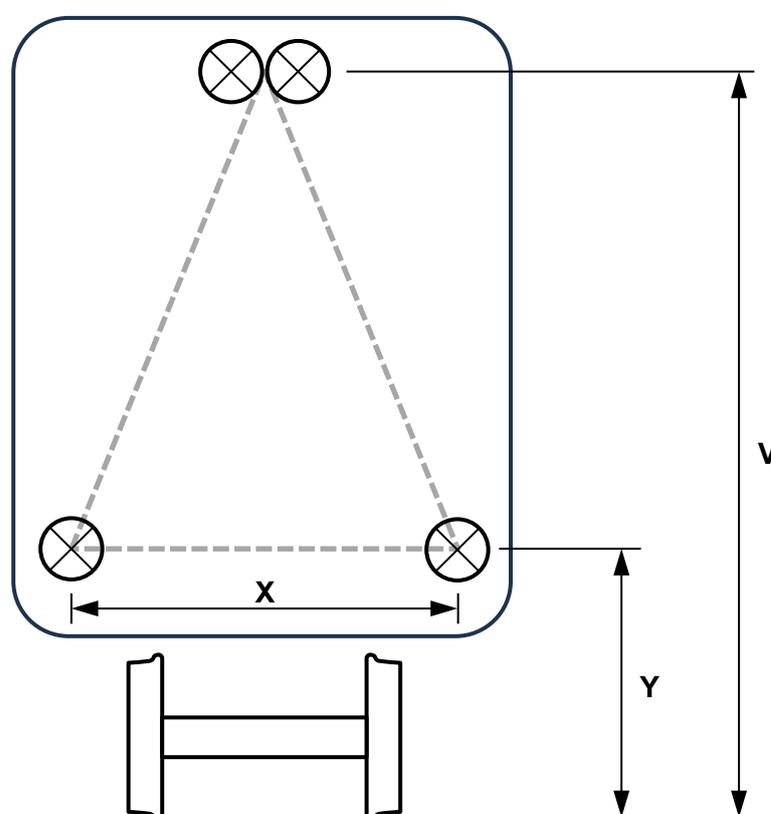


Figure 8: Leading End Lighting – Positioning Requirements

Rationale: The 'triangle of light' formed by headlights and ditchlights increases conspicuity and helps to distinguish approaching rolling stock from other vehicles (e.g., trucks, buses, etc.)

23.1.2 Positioning of leading end lights shall be symmetrical about the rail vehicle centreline.

23.2 Headlights

23.2.1 Leading ends of lead units shall be fitted with at least two headlights.

Rationale: This provides redundancy in the event of a headlight failure.

23.2.2 Headlights shall produce white light, with a colour temperature in the range 2800K to 4500K.

Rationale: Headlights are primarily for the purpose of forward-illumination for the driver, with a secondary function of vehicle visibility for onlookers.

23.2.3 At full beam, headlights shall each produce a peak luminous intensity of at least 200,000 cd and at least 3,000 cd at an angle of 7.5 degrees and at least 400 cd at an angle of 20 degrees from the centreline of the rail vehicle when the light is aimed parallel to the tracks.

Rationale: This requirement is aligned with United States Federal Regulation 49 CFR 229.125(a) and is intended to illuminate a person at 800 feet (approx. 244 m).

23.2.4 Total peak luminous intensity for all headlights in full beam mode shall not exceed 520,000 cd.

23.2.5 Headlights shall be aimed so their beams are parallel with the centreline of straight track and downward so that they strike a point 1 m ARL, 244 m forward of the headlight.

23.2.6 Controls to dim the headlights to low beam shall be fitted.

Rationale: This is to avoid headlight glare from blinding crew of passing trains.

Guidance: Low-beam setting may be realised by reducing lamp power or by means of shutters, etc. Where lamp power is reduced, headlights should generally produce a peak luminous intensity in the range 26,000 – 80,000 cd for low-beam.

23.3 Ditchlights

23.3.1 Leading ends of lead units shall be fitted with two ditchlights.

23.3.2 Ditchlights shall produce white light, with a colour temperature in the range 2800K to 4500K.

23.3.3 At full beam, ditchlights shall each produce a peak luminous intensity of at least 200,000 cd and at least 3,000 cd at an angle of 7.5 degrees and at least 400 cd at an angle of 20 degrees from the centreline of the rail vehicle when the light is aimed parallel to the tracks.

23.3.4 Ditchlights shall be aimed so their beams strike the running surface of the opposing rail on straight track, 240 m forward of the ditchlight.

23.3.5 Controls to dim the ditchlights to low beam shall be fitted.

Guidance: Common controls for high/low-beam settings on headlights and ditchlights is generally preferable. There is no requirement for independent control.

23.3.6 Ditchlights shall feature a flashing function, flashing alternately at full beam, at a rate of between 40 and 120 flashes per minute for a minimum duration of 15 seconds.

Rationale: Flashing in a 'wig-wag' pattern alerts persons to a train's presence and is primarily a control for level crossing collision risk.

Guidance: 85 flashes per minute is commonly used for ditchlights on KiwiRail vehicles and matches the historic norm for level crossing warning lights. 40 to 90 flashes per minute is the range currently allowed for new level crossing warning lights.

23.3.7 Ditchlight flashing shall be initiated automatically when an audible warning device is sounded.

Guidance: Flashing shall commence with initial sounding, but the minimum 15 second duration counted from the end of sounding. This ensures ditchlights remain flashing throughout long sounding periods or repeated sounding, as may occur in emergency situations.

23.3.8 A separate control shall be fitted to driving positions for the driver to manually initiate the ditchlight flashing function.

Guidance: A pushbutton is typically used for this purpose.

23.4 Tail Lights

23.4.1 Two tail lights shall be fitted to the rear end of all rail vehicles intended for operation at the rear end of a train. This excludes freight wagons, where Train End Monitors (TEMs) fulfil this function with a single red light.

Guidance: Freight wagons in this context can be applied to all hauled rolling stock without on board electrical energy.

23.4.2 Tail lights shall be positioned symmetrically about the vehicle centreline, at least 1500 mm ARL and with a horizontal spacing of at least 1000 mm.

23.4.3 Tail lights shall produce red coloured light, meaning within the colour space bounded by the below CIE 1931 chromaticity coordinates.

Table 1: Chromaticity Limits, CIE 1931, for Red Tail Lamps

X	Y
0.675	0.305
0.695	0.305
0.721	0.259
0.735	0.265

Guidance: Compliance to this requirement can be satisfied from direct observation by the Certifying Engineer or other independent person with normal colour vision, if the light source is “substantially red.”

23.4.4 Tail lights shall each produce a peak intensity of at least 100 cd.

23.4.5 Tail lights may flash.

23.5 Leading End Livery Colour

23.5.1 The livery for leading ends of lead units shall be yellow, meaning within the colour space bounded by the below CIE 1931 chromaticity coordinates with a CIE D65 illuminant (daylight).

Table 2: Chromaticity Limits, CIE 1931, D65, for Yellow Front Ends

X	Y
0.466	0.534
0.427	0.483
0.487	0.423
0.546	0.454

Rationale: High visibility front ends ensure vehicle conspicuity. Aligning vehicles to a standard colour, yellow, ensures recognition of vehicle frontages and provides contrast to orange high-visibility clothing worn by rail personnel.

Guidance: Standard KiwiRail livery yellow, BS 5252 08-E-53, meets this requirement. AS 2700 Y-15 (FP/FT-class Matangi EMUs), RAL 1003 (AM-class EMUs), and RAL 1004 (Infrastructure Maintenance Vehicles) are other compliant colours in use. For other yellows, compliance can be satisfied from direct observation by the Certifying Engineer or other independent person with normal colour vision, if it is “substantially yellow.”

23.5.2 Yellow coverage shall be at least 65% of the as-viewed available frontal area, excluding the following functionally essential features.

- Windscreens
- Lights
- Couplers
- Air cocks & hoses
- Vehicle identification signage (i.e., class/running number)

Guidance: For sloped front ends, it is just the vertical height that should be considered (i.e., the viewable surface of an approaching train, as it appears to an onlooker).

23.5.3 Yellow coverage should extend a suitable distance along the vehicle sides.

Rationale: This ensures visibility of approaching vehicles when the viewer is at an oblique angle.

Guidance: Suitability of this distance is dependent on vehicle design, but typically should be the full length of the vehicle cab or a minimum 2000 mm.

23.6 Reflective Delineators

23.6.1 All vehicles shall have at least two reflective delineators fitted to vertical surfaces on each side.

Rationale: Reflective delineators mitigate level crossing risk by improving rail vehicle conspicuity for road vehicles at night and in conditions of poor visibility.

23.6.2 Rail vehicle sides shall have reflective delineators within 500 mm of each vehicle end.

Guidance: This requirement is aimed at positioning reflective delineators as near to the vehicle corners as practicable. Vehicle ends, in this context, can be interpreted as headstocks or vehicle body (i.e., not coupler faces).

23.6.3 Reflective delineators should be positioned at a height between 800 mm and 2000 mm ARL.

Guidance: Delineators should typically be applied to vehicle decks or running boards. Some vehicle types, e.g., skeletal wagons, will preclude fitment in this height range – in these instances the positioning should be selected so that side visibility is maximised.

23.6.4 Reflective delineators shall be white or yellow.

23.6.5 Reflective delineators shall each have a minimum surface area of 30,000 mm², and a minimum height of 75 mm.

Guidance: 300 mm (W) x 100 mm (H) is a typical size for delineators. Where height is restricted, delineators should be lengthened to maintain surface area.

23.6.6 Reflective delineators shall meet or exceed performance of Class 1100 sheeting to AS/NZS 1906.1.

Guidance: 3M Diamond Grade Reflective Sheeting is commonly used for reflective delineators on KiwiRail vehicles.

24. Audibility

24.1 Horns

24.1.1 Leading ends of lead units shall be fitted with a minimum of two warning horns.

24.1.2 Horns shall have distinct fundamental frequencies (tones), selected from the following:

- 311 Hz (preferred)
- 370 Hz (preferred)
- 415 Hz
- 440 Hz
- 470 Hz
- 494 Hz
- 622 Hz
- 660 Hz (preferred)

Rationale: These tones are a combination of those defined in EN 15153-2:2013, and others with an established history of use in New Zealand. For safety, it is critical that train horns are recognisable and distinct from other noise sources.

- 24.1.3 At least one horn shall have a fundamental frequency of either 311 Hz or 370 Hz.

Rationale: These tones are common across the broad majority of New Zealand rolling stock, present and historic, and so are considered the most recognisable for a New Zealand context. Train Whistle Detectors, historically employed in signalling systems on the Controlled Network, were sensitive in the range 300 Hz – 450 Hz.

- 24.1.4 Horn controls shall allow the driver to sound the horn from all driving positions.

- 24.1.5 Horn controls may allow horns to be sounded as single tones or in combination (chords).

- 24.1.6 Horn controls may allow for the driver to sound horns at reduced output.

Guidance: 'Loud/Soft' positions on a toggle lever or separate pushbuttons are examples of appropriate controls.

- 24.1.7 At full output, horns shall produce a minimum sound level of 96 dB(A) and a maximum sound level of 110 dB(A) at 100 feet forward of the vehicle in its driving direction. Testing for this requirement shall be carried out in accordance with the method described in United States Federal Regulation 49 CFR 229.129(c).

Guidance: A vehicle's operational context should be considered in setting horn sound levels. Operation in predominantly suburban areas may mean a sound level in the lower end of this range is appropriate, whereas mainline freight locomotives will generally benefit from a level towards the upper limit.

Guidance: A horn's sound output will be influenced by its installation arrangement (muffling, etc.), and so it is essential it is tested in its representative condition.

- 24.1.8 Sounding of the horn shall initiate ditchlight flashing in accordance with 23.3.7.

24.2 Yard Warning Devices

- 24.2.1 A secondary audible warning device should be fitted to leading ends of lead units where the primary horn(s) is excessively loud for yard and depot environments.

Guidance: Special consideration for fitting a yard warning device should be given to vehicles with low noise emissions (e.g., electric rolling stock). Whistles or beepers are generally appropriate for this purpose.

Guidance: A minimum sound level of 75 dB(A) at 100 feet forward of the vehicle in its driving direction is generally appropriate for yard warning devices (tested as per 24.1.7).

- 24.2.2 Where fitted, controls shall allow the driver to sound the yard warning device from all driving positions.

- 24.2.3 Where fitted, sounding of a yard warning device should initiate ditchlight flashing in accordance with 23.3.7.

25. Signalling System Compatibility

25.1 Signal Viewing

25.1.1 Signal viewing envelopes for ground signals and running signals are shown in Figure 9 and Figure 10. The 10 m forward distance shall be measured from the vehicle's frontmost feature (e.g., front plane of coupler), and the full envelope(s) shall be visible from the driving position.

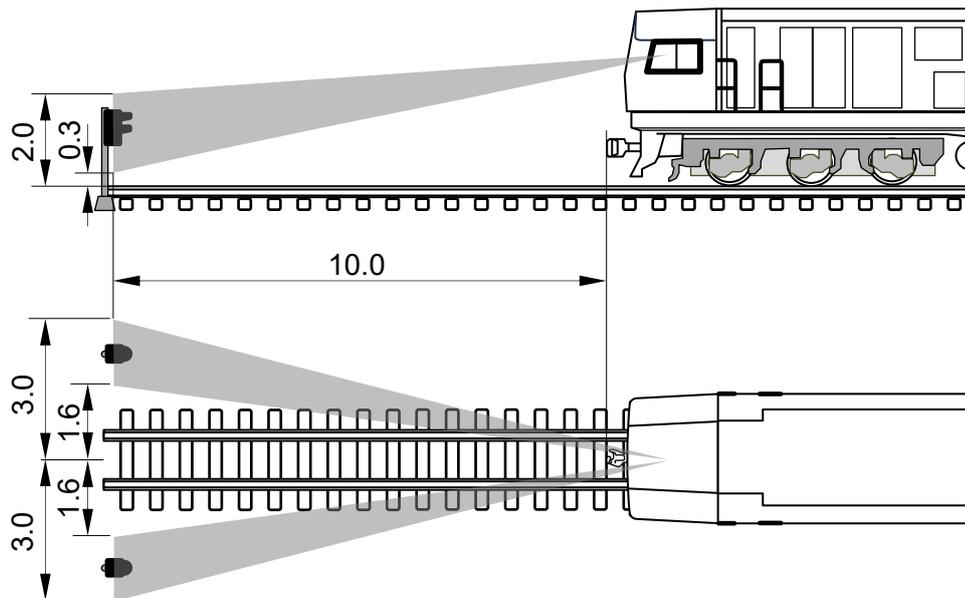


Figure 9: Viewing Envelope Dimensions for Ground Signals (metres)

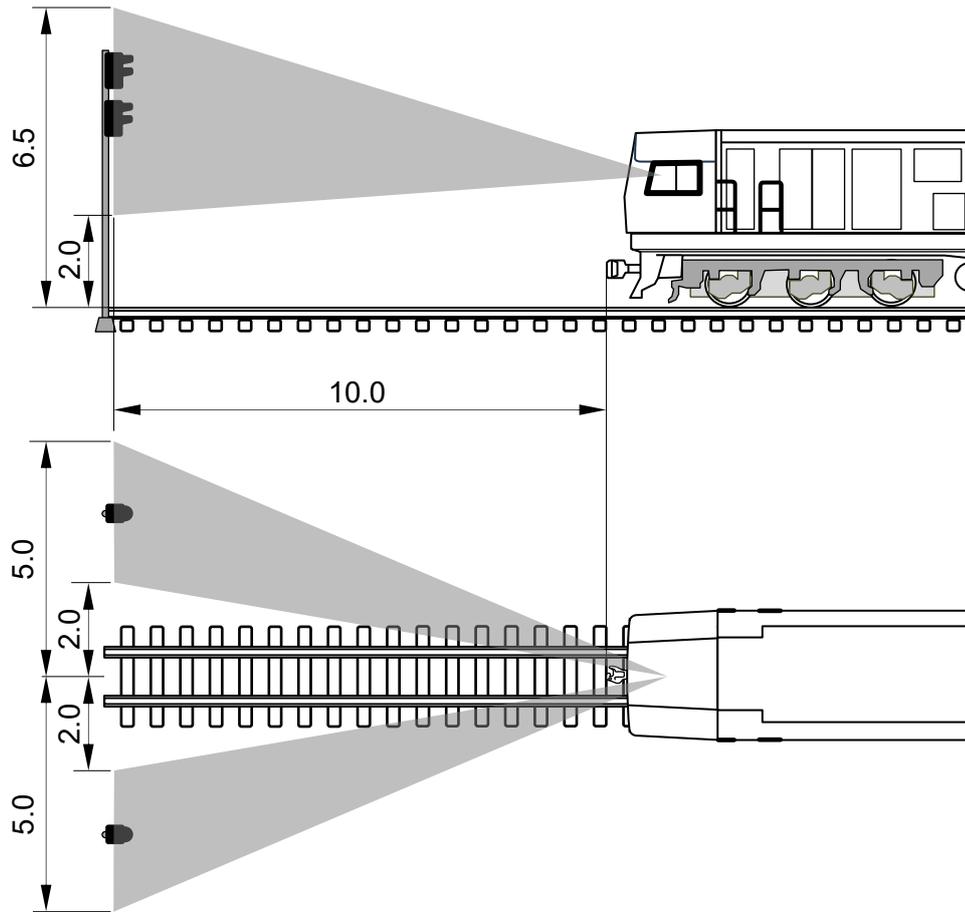


Figure 10: Viewing Envelope Dimensions for Running Signals (metres)

Guidance: The position of the driver's seat is not specified in this standard, but for New Zealand rolling stock is typically on the right side of the cab.

Guidance: The range of anthropometric dimensions among drivers must be considered against this requirement. Appendices E, F, and G of UIC Code 651 are an appropriate reference for this, but alternatives may be used.

- 25.1.2 Where fitted, the assistant's seat should meet the same viewing envelope requirements as 25.1.1.

Rationale: Driver trainers require visibility of signals.

25.2 Permitted Acceleration

- 25.2.1 All trains shall not exceed the acceleration performance limits defined in Appendix 7.

Rationale: The design of signalling systems sometimes relies on assumed maximum acceleration for trains. E.g., where calculating warning periods for active level crossings near speed-restricted curves or turnouts.

25.3 Track Circuit Detectability

Except for certain specialist rolling stock, rail vehicles shall be detectable to track circuits on the Controlled Network. Vehicles that are intended to be non-detectable,

or not dependably detectable, are allowed to not comply with the requirements of this section but must have this recorded in their Data Register.

- 25.3.1 Electrical resistance between the running surfaces of opposing wheels on a wheelset shall not exceed 5 mΩ, measured by an open circuit voltage between 1.8 VDC and 2.0 VDC.

Guidance: All rail vehicles intended for normal operation on the controlled network (passenger, freight, etc.) must be detectable by track circuits. Certain hi-rail and infrastructure maintenance vehicles may be intentionally designed to not activate track circuits.

- 25.3.2 Minimum axle load shall be at least:

- 3,500 kg for rail vehicles with wheel tread brakes,
- 5,000 kg for other vehicles.

Rationale: Axle loading benefits the electrical conductivity between the wheel tread and running surface. Tread brakes act to clean the wheel tread surface of contaminants that would otherwise increase contact resistance.

- 25.3.3 Rail vehicles able to operate as single units shall have a minimum of four axles, each with a minimum axle load of 10,000 kg.

25.4 Track Circuit Interference

- 25.4.1 Axle-to-axle voltages (i.e., longitudinal voltages) shall not exceed the limits specified in AS7505:2014 §6.4.

Rationale: Track circuits are susceptible to interference to interference caused by axle-to-axle voltages in their range of sensitivity.

Guidance: Assessment should include credible failure scenarios (i.e., ground faults).

Guidance: The frequency ranges and limits in AS AS7505:2014 §6.4 broadly cover track circuit types used on the Controlled Network. Future revisions of this document may further refine frequency ranges and voltage limits.

25.5 Sanding

- 25.5.1 Sanding devices may be fitted to vehicles, for the purpose of improving wheel-rail adhesion for traction or braking.

- 25.5.2 Sanding control may be either manual or automatic. For automatic control, means to isolate sanding from within the driving cab shall be fitted.

- 25.5.3 The maximum sand laying rate, per active sanding device, shall be:

- ≤ 4.5 g/m, at speeds 8 km/h or greater
- ≤ 300 g/30s, at speeds below 8 km/h

Rationale: Excessive sanding has adverse impacts on track systems and train detection for track circuits.

25.5.4 For multiple units there shall be a minimum 8 wheels between active sanding devices per rail. Closer spacing is permitted but the sand laying rate must be reduced proportionally.

25.5.5 For locomotives, there shall be a maximum of one active sanding device per rail per bogie.

25.5.6 Sand shall:

- be siliceous (i.e., SiO₂ – commonly referred to as silica or quartz sand),
- not contain high levels of fine particles (< 0.3 mm),
- not contain clays, organic matter, and other soft materials,
- not contain metallic compounds or salt.

Guidance: KiwiRail Specification 389 for locomotive traction sand provides detailed specification for procurement of sand. The effectiveness of this specification for other purposes (e.g., braking of multiple units) is untested.

25.5.7 Consideration should be given for the possibility of sand to adversely affect a rail vehicle's detectability by track circuits, accounting for its operational context.

Guidance: Mainline locomotives have heavy axle loads and primarily use sanding to improve tractive conditions, which differs from passenger vehicles sanding to control wheel slide under braking. Measures such as not sanding on leading bogies may be appropriate in these cases but may also depend on the number of trailing axles.

25.6 On Board Wheel Flange Lubrication & Adhesion Modifiers

25.6.1 On board wheel flange lubrication may be fitted to rail vehicles but shall be configured to minimise the possibility of lubricant migrating from the rail gauge face to the rail head.

Guidance: Rail Operators should discuss specific use cases for wheel flange lubrication with KiwiRail, as its potential for network impact varies significantly with operating context.

25.6.2 On board adhesion modifiers applied to the wheel tread area, other than sand (see 25.4), shall only be used by explicit agreement with KiwiRail as the Access Provider.

Rationale: There is limited experience with these types of products on the National Rail System, but it is recognised this is a developing technology that may benefit rail operations in New Zealand if its associated risks are properly managed.

25.7 Axle Configuration

25.7.1 Overhang, measured from the centre of the nearest axle to the rail vehicle headstock, shall not exceed 3000 mm.

Rationale: At turnouts, train detection boundaries are positioned so that stationary vehicles do not foul the path of moving vehicles. This positioning assumes a maximum vehicle overhang, with an additional safety margin applied.

Guidance: This requirement assumes a square-ended vehicle that with a half-width of 1415 mm (the maximum dimension for standard static gauge dimension). Where the headstock is not the foremost feature at the vehicle corners, overhang length shall be measured to such other features. Narrower vehicles or vehicles with tapered ends may be allowed longer overhangs but this must be supported by clearance analysis. Wider vehicles, if otherwise acceptable, may be restricted to shorter overhang lengths.

- 25.7.2 Spacing between adjacent axles, in mm, shall be no less than $7.2v$, where v is the rail vehicle's maximum speed in km/h.

Rationale: This ensures axle counters' resolution can reliably distinguish individual wheelsets.

- 25.7.3 Spacing between adjacent axles shall not exceed 16,248 mm.

Rationale: Short train detection sections are at risk of being straddled by vehicles with large distances between adjacent axles. This dimension reflects GT-class wagons, which have the largest spacing for any vehicle with service experience. Train detection sections are generally designed to a minimum of 20 m on the Controlled Network.

- 25.7.4 For rail vehicles able to operate as single units, spacing between the extremity axles (i.e., first and last axles) shall be no less than 1524 mm.

Rationale: This requirement addresses the risk where short wheelbase vehicles may sit wholly within a gap or stagger and be undetectable to track circuits. This value correlates to the 5' wheelbase of some TR-class shunting tractors.

Guidance: No maximum dimension is given for spacing between extremity axles, however typical turntable lengths throughout the National Rail System are 21.3 m and 22.9 m. This may be an important design consideration for vehicles where turning is a foreseen operational requirement.

25.8 Axle Counter Compatibility

- 25.8.1 Wheels shall have ferromagnetic characteristics and shall be electrically conducting.

Rationale: Axle counters rely on distortion of their electromagnetic field to detect passing wheels.

Guidance: This requirement is met by wheel materials compliant to AS 7514 (see 19.1.1).

- 25.8.2 Wheel diameter and flange dimensions shall be maintained within the limits described in 19.3.1 and M-ST-RS-8102 Rail Vehicle Wheelset Dimensions.

Guidance: These requirements are repeated to draw attention to the importance of wheel dimensions in the reliable operation of axle counters. Permitted wheel wear limits for the National Rail System allow for wheel flanges significantly thinner than comparable international benchmarks. This is mitigated by the comparably low operating speeds, which increases detectability of passing wheelsets.

- 25.8.3 Rail vehicles able to operate as single units and have fewer than 4 axles shall have this recorded in the Data Register and may have operational restrictions applied.

Rationale: Axle counters in parts of the Controlled Network are configured to suppress counts of 3 or fewer axles to avoid disruption to signalling systems that are non-detectable to track circuits and have wheels that are not reliably detectable by axle counters (typically hi-rail vehicles). Lead-in track circuits are fitted at boundaries to de-suppress counting for single vehicles with 3 or fewer axles that are detectable to track circuits.

Guidance: Where rail vehicles with fewer than 4 axles operate as a single unit, their detectability to track circuits will require demonstration as they will not meet 25.3.3 and therefore cannot be presumed as reliably detectable.

26. Instruments & Monitoring Equipment

26.1 Speed Indicating Device

26.1.1 Driving positions shall be fitted with a speed indicating device meeting the requirements in AS 7533:2021 §13.

Rationale: Speed information for the KiwiRail Network (bulletins, lineside speed boards, etc.) is universally described in kilometres per hour. Accurate speed indication for the driver is essential for safe train operation.

Guidance: ETCS requires greater accuracy from its odometry system. For rail vehicles where fitment of ETCS is foreseen it is recommended that odometry (speed and distance) meets the requirements of ERTMS/ETCS SUBSET-041.

26.2 Vigilance System

26.2.1 Driving positions shall be fitted with a vigilance system meeting the requirements in AS 7511:2020 §5.2.3, with further requirements as below.

26.2.2 Vigilance system timings shall allow a maximum period of:

- 50 seconds from acknowledging action to visual alert (i.e., illuminate vigilance light),
- 10 seconds from visual alert to audible alert (i.e., buzzer), if not acknowledged prior,
- 10 seconds from audible alert (i.e., buzzer) to penalty brake application, if not acknowledged prior.

Rationale: This reflects the limits of established practice for existing vehicles and allows a maximum period of 70 seconds from a driver's previous acknowledging action to emergency brake application.

Guidance: Operational context for individual vehicles/fleets should be considered when configuring vigilance, as discussed in AS 7511:2020. Current KiwiRail practice for mainline locomotives is a random period between 30 and 50 seconds from acknowledging action and vigilance light illumination. Randomised timing is aimed at avoiding driver habituation.

26.2.3 Vigilance suppression shall, at a minimum, require the following conditions to be met.

- Vehicle is at standstill.
- Main brakes applied to at least the level required to hold on a 1 in 25 gradient in full load conditions (see 20.6).

Rationale: Vigilance must only be suppressed while a train is stationary and can be expected to remain so.

Guidance: Absolute standstill detection can be technically challenging, and so a tolerance appropriate for the technology should be applied. A speed signal of < 5 km/h is typically used for standstill detection in KiwiRail's vehicles with radar-based speed detection.

26.2.4 The vigilance system's penalty brake shall achieve emergency braking performance, as defined in 20.6.6 and 20.6.7

26.2.5 The vigilance system shall alert the driver if the manual acknowledgement device is activated for longer than 6 seconds.

Rationale: This is the predefined period described in AS 7511:2020 §5.2.3.2.1

26.2.6 It shall only be possible to reset a vigilance-initiated penalty brake while the rail vehicle is at standstill.

26.3 Event Recorder

26.3.1 Applicable vehicles shall be fitted with an event recorder meeting the requirements of AS 7527:2015 (with 2019 amendments).

Guidance: Vehicle applicability is addressed in AS 7527:2015 §2.1

27. Vehicle Markings

27.1 Vehicle Identification

27.1.1 Rail vehicles shall have their unique identifying number (i.e., class designation and running number) displayed on each side, in contrasting lettering at least:

- 200 mm high for locomotives and passenger vehicles,
- 100 mm for other vehicle types.

Guidance: New Zealand rolling stock numbering typically uses 2-3 letters and a digit for class designation, followed by 2-3 digits for individual vehicle number (sequential), followed by a single check digit. New class designations and running numbers require issuing by KiwiRail as the Access Provider to ensure valid check digits and avoid duplication of vehicle numbers.

27.2 Functional & Safety Labelling

This standard only defines labelling requirements that relate to KiwiRail as Access Provider. It is left to Rail Operators to decide appropriate labelling for their vehicles, considering the applicable user groups, contrast against vehicle livery, human factors, etc.

27.2.1 For rail vehicles that may travel in electrified areas (see 28), labels with electricity hazard symbols and the supplementary text 'DANGER LIVE WIRES ABOVE' shall be fitted adjacent to any ladders, handholds, or other vehicle features that when climbed on allow persons to encroach above 3,600 mm ARL on the vehicle exterior.

Rationale: This is a required control for the risk of contact with live electrical overhead equipment that KiwiRail manages as Access Provider. It corresponds to a minimum 600 mm below the minimum wire height for the NIMTEA.

Guidance: The UK practice of painting orange warning lines at the cant rail level, per GM/RT2181, is not established practice in New Zealand rail and should not be adopted in lieu of warning labels.

Guidance: KiwiRail drawings 15024439 & 15024440 (KiwiRail stock items 250132 & 1103537) are suitable for this purpose. ISO 7010 W012 or similar warning symbols may alternatively be used but must have supplementary text.



Figure 11: Warning Labels 15024439 (Horizontal) & 15024440 (Vertical) – 20 mm Text, Red Symbol/Text on White Background

27.2.2 Rail vehicle mass conditions (e.g., tare weight and maximum load) shall be marked on the vehicle exterior.

Guidance: These will generally correspond with maximum and minimum mass conditions, per 15.2.1.

27.2.3 Air hose connections compatible with KiwiRail brake pipe control (see 20.5.3), and where manual coupling is required, shall be clearly labelled (e.g., BP / MR / EP for three-pipe vehicles).

27.2.4 Recovery of vehicles following incidents and derailments should be considered for labelling, including:

- Isolation switches and cocks
- Identification of lifting/jacking points

28. Electrified Areas

The National Rail System has three separate electrified areas:

- Wellington Electrified Area (WEA)
- North Island Main Trunk Electrified Area (NIMTEA)
- Auckland Electrified Area (AEA)

The extent within the National Rail System for each electrified area is described in Appendix 1. Basic parameters and reference documents for each electrified area are included as Appendix 8.

28.1 Vehicles that Operate in Electrified Areas

28.1.1 Rail vehicles that are operated by persons or carry persons (i.e., passengers or crew) under overhead electrification shall be bonded so that conductive vehicle exterior surfaces are equipotential with the running rails.

Rationale: This addresses the electric shock risk associated with high touch voltages if a vehicle structure contacts live elements of the electrification system (dropped contact wire, foreign items on vehicle roof, etc.).

- 28.1.2 Electrical bonding shall be capable of withstanding the maximum permissible fault current levels defined in EN 50388-1:2022 Table 7.

Guidance: Actual fault current levels throughout the National Rail System's electrified areas are generally below EN 50388-1 limits, but scope exists to increase towards these limits in future.

- 28.1.3 Where equipotential bonding is impractical for roof-mounted antennae, they shall be positioned in a protected location that prevents contact with overhead electrification.

Guidance: First preference shall be for DC-grounded antenna designed for railway rolling stock operating under overhead electrification, irrespective of positioning. Alternatives shall only be considered where such products are not available.

- 28.1.4 Maximum static height for all vehicles that travel under live overhead electrification shall not exceed:

- 3825 mm for the WEA,
- 3950 mm for the NIMTEA,
- 3864 mm for the AEA.

Rationale: This ensures adequate electrical clearance is maintained and includes a 25 mm allowance for vehicle vertical bounce.

Guidance: In all electrified areas this height limit exceeds the maximum vehicle height for KiwiRail Static Gauge drawings (Appendix 2 and Appendix 3) and so already requires specific clearance assessment (see 15.1).

- 28.1.5 Roof structures for all rail vehicles that travel under overhead electrification should, as far as is practicable, be designed without protruding elements or other features that may tend to snag or entangle overhead wires.

Rationale: This limits the extent of damage caused by vehicles encountering sagging or otherwise downed overhead wire systems.

28.2 Electric Vehicles

The complex nature of vehicle-infrastructure interaction for electric vehicles, and the limited number of classes of electric vehicles (a single vehicle class per electrified area as of the date of publication of this standard) means that new electric vehicles must be treated on a case-by-case basis between vehicle designers and KiwiRail as the Access Provider. The below sets out basic requirements for electric vehicles.

- 28.2.1 Collector head contact strips shall be carbon or metal impregnated carbon.

Rationale: There is an established operating history for these materials in KiwiRail Electrified Areas, being the norm for existing vehicles.

Guidance: All contact materials shall be jointly agreed between Rail Operators and KiwiRail as Access Provider, with consideration given to contact wire wear/degradation.

28.2.2 Nominal static pantograph uplift force shall be:

- 90 N for the WEA and AEA,
- 70 N for the NIMTEA.

Rationale: This reflects force settings for existing vehicles in each electrified area.

Guidance: Force settings for new vehicles may differ by agreement with KiwiRail as Access Provider. Consideration shall be given to contact quality, but also vertical wire displacement and its effects on electrical clearances, etc.

28.2.3 The maximum current at standstill, per pantograph, for the WEA shall not exceed 300 A.

28.2.4 Vehicle in-feed circuit breakers (i.e., vacuum circuit breakers, high-speed circuit breakers) shall be configured so that in normal operation they:

- do not close until the collector head is in contact with the overhead,
- open before the collector head breaks contact with the overhead.

Rationale: Arcing between the collector head and the contact wire shall be avoided, so as to avoid damage to both.

28.2.5 Pantographs shall have an overreach function that acts to immediately lower the pantograph when its extension exceeds:

- 5550 mm ARL, for the WEA,
- 6450 mm ARL, for the NIMTEA,
- 6448 mm ARL, for the AEA.

Rationale: This mitigates the risk of pantographs becoming entangled on the traction overhead equipment. Maximum contact wire height is maintained below these limits (see Appendix 8)

28.2.6 Pantographs should have an automatic dropping device (ADD) that acts to lower the pantograph when damage to the collector head is detected.

Guidance: Commonly, these systems employ an air chamber within the collector strip to detect cracks or gouging. No specific technical solution is mandated by this standard.

28.2.7 Live parts on the vehicle exterior (pantographs, conductors, etc.) shall be protected against direct contact in accordance with EN 50122-1:2022 section 5.4. Standing surface dimensions for each electrified area shall be as per Table 3.

Table 3: Standing Surface Dimensions for Live Parts Clearance Assessment

Dimension	WEA	NIMTEA & AEA
Platform Height (ARL)	680 mm	750 mm
Platform Edge, from Track Centreline	1450 mm	1520 mm

Rationale: Platform heights differ between the Wellington and Auckland metro areas, which along with nominal traction system voltage affects safe distances. Platforms in the NIMTEA are generally at a lower height than either metro area, but AEA dimensions should be used for clearance purposes – both because the nominal voltages are the same and the possibility of future rationalisation for platform dimensions across the Controlled Network.

Guidance: The manikin method described by 50122-1:2022 should allow the full-length hand-held object to be used when assessing vehicles for the WEA but likely require the allowed 50% reduction for the NIMTEA and AEA, attributable to the relatively small loading gauge of the National Rail System. In all cases, clearance to live parts on the vehicle exterior shall be maximised so far as is reasonably practicable.

29. Tunnel Operation

29.1 Gas Emissions

29.1.1 Exhaust emissions should be minimised so as far as is reasonably practicable, to limit the extent to which these may build up within tunnel environments.

Guidance: EU Stage V represents the current state-of-the-art for low emissions diesel engines for railway applications.

29.1.2 Occupied areas, such as driving cabs or passenger areas, shall be sealed against ingress of gases and fumes in tunnel environments so far as is reasonably practicable.

29.1.3 HVAC systems should have a tunnel mode that limits external air intake into occupied areas.

29.2 Running Capability in Case of Fire

29.2.1 Rail vehicle design shall take all reasonable steps to maximise the probability of continued running in the event of an on-board fire (running capability).

Rationale: For most on board fire scenarios, it is preferable for a train to continue to a safe area for detrainment and firefighting than for the train to be brought to a stop in a tunnel while there is a fire on board.

29.2.2 For running capability, rail vehicle design should:

- Not interlock the emergency brake function with fire detection/suppression systems,
- Provide driver-override for passenger-initiated emergency brake functions (see 20.4.17),
- Maintain tractive power to fullest extent practicable,
- Limit the effects of extinguishing agents on otherwise unaffected systems.

Guidance: EN 50553 provides a structured approach to running capability in case of fire for passenger trains.

30. Rail Ferry Compatibility

KiwiRail operates the Interislander ferry service on New Zealand's Cook Strait. No rail-enabled ferries are in operation as of the date of publication of this standard, but future ferry procurement is expected to include roll-on/roll-off (RORO) capability for rail vehicles.

Rail vehicles intended for transport on RORO rail ferries shall meet the requirements of this section and shall have their compatibility recorded in the Data Register.

- 30.1.1 Tie down points (hooks or similar) shall be incorporated in the vehicle structure to allow for vehicle lashing. Tie down points shall consider a lateral loading of 0.65 g, and a 100 kN load limit on lashings.

Guidance: A ferry securing assessment should be carried out for ferry-going vehicles at the vehicle design stage. KiwiRail Rolling Stock Asset Services can assist with this assessment

Guidance: The retired Aratere ferry had lashing points on its rail deck spaced 2084 mm from the track centreline, at 1150 mm longitudinal pitch. See KiwiRail Drawing 15001753. This layout may be used as an assumption for lashing analysis until any new layout(s) are known for future ferry procurement.

- 30.1.2 RESERVED FOR FUTURE USE.

Guidance: This clause is specifically reserved for a reverse curve case if it exceeds the general case given in clause 18.2.2 for future ferry procurement. For the retired Aratere rail ferry this case was R80 m – 4.95 m – R80 m.

- 30.1.3 Vehicles shall negotiate a vertical change from level track to a 1:35 gradient, without vertical curving transition.

Rationale: This is the design limit for new ferry linkspans at the extremes of tidal ranges and vessel draft.

Guidance: Special operating conditions may be put in place for occasional ferry-going vehicles. E.g., removal of cow catchers from lead units, restricted tidal conditions.

31. Environmental Restrictions

- 31.1.1 On-board toilets shall be equipped with retention tank systems so that no wastewater is discharged to the rail corridor.

- 31.1.2 Wastewater discharge connections should be stainless steel 3-inch (75 mm) male cam locking fittings to MIL C-27487.

Rationale: This supports interoperability with wastewater discharge facilities.

Guidance: MIL C-27487 is a now obsolete, but commonly quoted, US Military standard. Connections compliant to US Federal Standard A-A-59362, EN 14420-7, and DIN 2828 are all functionally interchangeable.

- 31.1.3 Rail vehicles shall not be designed to discharge material to the rail corridor, except:

- Washbasin water for crew-only areas,
- Windscreen washer fluids,
- Draining rainwater,
- Condensation from HVAC and other cooling systems,
- Sand (where fitted and within upper limit, see 25.4),
- Wheel flange lubricants (where fitted, see 25.6),
- Adhesion modifiers (where fitted, see 25.6),

- Fire extinguishing agents (emergency situations only).

Other sources of discharge shall only be permitted by agreement with KiwiRail as the Access Provider.

31.1.4 All reasonable steps shall be taken to prevent discharge of grease, oil, fuel, coolant, working fluids, bulk cargo (e.g., coal dust, etc.) and similar into the rail corridor.

31.1.5 All reasonable steps shall be taken to prevent the emission of sparks and embers from vehicles into the rail corridor.

Rationale: Lineside fire risk must be mitigated so far as is reasonably practicable.

31.1.6 Rail vehicle noise emission should be minimised so far as is practicable, considering:

- Stationary noise,
- Starting noise,
- Pass-by noise.

Prescriptive noise limits are not defined by this standard, but consideration should be given to operating context and likelihood of excessive noise complaints from neighbours of the National Rail System. Particularly, strong tonal noise should be controlled.

32. Rail Vehicle Electrical Power Systems

32.1 Electrical Safety & Compatibility

32.1.1 On board electrical systems shall be designed, constructed, and maintained to suitable electrical safety standards intended for railway rolling stock.

Guidance: Trains, locomotives, trams, and their fittings are expressly excluded from the scope of Electricity (Safety) Regulations 2010. However, under the Railways Act 2005 all Rail Participants are required to ensure, so far as is reasonably practicable, their activities do not cause, or are likely to cause, death or serious injury to individuals.

Guidance: AS 7530 is the appropriate Australasian standard for passenger rolling stock but may be applied to other types of rolling stock where appropriate. Other international standards may be adopted, provided they address relevant risks.

32.1.2 On board electrical outlets, where fitted, shall be to AS/NZS 3112.

32.1.3 On board electrical outlets, where fitted, should be protected by a residual current device (RCD) with a sensitivity of no greater than 30 mA.

32.2 Electrical Energy in Emergency

32.2.1 After loss of the main energy supply the radio system, per 33, shall remain available for a minimum 180 minutes. Within this period the radio system shall be capable of transmitting and receiving for an accumulated period of 30 minutes each.

Guidance: Main energy supply is typically overhead electrification or diesel generator set(s). Where redundancy exists, this may be considered in battery depletion and load-shedding arrangements, but must be justified (e.g., a shared fuel tank for multiple generator sets would not constitute a redundant system).

Guidance: For the TAIT radio system used in KiwiRail vehicles, 5 Ah at the supply voltage of 13.8 V DC is adequate. This is a conservative estimate based on the single-cab configuration.

- 32.2.2 For passenger vehicles, emergency lighting shall be provided in all passenger areas for a minimum period of 180 minutes after loss of the main energy supply.

Guidance: Emergency lighting is expected to be at a reduced level to normal lighting; 5 lux at floor level is a suggested minimum but is a consideration for the Rail Operator. Any overlap period between loss of main energy supply and lighting remaining at normal level may be counted towards this requirement.

- 32.2.3 For passenger vehicles, after loss of the main energy supply the public address (PA) system shall remain available for a minimum 180 minutes. Within this period the PA system shall be capable of functioning (i.e., making announcements) for an accumulated 30 minutes.

- 32.2.4 For passenger vehicles, after loss of the main energy supply ventilation shall be provided to a level that limits CO₂ to a maximum of 10,000 ppm for a minimum period of 90 minutes.

Guidance: For calculation purposes, external fresh air can be assumed as 400 ppm CO₂, and a per-passenger emission of 32 g CO₂ per hour. Full passenger load shall be considered. Mechanical and passive ventilation (e.g., opening windows) may be considered in combination.

33. Radio System

- 33.1.1 Driving positions shall be equipped with radio equipment to communicate with KiwiRail Train Controllers and with other trains on the Controlled Network.

- 33.1.2 Radio equipment shall comply with KiwiRail Control Systems Standard D-ST-RA-7116 Rail Vehicle Radios.

Guidance: The National Rail System uses VHF and UHF radio communications with specific protocols for Selcall and other functions. KiwiRail's own vehicles use customised TAIT equipment, details of which can be made available to Rail Operators.

Guidance: Selcall IDs are issued by KiwiRail as Access Provider and are linked to vehicle identifying numbers (see 27.1).

34. Remote Control Systems

- 34.1.1 Remote control systems, where fitted, shall limit vehicle speed to a maximum 25 km/h.

Guidance: This applies for remote operation where the operator is positioned on the ground or on the vehicle exterior (shunter's refuge, etc.). It is not intended to apply to possible future implementation of distributed power solutions.

- 34.1.2 Remote control systems, where fitted, shall comply with requirements of the Radiocommunications Act 1989 and the Radiocommunications Regulations 2001.

Guidance: Radio Spectrum Management (RSM) are responsible for managing the radio spectrum in New Zealand and allocating usage rights. KiwiRail's existing remote control shunting locomotives operate on licensed UHF channels.

35. Electromagnetic Compatibility

- 35.1.1 Electromagnetic compatibility (EMC) shall be managed in accordance with AS 7722 or an equivalent set of standards.

Guidance: For rolling stock, this is primarily covered by compliance to IEC 60571 or EN 50155. The broader EMC management of the railway environment is covered by IEC 62236 or EN 50121. Depending on the nature and complexity of on board systems, a joint test programme with KiwiRail as Access Provider may be required for new vehicles being introduced onto the Controlled Network.

- 35.1.2 Rail vehicles shall comply with electromagnetic field emission limits described in [ERA/ERTMS/033281](#) v5 §3.2.1.

Rationale: This ensures electromagnetic emissions from rail vehicles do not interfere with axle counters and similar equipment. The Controlled Network utilises wheel sensors that operate in bands 1, 2, and 3.

Guidance: 1068 mm is not a listed nominal track gauge in ERA/ERTMS/033281. For the purposes of this requirement §3.2.1 shall be interpreted as including it.

36. On Board Equipment

On board storage space should be considered in vehicle design. Exact requirements are dependent on operating context and are a matter for Rail Operators, but for guidance common on board equipment in KiwiRail's vehicles includes:

- A first aid kit,
- gas mask(s) and self-contained self-rescue (SCSR) device(s),
- a torch,
- signal flags / handlamps,
- tools,
- spare hoses, bungs, etc.
- bottled water.

36.1 Railway Track Signals

- 36.1.1 Lead units shall be fitted with a lockable magazine for storing railway track signals (i.e., 'detonators'), compliant to AS 2187.1-1998.

Rationale: Railway track signals are deployed to protect disabled trains. Being explosives, it is important they are housed in an appropriate container and protected from theft.

Guidance: Railway track signals used by KiwiRail are supplied by Howard & Sons Pyrotechnics. See drawing 15003133 for KiwiRail's standard tube type magazine.

36.1.2 Magazines shall hold a minimum of 24 railway track signals.

Guidance: This is two tubes of 12, as supplied by Howard & Sons Pyrotechnics. Large quantities of railway track signals, beyond what is required for operation, should not be permanently carried on board vehicles.

36.2 Fire Extinguishers

36.2.1 Driving cabs shall be fitted with a minimum of one fire extinguisher, 4.5 kg ABE dry powder type to AS/NZS 1481 or an alternative of equivalent performance.

36.2.2 Passenger areas should be fitted with fire extinguishers. Type, size, and position shall be appropriate for the vehicle's operating context.

37. Position Reporting

37.1.1 Lead units shall report their position to the Access Provider in near real-time.

Guidance: KiwiRail's own vehicles achieve this with the Kupe Mobile Controller (KMC) system, which is connected by mobile telecommunications (5G and previously 3G). Rail Operators may elect to use other systems, provided data can be provided to KiwiRail in a useable format. Rail Operators shall discuss specific arrangements with KiwiRail in advance of vehicles entering service on the Controlled Network.

38. Wayside Monitoring System Compatibility

38.1 Automatic Equipment Identification Tags

38.1.1 Rail vehicles shall have passive RFID tags fitted, compliant to the GS1 standard *EPC Compliant Class-1 Generation-2 UHF RFID Devices Conformance Requirements*. These are referred to as Automatic Equipment Identification (AEI) tags hereafter.

Rationale: There are continuous in-motion weighing (CIMW) and vehicle condition monitoring sites throughout the Controlled Network. AEI tags are used to identify vehicles as they pass through these sites, and operate in the frequency range 865 – 868 MHz

Guidance: See https://www.gs1.org/docs/epc/Gen2_conformance_requirements.pdf for this standard. These tags differ to those specified in AAR standard MSRP S-9203 (formerly S-918) and AS 7503, which operate in the frequency range 902.25 – 921.50 MHz and have different coding schemes.

38.1.2 AEI tags shall have:

- A minimum read distance of 10 m (for fixed readers),
- A Monza 4QT type chip,
- A minimum EPC memory size of 128 bits
- A minimum User Memory size of 512 bits

Guidance: KiwiRail use HID (formerly Omni-ID) EXO 2000 tags as the standard solution for its own rolling stock. These are service-proven as operating reliably with wayside equipment on the Controlled Network.

- 38.1.3 AEI tags shall be fitted on both vehicle sides, diagonally opposed and in accordance with Appendix 9.1.

Rationale: Tag mounting position is important for reliable reading at wayside monitoring sites and for determining vehicle travel direction so that individual wheelsets can be reliably identified.

- 38.1.4 AEI tags shall be coded with vehicle information as per Appendix 9.2.

Guidance: KiwiRail's rolling stock workshops and maintenance depots have capability to write vehicle information to tags with handheld reader/writer equipment.

Appendix 1 Route Parameters

The tables in this appendix describe the routes of the Controlled Network. This information is for the purposes of conveying route parameters that affect the interoperability of rail vehicles. Information is intended to be as accurate as possible but is subject to change as network upgrades occur.

Headings and abbreviations shall be interpreted as follows:

- Line – Name of line (lines are ordered by latitude of 0 km peg, north to south).
- Total Length – Line length expressed as final kilometre peg plus additional meterage beyond. Actual length, which may differ due to realignments etc., indicated in square brackets.
- Section – Section of line expressed as kilometre pegs plus additional meterage. Exact boundaries are complex in some cases (e.g., electrification limits), so these should be interpreted as indicative only.
- Passenger / Freight – Nominal allowed traffic types.
- Axle Load (see 15.2.3) – * indicates areas where 20 t axle loads are permitted for IP-class container flat wagons carrying steel products, the limit is 18 t for all other traffic.
- LA Rating (see 15.2.4)
- Electrified Area (see 28)
 - AEA: Auckland Electrified Area
 - NIMTEA: North Island Main Trunk Electrified Area
 - WEA: Wellington Electrified Area
- Clearance (see 15.1)
 - Standard (see Appendix 2)
 - Hi-Cube (see Appendix 3)
- Signalling Rules
 - ASR: Automatic Signalling Rules
 - ETCS L1: European Train Control System – Level 1
 - TWC: Track Warrant Control
 - SLA: Single-Line Automatic
 - Local Instruction (specifics vary)

Appendix 1.1 North Island Routes

Table 4 : Route Parameters – North Island

Line	Total Length (km)	Section (km)	Passenger / Freight	Axle Load (tonne)	LA Rating	Electrified Area	Clearance	Signalling Rules
Port Whangarei Branch	2km+250m [2.25 km]	Entirety	F	16.3	150	-	Hi-Cube	Local Instruction
Newmarket Line	3km+296m [3.296 km]	Entirety	F + P	18	170	AEA	Hi-Cube	ASR / ETCS L1
Onehunga Branch	3km+596m [3.596 km]	Entirety	P	18	170	AEA	Hi-Cube	ASR / ETCS L1
Southdown Branch	1km+888m [1.888 km]	Entirety	F	18	170	-	Hi-Cube	Local Instruction
North Auckland Line	281km+760m [283.323 km]	0km – 32km+226m	F + P	18	170	AEA	Hi-Cube	ASR / ETCS L1
		32km+226m – 36km+793m	F			-		ASR
		36km+793m – 226km+239m		16.3	150	TWC		
		226km+239m – 280km+760m						
Manukau Branch	1km+958m [1.958 km]	Entirety	P	18	170	AEA	Hi-Cube	ASR / ETCS L1
Mission Bush Branch	17km+107m [17.720 km]	Entirety	F + P	18*	170	-	Hi-Cube	ASR
Rotowaro Branch	7km+970m [8.574 km]	Entirety	F	18	170	-	Hi-Cube	Local Instruction
Waitoa Branch	11km+259m [11.225 km]	Entirety	F	16.3	150	-	Hi-Cube	Local Instruction
Mt Maunganui Branch	6km+415m [6.418 km]	Entirety	F + P	18	170	-	Hi-Cube	ASR
Kinleith Branch	65km+729m [65.857 km]	Entirety	F	18	170	-	Hi-Cube	ASR
Hautapu Branch	15km+500m [15.508km]	Entirety	F	16.3	150	-	Hi-Cube	Local Instruction

Line	Total Length (km)	Section (km)	Passenger / Freight	Axle Load (tonne)	LA Rating	Electrified Area	Clearance	Signalling Rules
East Coast Main Trunk	182km+200m [181.162 km]	Entirety	F + P	18	170	-	Hi-Cube	ASR
Murupara Branch	57km+649m [57.974 km]	Entirety	F	18	170	-	Hi-Cube	TWC
Napier Port Freight Branch	4km+795m [4.306 km]	0km – 2km+338m	F + P	18	170	-	Hi-Cube	ASR
		2km+338m – 4km+795m						Local Instruction
Whanganui Freight Branch	5km+562m [5.567 km]	0km – 4km+420m	F + P	18	170	-	Hi-Cube	ASR
		4km+420m – 5km+562m						Local Instruction
Castlecliff Line	3km+840m [3.952 km]	Entirety	F	18	170	-	Hi-Cube	Local Instruction
Marton - New Plymouth Line	212km+899m [212.549 km]	0km – 43km+609m	F + P	18	170	-	Hi-Cube	ASR
		43km+609m – 195km+199m						TWC
		195km+199m – 212km+899m						ASR
Palmerston North - Gisborne Line	391km+600m [390.994 km]	0km – 0km+892m	F + P	18	170	NIMTEA	Hi-Cube	ASR
		0km+892m – 181km+849m						
		181km+849m – 296km+500m	F	16.3	150	-	Standard	TWC
		296km+500m – 391km+600m						
Gracefield Branch	1km+820m [1.82 km]	0km – 0km+745m	F	18	170	WEA	Hi-Cube	Local Instruction
		0km+745m – 1km+820m						
Melling Branch	3km+002m [2.989 km]	Entirety	P	18	170	WEA	Hi-Cube	ASR
Johnsonville Line	10km+419m [10.343 km]	Entirety	P	18	170	WEA	Standard	ASR

Line	Total Length (km)	Section (km)	Passenger / Freight	Axle Load (tonne)	LA Rating	Electrified Area	Clearance	Signalling Rules
North Island Main Trunk	685km+374m [681.400 km]	0km – 55km+813m	F + P	18	170	WEA	Hi-Cube	ASR
		55km+813m – 135km+290m				-		
		135km+290m – 544km+167m				NIMTEA		
		544km+167m – 627km+435m				-		
		627km+435m – 628km+434m				AEA		ASR / ETCS L1
		628km+434m – 632km+970m						
		632km+970m – 664 km+280m						
		664km+280m – 681km+820m	18*	170*				
		681km+820m – 685km+374m	P	18	170	Standard		
Wairarapa Line	171km+143m	0km – 33km+070m	F + P	18	170	WEA	Hi-Cube	ASR
		33km+070m – 58km+350m				-		TWC
		58km+350m – 91km+431m						
		91km+431m – 154km+620m						
		154km+620m – 171km+143m						
	16	150						
	18	170						

Appendix 1.2 South Island Routes

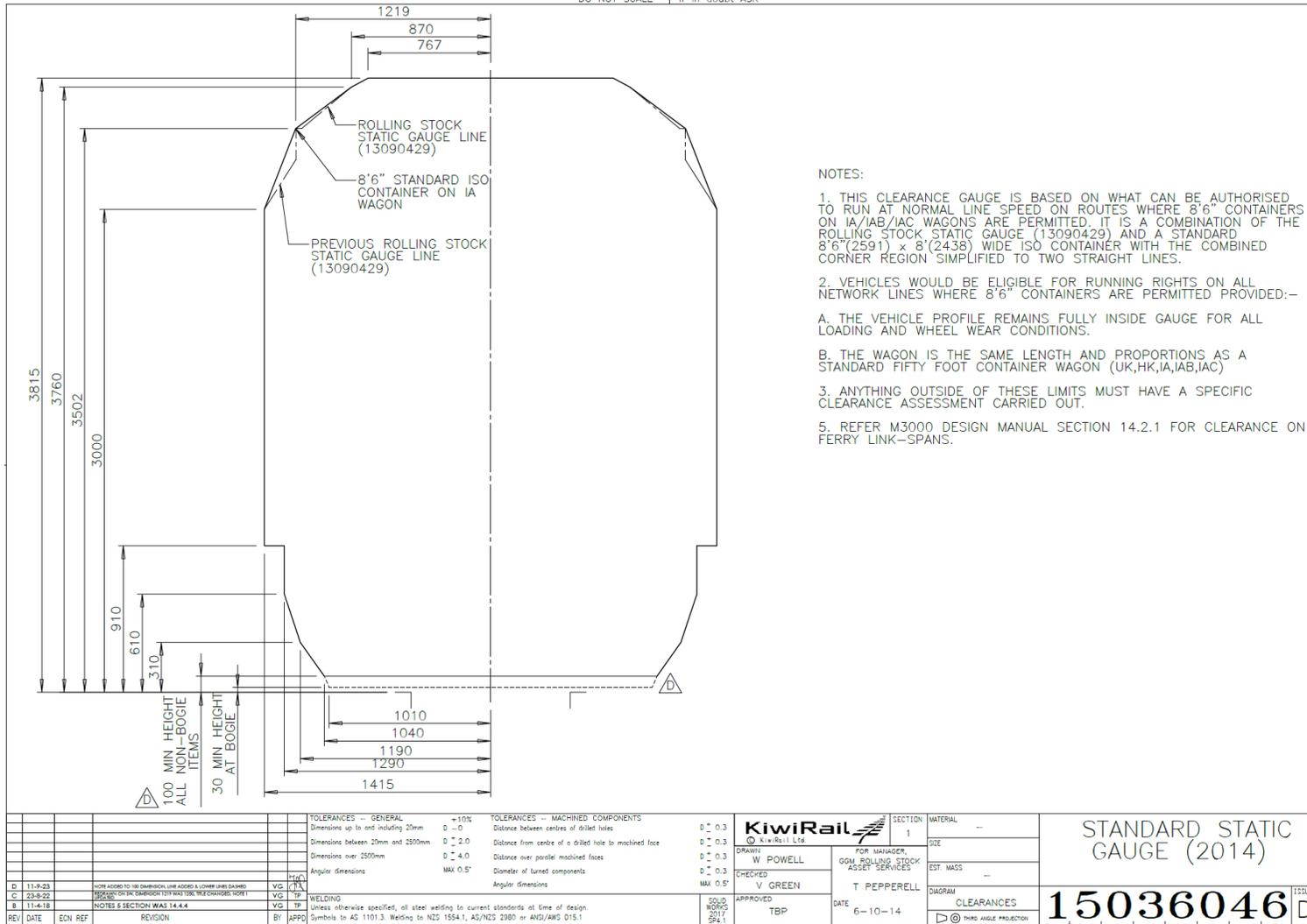
Table 5: Route Parameters – South Island

Line	Total Length (km)	Section (km)	Passenger / Freight	Axle Load (tonne)	LA Rating	Electrified Area	Clearance	Signalling Rules
Stillwater - Ngakawau Line	163km+931m [163.984 km]	0km – 0km+314m	F	18	170	-	Standard	SLA
		0km+314m – 164km+030m						TWC
Rapahoe Branch	9km+290m [9.782 km]	Entirety	F	18	170	-	Standard	TWC
Hokitika Line	39km+901m [38.467 km]	Entirety	F	18	170	-	Standard	TWC
Main North Line	347km+869m [347.590 km]	0km – 11km+992m	P + F	18	170	-	Hi-Cube	ASR
		11km+992m – 347km+600m						TWC
Hornby Branch	3km+102m [3.114 km]	Entirety	F	16.3	150	-	Hi-Cube	Local Instruction
Midland Line	212km+352m [212.094 km]	0km – 48km+330m	P + F	18	170	-	Hi-Cube	SLA
		48km+330m – 116km+214m						Standard
		116km+214m – 130km+256m					SLA	
		130km+256m – 197km+188m					TWC	
		197km+188m – 212km+352m						
Main South Line	601km+403m [601.899 km]	0km – 254km+620m	P + F	18	170	-	Hi-Cube	ASR
		254km+620m – 368km+190m						TWC
		368km+190m – 393km+545m						ASR
		393km+545m – 600km+872m						TWC
		600km+872m – 601km+403m						ASR
Port Chalmers Branch	1km+749m [1.755 km]	Entirety	P + F	18	170	-	Hi-Cube	TWC
Taieri Branch	3km+500m [3.564 km]	Entirety	P + F	18	170	-	Hi-Cube	ASR

Line	Total Length (km)	Section (km)	Passenger / Freight	Axle Load (tonne)	LA Rating	Electrified Area	Clearance	Signalling Rules
Finegand Branch	2km+421m [2.454 km]	Entirety	F	14.6	150	-	Hi-Cube	Local Instruction
Ohai Line	78km+753m [79.824 km]	0.00 – 1km+467m	F	16.3	150	-	Hi-Cube	ASR
		1km+467m – 12km+320m						TWC
		12km+320m – 78km+753m		14.6	130			
Bluff Branch	26km+552m [26.586 km]	0km – 1km+386m	F	16.3	150	-	Hi-Cube	ASR
		1km+386m – 26km+552m						TWC

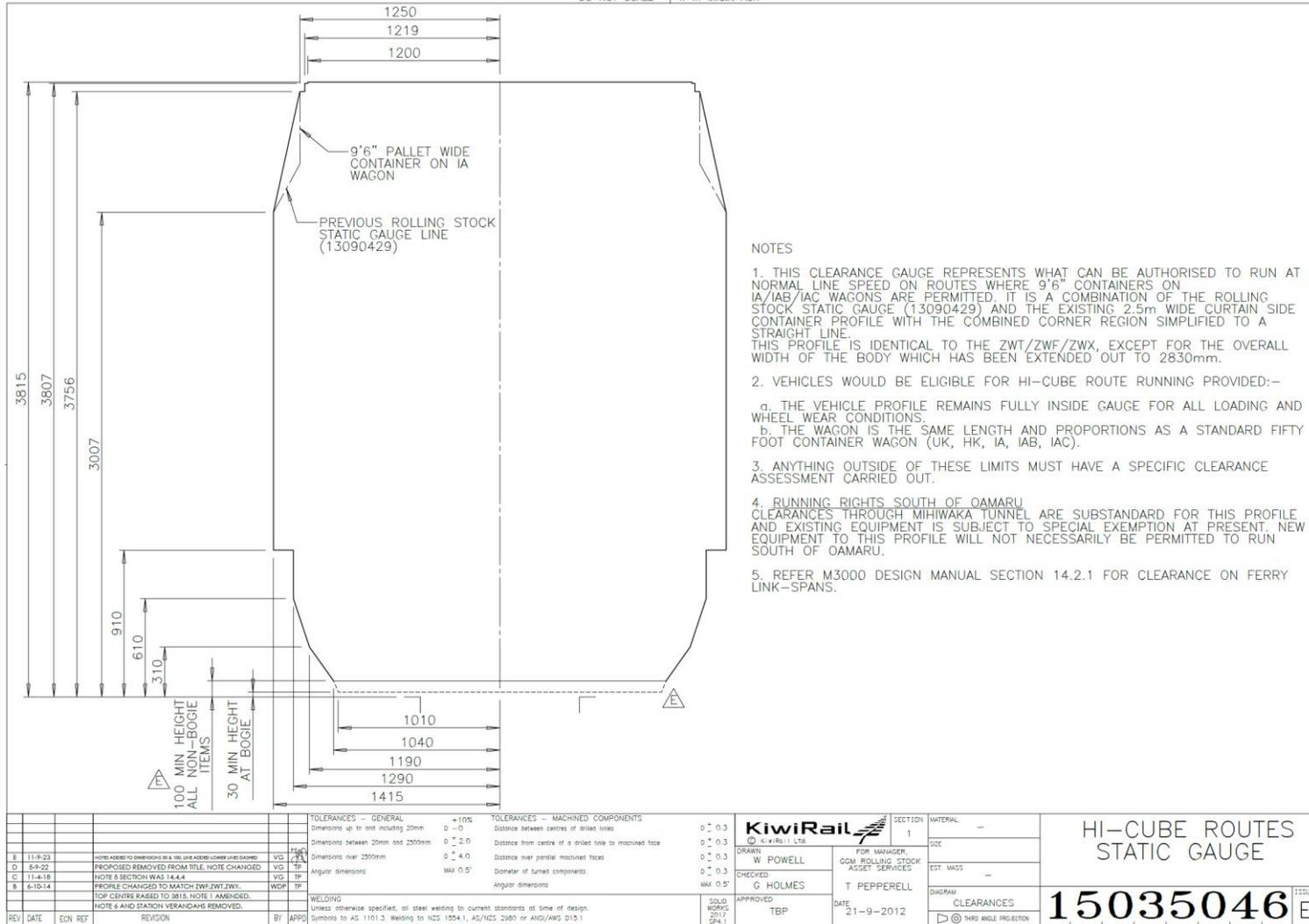
Appendix 2 Standard Static Vehicle Gauge

DO NOT SCALE | if in doubt ASK



Appendix 3 Hi-Cube Static Vehicle Gauge

DO NOT SCALE | if in doubt ASK



TOLERANCES - GENERAL		±10%	TOLERANCES - MACHINED COMPONENTS	0.3	KiwiRail © 2012 KiwiRail Ltd.	SECTION 1	MATERIAL	HI-CUBE ROUTES STATIC GAUGE
Dimensions up to and including 20mm		0 - 0	Distance between centres of drilled holes	0.3		SIZE	EST. MASS	
Dimensions between 20mm and 250mm		±2.0	Distance from centre of a drilled hole to machined face	0.3	FOR MANAGER, GGM ROLLING STOCK ASSET SERVICES	DIAGRAM		CLEARANCES
Dimensions over 250mm		±4.0	Distance over parallel machined faces	0.3	DRAWN W POWELL		T PEPPERELL	
Angular dimensions		MAX 0.5°	Diameter of turned components	0.3	CHECKED G HOLMES	DATE		ISSUE
			Angular dimensions	MAX 0.5°	APPROVED TBP	21-9-2012	① THRU ANGLE PROJECTION	E
WELDING			UNLESS OTHERWISE SPECIFIED, ALL STEEL WELDING TO CURRENT STANDARDS AT TIME OF DESIGN.					
Symbols to AS 1101.3 Welding to NZS 1554.1, AS/NZS 2980 or AWS/AWS D15.1								
REV	DATE	EDN REF	REVISION	BY	APPD			

Appendix 4 Comparative Gauging – AS 7507 Method

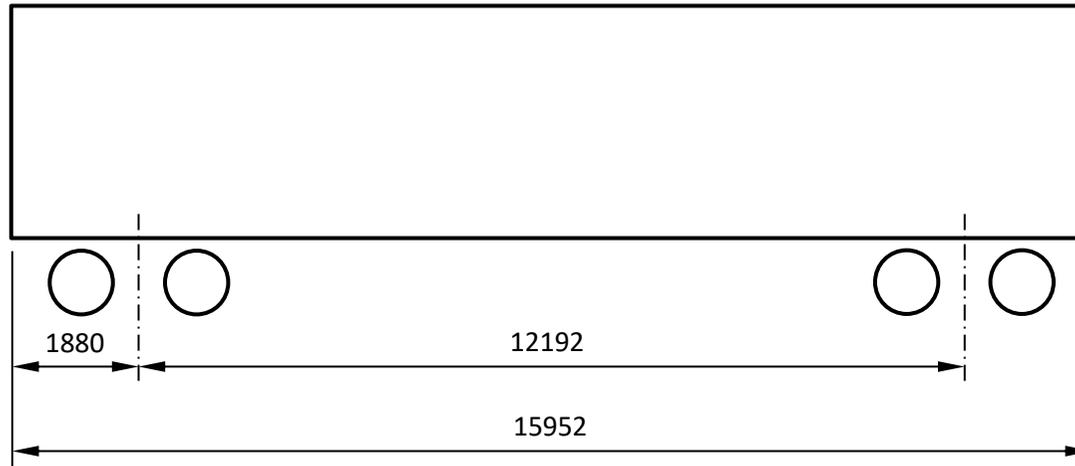
AS 7507 sets out a method for comparative gauging that incorporates rail vehicle kinematic movements. This can be applied for gauging assessment of new candidate rail vehicles for the National Rail System against any valid reference rail vehicle – i.e., rail vehicles with existing running rights and service history on the requested route(s).

Currently two KiwiRail reference vehicles are available for this method, with details as follows.

- Reference Vehicle 1, Appendix 4.1, is a UK-class wagon.
- Reference Vehicle 2, Appendix 4.2, is an IAB-class wagon.
- Standard or Hi-Cube static vehicle gauges can be applied to either reference vehicle, depending on the route clearance.
- The combined kinematic envelope for Reference Vehicles 1 and 2 may be used – generally this is dominated by Reference Vehicle 2 with its larger kinematic movements, but the greater end-throws for Reference Vehicle 1 afford a slightly larger envelope.
- Kinematic movements for candidate rail vehicles must consider:
 - 96 mm installed cant at trundle speed (inwards lean on high-cant curves)
 - Maximum cant deficiency at maximum speed (R441 m curve at 80 km/h was used to derive kinematic movements for both reference vehicles)
 - Track irregularity as per KiwiRail Rolling Stock Asset Services Specification 401 §A1 (scaled Vampire *Track200.dat* file)

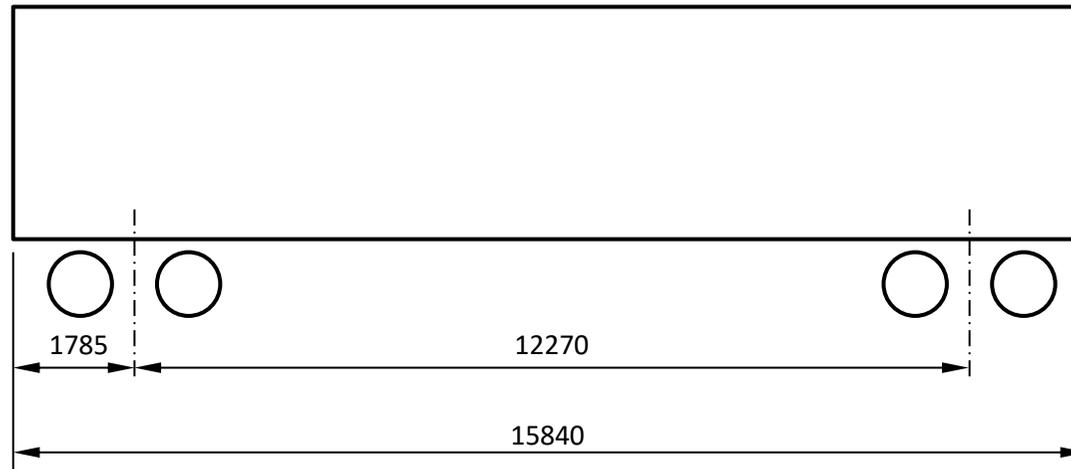
NOTE: Comparative gauging to Reference Vehicles 1 and 2 is unlikely to allow for larger candidate rail vehicles than what can already be demonstrated as compliant to static vehicle gauges, as both are 50-foot container wagons. Further reference vehicles may be developed by KiwiRail in future, or designers may propose to develop models of existing vehicles for use with this method.

Appendix 4.1 Reference Vehicle 1 (UK Wagon)



Lateral Translation +/- (mm)	Body Roll		Bounce (Upwards Only) (mm)
	Angle +/- (degrees)	Point of Rotation ARL (mm)	
10.6	1.5	610	12.6

Appendix 4.2 Reference Vehicle 2 (IAB Wagon)



Lateral Translation +/- (mm)	Body Roll		Bounce (Upwards Only) (mm)
	Angle +/- (degrees)	Point of Rotation ARL (mm)	
16.3	1.6	610	18.7

Appendix 5 Absolute Gauging – Static Outlines

Absolute gauging is the assessment of clearances between a rail vehicle and fixed infrastructure features, along with vehicle to vehicle clearances on adjacent tracks. This contrasts with comparative gauging, which compares a vehicle’s swept envelope to that of an existing route-cleared vehicle.

KiwiRail Infrastructure perform regular laser scanning of the National Rail System, and can assess static vehicle profiles for clearance to the infrastructure (see Figure 12 for an example assessment).

Absolute gauging with static vehicle outlines shall account for vehicle throws on curves, but does not quantify vehicle kinematic movements (lateral movement, sway, bounce). Instead, a minimum of 200 mm clearance is required above vehicle floor level (nominally 905 mm ARL) and 50 mm clearance below vehicle floor level. Tighter clearances are subject to vehicle speed restrictions per Table 6 and Table 7 below, which are also included in KiwiRail Track Standard T-ST-DE-5212 *Clearances*.

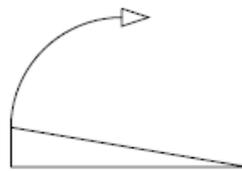
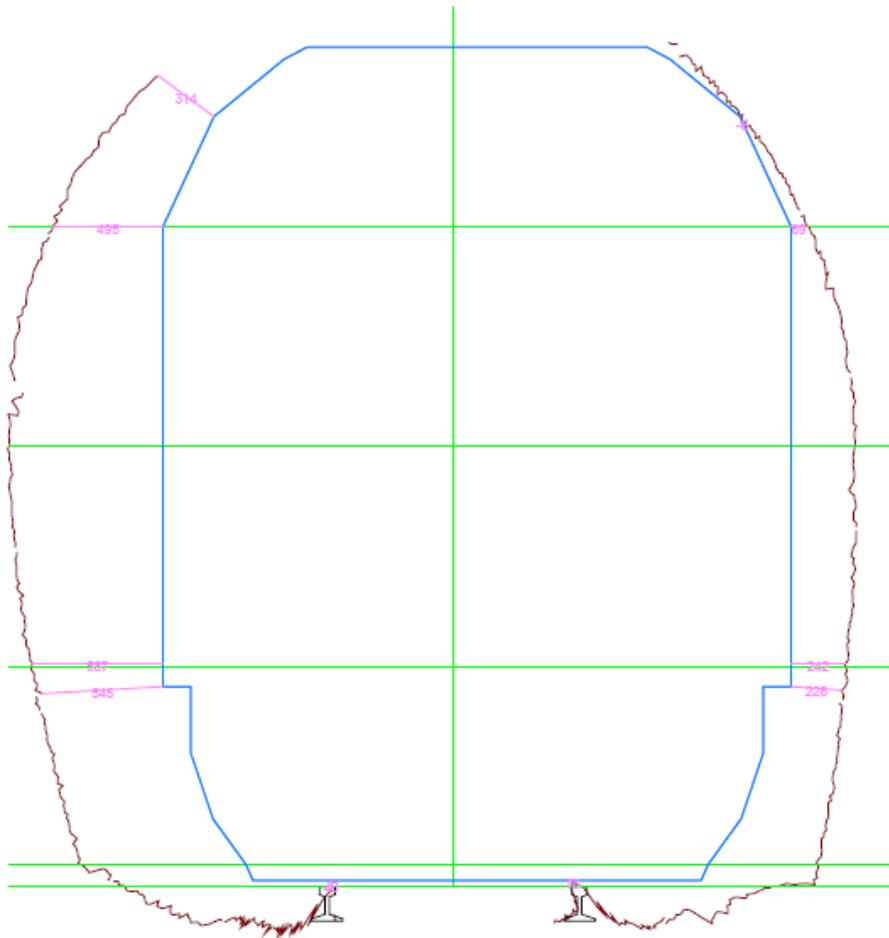
Table 6: Static Clearance & Speed Restrictions – Above Vehicle Floor Level

Lateral Static Clearance	Maximum Speed
> 200 mm	Unrestricted (line speed)
150 mm – 200 mm	55 km/h
75 mm – 149 mm	25 km/h
Frangible components excluded for > 75 mm clearance	
50 mm – 74 mm	15 km/h
< 50 mm	Not to run unless piloted

Table 7: Clearance & Speed Restrictions – Below Vehicle Floor Level

Static Clearance	Maximum Speed
> 50 mm	Unrestricted (line speed)
30 mm – 50 mm	25 km/h
< 30 mm	Not to run unless piloted

Frangible components are items that are intended to deform or break if they strike a fixed lineside structure and that will not cause significant damage to the structure – e.g., rear view mirrors.



Track 3000
Cant 49mm
Radius 196m

Figure 12: Static Clearance Assessment in ClearRoute (example)

Appendix 6 Service Brake Performance Curves

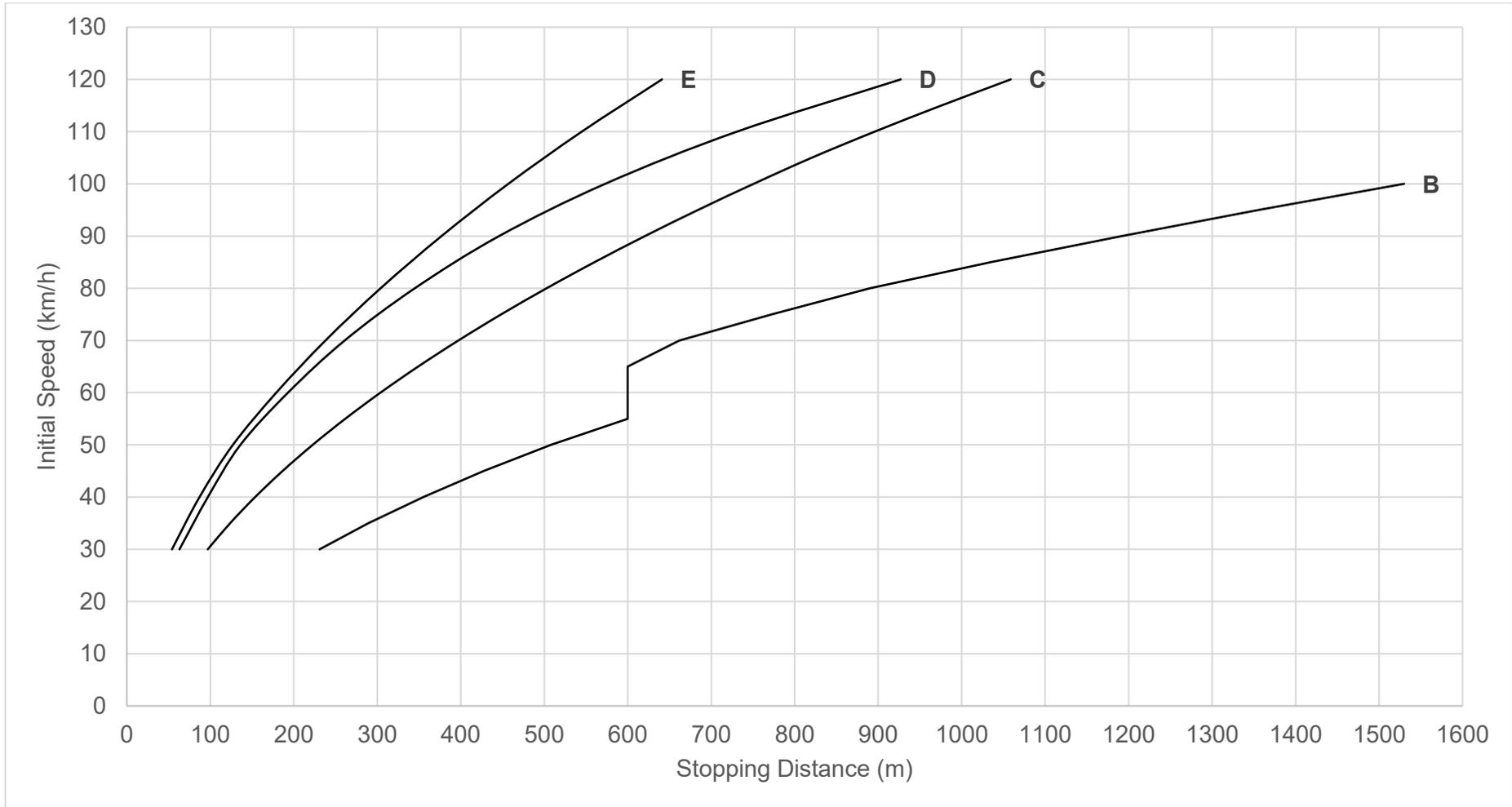


Figure 13: Service Brake Performance Curves, Tangent Level Track

Table 8: Service Brake Performance Values, Tangent Level Track

Brake Curve	30 km/h	40 km/h	50 km/h	55 km/h	60 km/h	65 km/h	70 km/h	80 km/h	90 km/h	100 km/h	110 km/h	120 km /h
A	<i>Reserved</i>											
B	231 m	355 m	508 m	600 m	600 m	600 m	662 m	890 m	1192 m	1530 m	-	-
C	97 m	154 m	223 m	-	304 m	-	397 m	503 m	621 m	751 m	896 m	1059 m
D	63 m	97 m	136 m	-	193 m	-	261 m	345 m	446 m	573 m	731 m	927 m
E	54 m	87 m	127 m	-	179 m	-	238 m	304 m	377 m	457 m	545 m	641 m

Appendix 7 Maximum Permitted Acceleration Performance Curve

Figure 14 below shows the maximum permitted acceleration for rail vehicles on level track. This reflects the assumptions used in KiwiRail’s active level crossings for setting train detection boundaries so that minimum warning times are met. Vehicles may be assessed against this curve by plotting test data and ensuring it stays below the curve, and the gradient does not exceed that of the curve at any point along it.

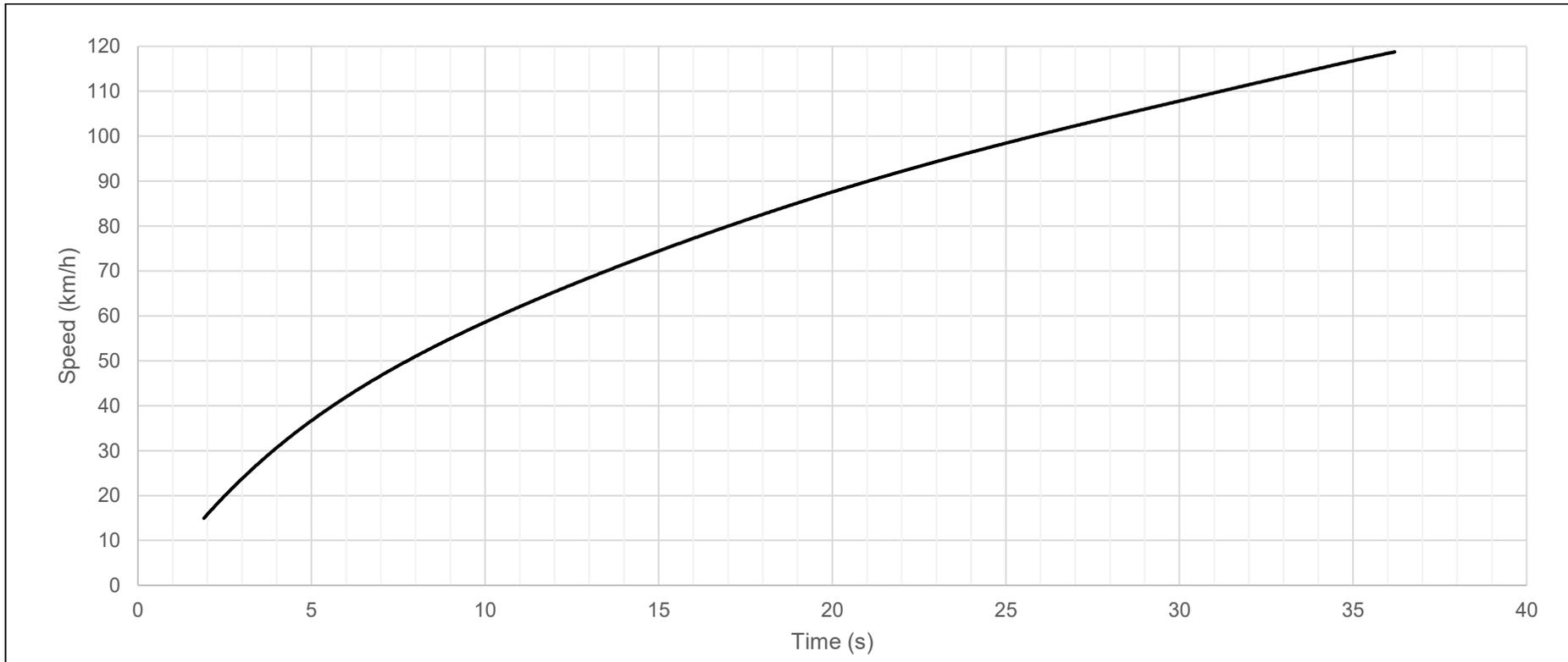


Figure 14: Maximum Permitted Acceleration Curve, Level Track

Table 9 on the following page expresses this same requirement as the minimum distance over which a vehicle may accelerate from a given initial speed to a given final speed. Vehicles shall not be able to accelerate over a shorter distance for any of the values given.

Table 9: Minimum Acceleration Distance (metres), Level Track

		Final Speed (km/h)																			
		15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110
Initial Speed (km/h)	0	4	7	11	16	24	33	45	60	79	101	126	156	191	231	277	329	387	452	525	607
	15		4	8	13	21	30	42	57	76	98	123	153	188	228	274	326	384	449	522	604
	20			4	9	17	26	38	53	72	94	119	149	184	224	270	322	380	445	518	600
	25				5	13	22	34	49	68	90	115	145	180	220	266	318	376	441	514	596
	30					8	17	29	44	63	85	110	140	175	215	261	313	371	436	509	591
	35						9	21	36	55	77	102	132	167	207	253	305	363	428	501	583
	40							12	27	46	68	93	123	158	198	244	296	354	419	492	574
	45								15	34	56	81	111	146	186	232	284	342	407	480	562
	50									19	41	66	96	131	171	217	269	327	392	465	547
	55										22	47	77	112	152	198	250	308	373	446	528
	60											25	55	90	130	176	228	286	351	424	506
	65												30	65	105	151	203	261	326	399	481
	70													35	75	121	173	231	296	369	451
	75														40	86	138	196	261	334	416
	80															46	98	156	221	294	376
	85																52	110	175	248	330
	90																	58	123	196	278
95																		65	138	220	
100																			73	155	
105																				82	
110																					

Appendix 8 Electrified Areas – Basic Parameters

		WEA	NIMTEA	AEA
System Voltage (nominal)		1500 VDC	25 kV AC 50Hz	25 kV AC 50Hz
KiwiRail Principles Document		<i>E-PR-WE-0021</i>	<i>E-PR-NE-0020</i>	<i>E-PR-AE-0019</i>
KiwiRail Specification Document(s)		<i>E-SP-WE-61330</i>		<i>E-SP-AE-61210</i> <i>E-SP-AE-61317</i>
Operating Rolling Stock		• FP/FT Class 'Matangi' EMUs	• EF Class Electric Locomotives	• AM Class EMUs
Pantograph Static Uplift Force		90 N	70 N	90 N
Contact Wire Height (ARL)	Nominal	4800 mm	5250 mm	5000 mm
	Maximum	5350 mm	6100 mm	6200 mm
	Minimum	3950 mm	4200 mm	4220 mm
Pantograph Overreach Setting (ARL)		5550 mm	6450 mm	6448 mm
Maximum Contact Wire Gradient (v = line speed in km/h)		1 in 3v		

Appendix 9 Automatic Equipment Identification Tags

Appendix 9.1 AEI Tag Positioning

AEI tag positioning ensures reliable tag reading by wayside readers and allows the direction of vehicle travel to be determined from vehicle side data encoded in the tag.

Positioning approximately follows the conventions of AAR Standard S-9203 (formerly S-918), with measurements converted to metric values. A similar metric-converted scheme is laid out in AS 7503 Appendix E, but with slightly different metric values adopted. Where New Zealand convention differs from both is that vehicle ends are defined No. 1 / No. 2 and vehicle sides are defined A-side / B-side.

For wagons and carriages with manually applied handbrakes, the end with the handbrake actuator is defined as the Hand Brake End (HBE) and the other end as the Non-Hand Brake End (NHBE). From the centre of the vehicle, facing towards the HBE, the A-side is on the left and B-side is on the right.

For locomotives and other lead units with a single driving cab at one end, the cab end is No.1 End and when facing outwards from the cab the A-side is on the left and B-side is on the right.

For locomotives and other lead units with a centrally located driving cab or with driving cabs at both ends the vehicle designer shall nominate No. 1 and No. 2 ends, and the A-side and B-side shall follow from that. For permanently coupled vehicles with driving cabs at each end (e.g., passenger multiple units) the same shall apply – i.e., A-side and B-side remain fixed over the full length of the consist.

Tag positioning requirements are shown in Figure 16 to Figure 19 below, noting:

- The lateral offset limit of 1415 mm reflects the limit of the standard static gauge (Appendix 2, Appendix 3), this may be increased where a vehicle has been granted a derogation from this gauging requirement.
- The top of sill on locomotives shall be taken to mean the level of the walking surface for units with external walkways, or the internal floor level for full width carbodies. Effort should be made not to exceed the nominal height limit of 1520 mm ARL.
- Vehicles not covered in any figure shall adopt the same basic principles, and KiwiRail Infrastructure consulted where doubt exists.

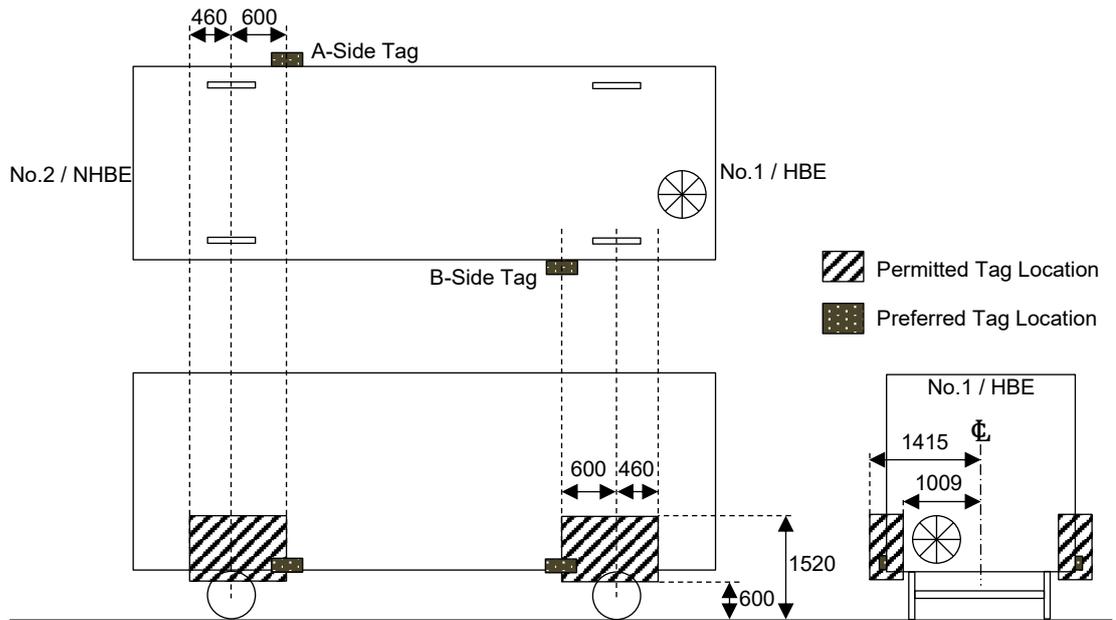


Figure 15: AEI Tags - 2-Axle Vehicles

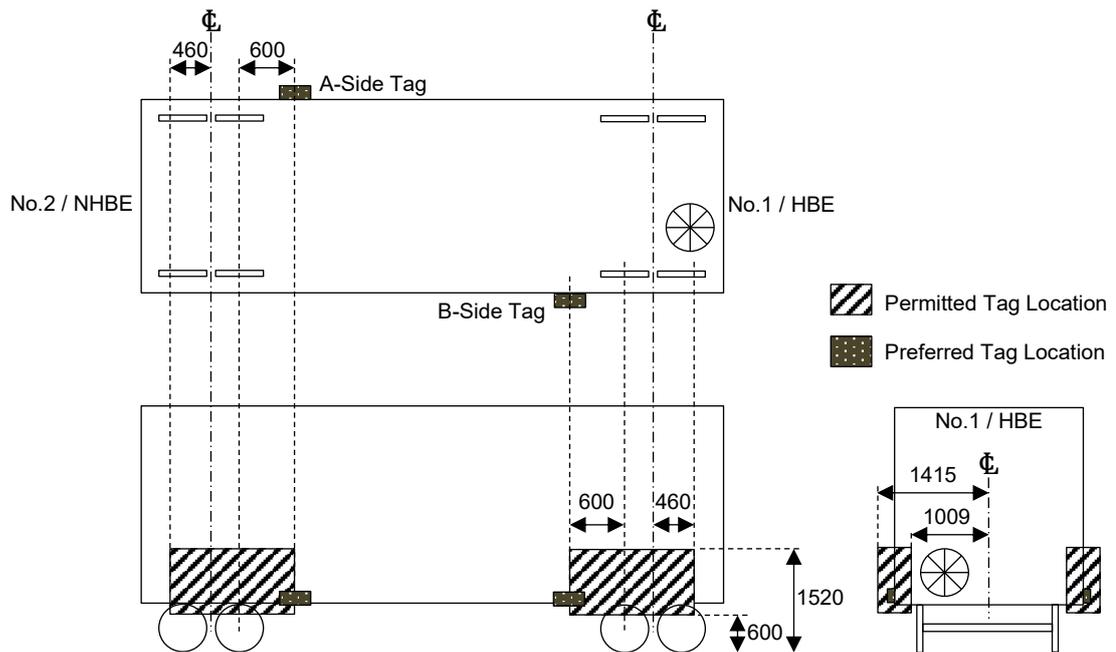


Figure 16: AEI Tags - 4-Axle Bogie Wagons / Carriages (mm)

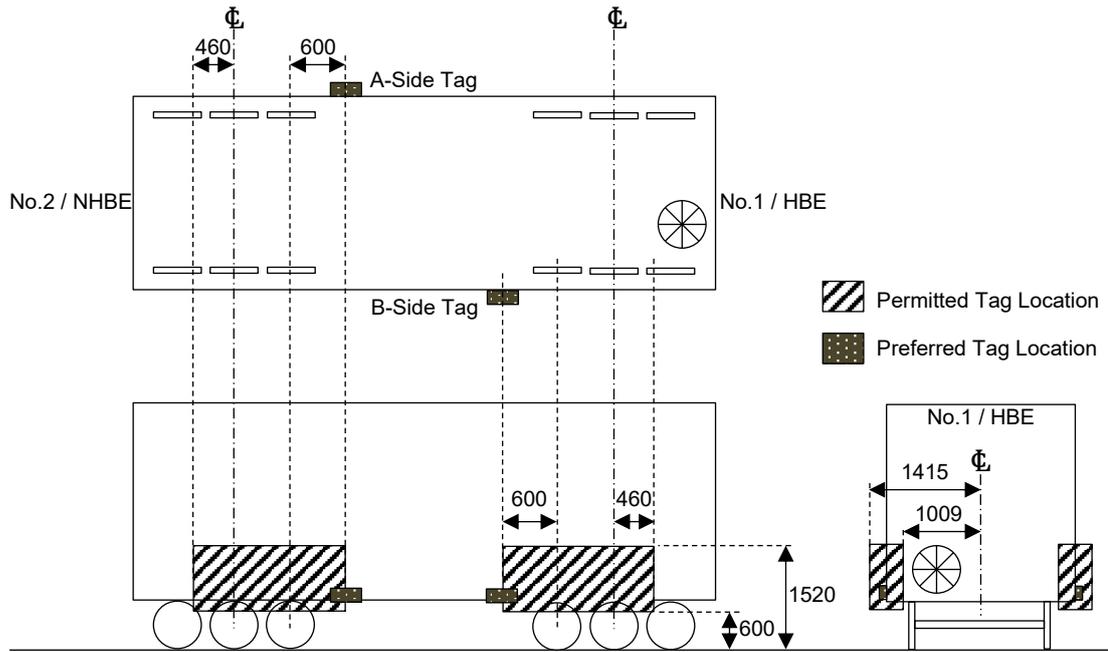


Figure 17: AEI Tags – 6-Axle Bogie Wagons / Carriages (mm)

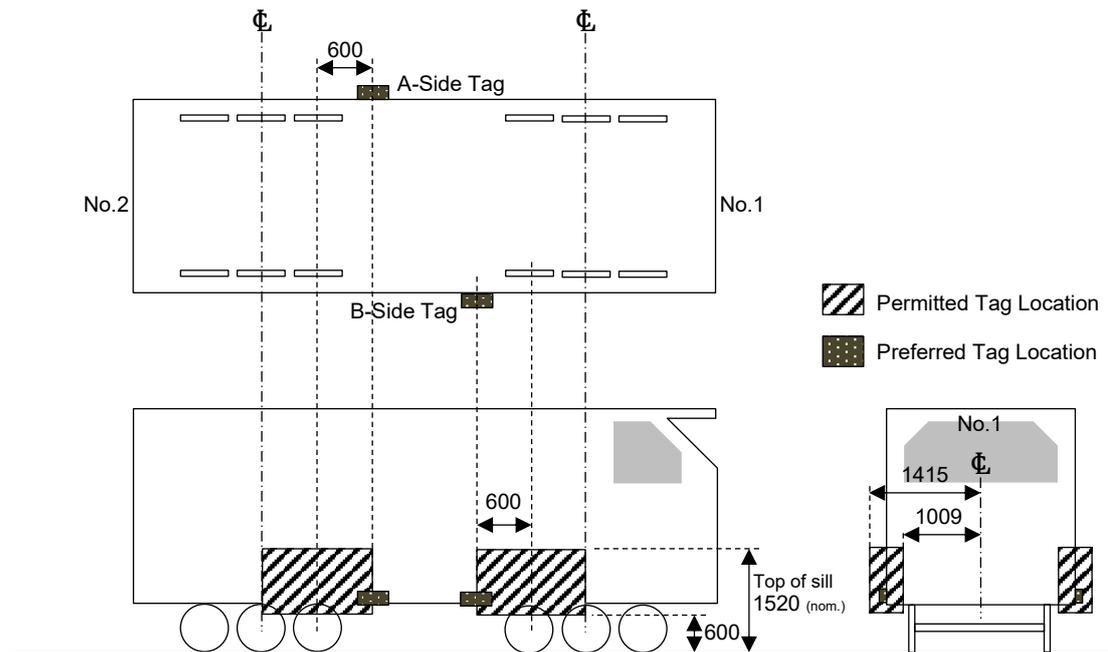


Figure 18: AEI Tags – 6-Axle Locomotives (Co-Co, etc.) (mm)

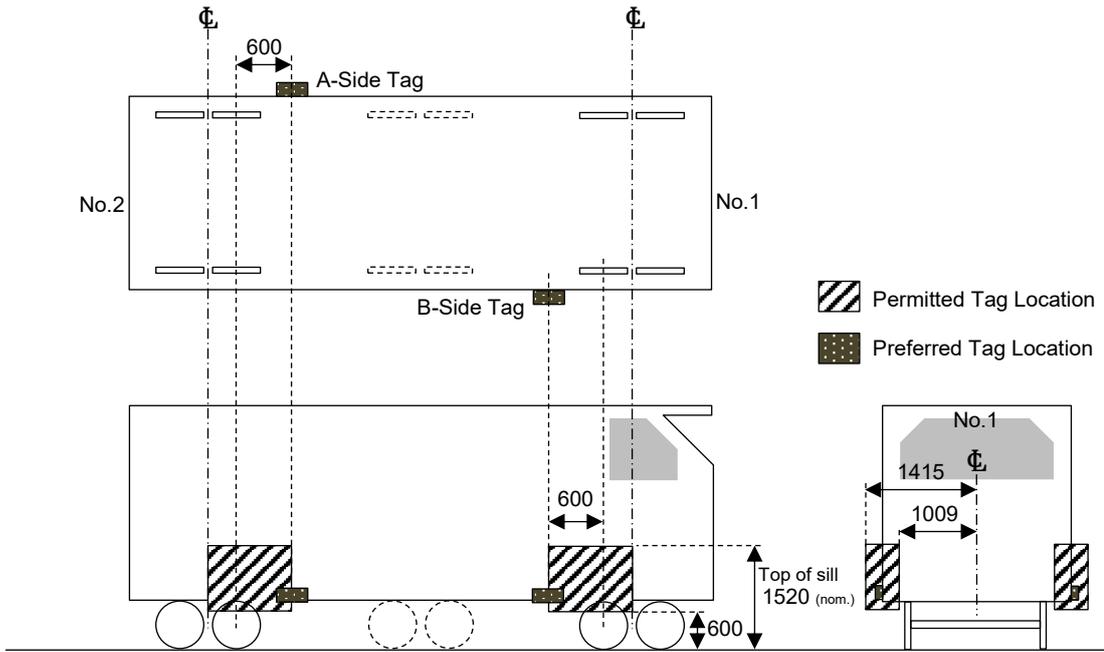


Figure 19: AEI Tag – 4-Axle / 6-Axle Locomotives (Bo-Bo-Bo, etc.) (mm)

Appendix 9.2 AEI Tag Programming Requirements

Overview

The following rail vehicle information is required to be programmed on AEI tags fitted to rail vehicles:

- Vehicle type, from the below options
 - Locomotive
 - Wagon
 - Other – includes all passenger vehicles, maintenance machines, and other rail vehicles that are not Locomotives or Wagons
- Vehicle class and running number, as displayed on vehicle – e.g., DXR8007
- Vehicle side (A or B, depends on vehicle side tag is fitted to)
- Number of axles
- Platform number (applies only to articulated or permanently coupled vehicles operated under a single running number, 0 for all other vehicle types)

EPC Class 1 Gen 2 tags have both electronic product code (EPC) memory and User memory. Rail vehicle information shall be programmed to both memories, but the encoding scheme differs for each as described below.

EPC Memory Encoding

The EPC Memory shall be encoded with vehicle information from 20h onwards (00h – 0Fh are cyclic redundancy and protocol control bits, per GS1 standards). EPC Memory coding shall be carried out per the table below.

Table 10: EPC Memory Encoding Scheme

Entry	Bits Required	Tag Data Sequence	Value (Min-Max)	Unit
Vehicle Type	2	0 - 1	0 – 2 (see Note 1)	Type Code
Vehicle Class & Running Number	84	2 - 85	0000000000000 – ZZZ99999999999	Alpha Numeric (6-bit)
Vehicle Side	1	86	0 – 1 (see Note 2)	Side Code
Number of Axles	4	87 - 90	1 – 15	Axles
Number of Platforms	2	91 - 92	0 – 3 (see Note 3)	Platforms
Unused (Reserved)	3	93 - 95	(see Note 4)	

Notes:

1. Vehicle Type Coding:
 - i. 0 = Locomotive

- ii. 1 = Wagon
 - iii. 2 = Other
2. Vehicle Side Coding:
- i. 0 = A-side
 - ii. 1 = B-side
3. Set to 0 for all single vehicle types. For articulated or permanently coupled units of multiple vehicles under a single running number, set to vehicle position within unit.
4. Unused bits to be set to 0.

The Vehicle Class and Running Number is 14 characters encoded in 6-bit per the below tables below.

Table 11: 6-Bit Encoding of Alphanumeric Characters – EPC Memory

Character	Binary	Character	Binary	Character	Binary
0	000000	D	001101	Q	011010
1	000001	E	001110	R	011011
2	000010	F	001111	S	011100
3	000011	G	010000	T	011101
4	000100	H	010001	U	011110
5	000101	I	010010	V	011111
6	000110	J	010011	W	100000
7	000111	K	010100	X	100001
8	001000	L	010101	Y	100010
9	001001	M	010110	Z	100011
A	001010	N	010111	[space]	100100
B	001011	O	011000		
C	001100	P	011001		

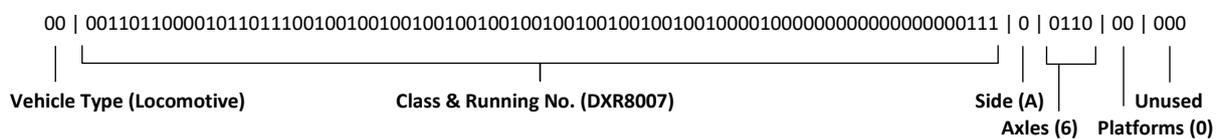
Vehicle Class (alphabetical characters) shall start from position zero, and the Running Number (numerical characters) shall end at position 13 (i.e., the final position). Unused positions between the Vehicle Class and Running Number shall be encoded as space characters.

For example, the vehicle DXR8007 would be coded as below:

Table 12: Example Class & Running No. Coding – EPC Memory ("DXR8007")

Position	Character	Binary
0	D	001101
1	X	100001
2	R	011011
3	[space]	100100
4	[space]	100100
5	[space]	100100
6	[space]	100100
7	[space]	100100
8	[space]	100100
9	[space]	100100
10	8	001000
11	0	000000
12	0	000000
13	7	000111

The full EPC Memory encoding for the A-side tag of DXR8007, a 6-axle locomotive, is below:



User Memory Encoding

User memory coding shall be in bytes with standard ASCII characters and carried out per the table below.

Table 13: User Memory Encoding Scheme

Entry	Bits Required	Tag Data Sequence	No. Bytes / ASCII Characters	Value (Coding, Min-Max)	Unit
Vehicle Type	16	0 - 15	2	19 = Locomotive 05 = Wagon 99 = Other	Type Code
Vehicle Class & Running Number	112	16 - 127	14	0000000000000000 – ZZZ9999999999999	Alpha Numeric
Vehicle Side	8	128 - 135	1	A or B	Side Code
Number of Axles	16	136 - 151	2	01 – 15	Axles
Number of Platforms	16	152 - 167	2	00 – 03 (set to 00)	Platforms
Unused (Reserved)	8	168 - 175	1	0	

Uppercase alphabetical characters shall be used in all cases.

Leading zeros are required for numeric values (e.g., 04 for a 4-axle wagon).

Vehicle Class (alphabetical characters) shall start from position zero, and the Running Number (numerical characters) shall end at position 13 (i.e., the final position). Unused positions between the Vehicle Class and Running Number shall be encoded as space characters. I.e., the same as with EPC Memory.

For example, DXR8007 would be coded as below.

Table 14: Example Class & Running No. Coding – User Memory ("DXR8007")

Position	Character	Decimal (ASCII)	Binary
0	D	68	01000100
1	X	88	01011000
2	R	82	01010010
3	[space]	32	00100000
4	[space]	32	00100000
5	[space]	32	00100000
6	[space]	32	00100000
7	[space]	32	00100000
8	[space]	32	00100000
9	[space]	32	00100000
10	8	56	00111000
11	0	48	00110000
12	0	48	00110000
13	7	55	00110111

Document History

Note page numbers relate to the document at the time of amendment and may not match page numbers in current document.

Issue No.	Section	Description	Page(s)
1.0		First Issue – Published to KiwiRail Intranet only.	
1.1	3 (prev.)	Review & Revision Procedure section removed – replaced by Document History (this table) in current template	7 (prev.)
	4	ARISO added to Acronyms to reflect RISSB name change in late 2025. References to RISSB updated elsewhere in document.	8
	15.1	Standard static vehicle gauge reference to Appendix 1 changed to Appendix 2 (error correction).	15
	16.1.1	“design speed” changed to “operating speed(s)” to reflect potential difference between design speed and certified operating speed, and possibility of conditional speeds (loading, deflated suspension, etc.).	17
	18.5	“not exceed” changed to “be at least” to correct error. Intent of clause unchanged – mitigating risk of vehicle roll-over in gales.	20