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Preface

This standard was prepared by the Braking Systems – Part 6: Trains Development Group, overseen by the ARISO Rolling Stock Standing Committee.

Objective

The objective of this Standard is to provide safety benefits in that proper braking performance contributes to the prevention of signals passed at danger, exceedances of authority, collisions or derailments of railway rolling stock by providing controls for known hazards (including those listed in Appendix B).

This Standard is intended to complement the rolling stock compliance certification process outlined in AS 7501, including all vehicle types such as new, modified and heritage rolling stock.

Compliance

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

(a) Requirements.

(b) Recommendations.

(c) Permissions.

(d) Constraints.

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

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

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

For compliance purposes, where a recommended control is not applied as written in the standard it could be incumbent on the adopter of the standard to demonstrate their actual method of controlling the risk as part of their WHS or Rail Safety National Law obligations. Similarly, it could also be incumbent on an adopter of the standard to demonstrate their method of controlling the risk to contracting entities or interfacing organisations where the risk may be shared.

Permissions – conveys consent by providing an allowable option. Permissions are identified within the text by the term 'may'.

Constraints – provided by an external source such as legislation. Constraints are identified within the text by the term 'must'.

ARISO Standards address known hazards within the railway industry. Hazards, and clauses within this Standard that address those hazards, are listed in Appendix B.

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

Commentary

Commentary *C Preface*

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

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Section 1 Scope and general

1.1 Scope

This Standard is applicable to trains that operate on rail networks.

This Standard is to ensure that the trains in their marshalled configuration are able to brake within a defined performance compliant with the rail networks signalling requirements, for general train control, and safe rail operation.

This Standard covers freight and passenger trains (comprising locomotive, wagons, carriages), multiple unit trains (EMU/DMU), and infrastructure maintenance vehicles.

This Standard does not cover trains operating on light rail, cane railway, and monorail networks.

This Standard assumes individual vehicles (locomotives, wagons, carriages, etc.) are compliant with individual vehicle brake requirements. Refer to other parts of the AS 7510 set of standards as applicable to the type of rolling stock vehicle to which individual vehicles should be assessed against:

(a) AS 7510.1, *Braking Systems – Part 1: Locomotive Rolling Stock*

(b) AS 7510.2, *Braking Systems – Part 2: Hauled Rolling Stock*

(c) AS 7510.3, *Braking Systems – Part 3: Multiple Unit Passenger Rolling Stock*

(d) AS 7510.4, *Braking Systems – Part 4: Infrastructure Maintenance Rolling Stock*

1.2 Normative references

The following documents are referred to in the text in such a way that *some* or all of their content constitutes requirements of this document:

- AS 7451:2023, *Train Integrity*
- AS 7504:2018, *Brake Blocks*
- AS 7504.2:2023, *Brake components – Part 2: Brake discs and pads*
- AS 7510.1:2014, *Braking Systems – Part 1: Locomotive Rolling Stock*
- AS 7510.2:2024, *Braking Systems – Part 2: Hauled Rolling Stock*
- AS 7510.3:2014, *Braking Systems – Part 3: Multiple Unit Passenger Rolling Stock*
- AS 7510.4:2014, *Braking Systems – Part 4: Infrastructure Maintenance Rolling Stock*
- EN 14531-1:2015+A1:2018, *Railway applications – Methods for calculation of stopping and slowing distances and immobilisation braking*
- *AAR Manual of Standards and Recommended Practices – Section E-II: 2007, Electronically Controlled Brake Systems*
- AAR S-9152:2014, *End-of-Train Communications*
- *RISSB Code of Practice – ECP Braking* (2017)

NOTE:

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

1.3 Defined terms and abbreviations

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

1.3.1
AAR
Association of American Railroads

1.3.2
automatic air brake
brake that automatically applies throughout a train when the brake pipe pressure is reduced and releases when the brake pipe pressure is restored

1.3.3
automatic brake
continuous brake system for trains or sets that will self-apply in the event of loss of continuity, including train or set separation

1.3.4
automatic park brake (APB)
park brake able to self-apply in predetermined circumstances without direct human intervention

1.3.5
auxiliary reservoir
automatic air brake reservoir on a vehicle in which is stored compressed air as the primary source specific to that vehicle for a non-relayed brake system or the compressed air that provides the pilot signal for a relayed brake system

1.3.6
brake block
friction element that is forced directly onto the tread of a vehicle wheel for the purpose of braking

1.3.7
brake disc pad
friction element that is forced directly onto a brake disc for the purpose of vehicle braking

1.3.8
brake system
braking equipment of a vehicle or a train

1.3.9
braking energy
energy to be dissipated from the braking surface

1.3.10
braking surface
equipment surface at which vehicle braking can be developed by friction

1.3.11
continuity
continuous connection and the operability of the brake system of a train on all vehicles from the front of the train to its rear

1.3.12
control valve
triple valve
distributor valve
control element of the automatic air brake of a vehicle

1.3.13
DIRN
Defined Interstate Rail Network of Australia

Note 1 to entry: DIRN has been replaced by National Network for Interoperability (NNI).

1.3.14
electronically controlled pneumatic (ECP)
electronically controlled brake equipment that complies with AAR standards

1.3.15
emergency application
application of an automatic air brake that is propagated at a higher rate than the normal rate of a service application and that can result in a rate of retardation that is higher than the normal rate of a service application and not less

1.3.16
electro-pneumatic (EP)
air brake equipment incorporating principal function control by electromagnetically operated valves but not electronically controlled in the manner of ECP brakes

1.3.17
extended range dynamic brakes
extended range dynamic brakes are dynamic brake systems which maximize the constant brake retardation over a wide range of vehicle speeds

1.3.18
friction element
sacrificial pad or block that is forced onto a braking surface to develop a braking force by friction

1.3.19
full service
application of the automatic air brake resulting from service braking to the extent that the maximum normal rate of retardation is achieved

1.3.20
holding brake
application of a predetermined braking effort in an electro-pneumatic brake system for emergency purposes or for parking or securing a train

1.3.21
hydrodynamic brake
braking equipment that enables a train driver to apply variable retardation by the utilisation of the transmission system of a prime-mover fitted with a hydraulic power transmission system

1.3.22
independent brake
straight air brake that is for the primary purpose of holding one or more vehicles stationary and that is operated via the control pipe

1.3.23
infrastructure maintenance rolling stock
hauled or self-propelled rolling stock or equipment intended for use in connection with infrastructure maintenance

1.3.24
National Network for Interoperability (NNI)
set of major interstate freight and passenger rail lines in Australia

Note 1 to entry: At the time of publication, the National Network for Interoperability is mapped and maintained by the National Transport Commission (NTC) and comprises rail networks managed by the following rail infrastructure managers: Queensland Rail (QR), Transport for NSW, Country Regional Network (CRN)), V/Line, Aurizon (Darwin line), Australian Rail Track Corporation (ARTC), ARC Infrastructure and the Public Transport Authority of Western Australia (PTA).

1.3.25
non-air brake
braking equipment such as dynamic, rheostatic, regenerative and hydrodynamic that does not rely on compressed air for its operation

1.3.26
operator
entity responsible by reason of ownership, control or management, for the provision, maintenance or operation of trains, or a combination of these, or a person or body acting on its behalf

1.3.27
passenger rolling stock
hauled or self-propelled rolling stock intended for the transportation of passengers or for use specifically on passenger trains

1.3.28
powered park brake
park brake that can be remote-controlled by a train driver

1.3.29
rail infrastructure manager (RIM)
As defined in Rail Safety National Law.

1.3.30
reference train
train which is representative of configuration to be used on a route, with wagons of the same type and brake configuration, with the maximum number of wagons and maximum load and the same number and type of hauling locomotives

1.3.31
regenerative brake
braking equipment that enables a train driver to apply variable retardation by the utilisation of traction motors to generate electrical energy that is fed into the off-train supply system

1.3.32
retention test
in-service static brake test to ensure that the automatic air brake of each of the last three trailing vehicles of a train will remain applied for a specified time with the brake pipe vented to atmosphere

1.3.33
rolling stock operator (RSO)
As defined by Rail Safety National Law.

1.3.34
service application
application of the stopping brake that is propagated within a train at a normal rate that is pre-determined and that results in a normal rate of retardation according to driver demand

1.3.35
service braking
normal manipulation of the stopping brake during train running

1.3.36
stopping brake
brake equipment or a brake function used to control the speed of, retard, or stop a train in running, including service braking and emergency braking, but excluding parking brake, holding brake, and securing brake functions

1.3.37
straight air brake
non-automatic air brake, direct acting

1.3.38
two pipe brake system
automatic brake system that has a brake pipe and a main reservoir pipe that is connected to the supply reservoir of a relayed brake system

Note 1 to entry: A two pipe brake system is typically used on trains operating on long descending grades

General rail industry terms and definitions are maintained in the ARISO Glossary. Refer to: https://www.ariso.org.au/glossary/

Section 2 Brake system basic requirements

2.1 Brake system operation

Each train shall be equipped with a continuous, automatic, failsafe brake system.

The train braking system shall be designed such that, when operated in accordance with the specified driving methodology, the train responds to brake commands in the predicted manner and can be controlled to remain within the posted speed limits for the route.

2.2 Stopping brake performance

2.2.1 General

The performance of the stopping brake shall meet the network stopping requirements specified by the relevant RIM.

The operator shall obtain the latest stopping requirements applicable to the rolling stock type and route.

Commentary *C2.2.1-1*

A sample of network stopping distance requirements can be found in Appendix A. The information in Appendix A is for information only.

Commentary *C2.2.1-2*

The network stopping requirements are typically derived from signalling system design assumptions for train braking performance and/or known and acceptable braking performance of existing trains.

Commentary *C2.2.1-3*

The network stopping requirements will typically be prescribed in terms of either:

- stopping distance (as a function of initial speed, and accounting for the effects of track gradient); or

- braking deceleration (which can include a braking delay time).

The network stopping requirements can specify different performance criteria for service applications (service braking distance), emergency applications (emergency braking distance) and other braking regimes of the stopping brake.

The performance of the stopping brake shall be assessed, taking into account the maximum train length and worst-case brake system delay and build up time.

Some vehicles in a train may have deceleration rates lower than the minimum deceleration rates, provided that:

(a) the vehicle is compensated by other vehicles having a higher than the minimum deceleration rate in order to run at line speed; and

(b) the stopping distances for the train as a whole do not exceed the requirements defined within the applicable standard(s).

Trains which operate predominately in a particular area or network, and have a braking performance which is consistent with that area or network, but which occasionally operate in an area(s) or network(s) with more stringent signalling stopping distance requirements shall either:

(c) have brake performance suitable for the more stringent area; or

(d) operate under a pre-determined speed restriction approved by the RIM or RSO to ensure that the train is able to stop within the limit of authority .

(e) Procedures that involve operation at lower speeds shall ensure that a full service brake application at a signal shall stop the train within the limit of authority.

2.2.2 Train separation

In the event of train separation, the stopping brake shall automatically initiate an emergency application on each vehicle on each section of the train (excluding those vehicles with cut-out brakes).

Each train should comply with the brake retention requirements of AS 7451

2.2.3 Braking system compatibility

The stopping brake on each vehicle within a train shall be compatible with and respond to brake application and release commands originating from an attached locomotive or other driven vehicle.

2.3 Braking capacity

2.3.1 General

Each train shall have sufficient braking capacity for the routes that it is intended to operate on, including air capacity, thermal capacity and dynamic braking capacity.

2.3.2 Brake system air capacity

The stopping brake shall have sufficient compressed air supply capacity and reservoir storage volume to achieve and maintain the required braking forces whilst providing for normal leakage of compressed air.

Trains which will be operated on routes with long descending grades shall have sufficient compressed air capacity to provide and maintain the required braking forces during cycle braking.

Commentary *C2.3.2*

Trains operating on long descending grades might require a two-pipe braking system to increase the recharge rate of the braking system and allow the system to be able to apply more frequent brake applications than a single-pipe system. Other solutions, such as ECP braking, can also be used to improve brake response and enable repeated brake applications on long descending grades.

2.3.3 Thermal capacity of the friction brake system

The friction brake system (including discs, pads, tread brake blocks, wheels) shall have the capacity to absorb and dissipate the braking energy input from all normal service and emergency braking demands without hazardous damage, and without any reduction in braking performance that would prevent compliance with the stopping distance and other braking performance requirements of this document and applicable network requirements.

In the event that any non-friction brake (e.g. dynamic, regenerative, hydrodynamic) is not available, the automatic (friction) brake acting alone shall have the capacity to meet the applicable emergency braking requirements at the maximum operating speed and worst-case in-service mass, without exceeding allowable thermal limits or causing thermal damage (including overheating, cracking, or material transfer on discs, pads or wheel treads/rims).

The friction brake system shall be capable of withstanding repeated high-energy brake applications and, where applicable to the intended duty, prolonged service braking for speed control on specified ruling gradients without exceeding specified allowable temperature limits or braking power and without exhibiting unacceptable fade or thermal damage.

The brake blocks, brake pads and brake discs fitted to the train shall comply with the applicable performance and validation requirements specified in AS 7504:2018

Compliance with thermal performance requirements shall be demonstrated by analysis and/or test.

See Section 6 for information about the validation of train braking function and performance. Documented service history may be accepted where technical similarity (e.g., mass, speed, brake architecture/materials, cooling, gradients, climate) is demonstrated.

Commentary *C2.3.3-1*

Where analysis, test, or monitoring shows thermal non-compliance, operating restrictions will typically be applied (e.g., reduced speed, mass/length limits, route/gradient exclusions, mandatory dynamic-brake availability, cool-down dwells, ambient-temperature limits or additional braking capacity).

Commentary *C2.3.3-2*

Verification by testing may include trials to the target duty (speed, mass and gradient). Typical assessment criteria during trials can be:

- speed is controlled on extended descending gradients without greater than expected brake demand or occurrence of brake fade; or
- any measured temperatures fall within declared limits; or
- no hazardous damage to the friction elements is visible upon inspection.

2.3.4 Dynamic brake

Dynamic brakes should be utilized to complement the friction brake and ensure safe control of trains (train speed/separation control).

Trains which will be operated on routes with long descending grades should have operational dynamic brakes in accordance with RIM requirements.

Trains which will be operated on routes with long descending grades might require extended range dynamic brakes in accordance with RIM requirements.

Trains operating on substandard tracks should restrict dynamic brake use, including limitation to the maximum dynamic brake force or number of dynamically-braked vehicles, in order to limit longitudinal track forces in accordance with RIM requirements.

Where dynamic brake and friction brake can be applied at the same time on any axle, the brake force shall be controlled within the available adhesion to ensure safe train control.

Where vehicles are not equipped with dynamic brake knock outs, blending or wheel-slide control systems used in combination with friction brake application, the operator/owner shall ensure an appropriate driving methodology is used for safe train control.

2.4 Park brake

2.4.1 Powered park brakes

When commanded by the driver, the powered park brake on each vehicle equipped with a powered park brake shall apply to achieve the required holding performance.

When commanded by the driver, the powered park brake on each vehicle equipped with a powered park brake shall release to allow unrestricted movement of the vehicle.

Section 3 Calculation of braking system performance

3.1 Stopping brake

3.1.1 General methods

The stopping brake performance should be calculated in accordance with the methodologies specified in *EN 14531-1:2015+A1:2018*, or equivalent.

Commentary *C3.1.1*

Appendix B of AS 7510.2:2024 contains an example braking calculation including methodologies for assessing stopping brake performance based on the standard EN 14531-1

3.1.2 Assessment conditions

Stopping performance assessments for braking systems incorporating disc brakes shall be based on new wheel diameters and fully worn wheel diameters.

The network stopping requirements, including brake mode and loading conditions, should be clearly specified in the RIM's network stopping requirements.

Stopping performance assessments shall assess loading appropriate for the service, which can include partially loaded, unloaded and fully loaded.

The performance of the stopping brake shall be assessed, taking into account the maximum train length and worst-case brake system delay and build up time.

The effects of wheelset and drivetrain rotational inertia may be neglected when assessing stopping performance.

The effects of rolling resistance may be neglected when assessing stopping performance.

The effects of residual tractive effort, that is any tractive effort applied momentarily prior to being cut out when brakes are applied, may be neglected when assessing stopping performance.

3.2 Park brake

3.2.1 General methods

It shall be demonstrated that trains can be held by a specified number of applied parking brakes without moving or sliding.

Non-operational parking brakes shall not be included in the braking performance calculations, where permitted by network requirements.

The park brake holding performance should be calculated in accordance with the methodologies specified in EN 14531-1:2015+A1:2018, or equivalent.

3.2.2 Assessment conditions

The parking brake holding force shall assess the maximum gradient that the train will be held on.

Park brake calculations shall determine the required holding force to hold the train in all loading conditions, within the adhesive limits of the park brakes applied.

Loading conditions to be considered in parking brake calculations can include unloaded, fully loaded, and partially loaded, as applicable.

The park brake holding performance shall be calculated with the maximum number of non-operational park brakes allowed by the minimum operating standards.

The park brake holding performance assessment shall assume that the park brake equipment that is functioning is functioning correctly.

The park brake shall have an appropriate safety factor to account for equipment tolerances, the range of friction material performance, ambient and equipment temperatures, and potential equipment failures and isolations.

The effect of wind force may be neglected when assessing park brake performance.

The effect of rolling resistance may be neglected when assessing park brake performance.

Section 4 Automatic brake control system

4.1 General

Every train in operation shall be equipped with an automatic brake that has continuity and that provides consistent utilization during train running.

The automatic brake control system may provide for electrical control of braking, for example, EP braking systems in passenger trains and ECP braking systems in freight trains.

4.2 Automatic air-braked trains

The standard brake pipe pressure of automatic air-braked trains shall be 500 kPa.

The control valve of each of the vehicles making up an air-braked train shall be compatible with the automatic brake control systems of the other vehicles in the train.

Operation of the control valve of each vehicle in an air-braked train shall ensure brake pipe signal propagation and response of the automatic brake control systems of all other vehicles in the train, such that uniform brake application and release is achieved.

The train length shall not exceed the maximum length permitted by the braking system, assessing the brake response time and propagation.

The braking system of each vehicle in the train shall comply with the requirements of AS 7510.1:2014, AS 7510.2:2024 or AS 7510.3:2014 as applicable to the type of vehicle.

The control system shall be designed so that an automatic train brake application will bring the train to a complete stop if there is a failure of the brake pipe or emergency brake control system.

4.3 Venting devices

If a train is made up of vehicles equipped with emergency venting devices such as AAR vent valves to achieve braking performance in accordance with network requirements, then the train should be equipped with sufficient vent valves to ensure the reliable activation of the emergency brake throughout the train.

> Commentary *C4.3*
>
> Venting devices assist with the propagation of an emergency brake signal by rapidly exhausting the brake pipe locally on the vehicle.

4.4 Brake pipe continuity

All trains shall have a means to inform the driver of the following:

(a) Train partings.

(b) Excessive brake pipe leakage.

(c) Low level of charge at the rear of the train.

If fitted, AAR End of Train devices shall comply with AAR S-9152:2014, or equivalent.

Commentary *C4.4*

The associated risks are increased for longer trains, especially over 1,000 m.

Separated wagons which are stationary on the track are a high risk in areas without track circuits.

Methods for addressing these risks include:

(a) devices which communicate brake pipe pressure at the end of the train;

(b) vent valves which force an emergency application; and

(c) alarms which will highlight unusual flow conditions.

AS 7451 provides further requirements and guidance regarding the end of train devices.

4.5 ECP-braked trains

For ECP-braked trains, the standard brake pipe pressure shall be 500 kPa.

The car control device (CCD) of each of the vehicles making up an ECP-braked train shall be compatible with the ECP brake control systems of the other vehicles in the train.

The installation of an ECP brake system on an ECP-braked train shall be in conformance with all applicable requirements of the *AAR Manual of Standards and Recommended Practices Section E-II* (AAR 2007) as amended by the *RISSB Code of Practice – ECP Braking* (2017). Where inconsistencies occur, the RISSB Code of Practice takes precedence.

Section 5 Brake system couplings between vehicles in trains

With the exception of vehicles coupled together with fixed drawbars or couplers incorporating pneumatic connections, pneumatic couplings between vehicles shall be designed to provide connections that are secure but easily parted without damage in the event of train separation.

Brake system couplings between each vehicle in the train shall comply with the requirements of AS 7510.1:2014, AS 7510.2:2024 or AS 7510.3:2014 as applicable to the type of vehicle or have been proven to be compatible in service.

Section 6 Validation of braking function and performance

6.1 General

For each new train configuration on a route, performance of the service brake shall be verified by testing and calculation as described in Clause 6.3.

The RSO shall maintain vehicles in accordance with a maintenance plan such that any degradation in condition does not result in non-compliant train braking performance.

The RSO shall perform in-service tests in accordance with AS7451:2023 to ensure basic functionality of the brake system.

Results shall be documented and preserved.

6.2 Long steep descents

For routes with long, steep descents nominated by RIMs, the following additional requirements apply, with the exception of ECP-equipped trains which need not comply with items (e) and (f).

(a) The train shall be driven in accordance with an established, written procedure for controlling speed using dynamic and air brakes. This procedure should include advice on target speeds and BP reductions, with guidance on monitoring the state of recharge. A brake pipe reduction of no more than about 2/3 should be required to control the train under normal circumstances.

(b) An emergency application shall be able to stop the train from line speed.

(c) For tread brakes, the braking power per wheel averaged over the descent should not exceed 25 kW. Higher braking power may be used if evidence can be provided that this will not degrade the wheel or the brake block.

(d) The speed at which 25 kW (or higher thermal limit) will be exceeded shall be determined, and this shall be included in the documentation for the driving procedure, along with the action(s) to be taken.

(e) When the train speed falls well below line speed on the grade, the speed at which the automatic brake can be released shall be determined and validated, such that all auxiliary reservoirs in the train will recharge sufficiently before another brake application is required to control the speed. Note that an incomplete recharge can control the train but with insufficient margin.

(f) The time for the auxiliary reservoir on the last wagon on the reference train to recharge after a release from the nominated reduction to the minimum required pressure shall be determined by a type test or from other evidence such as event log data.

(g) During the recharge test, the compressors shall run at the speed which will apply under braking conditions. This may be at engine idle speed for mechanically driven compressors.

(h) The unavailability of a compressor should be grounds to fail a train, unless the recharge test has demonstrated that this condition is acceptable.

(i) The number of vehicles which are allowed to have brakes cut-out or dynamic brakes not available must be established for the reference train.

(j) Where locomotives are different to the reference configuration, compressor operation and dynamic brake performance shall be at least the equivalent.

6.3 Train performance testing

For each new train configuration on a route, a type test of the stopping distance on track with a known grade shall be performed to demonstrate compliance with the required stopping curve and to validate the braking model. This shall be documented as the reference configuration and preserved to assist with calculation for validation activities.

The reference train tested shall reflect the configuration which will operate. Factors to be controlled are:

(a) number and type of locomotives on the train;

(b) number of vehicles on the train and their loading condition;

(c) number of wagons cut out;

(d) gradient on which the train is tested;

(e) brake application type (e.g., service, emergency); and

(f) whether locomotive brakes are bailed off.

Changes in marshalling order and wagon type within a configuration need not be considered unless it is known that wagons with lower braking performance are being introduced to the consist.

Calculations using a validated model may be used to demonstrate compliance for cases not tested, for example with different loads or grades. Propagation and filling times and the empty/load changeover points used in the model shall be based on test data.

6.4 In-service static brake tests

6.4.1 Multiple unit passenger trains

Multiple unit passenger trains must be subjected to in-service static brake tests to validate their brake system function and performance. Multiple unit passenger trains should be subjected to in-service static brake tests in accordance with AS 7510.3

Commentary *C6.4.1*
These tests are typically conducted according to specific procedures developed by the RSOs. Such procedures can vary by location to accommodate network-specific requirements or operational contexts.

6.4.2 Locomotive-hauled trains

The brake system of a locomotive-hauled train shall be subjected to a full static brake test at intervals of time or distance defined by the operator.

Static brake testing should be performed in accordance with AS 7451

For in-service locomotive-hauled trains, the brake system shall be subjected to a full static brake test prior to its departure from its point of origin.

An in-service static brake test may be performed in conjunction with a full train inspection, including a mechanical inspection of each vehicle to ensure train integrity.

A static brake test of the brake system of a train shall be conducted in accordance with network standards.

The static brake test of a train's brake system shall demonstrate that the brake system functions and performs in accordance with applicable network standards when the train is placed in service.

Corrective action followed by retesting shall be carried out if train brake system function or static performance specifications are not met.

Changes to trains whilst enroute shall undergo a partial in-service static train test to confirm brake integrity of attached vehicles and brake continuity throughout the train.

6.4.3 Locomotive hauled trains – Full in-service static brake test conditions

A locomotive-hauled train should be subjected to a full in-service static brake test:

(a) upon its entry into service; or

(b) following re-marshalling of the train.

6.4.4 Locomotive hauled trains – Partial in-service static brake test conditions

A locomotive-hauled train should be subjected to a partial in-service static brake test:

(a) following the attachment of vehicles to the train;

(b) following the detachment of vehicles from the train;

(c) following the coupling of locomotives to the train;

(d) following the uncoupling of locomotive(s) from the train;

(e) following train separation; or

(f) following the train being left unattended for an extended period of time, as defined by the RIM/RSO (refer to AS 7451:2023, Section 4 and Appendix A).

6.4.5 Locomotive hauled train – Full in-service static brake test requirements

A full in-service static brake test of a locomotive hauled train shall verify:

(a) that all brake hose couplings are securely connected;

(b) that all brake hose end cocks are fully opened;

(c) the brake pipe continuity throughout the train;

(d) that all cut-in brakes on the train apply upon driver command;

(e) that all cut-in brakes on the train release upon driver command;

(f) that all brake system parts are correctly installed;

(g) that all brake system equipment is securely fastened;

(h) that brake rigging slack adjusters maintain brake cylinder piston travels within their specified limits;

(i) that scheduled maintenance records confirm compliance with documented maintenance intervals;

(j) that at least 90% of the train's bogies have fully functional brakes;

(k) that vehicle brake equipment compressed air reservoirs are fully charged to their specified pressure;

(l) that friction element residual life meets the minimum service life criteria;

(m) that each wheel tread is free of defects exceeding specified acceptance limits;

(n) that brake cylinder piston travels are within their specified limits;

(o) for a freight vehicle fitted with manual grade control equipment, that the equipment is set to the correct operational position;

(p) for a freight vehicle fitted with manual load compensation equipment, that the equipment is set to the correct operational position;

(q) that the brake pipe pressure achieves the standard brake pipe pressure of 500 kPa within the required tolerance;

(r) that the brake pipe compressed air leakage is less than or equal to 35 kPa/minute;

(s) that vehicle brakes remain applied for the specified minimum duration when no release command is present;

(t) that all park brakes are released; and

(u) that the automatic brake of the last three (3) trailing vehicles remains applied for the specified retention test duration, unless those vehicles are fitted with automatic park brakes.

For ECP trains, a sequencing test shall be performed as per *RISSB Code of Practice - ECP Braking* (2017).

6.4.6 Locomotive hauled train – Partial in-service static brake test requirements

A partial in-service static brake test shall validate train brake system function and static performance and confirm that:

(a) all brake hose couplings are correctly coupled and appropriate end cocks are fully opened for continuity;

(b) any attached vehicles have had their brakes checked against the relevant requirements for the full in-service static train test set out in Clause 6.4.5;

(c) retention test requirements are met; and

(d) all cut-in brakes on the train to the rear of any brake pipe separation apply and release as demanded by the driver.

Appendix A Network Stopping Requirements (Informative)

The information in Appendix A are samples of network requirements and are for information only. The relevant RIM should be contacted to ensure the latest stopping requirements are obtained for the type of rolling stock and the route in question.

A.1 ARTC

Source (at time of publication):

Rolling Stock Signalling Interface, ESS-32-01, Version 1.0, 15th June 2023

Appendix D – Train Braking Tables

A.1.1 ARTC GW-10 Loaded Coal Train

Appendix Table A.1.1 ARTC GW-10 Loaded Coal – Train Stopping Distance

GW-10 Loaded Coal Train

STOPPING DISTANCE TABLE

(distances in metres)

Full-service brake application applied to locomotives and train until point of stop

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	100	60	40	33
Speed	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
50km/h	238	266	320	377	498	684	873	1270	1745
60	333	369	441	515	668	902	1146	1682	2363
65	385	426	507	590	760	1022	1299	1920	2742
70	441	487	576	669	857	1151	1465	2185	3179
75	500	551	651	753	961	1288	1644	2480	3691
80	562	618	728	841	1070	1435	1838	2808	4301

A.1.2 ARTC GW-11 Empty Coal Train

Appendix Table A.1.2 ARTC GW-11 Empty Coal – Train Stopping Distance

GW-11 Empty Coal Train
STOPPING DISTANCE TABLE

(distances in metres)

Full service brake application applied to locomotives and train until point of stop

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	100	60	40	33
Speed	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
50km/h	207	225	261	295	361	447	521	634	722
60	284	308	353	396	477	581	667	800	900
65	327	354	403	451	539	652	745	886	994
70	372	402	456	508	604	726	826	977	1092
75	419	452	511	568	671	802	909	1070	1194
80	468	504	569	630	741	882	995	1167	1300

A.1.3 ARTC GW-16 Superfreighter

Appendix Table A.1.3 ARTC GW-16 Superfreighter – Train Stopping Distance

GW-16 Superfreighter
For secondary lines with passing loops less than 900 metres
STOPPING DISTANCE TABLE

(distances in metres)

Full service brake application applied to locomotives and train until point of stop.

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	100	60	40	33
Speed	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
50km/h	197	214	245	275	332	409	480	603	714
60	272	293	333	372	444	545	637	800	951
70	356	383	432	480	572	700	818	1032	1233
80	449	482	543	602	716	876	1027	1302	1567
90	552	592	666	738	877	1077	1265	1616	1962
100	666	714	802	889	1058	1303	1538	1982	2430
105	727	779	875	971	1156	1426	1687	2186	2697
110	791	847	952	1056	1260	1558	1847	2404	2969
115	857	918	1033	1146	1369	1696	2014	2624	3247

A.1.4 ARTC GW-30 Superfreighter

Appendix Table A.1.4 ARTC GW-30 Superfreighter – Train Stopping Distance

GW-30 Superfreighter
for lines with Loops less than 1300 metres
STOPPING DISTANCE TABLE

(distances in metres)

Full service brake application applied to locomotives and train until point of stop

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	100	60	40	33
Speed	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
50km/h	230	254	302	352	452	598	732	971	1195
60	319	351	413	476	588	781	945	1244	1530
70	420	461	538	616	768	983	1184	1556	1920
80	534	583	677	760	951	1208	1452	1912	2376
90	659	718	829	939	1151	1457	1753	2321	2909
100	795	864	994	1121	1370	1733	2089	2789	3524
105	868	942	1082	1218	1487	1882	2272	3043	3833
110	943	1023	1172	1319	1609	2039	2466	3294	4147
115	1021	1107	1267	1424	1737	2203	2661	3548	4471

A.1.5 ARTC GW-40 Superfreighter

Appendix Table A.1.5 ARTC GW-40 Superfreighter – Train Stopping Distance

GW-40 Superfreighter
for Defined Interstate Rail Network
STOPPING DISTANCE TABLE

(distances in metres)

Full service brake application applied to locomotives and train until point of stop

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	100	60	40	33
Speed	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
50km/h	240	267	322	379	500	681	852	1158	1450
60	333	370	441	514	665	885	1091	1467	1834
70	441	486	575	666	848	1110	1357	1818	2280
80	560	616	724	833	1048	1358	1653	2218	2798
90	692	759	887	1015	1267	1630	1983	2672	3404
100	837	915	1064	1213	1504	1930	2351	3193	4063
105	914	998	1158	1317	1630	2091	2550	3458	4392
110	994	1084	1255	1426	1761	2260	2758	3725	4728
115	1076	1173	1357	1538	1898	2435	2966	3997	5073

A.1.6 ARTC GW-50 3/4 Loaded Container

Appendix Table A.1.6 ARTC GW-50 3/4 Loaded Container – Train Stopping Distance

GW-50 3/4 Loaded Container
for lines with standing room for 1800m long trains
STOPPING DISTANCE TABLE (distances in metres)

Full service brake application applied to locomotives and train until point of stop

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	100	60	40	33
Speed	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
50km/h	248	279	340	407	548	772	989	1386	1768
60	347	387	467	552	730	1001	1260	1740	2215
70	459	509	611	714	932	1253	1559	2138	2730
80	585	647	769	895	1152	1527	1888	2588	3327
90	725	799	943	1093	1390	1827	2254	3100	4023
100	876	963	1134	1306	1649	2154	2658	3673	4714
105	956	1052	1234	1419	1787	2329	2876	3954	5067
110	1041	1142	1339	1535	1928	2514	3100	4240	5427
115	1128	1238	1447	1656	2075	2702	3322	4531	5798

A.1.7 ARTC HSP – 160 High Speed Passenger Train

Appendix Table A.1.7 ARTC HSP – 160 High Speed Passenger – Train Stopping Distance

HSP – 160 High Speed Passenger Train
STOPPING DISTANCE TABLE

(distances in metres)

High speed passenger trains that operate up to 160km/h

Full service brake application applied to locomotives and train until point of stop

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	100	60	40	33
Speed	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
50km/h	100	103	110	117	130	146	159	181	198
60	138	144	155	164	182	204	223	254	279
70	184	192	206	220	244	276	303	345	380
80	238	249	268	285	318	361	397	455	503
90	300	314	338	362	405	460	508	585	650
100	370	387	419	449	503	576	637	738	822
110	448	470	510	547	616	706	784	913	1021
120	535	561	610	656	740	851	949	1110	1246
130	629	661	719	774	876	1011	1130	1329	1495
140	731	769	855	903	1023	1185	1328	1565	1768
150	841	885	965	1042	1183	1375	1543	1823	2067
160	960	1011	1104	1193	1376	1581	1778	2111	2399

A.1.8 ARTC MSP – 120 Self Propelled Passenger Train

Appendix Table A.1.8 ARTC MSP – 120 Self Propelled Passenger – Train Stopping Distance

MSP – 120 Self Propelled Passenger Train
STOPPING DISTANCE TABLE

(distances in metres)

Self-propelled passenger trains that operate up to 120km/h

Full-service brake application applied to locomotives and train until point of stop

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	100	60	40	33
Speed	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
50km/h	96	100	110	117	134	155	173	204	231
60	137	144	157	170	193	225	253	301	343
70	186	196	215	232	265	310	350	417	477
80	243	257	281	304	348	408	462	554	635
90	307	324	356	386	443	520	590	709	815
100	379	400	439	477	548	644	732	882	1016
110	457	483	530	577	663	781	887	1070	1233
120	542	573	630	683	786	927	1053	1270	1464

A.2 TfNSW Metropolitan Heavy Rail Network

Source (at time of publication):

Modified GW 16, Modified GW 30, Modified GW 40

TS 04068 (T HR RS 00830 ST)

RSU Appendix C – Brake Performance Curves

Revision 1.0

3rd March 2022

RSU 641

TS 04058 RSU 600 Series - Minimum Operating Standards for Rolling Stock - Multiple Unit Train Specific Interface Requirements (T HR RS 00600 ST)

Version 2.0

08 August 2019

A.2.1 TfNSW - Modified GW 16

Appendix Table A.2.1 TfNSW – Modified GW 16 – Train Stopping Distance

Modified GW-16

STOPPING DISTANCE TABLE (distances in metres) **(Includes 15 % allowance)**

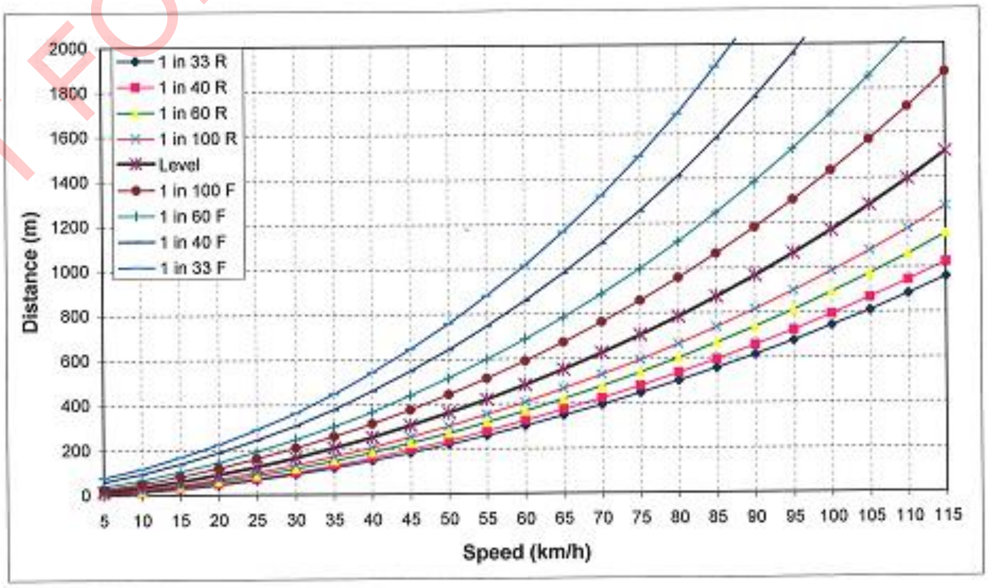
3/4 LOADED SUPERFREIGHTER - 2 x 81 class + 34 wagons for a brake pipe length of 1.15 x train length

NOTES:
Train mass = 2010 tonnes (excluding locomotives)
Train length = 900 metres (including locomotives)
Brake pipe length = 1035 metres (1.15 x train length)
Full service brake application applied to locomotive and train to point of stop
Results based on interpolation of GW-16 stopping distance data

	Rising			GRADE (1 in X)				Falling	
	33	40	60	100	Level	-100	-60	-40	-33
Speed km/h	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
5	2	3	5	6	15	26	38	60	77
10	13	15	18	24	36	51	67	94	117
15	26	30	37	44	60	83	104	138	167
20	44	49	60	70	90	118	144	187	223
25	66	72	85	99	124	161	191	243	288
30	90	99	116	132	163	207	244	306	361
35	118	129	150	169	207	258	301	378	446
40	150	162	186	209	254	313	366	460	542
45	183	198	227	254	305	375	438	547	645
50	220	237	270	301	361	442	515	642	758
55	259	279	317	353	420	513	598	745	881
60	302	325	367	407	484	590	687	858	1015
65	347	373	420	466	552	673	783	981	1164
70	394	423	476	527	624	761	887	1112	1324
75	445	477	536	593	703	856	998	1256	1500
80	498	534	599	662	784	957	1118	1410	1690
85	554	593	666	736	872	1065	1245	1578	1899
90	613	657	736	814	965	1180	1383	1760	2125
95	675	722	811	897	1064	1302	1530	1954	2372
100	741	792	889	983	1167	1433	1686	2164	2642
105	808	866	971	1074	1278	1571	1854	2391	2936
110	881	942	1057	1171	1394	1717	2031	2635	3245
115	956	1022	1148	1272	1516	1872	2220	2882	3557

Calculated from STOPDIST program
Parameters used (speed km/h decel m/s/s) (1,0.83) (45,0.63) (115,0.49) (,)
Rolling Resistance - included in decelerations
Brake delay - 0 seconds Average brake cylinder build up time - 26.5 seconds

Bryan Turnbull
Principal Engineer Rolling Stock
RailCorp
Date: ########



A.2.2 TfNSW Modified GW 30

Appendix Table A.2.2 TfNSW Modified GW 30 – Train Stopping Distance

Modified GW-30

STOPPING DISTANCE TABLE (distances in metres) **(Includes 15 % allowance)**

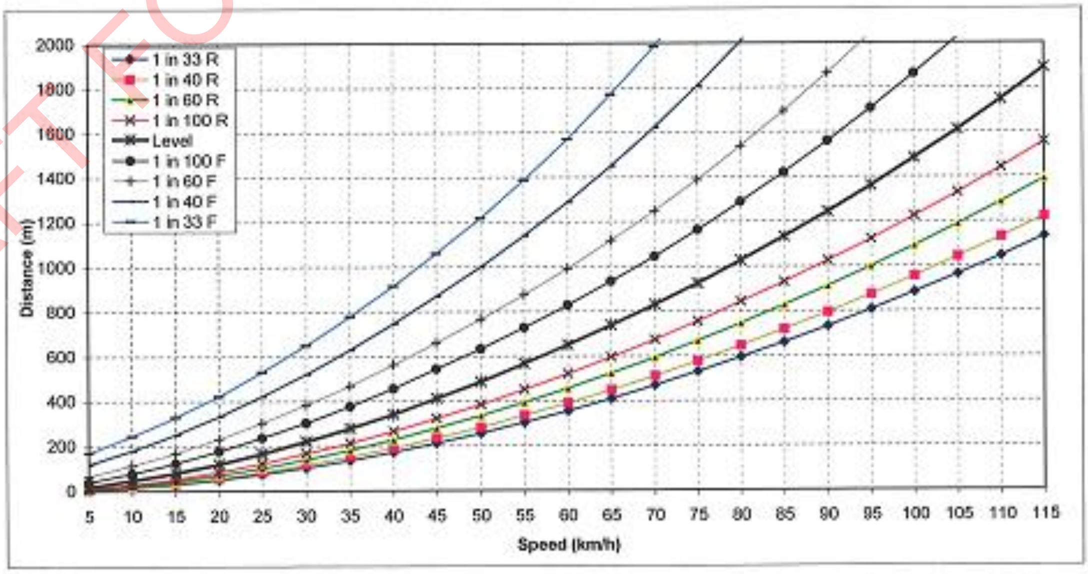
3/4 LOADED SUPERFREIGHTER - 4 x 81 class + 46 wagons for a brake pipe length of 1.15 x train length

NOTES: Train mass = 2760 tonne (excluding locomotives)
Train length = 1280 metres (including locomotives)
Brake pipe length = 1472 metres (1.15 x train length)
Full service brake application applied to locomotive and train to point of stop
Results based on interpolation of GW-30 stopping distance data

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	-100	-60	-40	-33
Speed km/h	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
5	3	3	6	7	18	40	66	118	169
10	14	16	21	28	46	77	112	179	244
15	29	33	43	53	80	122	168	251	328
20	49	55	70	85	120	176	231	331	422
25	74	83	101	122	167	236	302	421	529
30	102	115	139	166	220	302	382	520	647
35	135	151	181	213	278	376	467	629	777
40	172	190	227	266	342	455	561	746	913
45	212	235	278	323	412	542	660	868	1059
50	256	282	334	384	486	632	764	998	1216
55	304	335	392	451	566	727	874	1138	1386
60	355	389	455	521	649	827	991	1288	1570
65	409	448	522	595	736	933	1116	1449	1769
70	468	511	592	673	828	1044	1248	1622	1984
75	529	576	666	754	923	1163	1388	1806	2216
80	593	645	744	841	1026	1288	1538	2004	2468
85	660	718	825	929	1132	1420	1695	2216	2739
90	731	794	910	1024	1243	1559	1864	2443	3035
95	805	873	998	1121	1360	1707	2041	2686	3356
100	882	954	1090	1224	1484	1862	2231	2949	3703
105	963	1041	1187	1329	1611	2025	2431	3228	4046
110	1045	1129	1286	1441	1746	2198	2644	3506	4394
115	1132	1221	1390	1557	1887	2377	2859	3789	4753

Calculated from STOPDIST program
Parameters used (speed km/h,decel m/s/s) (1,0.83) (45,0.63) (115,0.49) (,)
Rolling Resistance - included in decelerations
Brake delay - 0 seconds Average brake cylinder build up time - 49 seconds

Bryan Turnbull
Principal Engineer Rolling Stock
RailCorp
Date: 14/09/2005



A.2.3 TfNSW Modified GW 40

Appendix Table A.2.3 TfNSW Modified GW 40 – Train Stopping Distance

Modified GW-40

STOPPING DISTANCE TABLE (distances in metres) **(Includes 15 % allowance)**

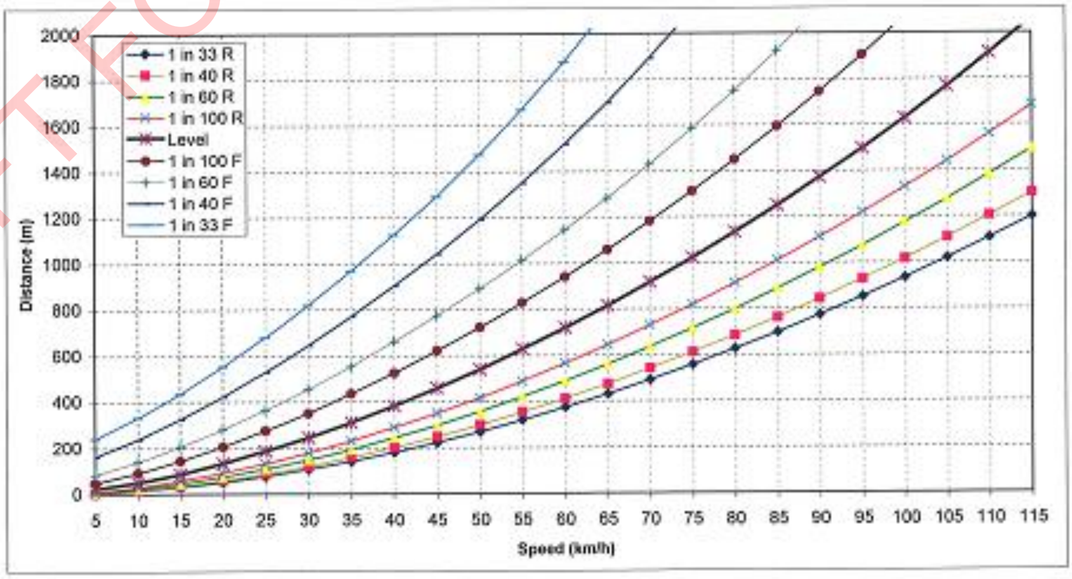
3/4 LOADED SUPERFREIGHTER - 5 x 81 class + 58 wagons for a brake pipe length of 1.15 x train length

NOTES:
Train mass = 3480 tonne (excluding locomotives)
Train length = 1600 metres (including locomotives)
Brake pipe length = 1840 metres (1.15 x train length)
Full service brake application applied to locomotive and train to point of stop
Results based on interpolation of GW-40 stopping distance data

	Rising			GRADE (1 in X)					Falling
	33	40	60	100	Level	-100	-60	-40	-33
Speed km/h	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance	Distance
5	3	3	6	8	23	48	84	162	239
10	14	16	23	29	51	92	139	237	331
15	30	34	45	58	87	144	205	324	435
20	51	59	74	92	133	205	279	421	551
25	76	86	108	132	186	274	363	527	678
30	107	120	147	178	245	350	454	644	819
35	141	158	192	230	310	434	553	770	967
40	179	200	243	288	381	523	660	902	1124
45	222	247	297	350	458	621	773	1041	1291
50	269	298	356	416	540	721	890	1189	1472
55	319	353	420	488	627	828	1013	1348	1668
60	373	412	488	565	719	940	1144	1517	1877
65	431	475	559	645	815	1058	1283	1697	2102
70	492	542	635	729	917	1181	1429	1891	2346
75	557	611	715	819	1022	1312	1585	2096	2609
80	626	684	798	912	1133	1448	1749	2316	2892
85	697	762	887	1010	1249	1593	1922	2552	3200
90	772	843	978	1111	1371	1743	2106	2804	3534
95	851	927	1073	1217	1496	1903	2299	3074	3895
100	933	1015	1173	1327	1628	2070	2505	3363	4260
105	1018	1107	1275	1441	1766	2246	2721	3660	4623
110	1106	1202	1382	1559	1911	2431	2950	3954	4993
115	1197	1301	1493	1684	2062	2624	3179	4254	5373

Calculated from STOPDIST program
Parameters used (speed km/h,decel m/s/s) (1,0.8) (45,0.63) (115,0.49) (,)
Rolling Resistance - included in decelerations
Brake delay - 0 seconds Average brake cylinder build up time - 60 seconds

Bryan Turnbull
Principal Engineer Rolling Stock
RailCorp
Date 14/09/2005



A.2.4 TfNSW RSU 641

Appendix Table A.2.4 TfNSW RSU 641 – Maximum Stopping Distances for New Multiple Unit Trains

Speed (km/h)	Full service brake application (m)	Emergency brake application (m)
0	0	0
10	7	10
20	22	27
30	44	50
40	74	80
50	113	115
60	160	155
70	215	207
80	278	265
90	349	330
100	428	400
110	516	480
115	565	521
120	620	565
130	720	657
140	834	755
150	955	861
160	1085	974

A.3 NSW Country Regional Network (CRN)

Source (at time of publication)

Maximum stopping distances for new multiple unit trains

CRN RS 004, MINIMUM OPERATING REQUIREMENTS FOR MULTIPLE UNIT TRAINS

Version: 1.0, 30th January 2022

GW30

TS 01273 (CRN SD 003), Signalling Design Principles – Braking Distance

Version 2.0, 30th January 2022

A.3.1 CRN RS 004

Appendix Table A.3.1 Maximum Stopping Distances for New Multiple Unit Trains

	Maximum stopping distance (metres)	
Speed (km/h)	Full service brake application	Emergency brake application
0	0	0
10	7	10
20	22	27
30	44	50
40	74	80
50	113	115
70	215	207
	Maximum stopping distance (Cont'd) (metres)	
Speed (km/h)	Full service brake application	Emergency brake application
80	278	265
90	349	330
100	516	480
115	565	521
120	620	565
130	720	657

A.3.2 CRN GW30

Appendix Table A.3.2 CRN GW 30 – Train Stopping Distance

GW-30

STOPPING DISTANCE TABLE (INCLUDES 15 % ALLOWANCE)

3/4 LOADED SUPERFREIGHTER - 4 x 81 class + 46 NQJW wagons

NOTES: Train mass = 2760 tonnes (excluding locomotives)
Train length = 1280 metres (including locomotives)
Brake pipe length = 1660 metres (bifurcated brake pipe)
Full service brake application applied to locomotives and train to point of stop
Results based on tests carried out in June 1991

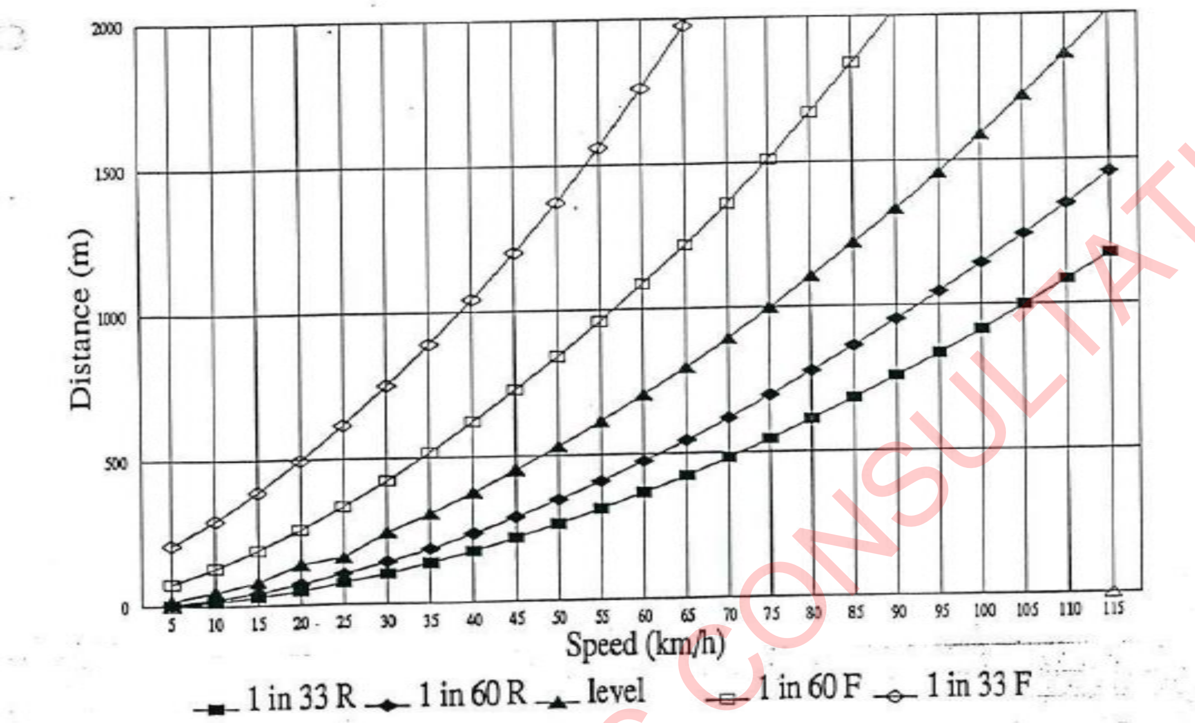
	Rising			GRADE (1 in X)				Falling	
	33	40	60	100	level	-100	-60	-40	-33
SPEED (km/h)									
5	3	3	6	8	18	46	75	141	207
10	14	16	23	29	48	85	128	210	291
15	29	34	44	55	80	135	189	0	388
20	49	58	72	89	139	192	259	383	496
25	75	85	106	129	162	258	337	483	616
30	105	117	144	174	246	330	423	593	751
35	139	155	187	223	308	409	519	715	892
40	176	197	236	278	377	497	622	842	1042
45	218	243	290	339	452	590	729	974	1202
50	264	292	347	405	531	688	842	1117	1374
55	314	346	409	474	615	790	960	1268	1559
60	367	404	475	547	704	898	1087	1431	1760
65	423	465	545	627	797	1012	1220	1603	1976
70	483	530	619	708	895	1130	1362	1789	2208
75	546	599	697	796	998	1257	1511	1986	2460
80	614	670	779	887	1105	1389	1670	2199	2732
85	684	746	865	981	1218	1530	1838	2426	3026
90	758	826	953	1080	1335	1676	2016	2669	3345
95	835	908	1046	1182	1458	1831	2203	2929	3692
100	914	994	1143	1289	1587	1993	2402	3207	4053
105	998	1083	1244	1401	1722	2164	2613	3499	4408
110	1084	1176	1348	1517	1862	2346	2836	3788	4769
115	1174	1273	1457	1638	2009	2533	3060	4081	5142

Calculated from STOPDIST programme
Parameters used (speed km/h, decel m/s/s) - (1 , .83), (45 , .63), (115 , .49)
Brake delay - 0 seconds Brake cylinder build up time - 56 seconds

SRA of NSW FreightRail Brake Engineers
Date: 29-Jun-93

A.3.3 CRN GW30

Appendix Table A.3.3 CRN GW 30 – Train Stopping Distance



A.4 Queensland Rail – Narrow Gauge

Source (at time of publication)

MD-10-194, QUEENSLAND RAIL SEMS Standard – Interface Standards

(Version 6.2) 19/09/2024

Operating area	Stopping distance category
Recommended maximum decelerating rate of a vehicle or train	A
North coast freight train	F
Brisbane suburban area passenger train	P
Central Queensland coal train	C
Mt Isa line	I
Cobarra nickel	N
South west corridor (grain and coal west of Ipswich to McAlister and Goondiwindi) and central west freight trains.	S
Tablelands line	T
Far south western lines	W

A.4.1 Queensland Rail – Tangent Level Track

Appendix Table A.4.1 Queensland Rail – Tangent Level Track – Train Stopping Distance

Initial Speed (km/h)		5	10	15	20	25	30	35	40	45	50	55	60
Braking Curve	A	-	-	-	11	17	25	34	44	56	69	83	99
	P	-	-	-	40	54	71	89	109	131	154	180	207
	F	-	-	-	84	119	159	205	257	314	377	446	520
	I	-	-	-	193	254	319	388	463	542	626	715	808
	N	-	-	-	133	180	232	290	353	422	496	576	661
	S	-	-	-	140	189	243	304	370	442	519	602	691
	T	-	-	-	117	161	210	265	325	392	463	541	624
	W	-	-	-	129	175	227	284	348	417	491	571	657

Initial Speed (km/h)		65	70	75	80	85	90	95	100	105	110	115	120
Braking Curve	A	116	135	155	176	199	223	249	276	304	333	364	397
	P	236	268	300	335	372	410	450	492	536	582	630	679
	F	600	685	772	864	960	1062	1168	1280	1396	1518	-	-
	I	906	1009	1117	1229	1346	1468	-	-	-	-	-	-
	N	752	848	950	1057	1170	1288	-	-	-	-	-	-
	S	785	885	991	1102	1219	1341	-	-	-	-	-	-
	T	713	807	-	-	-	-	-	-	-	-	-	-
	W	749	846	949	1057	1172	1291	-	-	-	-	-	-

Initial Speed (km/h)		125	130	135	140	145	150	155	160	165	170		
Braking Curve	A	431	466	502	540	579	620	662	705	750	796		
	P	797	858	921	986	1053	1123	1195	1269	1345	1423		

A.4.2 Queensland Rail – Tangent Down 1 in 50 Track

Appendix Table A.4.2 Queensland Rail – Tangent Down 1 in 50 Track – Train Stopping Distance

Initial Speed (km/h)		5	10	15	20	25	30	35	40	45	50	55	60
Braking Curve	A	-	-	-	13	20	29	39	51	65	80	97	115
	P	-	-	-	43	59	78	99	122	148	175	205	238
	F	-	-	-	137	197	267	348	438	539	650	771	902
	I	-	-	-	229	309	398	496	604	721	846	981	994
	N	-	-	-	188	266	356	549	574	701	841	994	1158
	S	-	-	-	201	285	318	492	615	752	902	1066	1243
	T	-	-	-	179	257	348	453	571	702	847	1005	1176
	W	-	-	-	190	271	365	472	593	727	874	1035	1209

Initial Speed (km/h)		65	70	75	80	85	90	95	100	105	110	115	120
Braking Curve	A	135	157	180	205	232	260	289	320	353	388	424	462
	P	272	309	348	389	433	479	527	577	629	684	741	801
	F	1044	1196	1358	1530	1713	1905	2108	2321	2545	2778	-	-
	I	1279	1441	1613	1794	1983	2182	-	-	-	-	-	-
	N	1335	1524	1726	1940	2167	2406	-	-	-	-	-	-
	S	1433	1636	1853	2083	2326	2583	-	-	-	-	-	-
	T	1360	1558	-	-	-	-	-	-	-	-	-	-
	W	1397	1597	1811	2039	2279	2533	-	-	-	-	-	-

Initial Speed (km/h)		125	130	135	140	145	150	155	160	165	170		
Braking Curve	A	501	542	584	628	674	721	770	820	873	926		
	P	999	1076	1156	1239	1325	1413	1505	1599	1696	1796		

A.4.3 Queensland Rail – Tangent Up 1 in 50 Track

Appendix Table A.4.3 Queensland Rail – Tangent Up 1 in 50 Track – Train Stopping Distance

Initial Speed (km/h)		5	10	15	20	25	30	35	40	45	50	55	60
Braking Curve	A	-	-	-	10	15	22	30	39	49	60	73	87
	P	-	-	-	37	51	65	82	100	119	140	162	186
	F	-	-	-	67	93	123	155	192	232	276	323	374
	I	-	-	-	179	232	290	350	413	480	549	621	697
	N	-	-	-	117	155	197	242	290	343	398	457	520
	S	-	-	-	123	163	206	253	304	358	416	477	542
	T	-	-	-	101	135	173	214	259	308	360	416	475
	W	-	-	-	112	149	190	234	282	333	388	446	509

Initial Speed (km/h)		65	70	75	80	85	90	95	100	105	110	115	120
Braking Curve	A	102	118	136	155	175	196	218	242	266	292	320	348
	P	212	239	268	298	330	363	398	435	473	512	553	596
	F	428	486	547	612	681	753	829	908	991	1078	-	-
	I	776	858	943	1032	1123	1218	-	-	-	-	-	-
	N	586	656	729	806	886	970	-	-	-	-	-	-
	S	610	682	758	837	920	1007	-	-	-	-	-	-
	T	538	605	-	-	-	-	-	-	-	-	-	-
	W	574	644	716	793	873	957	-	-	-	-	-	-

Initial Speed (km/h)		125	130	135	140	145	150	155	160	165	170		
Braking Curve	A	378	408	440	474	508	544	581	619	658	699		
	P	670	720	772	826	882	939	999	1060	1123	1187		

A.5 V/Line – Victorian Passenger

Source (at time of publication):

VEPR-2

V/Line, Standard Braking Curves for V/Line Rolling Stock

Revision 6

20th April 2023

(Braking curves in the following sections)

$$s = v_0 \times t + \frac{{v_0}^2}{2a}$$

where:

a = deceleration rate, in m/s^2.

s = distance, in m.

t = response time, in s.

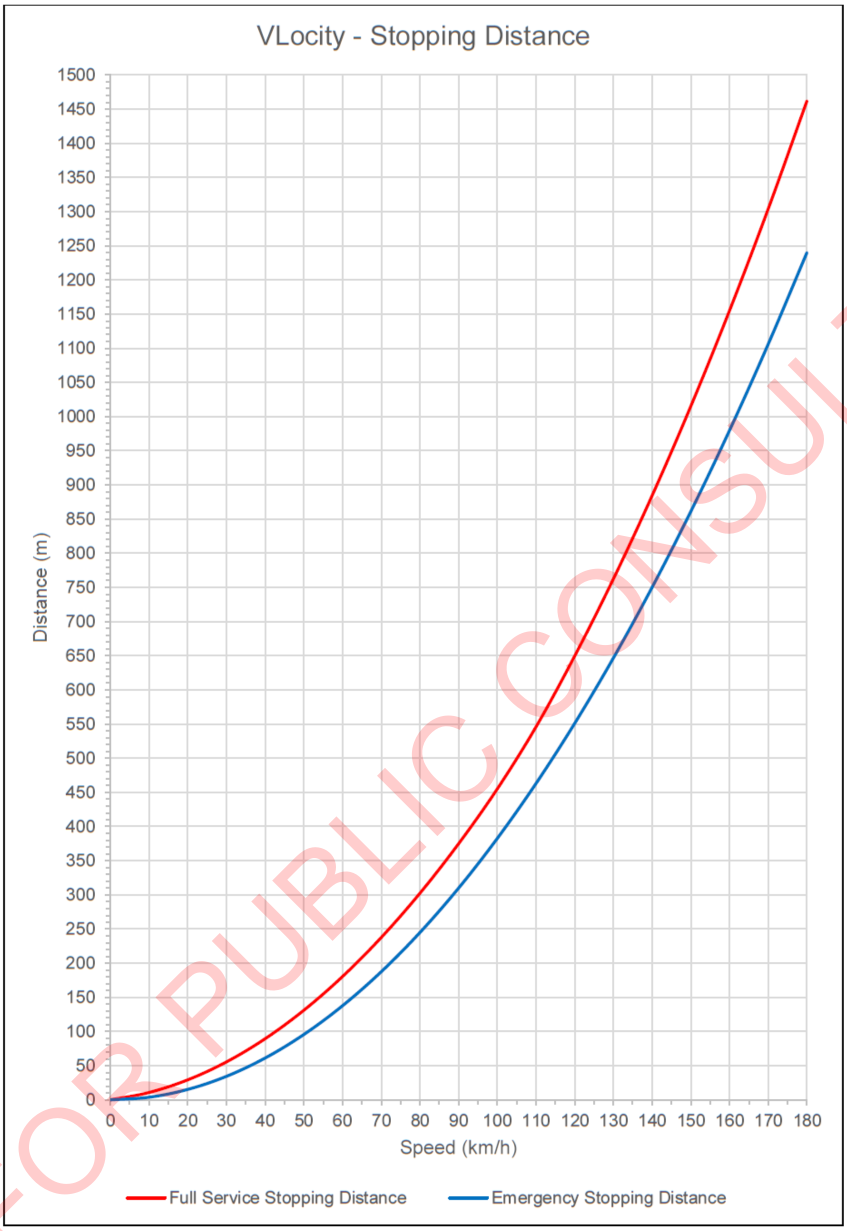
v_0 = initial speed, in m/s.

Vehicle	Service Brake Stopping Distance	Emergency Brake Stopping Distance
VLocity DMU	The greater from: a = 1.0 m/s^2. t = 2.5 s. or a = 0.855 m/s^2. t = 0 s.	a = 1.008 m/s^2. t = 0 s.
Sprinter DMU	a = 0.657 m/s^2. t = 0 s.	a = 0.747 m/s^2. t = 0 s.
Locomotive hauled Passenger Trains	a = 0.504 m/s^2. t = 0 s.	a = 0.54 m/s^2. t = 0 s.

All stopping distances are for conditions of dry, clean, level track in good condition.

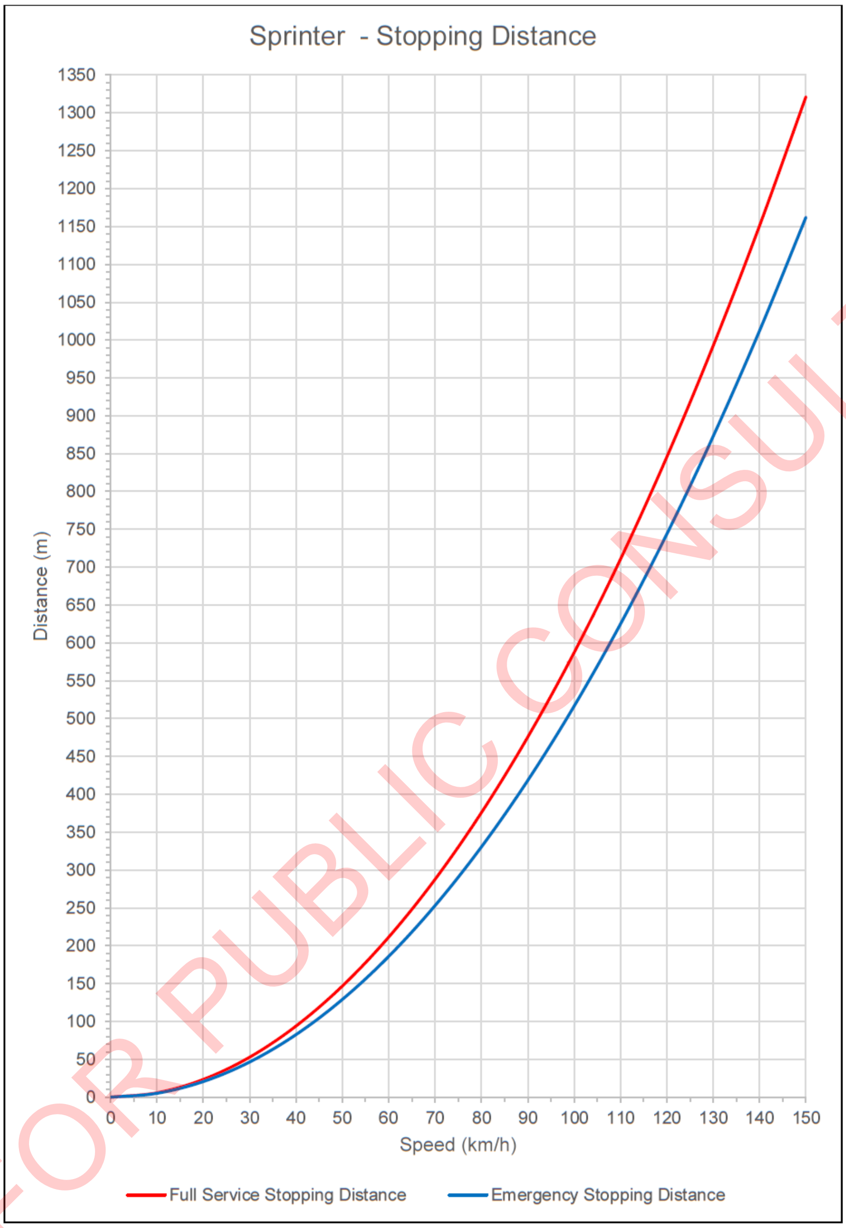
A.5.1 V/Line – Victorian Passenger – VLocity DMU

Appendix Table A.5.1 V/Line VLocity DMU – Train Stopping Distance



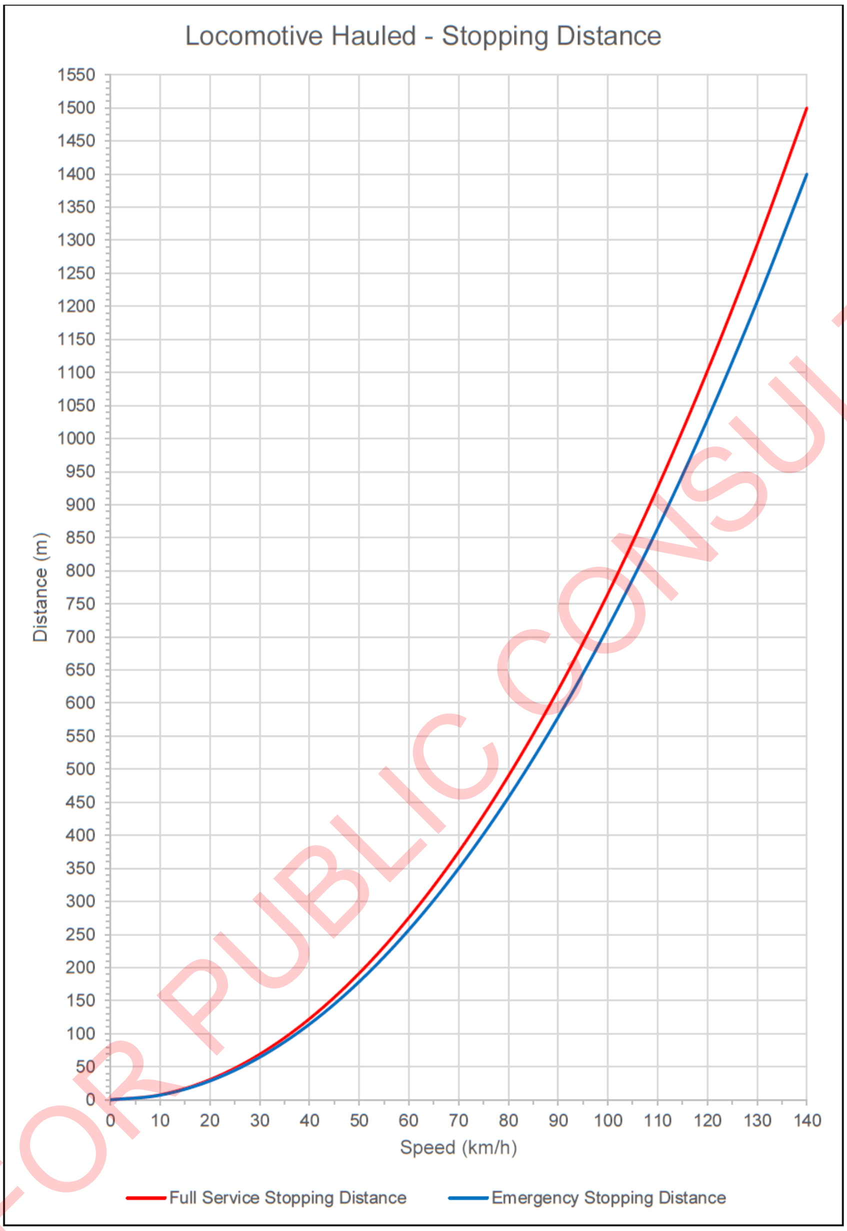
A.5.2 V/Line – Victorian Passenger – Sprinter DMU

Appendix Table A.5.2 V/Line Sprinter DMU – Train Stopping Distance



A.5.3 V/Line – Victorian Passenger – Locomotive Hauled Passenger Trains

Appendix Table A.5.3 Locomotive Hauled Passenger Trains – Train Stopping Distance



Appendix B Hazard Register (Informative)

Hazard number	Hazard
5.4.1.60	Harm to Rolling Stock - Derailment or Collision, Human Error, Track Failure, Track Obstruction, Design Failure, Health Failure, Organisational SMS Failure, Security Breach, Load not Secure and or Vandalism - Inadequate rolling stock pre-service testing and commissioning
5.4.1.61	Harm to Rolling Stock - Derailment or Collision, Human Error, Track Failure, Track Obstruction, Design Failure, Health Failure, Organisational SMS Failure, Security Breach, Load not Secure and or Vandalism - Inadequate rolling stock in-service testing
5.5.1.45	Harm to Rolling Stock Related Processes - Derailment or Collision, Human Error, Track Failure, Track Obstruction, Design Failure, Health Failure, Organisational SMS Failure, Security Breach, Load not Secure and or Vandalism - Design deficiency causing the inability to operate trains
5.5.1.46	Harm to Rolling Stock Related Processes - Derailment or Collision, Human Error, Track Failure, Track Obstruction, Design Failure, Health Failure, Organisational SMS Failure, Security Breach, Load not Secure and or Vandalism - Manufacturing deficiency causing the inability to operate trains
5.5.1.47	Harm to Rolling Stock Related Processes - Derailment or Collision, Human Error, Track Failure, Track Obstruction, Design Failure, Health Failure, Organisational SMS Failure, Security Breach, Load not Secure and or Vandalism - Maintenance deficiencies causing the inability to operate trains
5.5.1.48	Harm to Rolling Stock Related Processes - Derailment or Collision, Human Error, Track Failure, Track Obstruction, Design Failure, Health Failure, Organisational SMS Failure, Security Breach, Load not Secure and or Vandalism - Operational deficiencies causing the inability to operate trains
5.6.1.39	Out of Control Trains - Human Error, Design Failure, Health Failure, Organisational SMS Failure, Security Breach and or Vandalism - Brake system not fail-safe
5.10.1.4	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Inadequate braking on down grades
5.10.1.5	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Brake fade
5.10.1.6	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - A malicious act causing too many brakes to cut out
5.10.1.7	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Faulty brakes causing too many brakes to cut out
5.10.1.9	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Leaking brake cylinders leading to insufficient brake cylinder pressure
5.10.1.10	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Isolation cocks handles in the wrong or inconsistent orientation causing too many brakes to cut out (mistakenly)
5.10.1.11	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Friction elements are excessively worn or missing causing insufficient braking stroke

Hazard number	Hazard
5.10.1.12	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Incorrect or inadequate isolation cock labelling causing too many brakes to cut out (mistakenly)
5.10.1.13	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Faulty slack adjusters causing insufficient braking stroke
5.10.1.14	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Brakes not being cut back in after maintenance causing too many brakes to cut out (mistakenly)
5.10.1.16	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Nil or deficient procedures for driving with brakes cut out causing an operational process failure (Too many brakes cut out)
5.10.1.17	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Procedure for driving with brakes cut out not followed causing an operational process failure (Too many brakes cut out)
5.10.1.19	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Local brake control system mechanical failure e.g., control valve, (Braking system failure)
5.10.1.20	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Load / weigh system failure (Braking system failure)
5.10.1.21	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Brake control system software 'failure' - (Braking system failure)
5.10.1.22	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Second controller incorrectly cut out causing a brake controller failure (Braking system failure)
5.10.1.23	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Component failure causing a brake controller failure (Braking system failure)
5.10.1.24	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Exhaust being partially blocked increasing delay causing a brake controller failure
5.10.1.25	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - One-way partial blockage of brake pipes causing a braking signal transmission system failure resulting in a brake controller failure (Braking system failure)
5.10.1.26	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Kinked brake pipe hoses causing a braking signal transmission system failure (Braking system failure)
5.10.1.27	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Damaged or flow-restricted brake piping or hoses causing a braking signal transmission system failure (Braking system failure)
5.10.1.28	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Brake pipe cocks closed causing a braking signal transmission system failure (Braking system failure)

Hazard number	Hazard
5.10.1.29	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Brake signal wiring damaged causing a braking signal transmission system failure (Braking system failure)
5.10.1.36	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Reservoir capacity being inadequate causing a brake energy reservoir failure (Braking system failure)
5.10.1.37	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Reservoir being insufficiently recharged before next application causing a brake energy reservoir failure (Braking system failure)
5.10.1.41	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Incompatible braking systems on coupled vehicles (Braking system failure)
5.10.1.43	Brakes being Inadequate when Moving - Derailment and Collision, Human Error, Design Failure, Organisational SMS Failure, Security Breach and or Vandalism - Low air supply pressure leading to insufficient brake cylinder pressure
5.11.1.8	Brakes being Inadequate when Stationary - Human Error, Design Failure, Health Failure, Organisational SMS Failure, Security Breach and or Vandalism - Too many brakes cut out preventing brakes from holding trains on steep grades
5.11.1.14	Brakes being Inadequate when Stationary - Human Error, Design Failure, Health Failure, Organisational SMS Failure, Security Breach and or Vandalism - System leak allows air in brake cylinders to leak off prior to securement
5.12.1.3	Wheel Skidding - Derailment or Collision, Human Error, Track Obstruction, Design Failure, Security Breach and or Vandalism - Incompatible brake systems on vehicles in the train (Brake not released)
5.12.1.5	Wheel Skidding - Derailment or Collision, Human Error, Track Obstruction, Design Failure, Security Breach and or Vandalism - Crews not releasing (all) hand / park brakes (hand/park brake not released)
5.12.1.9	Wheel Skidding - Derailment or Collision, Human Error, Track Obstruction, Design Failure, Security Breach and or Vandalism - Vehicles in tare condition with brakes set for gross condition causing excessive brake cylinder force
5.30.1.5	Excessive dynamic longitudinal train forces - Derailment or Collision, Human Error, Track Failure, Design Failure, Health Failure, Load not Secure and or Vandalism - Brake jerk rate being too high
5.32.1.41	Out of gauge trains - Derailment or Collision, Human Error, Track, Design Failure, Health Failure, Security Breach, Load not Secure and or Vandalism - Failed brake equipment (Poorly restrained equipment)

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