ESC 361

BUFFER STOPS

Version 2.3

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Owner: Chief Engineer Civil
Approved by: John Stapleton
Principal Engineer Technology & Standards
Authorised by: Richard Hitch
Chief Engineer Civil

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## Document control

<table>
<thead>
<tr>
<th>Version</th>
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<th>Summary of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3</td>
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<td>Section 12 - add requirement for full ballast profile; new Section 15.2 - OHW termination insulator</td>
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<td>Correct internal section references throughout; Section 3.8 - change reference to TMC 304 to SPC 301; Section 11 - change various references to TMC 304 to SPC 301; Section 15: clarify that contact wire height above buffer stop is from rail level.</td>
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</tr>
</tbody>
</table>
Contents

1 Purpose, Scope and Application .............................................................................................................5

2 References ...........................................................................................................................................5
2.1 Australian and International Standards .........................................................................................5
2.2 RailCorp Documents ......................................................................................................................5
2.3 Other References .............................................................................................................................5

3 General Requirements .......................................................................................................................6
3.1 Design Standards .............................................................................................................................6
3.2 Existing Buffer Stops .......................................................................................................................6
3.3 Approved Materials ..........................................................................................................................6
3.4 Clearances .........................................................................................................................................6
3.5 Safety ...............................................................................................................................................6
3.6 Protection of the Environment .........................................................................................................6
3.7 Drawing Standards ............................................................................................................................7
3.8 Construction ......................................................................................................................................7
3.9 Maintenance .......................................................................................................................................7

4 Location Criteria ..................................................................................................................................7

5 Approved Configurations ...................................................................................................................7
5.1 Energy Absorbing ..............................................................................................................................7
5.2 Fixed ................................................................................................................................................8
5.3 Lower Order Protection Devices .....................................................................................................8

6 Risk Assessment ....................................................................................................................................8

7 Design Criteria – Passenger Train Buffer Stops .............................................................................9
7.1 Train Mass ..........................................................................................................................................9
7.2 Train Speed .......................................................................................................................................9
7.3 Retardation/ Deceleration Rates ......................................................................................................10
7.4 Maximum Force To Minimise Train Damage ...............................................................................10
7.5 Coupling Capability ........................................................................................................................10
7.5.1 General .........................................................................................................................................10
7.5.2 Buffer face rubber block ...........................................................................................................11
7.5.3 Buffer face cut-out .......................................................................................................................11
7.5.4 Drawings ....................................................................................................................................11
7.6 Over-Ride Protection .......................................................................................................................12

8 Design Criteria – Non-passerger Train Buffer Stops .....................................................................12
8.1 Rolling Stock Mass ............................................................................................................................12
8.2 Rolling Stock Speed ..........................................................................................................................12
8.3 Retardation/ Deceleration Rates .....................................................................................................12
8.4 Coupling Capability ........................................................................................................................12

9 Over-Run Track ..................................................................................................................................13

10 Additional Over-Run Protection .....................................................................................................13

11 Protective Coatings ..........................................................................................................................13
11.1 Steel Buffer Stops ............................................................................................................................13
11.1.1 Painted .......................................................................................................................................13
11.1.2 Galvanised.................................................................13
11.2 Timber Buffer Stops .........................................................14
11.2.1 Timber.....................................................................14
11.2.2 Steel plate.................................................................14
11.3 Stop Blocks .................................................................14
12 Track Requirements..........................................................14
13 Light Signal.................................................................14
14 Electrical Isolation.............................................................15
15 Electrical Requirements.....................................................15
15.1 Clearances ................................................................15
15.2 Overhead Wiring Termination Insulator .........................15
16 Type Approval Requirements............................................15
1 Purpose, Scope and Application

This document specifies the design requirements for buffer stops installed on the RailCorp network.

It applies to all terminal roads and sidings.

2 References

2.1 Australian and International Standards

AS 2700S - Colour standards for general purposes

2.2 RailCorp Documents

ESC 100 - Civil Technical Maintenance Plan
ESC 215 - Transit Space
ESC 220 - Rail and Rail Joints
ESC 302 - Structures Defect Limits
TMC 203 - Track Inspection
SPC 301 - Structures Construction
SPG 1571 - Light Signals

Signals Engineering Design Guideline - Control of Trains Approaching Catch Points, Buffer Stops and Short Overlaps

RailCorp Safety Management System

RailCorp Drawings:

<table>
<thead>
<tr>
<th>Supplier Number</th>
<th>EDMS Number</th>
<th>Drawing Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-82-00096</td>
<td>FL0344811</td>
<td>Sharon Interlocking Coupler Bottom Operated for Double Deck Intercity Cars (City Rail)</td>
</tr>
<tr>
<td>003-567</td>
<td>FL0305691</td>
<td>Tangara Suburban Cars Control Trailer Car No 2 End Full Auto Coupler Assembly with Cables, Piping &amp; Tread Plate (SRA)</td>
</tr>
<tr>
<td>205A-326</td>
<td>CV0255592</td>
<td>Standard Buffer Stop for Terminal Roads</td>
</tr>
</tbody>
</table>

2.3 Other References

Suppliers’ Drawings:

<table>
<thead>
<tr>
<th>Supplier Number</th>
<th>EDMS Number</th>
<th>Drawing Title</th>
</tr>
</thead>
<tbody>
<tr>
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<td>FL0333614</td>
<td>Alliance Automatic Coupler (Bradken Consolidated)</td>
</tr>
<tr>
<td>10615</td>
<td>FL0296161</td>
<td>Double Deck Motor Car – Coupler &amp; Draftgear Arrangement (Goninan)</td>
</tr>
<tr>
<td>108-689</td>
<td>FL0309046</td>
<td>General Arrangement Motor Car Interurban D/D Cars (Comeng)</td>
</tr>
</tbody>
</table>
3 General Requirements

3.1 Design Standards

New buffer stops are to be designed in accordance with this Standard.

Buffer stops shall be designed for a life of 40 years.

Designs are to be suitably robust using proven structural arrangements.

3.2 Existing Buffer Stops

Where existing buffer stops are to be refurbished or fully replaced, the replacement/refurbished structure is to be designed in accordance with this Standard.

3.3 Approved Materials

Approved construction materials for main structural elements are steel and concrete. With the exception of fixed buffer stops, timber materials shall not be used as structural elements.

Masonry is not approved for buffer stops.

3.4 Clearances

Horizontal and vertical clearances of buffer stops to adjacent tracks are to comply with RailCorp Engineering Standard ESC 215 - Transit Space.

3.5 Safety

The design of buffer stops is to take into account safety considerations for construction, maintenance and train operating personnel.

The design shall comply with the requirements of the RailCorp Safety Management System, particularly SMS-12-PR-0371 Managing Engineering Design Control.

3.6 Protection of the Environment

The design of buffer stops is to take into account environmental impacts during construction and maintenance activities, with a view to minimising any such impacts.
3.7 Drawing Standards

Construction drawings are to comply with RailCorp’s standard procedures and formats, and are to detail the design train mass, design train speed and deceleration rates and any other relevant information to ensure that the new structure is constructed and maintained in accordance with the design.

3.8 Construction

The design of buffer stops is to take into account construction constraints, particularly live rail operating conditions and track possession constraints.

RailCorp has a suite of technical specifications for construction of structures. The specifications are detailed in RailCorp Engineering Specification SPC 301 - Structures Construction and are to be incorporated in the design and construction documentation of buffer stops.

3.9 Maintenance

The design of buffer stops is to take into account the ability to access components for inspection and maintenance purposes.

Materials and finishes should be chosen to minimise future maintenance.

Spare components, especially consumables, shall be readily available.

Maintenance requirements are to be determined in the design process and documented in the installation and maintenance manual for the buffer stop. Requirements are to include examination tasks and frequencies, damage limits, re-setting procedures and repair standards. In some cases, ESC 100 - Civil Technical Maintenance Plan and ESC 302 - Structures Defect Limits will apply. However site specific maintenance requirements may need to be provided.

4 Location Criteria

Buffer stops shall be provided on all terminal roads and sidings where passenger trains operate.

Buffer stops or lower order protection devices shall be provided on all sidings where freight trains operate, and on engineering maintenance sidings.

Buffer stops shall not be located on curved track with a radius less than 800 metres without the approval of the Chief Engineer, Civil.

Buffer stops shall not be located under overhead wiring sectioning equipment such as insulators, overlaps and air gaps.

5 Approved Configurations

Approved configurations of buffer stop are:

- Energy absorbing
- Fixed.

5.1 Energy Absorbing

Energy absorbing buffer stops may be friction, hydraulic or combination friction/hydraulic type.
Energy absorbing buffer stops shall either be type approved by RailCorp from a supplier or to an approved design.

Energy absorbing buffer stops shall be used on new passenger line terminal roads and turnback sidings.

Energy absorbing buffer stops are preferred for existing terminal roads and sidings where passenger trains operate.

5.2 Fixed

Fixed buffer stops shall be the timber type.

Timber buffer stops shall be in accordance with RailCorp Drawing Number CV 0255592 “Standard Buffer Stop for Terminal Roads”.

Existing timber buffer stops are to have a cut-out at the bottom for the Scharfenberg guiding horn. The size of the cut-out shall be 400 mm wide (200 mm either side of the track centreline) and 50 mm high. The height above rail to the underside of the beam in the cut-out area shall be 750 mm.

Where passenger trains operate, fixed buffer stops shall only be used when space constraints exist and it is not economically feasible to reconfigure the location to provide for an energy absorbing type. At such locations, a risk assessment shall be carried out to ensure the residual risk is acceptable in accordance with the RailCorp Safety Management System.

5.3 Lower Order Protection Devices

On sidings where no passenger trains operate, lower order protection devices may be used in lieu of buffer stops, subject to a risk assessment.

Approved configurations are stop blocks and earth or ballast run-off areas.

Stop blocks shall be a 300 mm x 300 mm timber bearer secured to the rails. Concrete sleepers may be used in lieu of timber bearers.

The length of run-off area shall be based on type of rolling stock and potential speed. The minimum length shall be 5 metres.

6 Risk Assessment

A risk assessment of each location shall be carried out to determine the design performance criteria for the location and to determine whether additional over-run protection is required. The risk assessment is to include factors associated with the train approach to the buffer stop and areas of risk behind the buffer stop.

Factors to consider include:

- potential speed of rail vehicles approaching the line/siding termination
- type and mass of rail vehicles
- track usage level
- train patronage level
- gradient at the termination point
- potential proximity of personnel / public
- proximity and criticality of adjacent structures, facilities and property
- concourse areas
- buildings (retail, office etc)
• structures (bridges, tunnels, overhead wiring structures etc)
• location of adjacent roads, pedestrian areas, other tracks, ditches, embankments, water courses.

RailCorp passenger rolling stock includes:

• L, R, S, K, C and V sets
• Tangara G & T sets
• Millennium M sets
• Outer Suburban H sets
• XPT
• Xplorer
• Endeavour
• Hunter Rail Car.

RailCorp infrastructure maintenance rolling stock includes:

• Locomotives
• Freight wagons (ballast, sleepers)
• Rail carrying wagons
• Self propelled maintenance vehicles.

Locomotive hauled passenger and freight trains also operate on the RailCorp network.

The requirements of RailCorp Signal Engineering Design Guideline “Control of Trains Approaching Catch Points, Buffer Stops and Short Overlaps” shall be considered in the risk assessment.

The risk assessment shall be carried out in accordance with the RailCorp Safety Management System.

7 Design Criteria – Passenger Train Buffer Stops

The following design criteria are to be applied in the design of new buffer stops for passenger line terminal roads and passenger train stabling yards.

7.1 Train Mass

The design of buffer stops shall consider both the minimum mass and the maximum mass of trains.

At each site, the risk assessment process shall determine the appropriate minimum and maximum masses based on the type of rolling stock, train set combinations and whether empty or loaded in operation or proposed to operate at the site.

The masses below are based on the range of rolling stock across the network:

• 90 tonnes for an empty 2-car set (2 x motor cars at 45 tonnes each)
• 180 tonnes for an empty 4-car set
• 410 tonnes for a loaded 8-car suburban set
• 500 tonnes for a loaded 8-car Intercity set (4 x motor cars at 70 tonnes each and 4 x trailer cars at 54 tonnes each)
• 1,500 tonnes for a fully-laden Indian Pacific (2 x locomotives at 132 tonnes each, 24 x passenger cars at 50 tonnes each and 2 x car trailers at 30 tonnes each).

7.2 Train Speed

The design speed shall be the “probable worst case speed”.
The “probable worst case speed” is to address the causal mechanisms of driver error, rolling stock problems (eg. brake failure) and/or loss of wheel/rail adhesion. It is not expected to address deliberate mal-intent of the driver, driver incapacitation, or a runaway train. The exception is that for yards and sidings a runaway of a stabled train shall be included in the determination of “probable worst case speed”.

When determining the probable worst case speed the factors shall include:

- The route approaching the buffer stop
- The advertised speed
- Track gradient
- The speed of the train following the negotiation of points
- Any wheel/rail adhesion issues
- Trip gear fitted to rolling stock
- The likely speed achieved after stopping at a signal.

The minimum determined design speed shall be 10 km/hr.

### 7.3 Retardation/ Deceleration Rates

For the range of train masses specified, trains shall be brought to a stop from the maximum speed at a deceleration rate of 1.5 m/s².

Where site constraints make this difficult to achieve for the lightest train as well as the heaviest, the deceleration rate shall be no greater than 2.5 m/s², subject to compliance with Section 7.4.

### 7.4 Maximum Force To Minimise Train Damage

Recent rolling stock procurement specifications include the requirement for progressive energy absorbing components at the impacting end of the set. However, older rolling stock does not have this allowance for progressive energy dissipation, and may begin to suffer structural damage at forces in excess of 1,000kN.

To prevent damage to the rolling stock, the buffer stop shall exert a maximum force of 1,000 kN on the rolling stock.

### 7.5 Coupling Capability

#### 7.5.1 General

Buffer stops shall be designed to suit the range of couplers on the rolling stock on the RailCorp network.

Buffer stops shall be generally designed for the Scharfenberg type coupler, but shall be capable of stopping a train with a Sharon interlocking coupler without causing structural damage to either the coupler or the buffer stop.

The nominal height of the centreline of couplers above rail level for most passenger rolling stock is 865 mm +25/-12 mm. For Endeavour and Xplorer cars the height is 905mm.

The underside of the buffer beam/plate shall be high enough above rail to allow for the Scharfenberg guiding horn on the train coupler to protrude beneath the buffer beam/plate when engaging the coupler. The minimum height above rail of the underside of the buffer beam/plate is 750 mm.
Buffer stops are not required to have a Scharfenberg guiding horn fitted.

7.5.2 Buffer face rubber block

The couplers on trains will not always be centrally located in their design position. Some couplers such as the Sharon interlocking coupler are not self-centring.

The buffer beam/plate shall have a rubber block to mitigate the impact and to re-centre misaligned couplers on impact. The rubber block shall be able to withstand the impact of the various types of couplers without causing damage to the rubber block, the coupler or equipment on the front of the train in the vicinity of the coupler such as electrical heads and the horizontal protrusion on one side of the coupler on some rolling stock.

The rubber block shall be mounted in such a way that impact from the coupler cannot damage the fastening of the rubber block to the backing plate.

The rubber block shall have a Shore Durometer value of 75 + 5 and shall be UV stable.

The configuration of the rubber block shall be approved by the Chief Engineer Rolling Stock.

7.5.3 Buffer face cut-out

The coupler interface on the rubber block shall include a cut-out for engagement of the coupler. The cut-out shall be a minimum 215 mm in diameter. The centre of the cut-out shall be offset 106 mm from the centreline of the buffer stop. The depth of the cut-out shall be sufficient so that the cone protrusion of the coupler does not impact the buffer stop.

Refer to Figure 1 for details of the cut-out.

![Figure 1 – Coupler Interface Cut-out](image-url)

7.5.4 Drawings

Relevant drawings for RailCorp rolling stock include:
- BK 15801 Alliance Automatic Coupler (Bradken Consolidated)
- 10615 Double Deck Motor Car Coupler & Draftgear Arrangement (Goninan)
- 108-689-General Arrangement Motor Car Interurban D/D Cars (Comeng)
- 1-82-00096 Sharon Interlocking Coupler Bottom Operated for Double Deck Intercity Cars (City Rail)
- 003-567 Tangara Suburban Cars Control Trailer Car No 2 End Full Auto Coupler Assembly with Cables, Piping & Tread Plate (SRA)
- 055000078 Automatic Coupler Millennium Train (EDI)
- 055000093 Automatic Coupler Millennium Train (EDI)
- 70605 Sheets 1 & 3 Outer Suburban Car A Car General Arrangement (United Goninan)
- 882 015600 Automatic Coupler for Xplorer & Endeavour Railcars (ABB)
- 1004231 Automatic Coupler for Oscars (Goninan)
- C69823 Automatic Coupler for Hunter Railcars (United Goninan).

7.6 Over-Ride Protection
Buffer stops shall include positive features to mitigate the possibility of over-riding.

Where anticlimber plates are used, they shall be compatible with the anticlimber plates fitted to recently procured rolling stock. Refer to drawing number 254000462 Anticlimber Plate (EDI).

The centreline of the anticlimber plates is nominally 1030 mm horizontally from the centreline of the rolling stock and 1100 mm vertically above rail level.

The buffer stop shall be designed to allow for the coupler to compress 400 mm before the anticlimber plates on the rolling stock are engaged on the buffer stop.

For friction buffer stops with anticlimber plates, the plates may be omitted if it is determined by calculation that the impact speed will not result in sufficient compression of the coupler to engage the anticlimber within the design length of over-run track.

8 Design Criteria – Non-passenger Train Buffer Stops

8.1 Rolling Stock Mass
Minimum and maximum mass to be specified based on the range of trains and rolling stock, including maintenance vehicles, which use the siding.

8.2 Rolling Stock Speed
Buffer stops shall be designed for a speed of 10 km/hr unless the risk assessment in Section 6 determines a higher design speed.

8.3 Retardation/ Deceleration Rates
For the range of train masses specified, trains shall be brought to a stop from the maximum speed at a deceleration rate 2.5 m/s².

8.4 Coupling Capability
To suit the range of train and rolling stock that uses the siding, but nominally 865 mm +25/-12 mm above rail.
9 Over-Run Track

The length of over-run track shall be based on:

- Train mass
- Train speed
- Deceleration rate
- Maximum force on rolling stock
- Track grade
- Safety factor to mitigate variability in friction values.

10 Additional Over-Run Protection

When the risk assessment determines that additional over-run protection is required, it shall be provided for the mitigation of the consequences of a train hitting the buffer stop at speeds in excess of the “probable worst case speed”.

Options for the design of suitable over-run protection include:

- Provision of space free from structures, other tracks and people
- A speed-arresting device such as a ballast or sand trap beyond the buffer stop
- End impact walls
- Speed control devices to significantly reduce the speed of an approaching train.

Where over-run protection cannot be provided, a safety assessment shall be prepared and a waiver obtained. In this situation the buffer stop shall be designed to provide the best risk mitigation reasonably possible within the local constraints.

11 Protective Coatings

11.1 Steel Buffer Stops

Steel buffer stops shall have protective coatings applied in accordance with SPC 301. They shall be either painted or galvanised.

11.1.1 Painted

The paint system shall be in accordance with SPC 301 Specification S24 - Protective Paint Coating of Steelwork – System P.

The buffer stop shall be painted white, except for a section of the front, as below.

The section of the horizontal front beam / buffer beam between the running rails shall be painted black. Only the front face of the beam needs to be black.

White paint colour shall be N14 White of AS 2700S - Colour standards for general purposes.

Black paint colour shall be N61 Black of AS 2700S.

Paint plaques are not required.

11.1.2 Galvanised

Galvanising shall be in accordance with SPC 301 Specification S25 - Protective Galvanised Coating of Steelwork – System G.
11.2 Timber Buffer Stops

11.2.1 Timber
Timber components shall be painted with a pink wood primer, an all purpose undercoat and a white alkyd gloss enamel finishing coat.

The minimum dry film thickness shall be 40 micrometres per coat.

The colour shall be N14 White of AS 2700S.

All paints shall be paints approved by the Australian Paint Approval Scheme (APAS).

11.2.2 Steel plate
Steel sections shall be in accordance with SPC 301 Specification S22 - Miscellaneous Steelwork.

They shall be painted in accordance with SPC 301 Specification S24 - Protective Paint Coating of Steelwork – System P.

Paint colour shall be N61 Black of AS 2700S.

11.3 Stop Blocks
Timber stop blocks shall be painted in accordance with Section 11.2.1.

12 Track Requirements
This section specifies the track requirements for the installation of sliding friction buffer stops.

The extent of buffer stop track shall be from 20 metres in front of the buffer stop to the end of the designed length of track required for the buffer to stop a train at the design speed.

The track configuration shall comply with relevant RailCorp asset strategies and track engineering standards.

The rail configuration shall be in accordance with the requirements in ESC 220 - Rail and Rail Joints.

Where timber sleepers are used, the minimum requirements are:

- all sleepers in the buffer stop track area assessed as good in accordance with the definition in TMC 203 - Track Inspection
- resilient fastening assemblies
- plates to be secured with screw spikes
- full ballast profile.

13 Light Signal
Light signals shall be installed at each buffer stop location in accordance with RailCorp Signals Standard SPG 1571 - Light Signals.

Light signals are not required on lower order protection devices.
14 Electrical Isolation

Steel buffer stops shall be electrically isolated. They shall be:

- Insulated
- Isolated from the rails
- Isolated from one side of the assembly to the other
- At least 2 metres from adjacent earthed metal structures.

Electrical isolation from the rails shall be achieved by installation of impedance bonds and one insulated joint in front of the buffer stop.

15 Electrical Requirements

15.1 Clearances

Buffer stops installed under overhead wiring shall have signs attached warning of the high voltage overhead wiring above.

The minimum contact wire height over the buffer stop shall be 5.4 metres above rail.

15.2 Overhead Wiring Termination Insulator

The overhead wiring (OHW) termination insulators are normally cut in approximately two (2) metres on the approach side of the buffer stop. This is to ensure that any person who may stand on top of the buffer stop will not encroach within the safe approach distance for 1500V dc equipment.

For friction buffer stops, consideration shall be given to how far the buffer stop is designed to move, and ensure that the termination insulators will not be hit by the pantograph.

If the wire above the buffer stop is live, design the OHW so that the clearance of the contact wire above the buffer stop is at least 3.7 metres.

16 Type Approval Requirements

The following information is to be submitted when requesting type approval of a buffer stop design:

- Design calculations
- Drawings
- Range of couplers and coupler heights allowed for in the design
- Compatible rail types and sizes
- Test results from impact trials
- Performance under specific design criteria
- Assembly and installation procedures
- Resetting procedures
- Spares list and availability
- Maintenance plan including details of failure modes, inspections (routine and post incident) and procedures manual
- Protective coating specification.