Australian Government
Australian Transport Safety Bureau

Derailment of train ST24

near North Melbourne, Victoria | 11 July 2014

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2014-013
Preliminary – 25 September 2014

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Addendum

Page	Change	Date

Contents

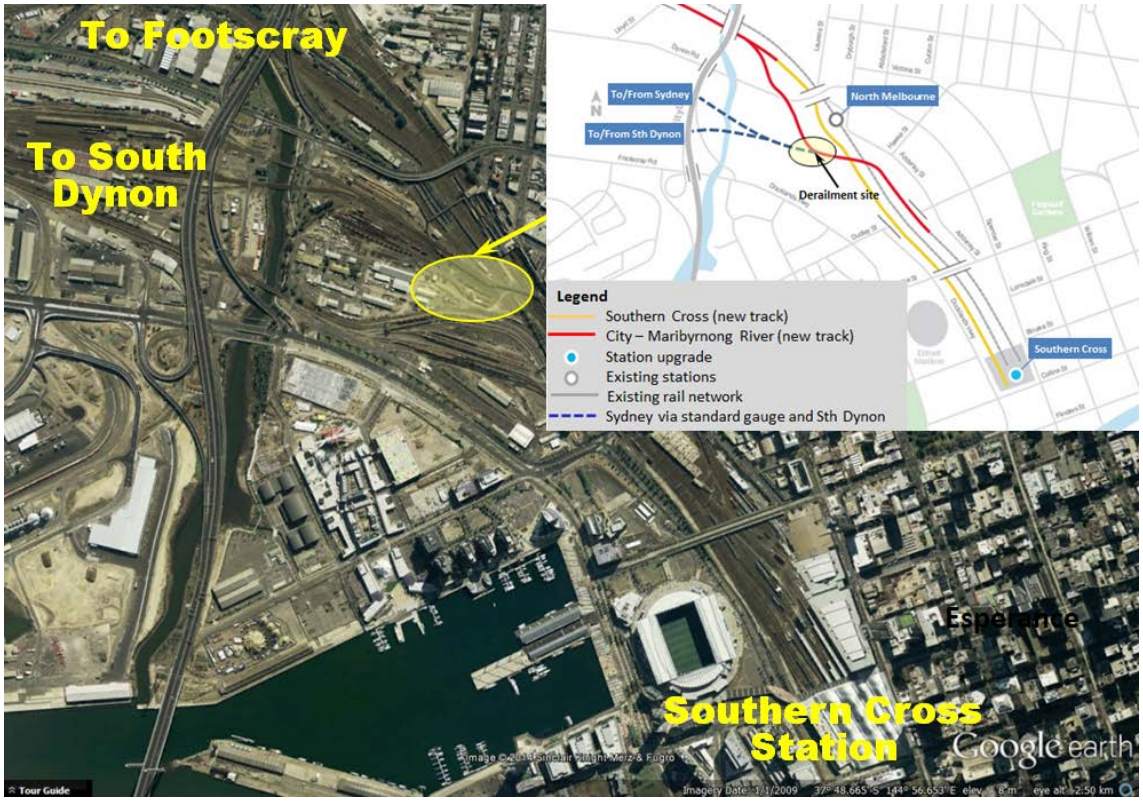
The occurrence

The information contained in this Preliminary report is released in accordance with section 25 of the Transport Safety Investigation Act 2003 and is derived from the initial investigation of the occurrence. Readers are cautioned that new evidence will become available as the investigation progresses that will enhance the ATSB's understanding of the accident as outlined in this Preliminary report.

On the morning of 11 July 2014, train ST21, a scheduled XPT passenger service, was travelling from Sydney to Melbourne. At Broadmeadows station (about 18 km north of the Melbourne CBD), a pilot boarded the train for the final part of the journey into Southern Cross station. The pilot was required to provide route familiarisation training for XPT drivers who were operating over the newly commissioned section of dual gauge track leading into and out of the Southern Cross station.

At about 0738,[1] train ST21 entered the dual gauge 'up' fly over track (Figure 1) and passed over MYD882 (dual gauge 'up' turnout), which was part of the newly commissioned track. As the train traversed the turnout, it bounced heavily. The pilot described it as 'a short sharp dip in the track, similar to a short deep bog hole (mud hole)' and explained that if the train hadn't kept rolling, he would have thought they had derailed. The pilot immediately rang Southern Cross number 1 signal box and reported the occurrence. Number 1 signal box advised that they would arrange for a track inspection. The train continued into Southern Cross, where it was fuelled and joined by passengers and new crew, in readiness for the return journey to Sydney as train ST24.

Figure 1: Location map – Derailment site near Southern Cross station



Source: Google earth and RRL with annotation by ATSB

At about 0830, train ST24 departed Southern Cross and travelled along the dual gauge 'down' fly over track on its journey towards Sydney. As the train approached signal MYD987, the driver

[1] The 24-hour clock is used in this report and is referenced from Eastern Standard Time (EST), UTC + 10.0 hours.

observed a *clear medium speed* with 'S' indication. To the driver, this meant that the route was correctly set and that the train could traverse MYD887 (dual gauge 'down' turnout) at up to 25 km/h. As the train traversed the turnout at about 20 km/h, the driver and pilot felt several large jolts, followed by a series of fault indications on the driver's display screen as the train came to a standstill. The pilot then rang the train controller and advised that train ST24 had derailed on the fly over (Figure 2). When the site was secured, the driver walked back to inspect the extent of the damage. Recovery personnel arrived shortly thereafter and commenced disembarking passengers.

Figure 2: Train ST24 trailing power car 2003 and derailed carriage 2176

Source: CITS

Investigators from the ATSB and the Chief Investigator Transport Safety (CITS) Victoria attended the site and began gathering/protecting perishable evidence, including site data, photographs, measurements, CTC[2] data logs and train data logs.

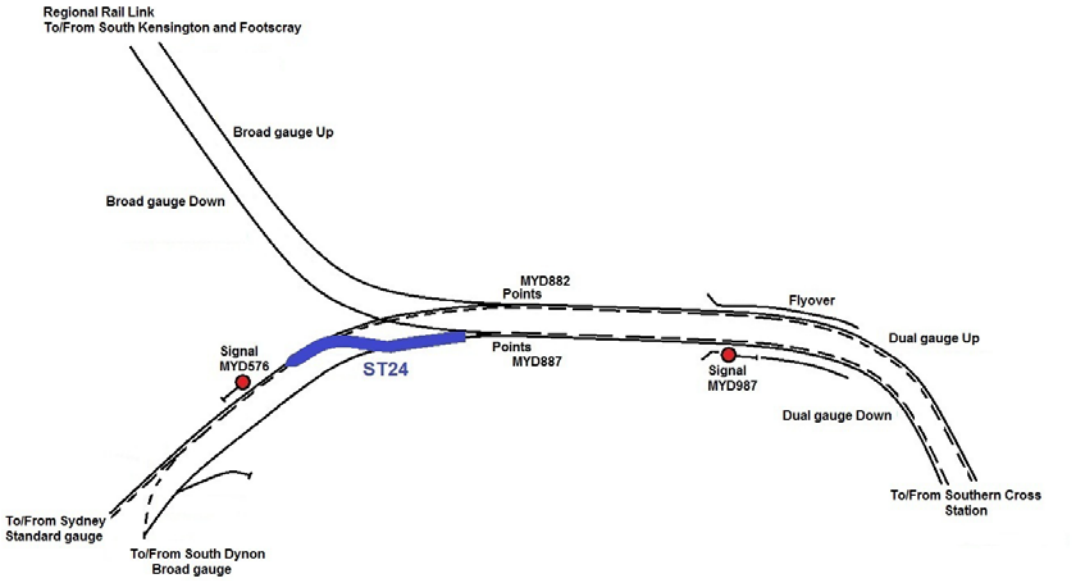
[2] Centralised train control – A system of remotely controlling the points and signals at a number of interlocked stations, junctions and crossing loops in automatic signalling areas, from a centralised control room or signal box.

Context

Location

The derailment occurred at turnout MYD887, located on a section of track that had been recently constructed as part of the Regional Rail Link project (RRL). Turnout MYD882, where the driver and pilot experienced the heavy bounce when travelling towards Southern Cross station, was located adjacent to MYD887 (Figure 3). The RRL project included extensive track reconfiguration and upgrades to the North Melbourne rail-over-rail fly over for accessing platforms 1 to 8 at Southern Cross station. V/Line provided both the infrastructure management and train control functions for this section of track, under a lease arrangement with VicTrack.

Figure 3: Location of turnouts MYD882 and MYD887



Source: ATSB

Track Information

The track through the derailment site comprised a combination of broad gauge (1,600 mm), standard gauge (1,435 mm) and dual gauge track; that is, broad and standard gauge track having a common running rail. Turnouts MYD882 and MYD887 provided dual gauge rail access to and from Sydney/South Dynon, and broad gauge to and from Kensington/Footscray. The turnouts were installed about 6 months before the derailment, but were only issued with a certificate of acceptance on 8 July 2014 – three days before the derailment. During the commissioning and acceptance process, both broad and standard gauge trains were operated over the turnouts, but the tests had not included the standard gauge XPT passenger train.

The installed turnouts were documented as 50 kg type 37 dual gauge turnouts. The design of the type 37 turnout was based on an existing dual gauge turnout design (type 29) in common use by the Australian Rail Track Corporation (ARTC).

Train information

Train ST24 was a scheduled XPT passenger service operated by NSW Trains. It consisted of leading and trailing diesel power cars, six passenger carriages and a buffet car. The train had an overall length of 204 m and a gross weight of 460 t, with a maximum operating speed of 160 km/h (restricted to 25 km/h on the fly over section of track).

Train crew information

Train ST24 was operated by a single driver, with hospitality staff in attendance catering for passenger needs. In addition, a pilot was assigned to assist the driver with route familiarisation over the newly commissioned section of dual gauge track leading out of the Southern Cross station and the fly over before heading north on standard gauge track towards Sydney.

Initial information indicated that the driver and pilot were appropriately qualified, had extensive experience and were medically fit for duty. Following the derailment, both the driver and pilot underwent mandatory drug and alcohol testing – the results of which were negative.

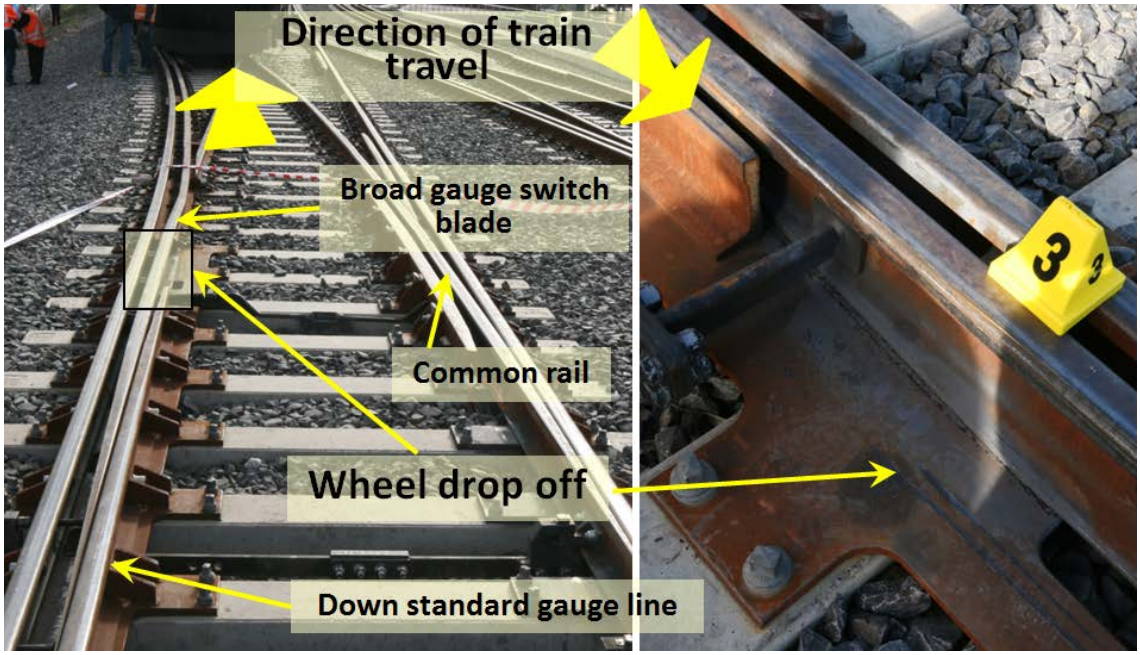
Environmental conditions

The environmental conditions at the time of derailment were examined and deemed unlikely to have contributed to the occurrence.

Site observations

An examination of the track across the area of the derailment found that as the left wheel of a carriage from the XPT train had transitioned from the down standard gauge line onto the broad gauge switch blade[3], the wheel had dropped into the four foot[4]. This is evidenced at Figure 4 (right side image) which shows bruising on the gauge face corner of the broad gauge switch blade, and flange marks on the base plate at the bottom of the turnout. At that point however, there was no evidence of corresponding wheel flange marks on the opposite side – suggesting that the right wheel had not derailed at that point. It was not until about 1.3 m further along the track that there was evidence (wheel flange marks) produced by the right wheel climbing over the head of the right rail.

Figure 4: Turnout MYD887 point of wheel drop and flange marks on turnout base plate



Source: CITS with annotation by ATSB

[3] The design of the dual gauge turnout required standard gauge wheels to traverse the broad gauge switch blade for a short distance between the end of the short standard gauge rail and the heel (or pivot point) of the broad gauge switch blade.

[4] The area between the rails of a standard gauge railway

An examination of the rolling stock determined that all wheels under passenger carriages XL2229 and XAM2176 were derailed. It was noted that the lead bogie of carriage XL2229 had derailed to the left in the direction of travel, while all others had derailed to the right. Considering that evidence markings on the rail indicated that the initial derailment was to the right, it is likely that that the lead bogie of carriage XL2229 had derailed to the left as a consequence of the carriage twisting when its rear bogie derailed to the right. Examination of the derailed carriages therefore focused on the wheelsets of XL2229 (trailing bogie) and XAM2176 (Figure 5 - lead bogie).

Figure 5: Photo – Derailed leading wheelset carriage XAM2176

Source: CITS with annotation by ATSB

Observations established that one (or more) left wheels had dropped off at the broad gauge switch rail, while the opposite right wheel(s), on the same axle, had initially remained on the common rail. An initial review of this evidence suggests a possible mismatch between the wheelset dimensions and the track gauge through the transfer area of the dual gauge turnout.

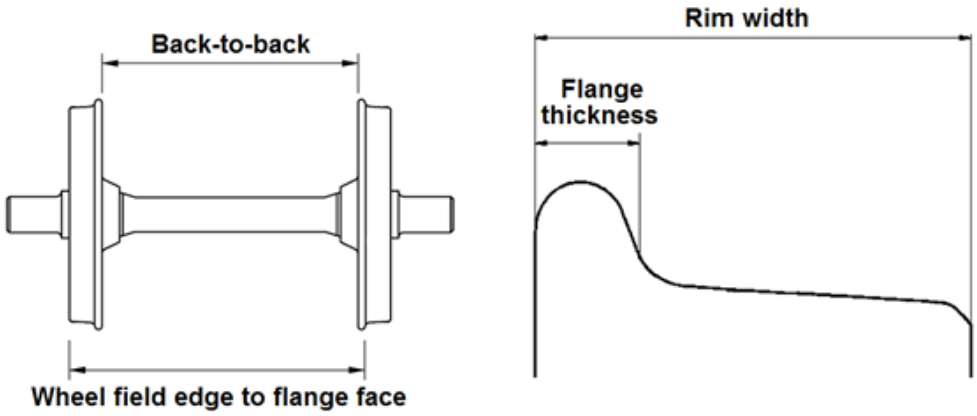
Wheelset measurements

For rolling stock, the wheelset dimensions that are critical to ensure compatibility with track gauge, are rim width, flange thickness and wheelset back-to-back distance (Figure 6). For a wheel to drop in between a track, the *wheel field edge to flange face* distance theoretically must be less than track gauge.

The design and maintenance standards for rolling stock wheelsets and rolling stock wheels are documented in Australian Standard AS7517.3-2009 (Railway Rolling Stock Wheelsets Part 3) and AS7514.3-2010 (Railway Rolling Stock Wheels Part 3).

AS7517.3-2009 prescribes back-to-back dimensions of between 1357 mm and 1360 mm for standard gauge rolling stock. In this occurrence, the measured back-to-back dimensions for all derailed wheelsets were 1358 mm or 1359 mm and therefore within tolerance.

Figure 6: Wheelset dimensions



Source: ATSB

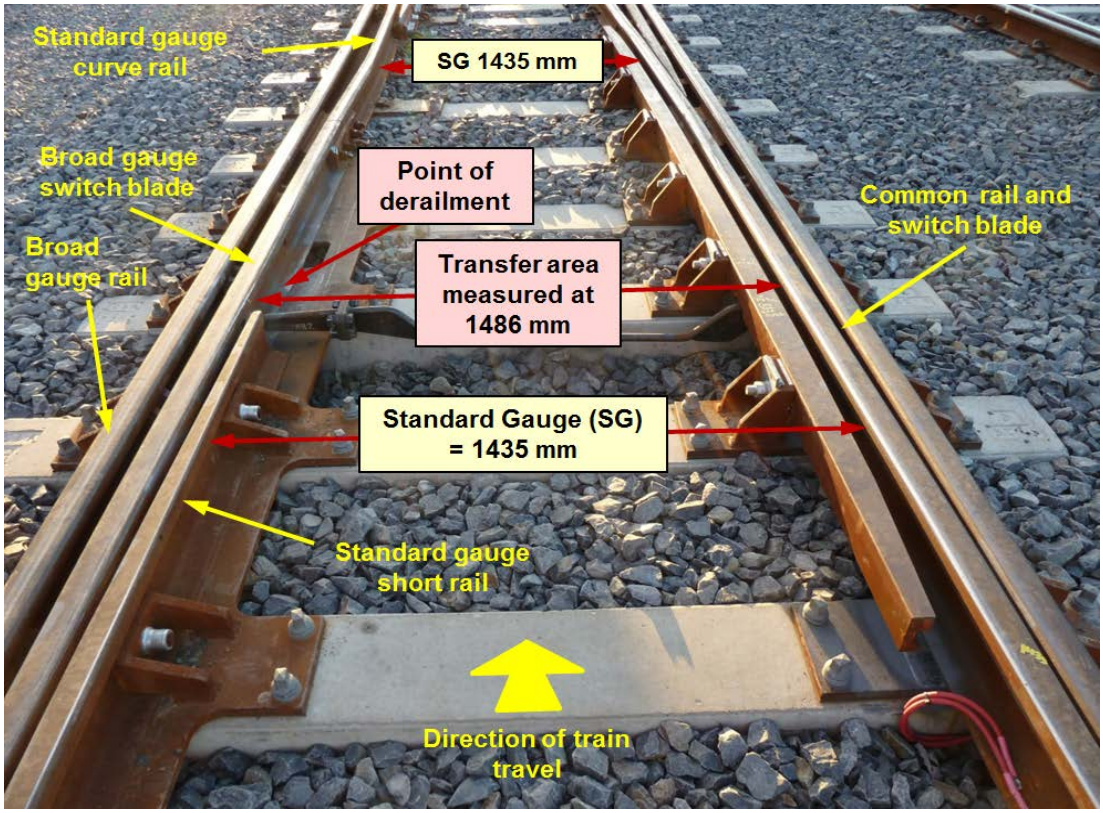
AS7514.3-2010 prescribes rim widths of between 127 mm and 140 mm for both broad and standard gauge rolling stock wheels, and recommends a minimum flange thickness of 19 mm. Train ST24 had authority to operate on V/Line's network, and all examined wheels were compliant with the corresponding Australian Standard requirements. All examined wheels had a rim width of 127 mm.

It was noted that during commissioning of the dual gauge turnouts, the test trains all had wheels with rim widths of 140 mm.

Track measurements

Dual gauge turnout (MYD887) provided for broad gauge movements to the right and dual gauge movements to the left – the direction of ST24 train travel.

Figure 7: On site track measurements



Source: CITS with annotation by ATSB

For standard gauge trains, as the left wheels transfer from the standard gauge short rail (Figure 7) onto the broad gauge switch blade (before entering the standard gauge curve rail), the gauge by necessity is wider. This is to allow both broad and standard gauge wheelsets to pass through the transfer area. For a standard gauge train, this results in reduced rim contact on the rail head through the transfer area, and it was at this area that train ST24 derailed.

After the derailment, the measurement through the transfer area was 1,486 mm; 6 mm greater than the design width of 1,480 mm. It is likely however, that there was some level of permanent bending of the switch rail as a result of the derailment.

Examination of the lead wheelset/lead bogie of carriage XAM2176 (wheelset with narrowest field edge to flange face distance) confirmed that there was limited rim contact on the rail head through the transfer area. With the left wheel of XAM2176 running on the right edge of the broad gauge switch rail (in the direction of train travel), this would likely have applied high outward torsional loading on the switch blade. In circumstances where the broad gauge switch blade is insufficiently restrained through the transfer area, the switch blade can both roll and flex outward, increasing the likelihood of one or more wheels dropping in between the track and causing the train to derail.

Safety analysis

Examination of train ST24 found that all wheels on the derailed XPT were compliant with Australian standards and V/Line's requirements to operate on their network. All measured wheel rim widths were 127 mm.

Inspection of the dual gauge turnout MYD887 established that as a wheel (or wheels) of the XPT transitioned from the short standard gauge running rail, through the turnout, and onto the broad gauge switch blade, there was reduced wheel rim contact on the rail head. The investigation found that for a 127 mm wheel rim width, an insufficiently restrained broad gauge switch blade in the transfer area can roll and flex, allowing wheel(s) to drop off the switch blade and produce a derailment. Wheel flange wear and narrow back-to-back wheel distance will compound this risk.

The ATSB concluded that these factors probably contributed to the derailment of XPT passenger train ST24 at turnout MYD877 on 11 July 2014.

Similar conditions likely existed for turnout MYD882. Evidence suggested that a wheel or wheel(s) of train ST21 (travelling towards Southern Cross station) had derailed as it passed over turnout MYD882. The wheel(s) subsequently re-railed shortly thereafter, leading the driver and pilot reporting the incident as a possible track geometry defect. While that report had prompted the scheduling of a track inspection of turnout MYD882, there had been no inspection for potential defects to rolling stock or other track infrastructure (turnout MYD887) before train ST24 departed Southern Cross station.

Ongoing investigation

The investigation is continuing and will include an examination of the following:

- Design, quality control, commissioning and acceptance testing processes for dual gauge turnouts.
- The process for identification and examination of potential infrastructure or rolling stock defects that may result in derailment, following reports of suspected infrastructure irregularities.

Preliminary findings

From the evidence available, the following preliminary findings are made with respect to the derailment of XPT passenger train ST24 on 11 July 2014. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing safety factor

- **Inherent to the design of many dual gauge turnouts is a region of reduced wheel rim contact on the broad gauge switch blade (rail head) through the transfer area. In circumstances where the switch blade is insufficiently restrained, and where the passing train has a narrow (127 mm) wheel rim width, there is an increased risk of derailment. [Safety issue]**

Other findings

- All wheel and wheelset dimensions for the derailed rolling stock that were critical for compatibility with track gauge were within the requirements specified in the Australian Standards, and considered fit for purpose operation on the V/Line network.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Safe transition of dual gauge turnouts

Number:	RO-2014-013-SI-01
Issue owner:	V/Line
Operation affected:	Rail Operators – All rail operators.
Who it affects:	All rail operators throughout Australia.

Safety issue description:

Inherent to the design of many dual gauge turnouts, is a region of reduced wheel rim contact on the broad gauge switch blade (rail head) through the transfer area. In circumstances where the switch blade is insufficiently restrained, and where the passing train has a narrow (127 mm) wheel rim width, there is an increased risk of derailment.

Proactive safety action advised by: V/Line

V/Line is currently actively managing the redesign, alteration and validation of the type 37 turnout to support restoration of standard gauge, 127 mm rim width, services.

Office of the National Rail Safety Regulator (ONRSR) – Safety Alert

The Office of the National Rail Safety Regulator has independently reviewed this occurrence and identified the higher risk of derailment through the wheel transfer area of some mixed and dual gauge turnouts for rolling stock having wheel rim widths of 127mm. ONRSR has issued an industry wide Safety Alert (RSA-2014-03) shown at Appendix A

ATSB comment:

While the ATSB is satisfied that the action proposed by V/Line will adequately address this safety issue in the context of type 37 turnouts, it is considered appropriate that all rail transport operators should be made broadly aware of the increased derailment risk in operating trains with narrow (127 mm) rimmed wheels through similar dual gauge turnouts.

ATSB safety advisory notice RO-2014-013-SAN-001 to: All rail transport operators

The Australian Transport Safety Bureau encourages all relevant rail service operators and rail infrastructure managers to note the circumstances of the derailment outlined in this preliminary report, and to undertake an examination of all dual gauge turnouts under their control, to ensure that all authorised rolling stock can safely transition the turnouts.

General details

Occurrence details

Date and time:	11 July 2014 – 0835 EST	
Occurrence category:	Serious incident	
Primary occurrence type:	Derailment - Running Line	
Location:	North Melbourne 2 km north west of Southern Cross Station	
	Latitude: 37° 48.419' S	Longitude: 144° 56.341' E

Train details

Train operator:	NSW Trains	
Registration:	ST24	
Type of operation:	Passenger rail	
Persons on board:	Crew – 5 (6 including pilot)	Passengers – 193
Injuries:	Crew – 6 (Minor)	Passengers – 10 (Minor)
Damage:	Minor	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- NSW Trains
- The Australian Rail Track Corporation (ARTC)
- V/Line
- Vossloh

References

AS7517.3-2009 (Railway Rolling Stock Wheelsets Part 3)

AS7514.3-2010 (Railway Rolling Stock Wheels Part 3)

RISSB National Guideline - Glossary of Railway Terminology

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to NSW Trains, the Office of the National Rail Safety Regulator, the Australian Rail Track Corporation, V/Line, Vossloh and train crew.

Submissions were received from NSW Trains, the Office of the National Rail Safety Regulator, the Australian Rail Track Corporation, V/Line, Vossloh and train crew. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Appendices

Appendix A – ONRSR safety alert RSA-2014-03

Safety Alert

OFFICE OF THE national rail safety regulator

NOTICE TO RAIL TRANSPORT OPERATORS

RSA-2014-03 Date Issued: 20 August 2014

SUBJECT

Operational interfaces between Rail Infrastructure Managers and Rolling Stock Operators – mixed and dual gauge turnouts

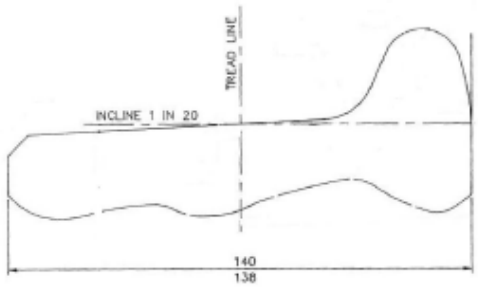
ISSUE

On 11 July 2014 a standard gauge interstate passenger train derailed in a facing movement while attempting to negotiate the diverge leg of a Type 37 mixed gauge (1435mm / 1600mm) turnout.

The derailment occurred at the wheel transfer area approximately midway along the point blade of the turnout. The train wheelsets had a rim width of 127mm.

Due to the design of the wheel transfer area of some mixed and dual gauge turnouts, rolling stock with wheelsets of 127mm rim width are at higher risk of derailment than wheelsets of 140mm rim width.

Similar mixed gauge and dual gauge (1435mm / 1600mm) turnouts are used elsewhere on Australian rail networks.



ANZR1 Wheel Tread Profile

Both Rail Infrastructure Managers (RIMs) and Rolling Stock Operators (RSOs) have rail safety duties under the Rail Safety National Law and obligations to manage, so far as is reasonably practicable, the safety of the operator's railway operations. These duties include:

- Ensuring they have an appropriate documented set of engineering standards and procedures, and operational systems, safety standards and procedures to cover the following, and, if relevant, the interface between any 2 or more of the following:
  a) rail infrastructure
  b) rolling stock
  c) operational systems.

RSA-2014-03 ECM: 42019 Date issued: 20 August 2014 Page 1 of 2

- Managing the risks associated with their railway operations, including at the rolling stock / track infrastructure interface (including the wheel / rail interface) which may be managed jointly through track access agreements or similar type agreements.
- Ensuring they have procedures for ensuring that changes that may affect the safety of railway operations are identified and managed, including consultation with all affected parties.

As a result of this occurrence, and pending the outcome of formal investigations into the incident, the ONRSR recommends all relevant RIMs and RSOs operating standard gauge rolling stock over mixed gauge and dual gauge turnouts undertake the following:

1. RSOs to contact any relevant RIM of the network they operate on that has dual gauge operations to determine if your rolling stock operates over mixed gauge and dual gauge turnouts.

    a. RSOs to ensure they are operating in accordance with the route access standards and track access agreement (or similar documents) as defined by the RIM.

    b. RSOs to check their rolling stock fleet to ensure they are operating the correct wheelsets (in particular, wheel rim widths and wheel profiles) in accordance with the RIM's requirements.

    c. RSOs to ensure no changes are made to the operational configuration of their rolling stock such as changes in operational routes, introduction of new or modified rolling stock or changes to wheelset configuration (in particular, wheel rim widths and wheel profiles) without first confirming that the changes will continue to meet all requirements of the RIM.

2. RIMs to review the design of the wheel transfer areas of all mixed gauge turnouts. The review should focus on:

    a. Turnout designs similar to Type 37 mixed gauge turnouts (including Type 27, Type 28 and Type 38 mixed gauge turnouts).

    b. Ensuring wheel transfer designs are suitable for the operation of all rolling stock including the operation of wheelsets with 127mm rim widths.

3. RIMs to notify all RSOs affected by any relevant changes implemented as a result of undertaking step 2 above.

4. RIMs with mixed gauge turnouts similar to Type 37 mixed gauge turnouts (including Type 27, Type 28 and Type 38 mixed gauge turnouts) to inspect and adjust the turnouts as required to ensure the correct wheel transfer.

Additional information and updates regarding this safety alert may be provided in the future based on the outcomes of investigations currently underway.

For further information please contact Geoff Bell, Infrastructure Safety Engineer within the Victorian Branch of the ONRSR via e-mail geoff.bell@onrsr.com.au or phone (03) 9655 8954.

THIS ADVICE IS EFFECTIVE IMMEDIATELY

Peter Doggett
Executive Director National Operations

Australian Transport Safety Bureau

Enquiries 1800 020 616
Notifications 1800 011 034
REPCON 1800 011 034
Web www.atsb.gov.au
Twitter @ATSBinfo
Email atsbinfo@atsb.gov.au

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
Derailment of train ST24 near North Melbourne, Victoria
11 July 2014

RO-2014-013
Preliminary – 25 September 2014