



Australian Government
Australian Transport Safety Bureau

Derailment of grain train 9130

Emu, Victoria | 12 February 2014



Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2014-003
Final – 20 May 2015

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Addendum

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Safety summary

What happened

At about 1411 on 12 February 2014, 10 wagons of a loaded grain train en-route from Birchip to North Geelong derailed at Emu in North Central Victoria. The weather was hot with a forecast temperature of 36° C.

As a consequence of the derailment there was damage to about 210 m of track. Five wagons overturned resulting in significant damage and a loss of load. The subsequent rolling stock recovery and track repair activities closed the line for five days. Emu Loop was not reinstated as a crossing location.

What the ATSB found

The ATSB found that rail creep readings within Emu Loop had been identified by V/Line as a Priority 2 defect – requiring prioritisation for rectification – and that this rectification had not been carried out by the time the derailment had occurred. The hot conditions of the day together with a latent rail creep condition contributed to the rails within Emu Loop assuming a state of longitudinal compression.

The track-train dynamics generated by the passage of 9130, even at the relatively low speed, in combination with the compressed state of the rail, produced lateral loads that exceeded the lateral resistance of the ballast, causing misalignment. The lateral misalignment was of a sufficient magnitude to result in derailment.

Due to the high forecast temperature, train speed restrictions and special track heat patrol requirements had come into force. Speed restrictions were met and a heat patrol was planned to be conducted over the length of line where the derailment occurred. However, as the train was in possession of an authority through the section, the patrol was not conducted ahead of the train.

What's been done as a result

V/Line is undertaking a review of the current procedure for managing Priority 2 rail creep defects. This will be completed by November 2015.

Safety message

This derailment highlights the need for rail infrastructure managers to monitor and address rail creep conditions and track lateral stability, particularly prior to the onset of hot weather conditions.

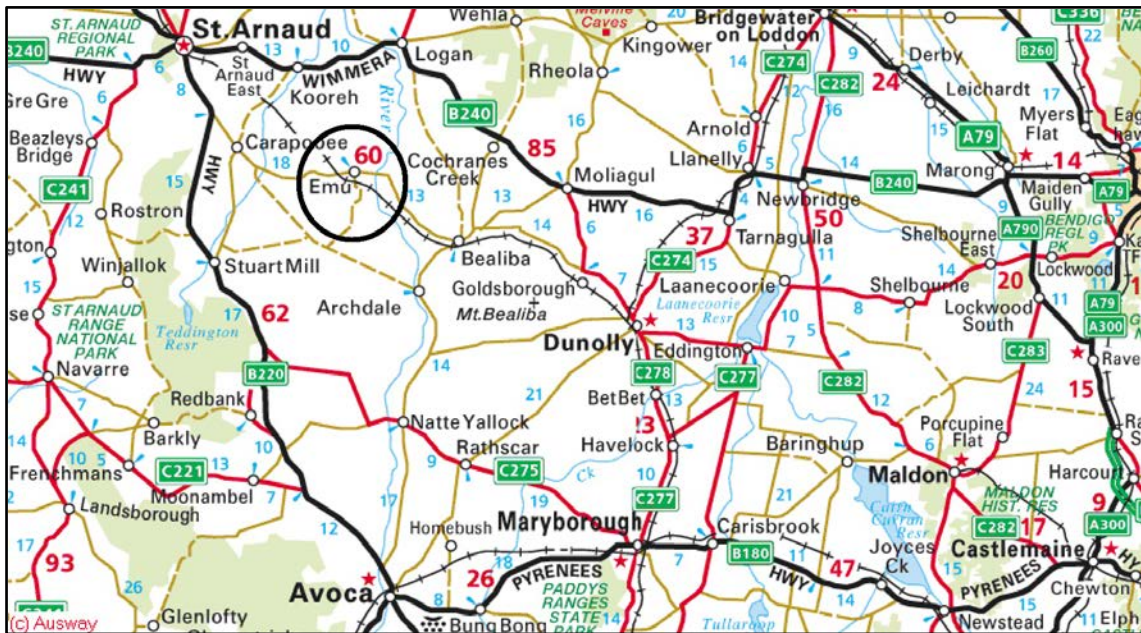
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The occurrence

After loading at the Birchchip grain facility, train 9130 operated by Pacific National departed for North Geelong at 1157¹. It travelled to Watchem where the train crew was issued with their next Train Order authorising 9130 to proceed to Maryborough. Because the temperature was forecast to reach 36° C, they were also issued with a WOLO² Heat Speed Restriction Notice which reduced the authorised maximum speed of the train from 80 km/h to 65 km/h.

Figure 1: Location of incident



Source: Melway Publishing 2013 (copyright) annotated by Chief Investigator, Transport Safety (Vic)

The train proceeded under the WOLO conditions for 92 kilometres without incident at speeds not exceeding 60 km/h. At Emu Loop the train crew did not observe any irregularity with the track or ride and slowed the train to about 40 km/h to negotiate the trailable points³ at the Up⁴ end of the loop. After the lead locomotive had negotiated the points, 9130's speed was increased to 50 km/h. At about 1411 and with more than half the train having travelled through the Up-end turnout, there was a loss of brake pipe pressure and the train was brought to a stand.

Ten wagons towards the rear of the train had derailed just prior to the Up-end of the loop (Figure 2). Five of the derailed wagons had toppled resulting in a significant loss of load. The initial point of derailment was identified within the loop, about 30 m from the trailable points. About 210 m of track, including the turnout assembly, was severely damaged.

The locomotives, 26 leading wagons and the last wagon remained on track and upright. The train crew did not sustain any injuries.

¹ Eastern Daylight Time (EDT).

² The application of a heat-related speed restriction is accomplished by publishing a notice called a WOLO. The name is not an acronym, but derives from the original railway telegraph code for such a notice.

³ A low-cost way to provide crossing loop infrastructure. The facing point blades are maintained in one pre-determined direction by a hydraulic piston with built-in time delay called a 'Mechanical Switchman' and the train must take that direction at the points. On departure from the crossing location the train will force the trailing points across to accommodate the movement (the 'trailable' condition) and the Mechanical Switchman arrangement will return the blades to their intended facing position a short time after the train has passed.

⁴ For rail operations in Victoria the 'Up' direction refers to trains travelling towards Melbourne.

Figure 2: Incident site viewed from the Up-end points



Source: Chief Investigator, Transport Safety (Vic)

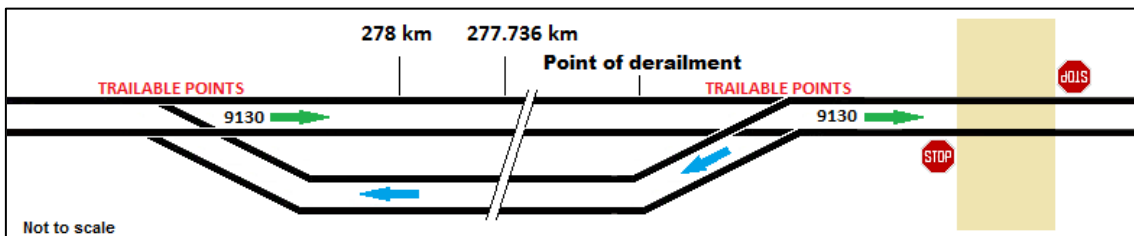
Context

Infrastructure

The line between Maryborough and Mildura is classified by V/Line as Class 3 (minor passenger line and major freight line). Class 3 track nominal construction requirements are; timber sleepers with non-resilient fastenings and sleeper plates with mechanical jointed 47 kg/m rail in 82 m lengths. Ballast for new and upgrade works is required to be 300 mm deep under the sleeper and level with the top of the sleeper. The ballast top should extend at least 400 mm beyond the sleeper ends.

Emu Loop was an 840 m long crossing loop configured so that trains were routed onto the left-hand track in the direction of travel and through trailable points at the opposite end (Figure 3). The loop (mid-point) was located 277.736 km from Melbourne, between Dunolly and St Arnaud. A trackside distance marker and creep monument⁵ was provided at 278 km.

Figure 3: Schematic of track layout at Emu Loop



Source: Chief Investigator, Transport Safety (Vic)

Several sleepers within Emu Loop had been ‘box anchored’ (the rail secured on both sides of the sleeper) to minimise longitudinal rail movement. The condition of the sleepers and rail fastenings was good to fair. Ballast was generally fouled with soil and sand.

Managing rail stress

Rails in jointed track are laid to make use of an expansion gap between the lengths of rail (Figure 4). The objective is to install rails so that the extremes of weather can be tolerated. This is a balance aimed at minimising rail fractures in cold weather (rails contracted and in tension) and track misalignment in hot weather (rails expanded and in compression).

V/Line construction standards specified procedures to ensure that rails are installed to achieve design levels of maximum tensile and compressive stress. For 82 m jointed rail, the standards specified that the gap between rail ends should be fully open (11 mm) for rails laid at a rail temperature of 25-27° C, and fully closed (rail ends butted together) when laid at rail temperatures of 37-38° C. For installation temperatures between 28 and 36° C, gap requirements were specified, and other procedures prescribed for temperatures outside the 25-38° C range.

Correctly installed rails should therefore be effectively stress free within the working limits of the expansion gap at rail temperatures of between 25 and 38° C. At temperatures below 25° C, the contracted rails would be in tension, and at temperatures above 38° C the rails would be in compression.

⁵ A fixed marker located square to the track to facilitate the accurate measurement of creep.

Figure 4: Typical expansion gap in jointed rail

Source: Chief Investigator, Transport Safety (Vic)

In hot weather, rail temperatures in excess of 50° C are not uncommon as rail temperatures can typically be up to 50 per cent more than the ambient temperature⁶. As a result, in hot weather, rails are expected to be in a longitudinally compressed condition. Under such conditions, track stability is reliant on rail fastenings and track supporting formations, including ballast, to resist rail and track lateral misalignment.

The ongoing management of stress in rails relies on a number of factors including maintaining the function of mechanical rail joints. Frozen joints that no longer allow movement of the rail ends removes one component of rail stress management.

Monitoring of rail creep—the longitudinal movement of rail over time—is likewise an important maintenance activity to ensure that rail is not bunching in some areas and being stretched in others, thus altering its state of stress beyond the limits intended at installation. To facilitate measurement of creep, fixed track-side monuments are provided at one km intervals. Such a monument was provided within Emu Loop at the 278 km mark and measurements were taken in spring and autumn each year. The creep measurement⁷ on the Up track taken in spring 2013 indicated a six monthly change of 30 mm (in the Up direction) compared to the autumn measurement. This change was identified within V/Line's management system as a C2 defect⁸. The current procedure for 'Inspection and Assessment of Lateral Stability' does not identify time limits for when C2 defects shall be remediated - only that the location be assessed and prioritised for rectification. A work order was generated for this defect; however, there was no record of monitoring or remedial action.

Heat speed restrictions and patrols

During periods of hot weather, the risk of rail misalignment or track buckling is elevated. To manage this risk, V/Line implements measures in the form of special patrols and reduced train speeds (WOLO heat speed restrictions). In the case of WOLO speed restrictions, threshold temperatures are determined for each section of a line giving consideration to its condition. For this section of line, WOLO precautions were implemented when temperatures exceeded or were

⁶ Wu Y., Munro P., Rasul M.G., Khan M.M.K., A review of Recent Developments in Rail Temperature Prediction for use in Buckling Studies, RTSA Conference on Railway Engineering, Wellington, 2010.

⁷ Recorded in the Creep Exceedence Defect Report.

⁸ A C2 defect required the location to be assessed and prioritised for rectification.

forecast to exceed 36° C. WOLO heat speed restriction notices may also be utilised to prohibit trains from operating due to weather conditions (actual or forecast).

Train and train crew

Train 9130 was operated utilising a two person crew who were qualified and medically fit to perform their respective duties. Post incident drug and alcohol testing recorded nil results for both crew members.

The train comprised of two BL locomotives (owned by Pacific National) and 37 grain hopper wagons (owned by CARGILL). It had a total weight of 2776 t and was 650 m long. The first 36 wagons were WGSY class wagons and the last vehicle was wagon WGBY 01063R that was not authorised to operate on the V/Line broad gauge network. The V/Line Network Service Plan described wagons WGBY 1001-1084 as being two permanently coupled standard gauge only grain wagons, whereas WGBY 01063 had been split and modified to broad gauge. Wagon bogie inspections did not identify any condition that may have contributed to the derailment.

Loading of 9130

At Birchip, grain was distributed into rail wagons from over-rail silos. The total train load was measured when transferred to the silos; however, there was no system of measuring the load into each wagon. To load at the Birchip facility, trains are run slowly and continuously below the silos. One or two loaders are positioned on a platform above the train and manually open and close silo chutes to control the flow of grain into each wagon. This is a task that requires judgement by the loader(s).

WGSY wagons have a tare of 24 t and a capacity of 68 t, for a gross vehicle mass of 92 t. However, they were limited on the V/Line network between Birchip and North Geelong to a maximum vehicle mass of 76 t, meaning they have excess capacity and are susceptible to overloading. Inspection at site found that in this instance (compared to previous investigation⁹) the hopper end-bins had not been loaded (Figure 5).

Figure 5: Train 9130 typical loaded WGSY wagon



Source: Chief Investigator, Transport Safety (Vic)

⁹ Chief Investigator Transport Safety, Victoria report 2011/13, Derailment Freight Train No. 9162, Donald, 23/12/2011.

The train consist report indicated that the last wagon was empty, the second last partially loaded and all other WGSY wagons loaded to the network limit of 76 t. However, it was identified that the last and second last wagon were both empty and the third last partially loaded. In effect, this meant that the total train load was distributed across the other loaded wagons. Post derailment weighing of the leading 25 wagons confirmed that 11 of these wagons had a mass exceeding the network limit, by up to five tonnes.

Improvements have been achieved in the loading process of WGSY wagons by keeping the hopper end-bins empty, however a proportion of these wagons continue traversing the V/Line network in an overloaded condition.

Safety analysis

Rail creep

Creep is the longitudinal movement of rails and track caused by the action of traffic on the line over time. It is most likely to occur on grades, at locations where trains brake, and in the direction of predominant traffic tonnage. Rail is also prone to bunching up on the approach to level crossings and turnouts when creep is present.

The traffic pattern between Mildura and Maryborough, and therefore through Emu, was such that loaded traffic was predominant in the Up direction. Up trains approached the permanent speed restriction of 65 km/h for the Up end trailable point on a slight descending gradient. The combination of these operational and physical characteristics created conditions conducive to rail creep of the left-hand track in the Up direction. The fixed points at the loop's Up-end, comprising of the turnout and the level crossing, provided resistance to any creep and therefore heightened the potential for high rail compression at this location.

No action had been taken to rectify the C2 creep defect on the Up track and it is probable that given the operational loading of this track, the creep condition probably worsened in the months between the creep measurement and the derailment. During this same period, significant maintenance works were conducted at the loop's Down-end turnout assembly that involved disturbance of the rail and it is possible that these works also influenced the stress condition of the track.

Track formation and condition

Track stability is reliant on good ballast that is packed below, between, and around the sleepers. It is essential for ballast to be level up to the top of the sleeper and for a substantial shoulder to be placed at their ends as the ballast shoulder is for the most part the only component restraining lateral movement of the track.

The ballast profile within Emu Loop was shallow with inconsistent and sub-standard shoulder widths throughout. These conditions reduced track lateral stability, especially when combined with the extreme heat conditions.

Track misalignment

The train crew did not observe any misalignment in the track which is consistent with the site observations of the misalignment not having been initiated until the passage of the locomotives and 27 wagons.

The rail temperature was measured at about 50° C some hours after the event and it is probable that the rail was at this temperature or higher at the time of derailment. As a result the rails would have been in a state of compression and probably in a higher compressive state than the 'design' stress condition due to rail creep.

The track-train dynamics generated by the passage of 9130, even at the relatively low speeds of 40 to 50 km/h, in combination with the compressed state of the rail produced lateral loads exceeding the lateral resistance of the ballast, causing misalignment. Site observations identified wheel flange marks on the railhead that were consistent with a lateral movement of the track and aggressive wheel flange climb activity.

Heat patrol

Whenever WOLO heat speed restrictions were imposed, V/Line required additional track inspection patrols to be conducted. Whenever possible, heat patrols were to be conducted during the hottest forecast time of the day and ahead of the next scheduled train.

On 12 February 2014, the patrol ganger had planned to conduct heat patrols on both lines within his area of responsibility. The heat patrol on the Kulwin line was conducted first, as this line was considered more vulnerable to a heat induced event. Train 9130 had authorisation to proceed from Watchem to Maryborough and had passed through St Arnaud before the patrol ganger was in position.

Given that a misalignment was not observed by the train crew, the high-rail heat patrol may also not have detected anything untoward at Emu Loop. However, the operational decision to permit 9130 to continue beyond St Arnaud prior to the heat patrol being conducted removed one layer of defence.

Findings

From the evidence available, the following findings are made with respect to the derailment of grain train 9130 at Emu, Victoria on 12 February 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 factors

- **V/Line’s organisational processes for responding to and rectifying rail creep defects did not ensure that all such defects were addressed before the onset of warmer seasonal conditions. [Safety issue]**
- The C2 rail creep defect identified within Emu Loop in the spring of 2013 was not remediated prior to the summer season.
- The rail creep condition probably worsened during the summer season and prior to the derailment.
- The condition of the track ballast in conjunction with the compressed state of the rail rendered the track vulnerable to a heat induced lateral misalignment.
- A lateral misalignment of the track developed during the passage of train 9130 and was of a sufficient magnitude to cause the derailment.

Other factors that increased risk

- A heat patrol was not conducted between St Arnaud and Dunolly prior to train 9130 travelling through that section.

Other findings

- Several wagons of 9130 exceeded the network maximum freight vehicle mass of 76 tonnes.
- WGBY wagons were authorised to operate as two permanently coupled grain wagons on the V/Line Standard-Gauge network however they were not authorised to operate on the Broad-Gauge 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.

Rail creep management

Number:	RO-2014-003-SI-001
Issue owner:	V/Line Pty Ltd
Operation affected:	Rail – infrastructure maintenance
Who it affects:	All owners of rail infrastructure.

Safety issue description:

V/Line's organisational processes for responding to and rectifying rail creep defects did not ensure that all such defects were addressed in a timely way.

Proactive safety action taken by V/Line Pty Ltd

Action number: RO-2014-003-NSA-018

V/Line has advised that it will review its processes and timeframes for addressing C2 defects. This review is to be completed by November 2015.

Current status of the safety issue

Issue status: Safety action pending

Justification: The ATSB expects that a review will result in the amendment to the current procedure that will establish processes and timeframes for C2 defect remediation.

General details

Occurrence details

Date and time:	12 February 2014 - 1411 EST	
Occurrence category:	Serious incident	
Primary occurrence type:	Derailment	
Location:	Near Emu, Victoria	
	Latitude: 36° 44.126' S	Longitude: 143°26.752' E

Train details

Train operator:	Pacific National Rail – Rural and Bulk Division	
Registration:	Train No. 9130	
Type of operation:	Freight	
Persons on board:	Crew – two	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Significant to track and rolling stock.	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- V/Line Pty Ltd
- Pacific National
- Train crew.

References

Wu Y., Munro P., Rasul M.G., Khan M.M.K., A review of Recent Developments in Rail Temperature Prediction for use in Buckling Studies, RTSA Conference on Railway Engineering, Wellington, 2010.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (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 V/Line, Pacific National, the train driver and Grain Flow. Submissions received were reviewed and where considered appropriate, the text 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.

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Investigation

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