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Australian Transport Safety Bureau

Derailment of ore train 24KW

near Whyalla, South Australia | 7 July 2014

Investigation

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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

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Addendum

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Safety summary

What happened

On 7 July 2014, Genesee & Wyoming Australia train 24KW departed from Iron Duke, a mine site near Whyalla, South Australia. The train was loaded with iron ore destined for the port of Whyalla. Shortly after the train entered the Iron Baron to 21km Junction section, the driver felt a slight 'bump' and noticed a loss in brake pipe pressure, before observing a large cloud of dust toward the rear of the train. Once the train had come to a stand the driver walked back along the consist and saw several wagons had derailed, resulting in significant track damage.

Derailed wagons of train 24KW

Source: ATSB

What the ATSB found

The ATSB found that two mechanical fishplate joints located at the 108.100 km mark had failed under the passage of the train. The joints failed due to a combination of pre-existing fatigue cracks in the fishplates, and at least one joint being in a condition of weakened structural integrity due to inadequate fastening. As the rollingstock passed over the incomplete and ineffective rail joints, joint instability and movement produced increasing impact forces, lateral pressure and subsequent joint separation. This was followed by the progressive failure and misalignment of the track until the wagons of train 24KW inevitably derailed.

Other fishplated joints within the immediate vicinity of the 108.100 km mark were also examined. While some bolts were missing, examination of the bolt holes suggested that four fasteners had been used to secure the joints. Based on the evidence available, the ATSB concluded that the deficient permanent mechanical rail joint installed at the 108.100 km mark was an isolated anomaly and not indicative of the assembled condition of other plated joints.

What's been done as a result

Shortly after the derailment, Genesse & Wyoming Australia, through a welding program, removed all the mechanical joints within the Whyalla Narrow Gauge mainline network.

In addition to the welding program, GWA and Transfield Services Australia completed an audit of maintenance standards and processes - focussed on improving instructions relating to joint inspection, maintenance and risk reporting. In November 2014, Transfield Services Australia, in cooperation with GWA, disseminated the document *Mechanical Joint Rectification* to all track maintenance staff.

Following an internal investigation and an incident cause analysis study into the derailment of train 24KW, GWA identified corrective actions associated with installation, inspection and maintenance of mechanical rail joints. GWA have made significant progress implementing those recommendations.

Safety message

To ensure fishplate joints are correctly installed and joints are not compromised during operation, track infrastructure owners and operators should ensure that track maintenance staff are provided with sufficient guidance and instruction for all works requested.

Track managers should ensure the effective application of policy and procedures relating to the assurance of the structural integrity of track joints - before returning the joints to service.

Contents

The occurrence

At 0040[1] on 7 July 2014, Genesee & Wyoming Australia (GWA) train 24A departed from Whyalla for the mine site of Iron Duke, South Australia (Figure 1). The train, crewed by one driver, consisted of two locomotives and 28 empty (2-unit[2]) ore wagons.

On arrival at Iron Duke (at the 55 km mark[3]), part of the train was loaded with iron ore before departing on its return journey at 0353, as train 24KW. At 0416, train 24KW arrived at Iron Knight where the remainder of the wagons were loaded. When loading was completed, train 24KW continued its journey (at about 0816) to the port of Whyalla.

The passage of the train to Iron Baron (121.1 km) was uneventful. As the train entered the Iron Baron to 21km Junction section, the driver gradually accelerated towards 60 km/h, the maximum permitted track speed for ore trains in this section. From the 110 km to 109 km mark the track descends slightly. To prevent the train from exceeding 60 km/h, the driver made a partial brake application, put the train into light dynamic braking,[4] and reduced speed to 50 km/h.

Figure 1: Location map – South Australia

Source: NatMap Railways of Australia annotated by ATSB

At around the 108 km, the driver felt a slight 'bump' under the locomotive. He looked in the rear vision mirror, checked the locomotive instruments and noted that all appeared normal. The train travelled a further 500 m when the driver noticed a sudden change in the reading on the air brake flow gauge and a loss in brake pipe pressure. Observing a large amount of rising dust behind, the driver realised that the train had probably derailed.

The driver allowed the train to slow and come to a stop. At 0913, he secured the train and advised the train controller that the train was at stop within the Iron Baron to Middleback section, had probably derailed, and that he was going back to investigate.

The driver walked back along the train where he saw a number of derailed wagons in the middle to rear portion of the train. After an initial assessment of the damage, he contacted train control and reported that a total of seven wagons had derailed and, except for one bogie, the rear two wagons of the consist were still on the rail.

The driver continued walking west to inspect the track past the end of the train, and after a period of time was met by the GWA Shift Coordinator who had arrived onsite by road. The GWA Shift Coordinator and the driver returned to the locomotive where they were met the GWA Depot Co-ordinator and a Transfield Services Australia track inspector. While discussing the event, the group were advised that broken fishplated joints had been found under the first of the railed

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1 The 24-hour clock is used in this report and is referenced from Central Standard Time (CST).
2 A wagon consisting of two permanently coupled vehicles, each vehicle independently supported on a pair of bogies.
3 Distances are track kilometres measured from the 21 km junction, South Australia.
4 The trains' electric traction motors are used for regenerative/electric braking.

wagons at the rear of the train (around the 108 km mark). A consensus of the group was that the slight 'bump' felt by the driver was probably the locomotive traversing the failed joint prior to noticing the loss in brake pipe pressure and subsequently stopping.

Figure 2: Train 24KW – Derailed Ore Wagons

Source: ATSB

In response to the derailment, the Iron Baron to 21km Junction track section was closed, recovery personnel were dispatched to the site, and the driver was relieved from duty and returned to Whyalla. Track and train maintenance crews commenced recovery and restoration works on 07 July 2014. The track was re-opened to traffic on 9 July 2014.

Context

Location

Whyalla is located on the east coast of the Eyre Peninsula in South Australia. A seaport owned and operated by Arrium Mining is located to the east of the town centre. The rail network, also owned by Arrium Mining, extends to the west of Whyalla, through the Middleback Range, to the mines of Iron Monarch and Iron Duke.

The derailment occurred between Iron Baron and 21km Junction, at 108.100 track km in the Southern Middleback Range, South Australia (Figure 1).

Environmental conditions

The weather at 0900 on the day of the occurrence was fine with a temperature of about 4.5°C and winds from the north at 20 km/h. The environmental conditions were not considered exceptional for July and there was no evidence that they had contributed to the derailment.

Train and train crew information

Arrium Mining had contracted its rail operations to GWA for the transport of iron ore from its mine sites to the port of Whyalla. Management of train movements was carried out from the GWA Network Control centre located at Whyalla, using the Train Order Working[5] system of safeworking.

Rolling stock

Train 24KW was a regular Arrium iron ore service that operated between Whyalla and Iron Duke. The train was configured with two locomotives (GWA1302 leading and GWN5 trailing), followed by 56 bottom-dump ore wagons. The train had an overall length of 626 m and a gross mass of 5,000 t.

The wagons had predominately derailed to the left of the track (in the direction of travel). While it was unclear as to which wagon and wheel-set had derailed first, examination of the derailed wagons did not find any mechanical deficiencies or issues with the rolling stock that may have contributed to the derailment.

Train crew

The train was operated as driver-only[6]. At the time of the derailment, the driver had been working at GWA for 1 year and had 6 months experience in driver-only operation. He held the required qualifications to operate the train, was route certified and assessed as medically fit for duty.

Following the derailment, the driver underwent mandatory drug and alcohol testing, the results of which were negative

There was no evidence to suggest that driver handling contributed to the derailment of train 24KW.

Track Information

The track from Iron Duke through to Whyalla comprised a single line with loading loops/sidings for the loading and crossing of trains. The track was narrow gauge (1,067 mm) and mainly consisted

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5 A communications based system where proceed authorities are issued in the form of a train authority which authorises a train (or other track vehicles) to move between specified points. A train authority is issued by a Network Control Officer to the driver and the driver is required to comply with the instructions in the authority.

6 Operations in which an individual rail safety worker has the responsibility for the control, operations and procedures of a train.

of 47 kg/m continuously welded rail[7] (CWR). The rail was fixed to steel sleepers and secured by resilient fastenings.[8] It was supported on a bed of ballast having a nominal depth of 300 mm under the sleepers. In the months prior to the derailment the track through the derailment site underwent tamping and re-railing with the use of bolted joints (prior to welding).

Maintenance of the track infrastructure was carried out by Transfield Services Ltd under contract to GWA, and in accordance with the Westrail *Narrow Gauge Code of Practice 2004* (CoP).

Mechanical Fishplate Joints

A mechanical fishplate[9] joint is constructed using two opposing fishplates, positioned within the rail web, and fixed across two rails butted end to end. The joint is fastened by bolts that are passed through the fishplates and the web of the butted rails. When fixed in position, fishplates should be capable of supporting and transferring all loading between the two rails – without relative movement between the rails and fishplates.

The CoP described *permanent* mechanical fishplate joints as those intended for use in track where special inspections[10] or speed restrictions are not required. Fishplates used in jointed track[11] usually have six bolt holes and require bolts to be fastened through all six holes (three either side of the joint). A mechanical joint is installed in CWR after repair or other work, to allow continued rail operations until the joint can be welded. The CoP still described such joints as 'permanent' but notes that the two holes closest to the rail ends (closest to the intended weld) are not drilled and the joint is fastened through the remaining four bolt holes.

The CoP described a *temporary* joint as one intended for temporary joining of rails to permit short term passage of trains, such as during track construction. Temporary joints are often clamped rather than bolted. While not specifically defined in the CoP, a bolted joint of a lower standard to that of a permanent joint would be considered, at best, a temporary joint. Temporary joints generally have speed restrictions applied and require higher frequency, special inspections when in use.

Typically, all bolt holes for plated joints (permanent and temporary) should be drilled square to the rail web and the rail ends should be saw cut. The CoP requires all bolts/nut/spring washer assemblies to be tightened such that full compression of the spring washer is achieved. If installed correctly, permanent joints in CWR and jointed track should be suitable for normal track speeds, though the joints would not normally be expected to remain in CWR track for extended periods of time.

While not specified in GWA's CoP, flame cutting of joint components is usually only acceptable for emergency repairs. Mechanical joints may contain flame cut rail ends, but a speed restriction would typically apply (usually 20 km/h). Similarly, flame cut holes in the rail or joint components may be used in emergencies with a speed restriction applied (usually 10 km/h). In emergencies, fishplates may also incorporate slotted (elongated) holes, but these joints should be removed as soon as the rail can be adjusted correctly. Slotted holes in fishplates should be properly prepared (machined) and flame cut slots are not usually permitted.

The CoP also specified the requirements for monitoring and maintenance of track infrastructure. General periodic inspections were specified for identifying visual joint defects; with more detailed

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7 Continuous welded rail (CWR) – Track where the rail is joined by welding (and other non-moveable joints such as glued insulated joints) in lengths greater than 300 metres.

8 A fastening that provides a degree of elasticity between the sleeper and rail with the aim of avoiding the loosening of the fastening due to vibration, as well as enhancing the ability of the fastening system to resist longitudinal creep forces and buckling forces associated with continuously welded rail (CWR).

9 A steel component normally used in pairs for the purpose of joining rail ends together.

10 Special inspections are conducted outside of the scope of scheduled inspections, usually due to particular events or track defects.

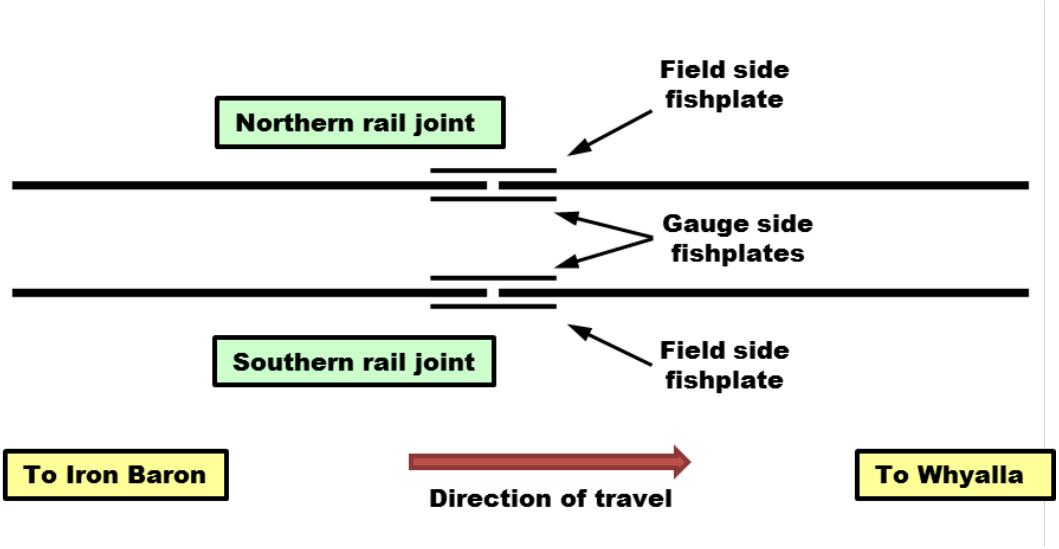
11 Track in which rail lengths are joined with bolted mechanical joints, as opposed to welded track.

inspections required where a joint may be suspected of containing additional defects. In general, defective joints are required to be replaced.

Site observations

Site observations around the point of derailment (PoD) showed broken mechanical joints on both the northern and southern rails at the 108.100 km mark (Figure 3).

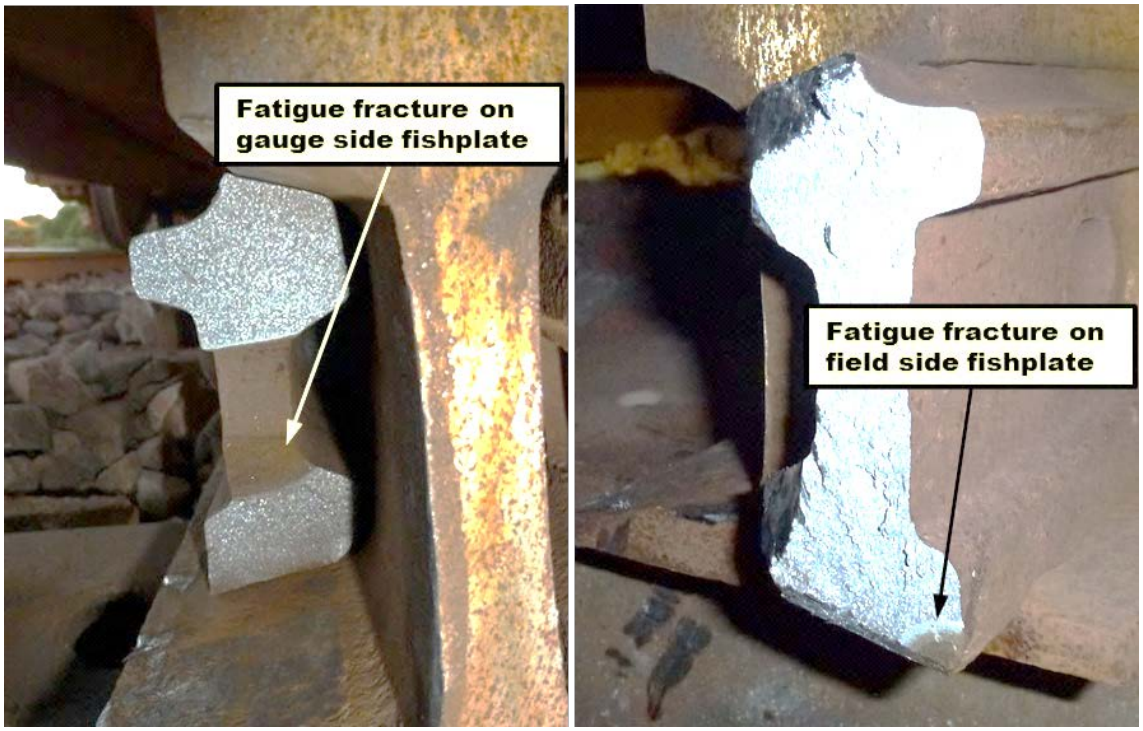
Figure 3: Site orientation and component naming convention



Source: ATSB

Examination of the northern rail joint showed that the joint had been fastened with four bolts, two on each side of the rail joint. The fracture surface of the gauge-side fishplate showed evidence of a substantial and pre-existing fatigue crack extending from an unused bolt-hole (Figure 4, left). The fracture surface of the field side fishplate also showed evidence of pre-existing fatigue cracking, but originating from the lower outside corner of the fishplate (Figure 4, right). The remainder of each fracture surface was rough and matt grey/silver in appearance, consistent with a fracture due to mechanical overload.

Figure 4: Northern rail joint fracture surfaces



Source: Left: Office of the Rail Safety Regulator – Right: ATSB

Examination of the southern rail joint showed that the Iron Baron end of the joint had been fastened with only one bolt. It was also evident that both the field and gauge-side fishplates had been modified by slotting (elongating) the bolt hole using an oxy/acetylene thermal cutting tool. There was evidence that the fishplate in this location had moved in relation to the rail, which was consistent with the use of only two bolts for the joint, and also possibly suggested that the bolt through this hole had not been sufficiently tightened. Again, pre-existing fatigue cracks were evident; originating from the lower and upper outside corners of the field-side fishplate. The remainder of the fracture surfaces on both fishplates were consistent with a fracture due to mechanical overload (Figure 5).

Figure 5: Southern rail joint

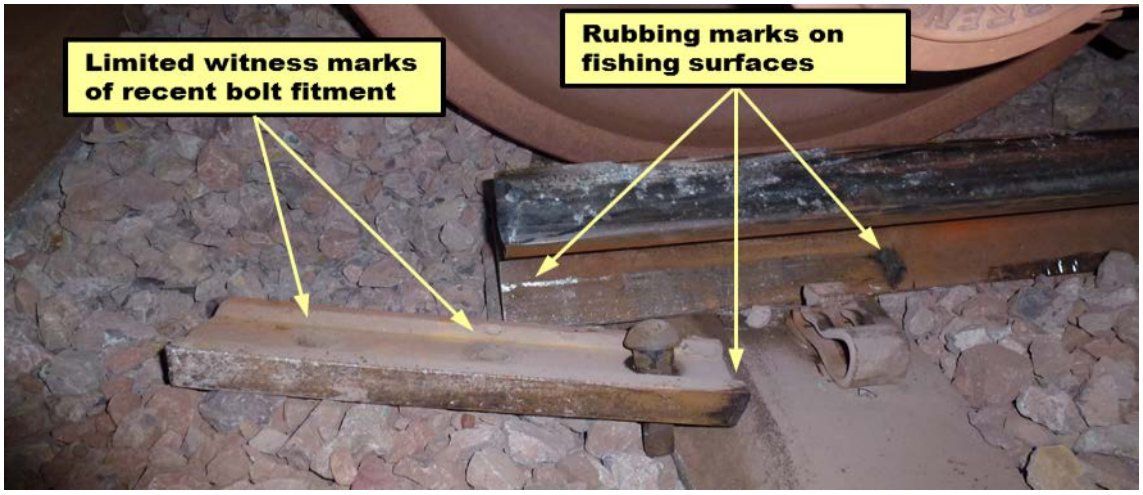
Source: ATSB

While the Whyalla end of the southern rail joint had completely separated during the derailment sequence, the components were recovered and examined. The holes through both fractured fishplates and the rail web showed no definitive indication that bolting had been installed through

two of the three bolt holes, suggesting that the assembly had also been secured by a single bolt through this end of the joint. Rubbing marks were evident on the fishplate/rail web contact surfaces, indicative of excessive movement within the joint (Figure 6).

Heavy battering on the Whyalla side of both rail joints indicated that a number of rail wheels traversed the joints while in a spread (failed) condition. Leading up to the broken rail joints there was no evidence of any other track anomaly, such as wide track gauge or broken/fractured rail.

Figure 6: Southern joint, Whyalla end



Source: ATSB

Based on the evidence available, the ATSB concluded that the southern rail joint was probably the first to fail from a combination of pre-existing fatigue cracks in the field side fishplate and the joint being in a condition of weakened structural integrity due to inadequate fastening.

As rail wheels passed over the failed southern joint, increased impact forces and lateral pressure through the track structure, together with the pre-existing fatigue cracks in *both* fishplates, probably resulted in the failure of the northern rail joint. With both joints failed, the continued impact of rail wheels likely led to the progressive misalignment of the track until wagons inevitably derailed.

Safety analysis

Joint inspection and maintenance

Genesee Wyoming Australia (GWA) advised the ATSB that a number of permanent mechanical fishplated joints had been inserted into the Arrium Mining rail network until sufficient track access time was available to permit joining of the rail by welding. Taking this into consideration, the CoP required these joints to be secured by four bolt, nut and spring washer fastenings through the outer four bolt holes and tightened such that full compression of the spring washer was achieved. The joints would then have been considered structurally sound for normal speed operations at 60kph.

On the afternoon of 5 July 2014, rail track maintenance workers inspected the joints and replaced the fishplates and fasteners in the joint at the 108.100 km mark. The track maintenance crew stated that when repairing two mechanical joints, they needed to flame cut slots into the fishplates to align the bolt holes, before they installed four new bolts and tightened them using a rattle gun[12]. However, post-derailment observations suggested that only two bolts had been installed in the southern rail joint at the 108.100 km mark. There was insufficient information available to reconcile the difference between the track maintenance crew recollection of the work they completed and the evidence collected after the derailment.

Regardless of the number of bolts, the action of flame cutting slots in the fishplates resulted in a joint that was of a standard lower than that of a permanent joint. The rough edges of the flame cut holes were unlikely to provide a flat interface surface for the bolts, nuts and washers. Marks on the foot of the rail and the fishplate contact surface (Figure 6) showed movement within the joint and suggested that the bolts were not sufficiently tightened. As such, the joints were not structurally sound and, without an appropriate speed limit, the joints were likely to move under the load of a train – placing excessive stress on the bolts and fishplates.

Compounding the weakened joint construction was a number of pre-existing cracks within the fishplates in both the northern and southern rail joints. GWA's CoP specified the inspection and maintenance requirements for fishplates installed in track, but did not specifically address the acceptance requirements for the condition of used joint components. Consequently, there was no guidance or requirement for track maintenance crews to assess the suitability of second-hand components for re-use prior to installation.

Other fishplated joints within the immediate vicinity of the 108.100 km mark were also examined. It was noted that bolts were missing from these joints as well. However, examination of the bolt holes suggested that four fasteners (that is, a permanent joint in CWR) had been used to secure the joints and that some bolts may have dislodged as a consequence of the derailment. Based on the evidence available, the ATSB concluded that the deficient permanent mechanical rail joint installed at the 108.100 km mark was an isolated anomaly and not indicative of the assembled condition of other plated joints.

[12] A rattle gun is a term used to describe a mechanical impact wrench, often driven by compressed air.

Findings

From the evidence available, the following findings are made with respect to the derailment on 7 July 2014 of Genesee & Wyoming Australia train 24KW near the 108.100 km mark, Whyalla, South Australia. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- When maintained on 5 July 2014, the southern fishplated rail joint was assembled using inappropriately-modified fishplates, with an inadequate number of through-bolts; reducing its structural integrity and allowing relative movement within the joint under the load of a train.
- The fasteners used in the assembly of the fishplated rail joint had not been sufficiently tightened to prevent relative movement within the joint under the load of a train.
- The fishplates used at the 108.100 km mark contained fatigue cracks and had not been assessed as fit for purpose before re-use.
- **GWA had no documented system in place to assess the suitability of second-hand components for re-use. [Safety Issue]**

Other findings

- The ATSB investigation found no evidence to suggest that environmental conditions, train speed, train handling, rolling stock condition or operational performance had contributed to the derailment.

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.

Assessment of the suitability of second-hand components

Number:	RO-2014-012-SI-01
Issue owner:	Genesee Wyoming Australia (GWA)
Operation affected:	Rail: Infrastructure
Who it affects:	All rail infrastructure managers

Safety issue description:

GWA had no documented system in place to assess the suitability of second-hand components for re-use.

Proactive safety action taken by GWA

Action number: RO-2014-012-NSA-017

To mitigate the likelihood of a similar derailment, GWA conducted an inspection of all mainline fishplated joints to ensure structural integrity of each join and have since removed all the joints through a welding program.

In addition to the welding program, GWA completed an organisational audit and review of maintenance standards and processes. This review included the contracted maintainer (Transfield Services Australia), and targeted:

- inspection of used fishplates prior to installation
- removal of fishplates with flame cut bolt holes from service
- improving the training of track inspectors with respect to monitoring and maintaining mechanical joints the accurate recording of the derailment risks attributable to the activities carried out by track maintenance staff
- track standards to determine what constitutes a temporary joint along with track speeds and the inspection frequencies that should apply.

Through their own investigation GWA identified the degradation of the track substructure as a contributor to the derailment of 24KW. In cooperation with Arrium Iron Ore they are currently completing a study into the track substructure in the section between Iron Baron and 21km Junction and have engaged a subject matter expert to manage this process.

Current status of the safety issue

Issue status: Adequately addressed

Justification: The ATSB is satisfied that the actions taken by GWA will adequately address this safety issue.

General details

Occurrence details

Date and time:	7 July 2014 – 0910 CST	
Occurrence category:	Accident	
Primary occurrence type:	Derailment	
Location:	108.100 km Iron Baron to Middleback section, South Australia	
	Latitude: 32° 57.075' S	Longitude: 137° 18.593' E

Train details

Train operator:	Genesee & Wyoming Australia	
Registration:	24KW	
Type of operation:	Freight Haulage	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Damage:	Substantial damage to track infrastructure and rolling stock	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- Genesee Wyoming Australia
- Transfield Services Australia

References

- NatMap Railways of Australia, Geoscience Australia
- National Guideline Glossary of Railway Terminology (www.rissb.com.au).

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 Genesee Wyoming Australia, the Office of the National Rail Safety Regulator and Transfield Services Australia.

Submissions were received from Genesee Wyoming Australia and the Office of the National Rail Safety Regulator. 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.

Australian Transport Safety Bureau

Enquiries 1800 020 616
Notifications 1800 011 034
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Email atsbinfo@atsb.gov.au

Investigation

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