Australian Government
Australian Transport Safety Bureau

Derailment of ore train ND575

Near Tom Price, Western Australia | 15 December 2015

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2015-025
Final – 11 December 2017

Cover photo: Rio Tinto

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Addendum

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Safety summary

What happened

On 15 December 2015, train ND575 – a south bound empty bulk iron ore service operated by Rio Tinto, derailed on the Hamersley Railway east mainline, about 50 km north of Tom Price, Western Australia. As a result of the derailment, there was significant damage to track and rolling stock. There were no injuries.

What the ATSB found

The ATSB concluded that the derailment most likely began with a small horizontal track misalignment on the east mainline, just south of the Mt Brockman Road railway crossing. It was likely that the misalignment grew under train ND575, and eventually became large enough to cause the train to derail. The pathing of a large number of north-bound loaded ore trains on the east mainline probably caused a redistribution of longitudinal rail stresses south of the Mt Brockman railway crossing. This redistribution of rail stresses, coupled with extremely hot weather, and a track irregularity near the point of derailment, meant the track had a reduced capacity to withstand lateral forces, thereby increasing the likelihood of a track buckle event.

What's been done as a result

Rio Tinto have implemented a range of initiatives to reduce the risk of a similar occurrence including changes to operational and maintenance procedures, enhanced strategies for responding to minor track irregularities, and a strategy for balancing tonnage over the line.

Safety message

Early detection, assessment, and effective management of track defects are critical in minimising the risk of derailment and maintaining safe rail operations.

Derailed portion of train ND575, view looking north from ore car 20322

Source: Rio Tinto

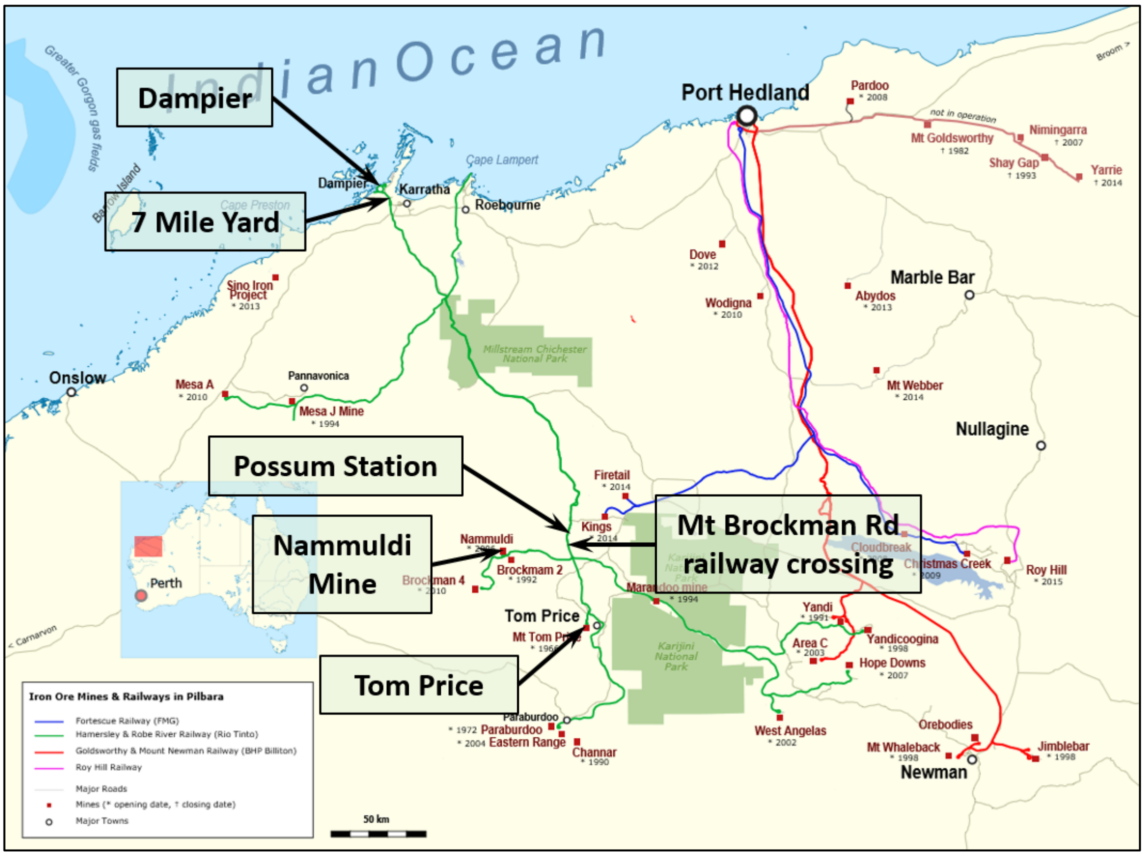
Contents

The occurrence

On 15 December 2015, train ND575 operated as a routine empty bulk ore service from 7 Mile Yard, Dampier to Tom Price, Western Australia (Figure 1). The train departed 7 Mile Yard at 1004 and travelled on a section of double line, through to Brolga 27 (21.400 km),[1] then on a section of single line through to Emu Yard (78.500 km). The onward passage from Emu Yard, on the east mainline (double line track) through to Possum Station (227.250 km) was uneventful.

During this time, a series of south bound empty ore trains (YC2155, PD1058, RC1889, BC824, TD1284, YC156 and RD1890), also travelling on the east mainline, passed over the Mt Brockman Road railway crossing (234.335 km) at speeds ranging from 79 km/h to 59 km/h.

Figure 1: Location map – Rio Tinto network



Source: Map data (c) OpenStreetMap (and) contributors, CC-BY-SA

The train departed Possum Station at 1614. At about 1619, after passing over the Mt Brockman Road railway crossing, the train driver reduced train power from notch 8 to notch 3 to maintain a track speed of not more than 80 km/h.

Shortly thereafter, the driver felt a small surge from the train, followed by an automatic emergency brake application. The driver looked back, towards the rear of the train, and saw a large dust cloud. He immediately 'bailed off'[2] the independent train brakes to prevent the trailing ore wagons from bunching behind the locomotives during braking. The train slowed down, and came to a stop about 1 km past the Mt Brockman Road railway crossing.

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1 Measured from a zero reference mark at Dampier.

2 'Bail off' is a term used to describe the action of:
- preventing the locomotive(s) brake from applying automatically during a train brake application, or
- releasing the locomotive(s) independent brakes during a train brake application.

Post occurrence

The driver spoke to train control and advised that the train had come to a stand south of the Mt Brockman Road railway crossing, and some ore cars had probably derailed. After speaking to train control, he detrained and walked the length of the train to inspect for damage.

On completing the inspection, he returned to the cab and communicated with train control, advising that 56-ore cars had derailed (Figure 2). The derailed wagons were located in positions 71 through to 126, and there was about 450 m of track damage.

Figure 2: Derailed portion of train, ore car 35907 and 30907 in foreground near 234.500 km

Source: Rio Tinto, annotation by ATSB

Rio Tinto dispatched operations staff, investigation and recovery crews to site. An authorised person, while on-site, tested the train driver for the presence of drugs and alcohol; the results were negative.

The railway network was re-opened to rail traffic, on a restricted basis, using the west mainline. The east mainline was made operational for rail traffic by 18 December 2015, three days after the derailment.

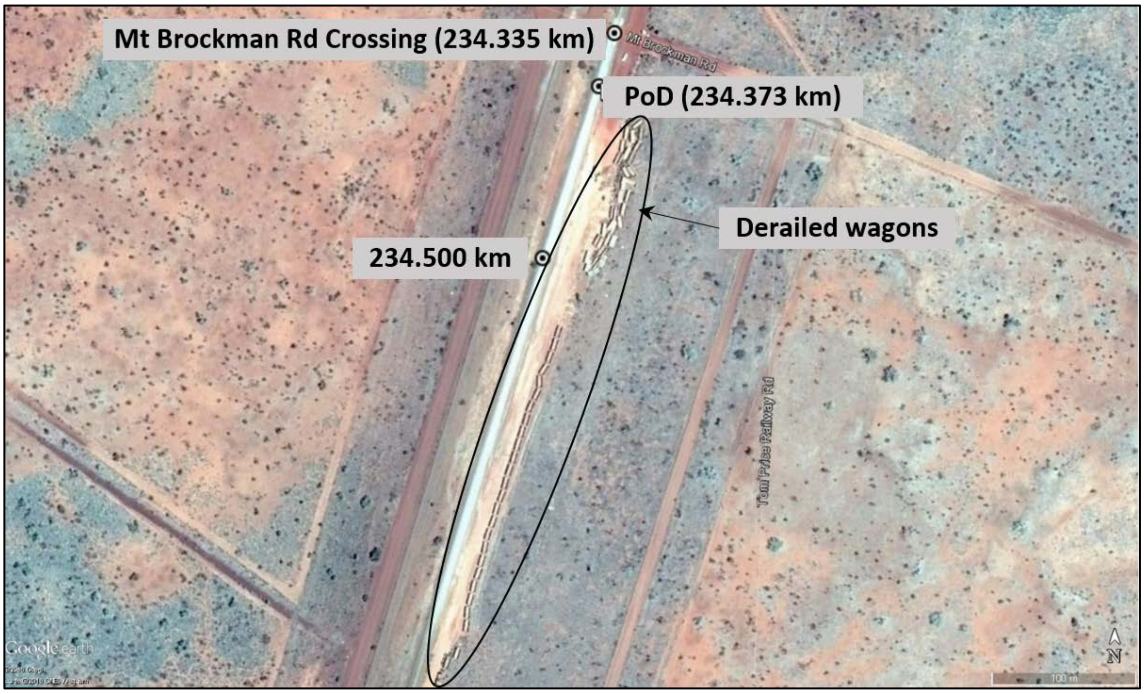
Context

Location

The Hamersley railway is a privately owned rail network in the Pilbara region of Western Australia, built for carrying iron ore. The line shown at Figure 1 connects the port of Dampier at King Bay to a cluster of mine sites located about 250 km to the south, including the Nammuldi mine. The derailment occurred about 38 m south of the Mt Brockman Road railway crossing (Figure 3) on the Hamersley railway east mainline, 50 km north of Tom Price.

Rio Tinto own and manage the Hamersley railway.

Figure 3: Derailment site, near Mt Brockman Road railway crossing showing point of derailment (PoD) and location of derailed wagons.



Source: Rio Tinto, annotation by ATSB

Train and train driver information

Train ND575 was a regular Rio Tinto empty ore service operating from the port of Dampier, travelling south on the east mainline, to the Nammuldi mine. The train comprised three GE Evolution locomotives (HL8180 leading, HL8157 and RL8117 trailing) followed by 112 permanently coupled 'pooled fleet ore cars' sets.[3] Each permanently coupled set of ore cars had an overall length of 18.667 m and tare weight of approximately 42 t. Train ND575 had an overall length of 2,160 m and was hauling a trailing mass of 4,704 t.

Train driver

The driver in control had extensive train driving experience. He had worked for Rio Tinto for about 16 years and had driven trains for about 27 years. He held the required qualifications to drive trains on the Hamersley network, and was route certified for the track where the derailment occurred.

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3 Each 'pooled fleet ore car' comprised two permanently coupled ore cars, each independently supported on a pair of bogies.

An examination of the driver's records confirmed that he had been assessed as meeting the medical standards prescribed by the *National Standard for Health Assessment of Rail Safety Workers*. A review of the driver's roster by the ATSB determined that fatigue impairment was unlikely to have affected his performance. The driver said he felt well when signing on for duty, and at the time of the derailment.

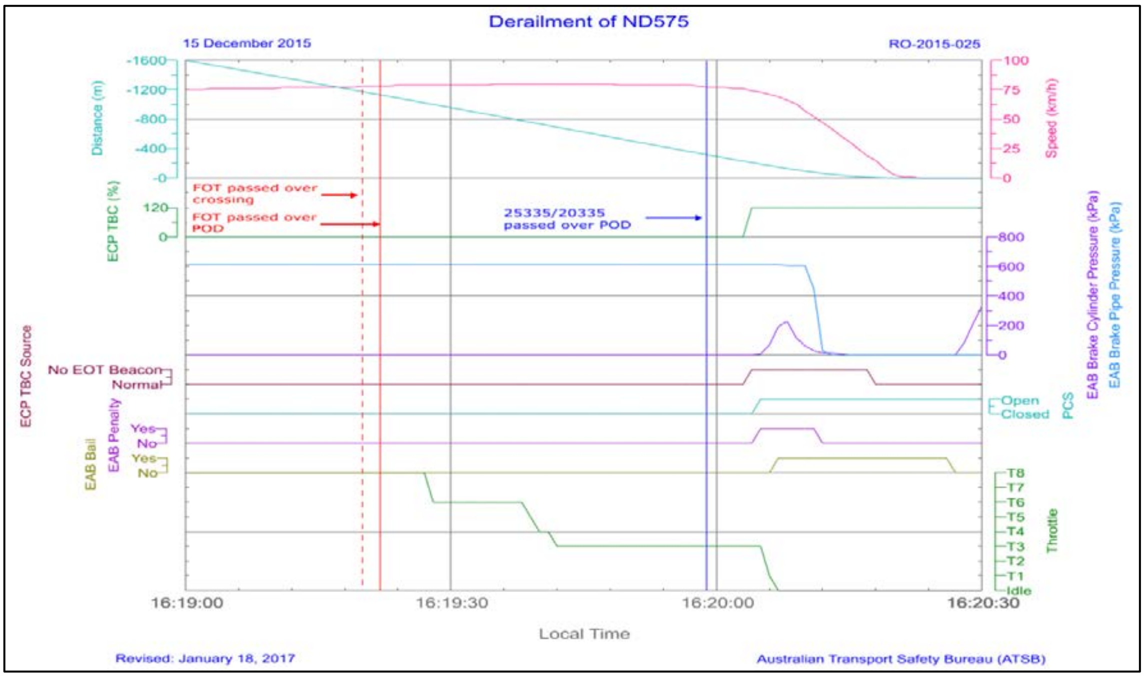
Train handling

Locomotives HL8180, HL8157 and RL8117 were each equipped with data recorders (loco-logs). The loco-logs capture information such as date/time, speed, brake pipe pressure, throttle position, and distance travelled.

An extract of the data from the lead locomotive (HL8180) was used to derive the graph at Figure 4; from this data, it was found:

- Train ND575 was travelling at 78 km/h (2 km/h below the permitted track speed) as it passed over the Mt Brockman Road railway crossing.
- During the period 1619:35 through to 1619:42, the driver moved the throttle from position T8 to T3 thereby maintaining a train speed below the track speed limit of 80 km/h.
- The speed of train ND575 dropped from 79 km/h (1 km/h below track speed) to 73 km/h as ore cars in the group 71 to 94 (ore cars numbered 25332 to 20353) passed over the point of derailment (PoD).
- At 1620:04, the electronically controlled pneumatic (ECP) brake parameters changed, followed by an emergency brake application.
- At 1620:06, the driver throttles off from T3 through to Idle, and bails off.
- At 1620:08, there is evidence of an initial reduction in brake pipe pressure (BPP).
- At 1620:11, there is a major BPP reduction.
- Train slowed down, coming to a stand at 1620:23, about 1 km past the PoD.

Figure 4: Graph derived from loco-log data, lead locomotive THL8180



Source: Rio Tinto, graphed by ATSB

A review of loco-log data corroborated the driver's recollection of the final moments of the event, and showed that train handling, and driver performance was unlikely to have been factors that contributed to the derailment.

Rolling stock – pooled fleet ore cars

Train ND575 was hauling 112 pooled fleet ore car pairs. Two of the ore cars, 30907 and 30910 (position 102 and 154 respectively), were instrumented ore cars (IOCs). Data from the IOC at position 102 (30907) was corrupt after 1620:10. This probably coincided with the time the ore car incurred catastrophic damage during the derailment sequence. The second instrumented ore car (30910) did not pass over the PoD, and continued to supply data throughout and after the derailment event.

An examination of the non-corrupted data from IOC 30907 indicated a significant change in coupler forces at about the time ore car set 25335/20335 (position 81/82 - Figure 5) traversed the PoD. Based on the IOC data, and subsequent examination of damage to ore cars and the track, it was resolved that this probably coincided with the derailment event, and that ore car set 25335/20335 derailed first. Although ore car set 25332/20332 (position 71/72) was also in a derailed state, it was probably dragged off the track by ore car set 25335/20335 through to 25321/20321 (position 73/74).

Figure 5: Looking north - derailed ore car 25332/20332 (foreground) and ore car 25355/20335 (background)

Source: Rio Tinto, annotation by ATSB

An onsite inspection of derailed ore cars found no evidence of component deterioration or damage that may have initiated the derailment. All ore cars were considered fit for purpose, and in compliance with Rio Tinto maintenance standards. A post-derailment review of Rio Tinto records established that all derailed ore cars were serviced in accordance with Rio Tinto's engineering requirements, and that there were no outstanding maintenance issues.

An examination of data from trackside monitoring systems (RailBAM[4] and WID[5]) did not uncover any evidence of wagon overloading or wheel defects that may have contributed to the derailment.

Based on available evidence the ATSB considered unlikely that rolling-stock condition was a factor that contributed to the derailment.

4 RailBAM® is a predictive monitoring system that detects and ranks wheel bearing faults and out-of-shape wheels (wheel flats) by monitoring the noise they make.

5 WIDS is an acronym for wheel impact detection system. The WIDS system is primarily used for detecting wheel flats but can be used for calculating the weight of rolling stock.

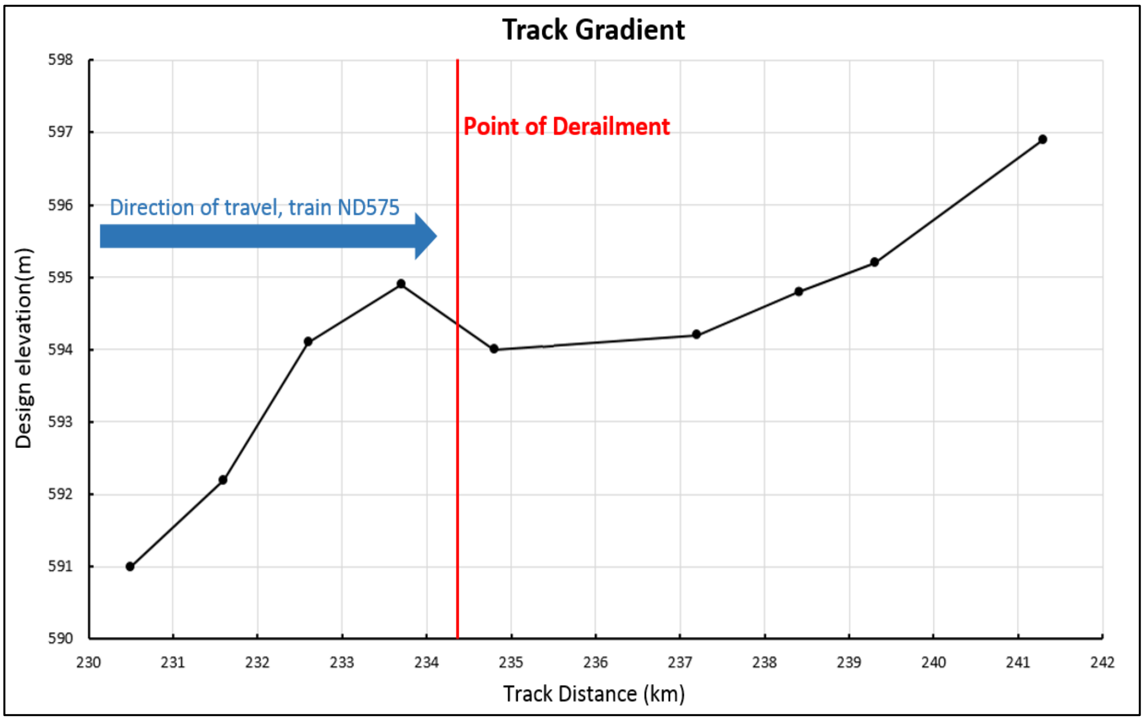
Track information

The track from the port of Dampier to Tom Price comprised a combination of single line with crossing loops, and double line (east/west mainline) with crossovers. Rail traffic operated bi-directionally on the mainlines, a strategy used by Rio Tinto for balancing rail wear, and minimising stress build up in the rails.

The derailment occurred on the east mainline just south of Possum Station (227.25 km), about 50 km north of Tom Price. The track leading into the derailment site (travelling from north to south) was straight (tangent track) and on a slight upgrade followed by a slight downgrade towards the point of derailment (Figure 6). The track comprised standard gauge (1,435 mm), 68 kg/m continuously welded rail (CWR) mounted on concrete sleepers at 650 mm centres. The sleepers had resilient fasteners (Pandrol Clips) on a nominal 200 mm layer of ballast below the sleepers.

At the time of derailment, axle loads were limited to a maximum of 36 t. The speed limit for trains was 80 km/h. There were no further speed restrictions in place, approaching the derailment site.

Figure 6: Design track elevation – 230 km to 242 km, showing point of derailment and direction of train travel



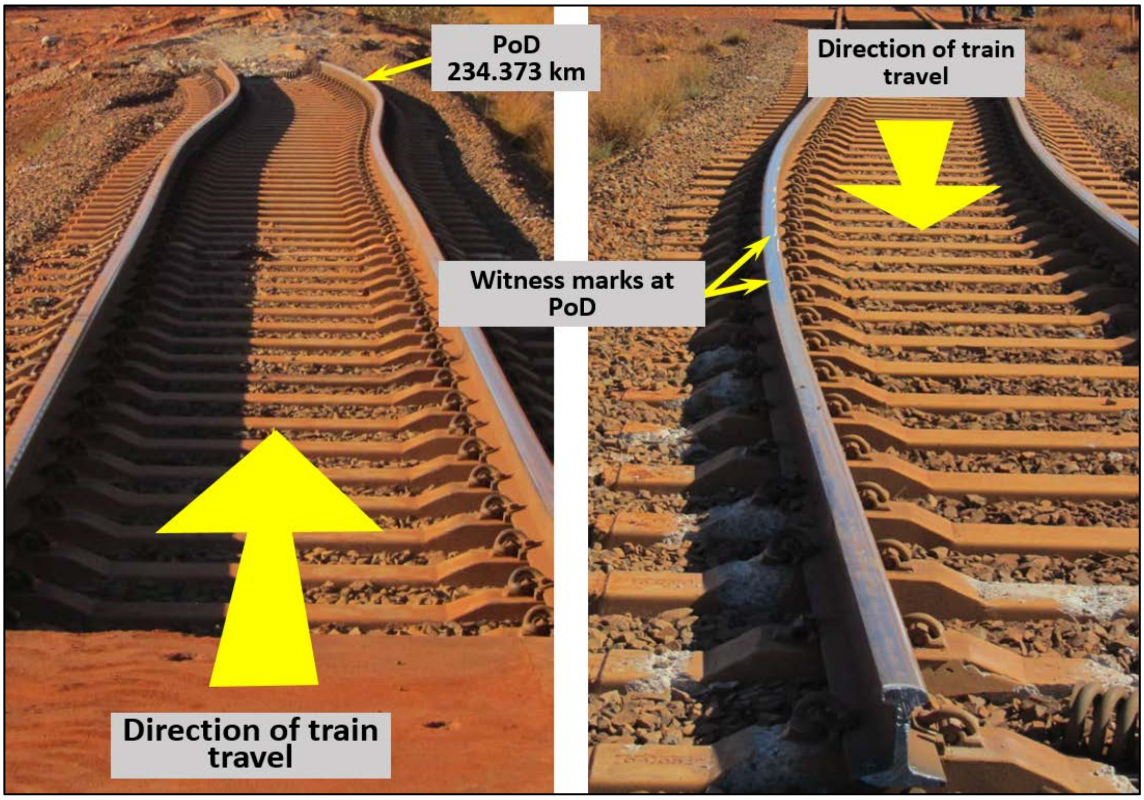
Source: Rio Tinto, annotation by ATSB

Examination of the track

The post derailment examination of evidence established that there were no apparent signs of track spread at or before the PoD, so gauge widening was discounted. Similarly, there were no signs of any broken/fractured rail immediately at or before the PoD. The track near the PoD (Figure 7) showed evidence of a significant horizontal displacement of the track to the right, in the direction of train travel, and was indicative of a track misalignment/buckling event. The railhead[6] at 234.373 km (Figure 7 – right image) showed evidence of wheel flange climb[7] on the right side running rail (direction of travel) followed by witness marks (about 4 – 5 m in length) consistent with a wheel flange crossing the railhead.

6 The upper part of the rail on which the wheels of rolling stock run.
7 A derailment in which a wheel flange will climb to the railhead.

Figure 7: Witness marks at PoD (234.373 km) shown by line of arrows on railhead



Source: Rio Tinto, annotation by ATSB

Damage to sleepers (Figure 7– right image and Figure 8) was only evident after the point where the wheel(s) dropped off the railhead. Beyond the drop-off point, the wheels and bogies of derailed ore cars advancing along the track progressively damaged the track structure, both within the four foot,[8] and to the right side of the track (direction of travel).

Figure 8: Ballast condition before PoD indicate profile and quality in accordance with Rio Tinto requirements

Source: Rio Tinto, annotation by ATSB

8 The area between the rails of a standard gauge railway.

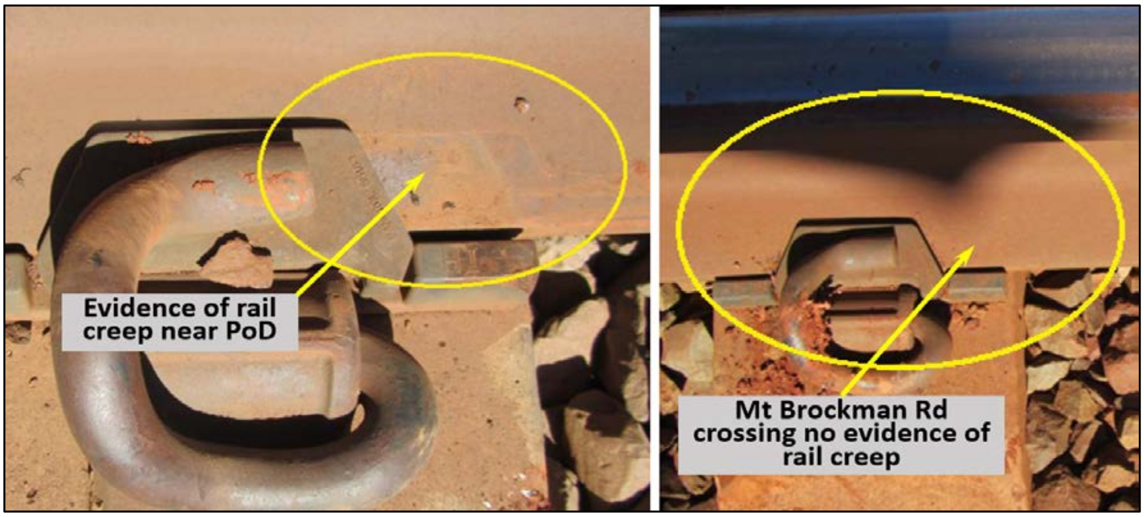
As initially intact but derailed ore cars continued to move along the track, and bounce over sleepers, bogie wheels caused heavy damage within the four foot. This resulted in ore cars tilting to the left, dropping off their bogies, and eventually ejecting to the left side of the track. This gave rise to the multi-wagon pile-up shown at Figure 2.

Rio Tinto measured the rail profile, post derailment. The ATSB assessed these measurements for compliance against Rio Tinto standards. Side wear was negligible, vertical wear was about 14 mm. Measurements confirmed that the rail profile was within specified limits, and unlikely to be a factor that contributed to the derailment.

The ATSB assessed the ballast and ballast profile for compliance against Rio Tinto standards using photographs and other information provided by Rio Tinto. The amount of ballast (Figure 8) within the cribs,[9] and the shoulder[10] width and height was all in accordance with requirements. There was no indication of ballast fouling at or near the derailment site.

While the track leading into the derailment was in good condition, there was evidence of rail creep[11] (Figure 9 – left image) between the PoD and the Mt Brockman Road railway crossing. The observed rail creep was in a northerly direction, that is, from the PoD towards the Mt Brockman Road railway crossing, which was acting as a fixed point. There was no observed rail creep at and to the north of the crossing (Figure 9 – right image).

Figure 9: Evidence of rail creep through resilient fastener at PoD



Source: Rio Tinto, annotation by ATSB

Track inspection and maintenance standards

Inspections of track visually, and by use of mechanised track geometry vehicles, are two of the main methods for identifying and assessing track defects. Rio Tinto's *Track and Civil Code of Practice, Volume 5 – Track Geometry* (GN-R105) defined the criteria for assessing and recording the condition of track, and determining mandatory remedial maintenance actions. The standard identified two inspection routines: unscheduled and scheduled inspections.

Unscheduled

Unscheduled inspections were generally in response to defined events, such as extreme weather conditions known to increase the risk of geometry defects. Unscheduled inspections could also be triggered by third-party intervention, such as a train driver's report of a rough riding track.

9 Ballast area between sleepers.
10 The ballasted section outside the sleeper ends.
11 The longitudinal movement of the rails in track caused by expansion or contraction of the rail or the action of traffic.

There were no train driver reports, regarding rough track/track quality near the PoD that resulted in an unscheduled inspection prior to the derailment.

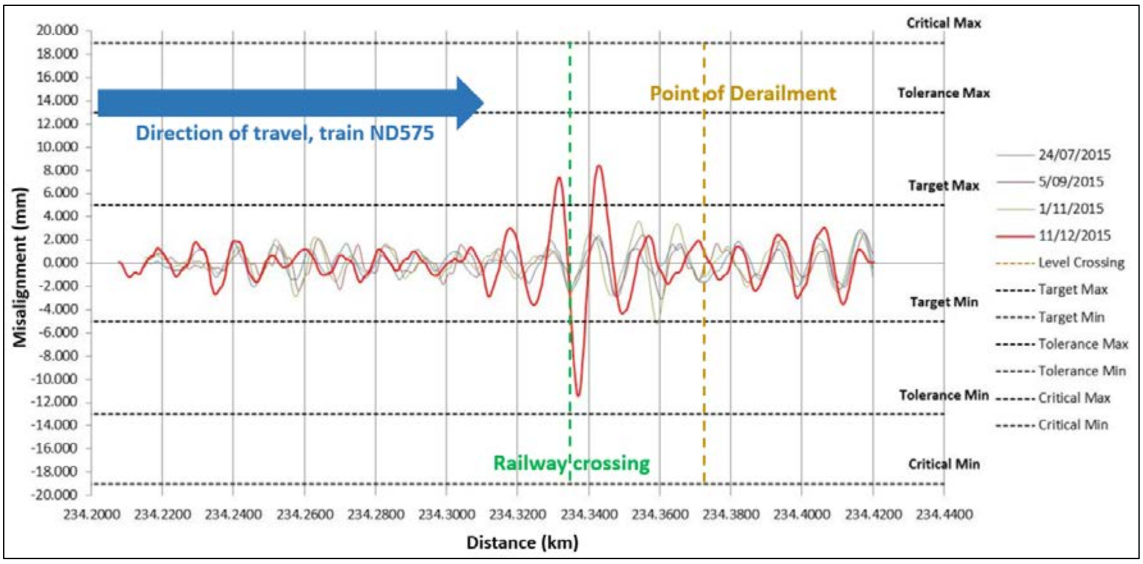
Scheduled

Rio Tinto uses two main scheduled inspections methodologies for assessing track geometry and identifying defects. These comprise the visual inspections of track and the use of mechanised track geometry vehicles. GN-R105 mandated that inspections be carried out weekly (intervals not exceeding seven days) by track patrol (road/rail vehicle), two monthly by track geometry vehicle inspection, and six monthly by on-train inspections.

A review of maintenance records established that the track near the PoD (234.373 km) was:

- Regularly inspected by track patrol (road/rail vehicle). The last inspection was on 12 December 2015, three days before the derailment. No defects were identified.
- Regularly examined using a track geometry car US6. The last inspection was on 11 December 2015 (Figure 10 – red line), four days before the derailment. While the red line in Figure 10 shows that there was evidence of a growing horizontal track misalignment at the railway crossing, the magnitude of the misalignment was well below the Rio Tinto maintenance intervention limit (Figure 10 – 'Critical Max').

Figure 10: Graph showing growth of horizontal track misalignment at PoD from data obtained by track geometry car US6.



Source: Rio Tinto – annotations ATSB

Rio Tinto advised that they do not usually record the date of on-train inspections, and therefore, could not advise if the last on-train inspection was done within the six-month period leading up to the derailment. However, Rio Tinto had an established process for monitoring track condition through a range of parameters (longitudinal, vertical and lateral acceleration) that indicated the ride quality of the fleet of IOCs. This data was progressively being optimised, by Monash University (Victoria) for Rio Tinto, to assist with the determination and evaluation of track irregularities. The setting and monitoring of pre-determined IOC track irregularity limits was intended to allow Rio Tinto to instigate site inspections on an as required basis to enable a maintenance response strategy before exceedances are reached.

While examination of data recorded by the IOC fleet in the eight months prior to the derailment showed an increase in IOC suspension travel and bounce (potentially reflecting a degradation in track quality just south of the Mt Brockman Road railway crossing), the magnitude of the bounce was well below pre-determined intervention limits.

Environmental conditions

The closest Bureau of Meteorology weather station to the derailment site was located at Paraburdoo, about 100 km south of Possum Station. On the day of the derailment, the temperature recorded at Paraburdoo at 1500 was 42.3 °C. There was no rainfall recorded in the 24-hour period preceding the derailment. At the time of derailment (about 1620), the weather was fine and very hot, probably in excess of 43 °C. The minimum overnight temperature was 23.1 °C, a temperature differential of 20.7 °C. For the week preceding the derailment, the weather was dry and very hot; most days exceeded 40 °C.

Rio Tinto also measured actual rail temperature at specific sites along the track. The closest measuring station was at 224 km, about 10 km north of the derailment site. At the time of the derailment, rail temperature measured at the 224 km measuring station was 54.4 °C or 14.4 °C above Rio Tinto's neutral rail temperature12 of 40 °C.

Other track misalignment occurrences

The ATSB has investigated eight previous derailments that were attributed to track misalignment/buckle events, namely:

- RO-2014-003 – Derailment of grain train 9130 at Emu, Victoria on 12 Feb 2014
- RO-2013-006 – Derailment of train 3MC1 near Locksley, Victoria on 12 Feb 2013
- RO-2013-002 – Derailment of freight train 3PS6 Yunta, South Australia on 17 Jan 2013
- RO-2010-015 – Derailment of train 1MP5 at Goddards, Western Australia on 28 Dec 2010
- RO-2009-004 – Derailment of freight train 6MB2 at Tottenham, Victoria on 30 Jan 2009
- RO-2008-012 – Derailment of train 3DA2 near Katherine, Northern Territory on 4 Nov 2008
- RO-2006-001 – Derailment of freight train 3AB6 Yerong Creek, New South Wales on 4 Jan 2006
- RO-2005-002 - Derailment of train 6MP4 Koolyanobbing, Western Australia and train 6SP5 Booraan, Western Australia on 30 January 2005 (two different events on the same day).

Although each of these occurrences was unique in its own right, and involved various track owners and rail operators, there are some common factors. These factors should be considered in mitigating the risk of derailment from track misalignment/buckling events. They include:

- The effects of track disturbing works need to be prudently managed, particularly during periods of hot weather.
- Rail de-stressing operations, if incorrectly managed, can result in high longitudinal track forces, increasing the risk of track buckling events.
- Ballast quality and profile is essential for providing resistance against lateral track movement.
- Effective creep monitoring points should be considered (particularly high-risk areas such as curves, and near fixed points, such as railway crossings, turnouts and bridge structures), to assist maintenance staff in determining the potential risk of track misalignment events.
- Organisations should consider appropriate 'heat speed restriction' strategies to lower the risk of derailment events arising from track buckling during periods of high ambient temperature.
- Management and quality assurance processes need to be robust to ensure that track work is carried out in accordance with prescribed standards.

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12 The stress free temperature for rail which is a theoretical temperature at which the rail is neither in tension nor in compression.

- Trains travelling along a track, particularly in one direction, can result in a redistribution of longitudinal rail stresses along the track. A fixed point (level crossings, turnouts, bridge structures, etc.) can further compound the risk of longitudinal rail stress redistribution, resulting in increasing track-buckling risk.

Safety analysis

Based on available evidence, the ATSB concluded that the derailment of train ND575 most likely originated at a horizontal track misalignment at 234.373 km on the east mainline, just south of the Mt Brockman Road railway crossing.

Track inspection and maintenance were found to be in accordance with Rio Tinto's standards. Rolling stock and driver performance (train handling) were discounted as factors that contributed to the derailment.

The subsequent analysis focuses on track performance and operational demand, and track inspection philosophies as key areas of interest.

Track stability

Track integrity is of prime importance in the running of a safe railway, and is reliant on the inter-relationship of many track components, including the sub-base, ballast bed, sleepers, rail and fastening systems. Although continuously welded rail (CWR) provides significant advantages over traditional rail jointing methods (such as fish-plated track), track disturbing activities (for example, trains moving along a section of track, thermal expansion, resurfacing, undercutting and removal of rail defects) can have an effect on track stability, and result in track that is susceptible to buckling (horizontal misalignment).

Track buckling[13] typically occurs when longitudinal compressive forces, induced by thermal expansion, rail creep and dynamic vehicle loads produce a lateral or vertical load that exceeds the passive restraining forces provided by the track structure. The cause of buckling is normally associated with the following factors:[14]

- longitudinal rail forces (compressive rail forces)
- dynamic rail forces (vehicle interaction)
- lateral track resistance.

Longitudinal rail forces

Longitudinal rail forces, those along the length of the track, can be considerable and are particularly sensitive to rail temperature. The neutral temperature (Rio Tinto used a temperature of 40 °C) or stress free temperature for rail is a theoretical temperature at which the rail is neither in tension nor in compression. If the rail temperature is greater than the neutral temperature, the rail will be in compression, with an increased likelihood of track buckling. Conversely, if the rail temperature is less than the neutral temperature, the rail will be in tension, with an increased likelihood of the rail breaking.

Longitudinal rail forces are directly proportional to the difference between the rail neutral temperature and actual rail temperature.

The high temperature at the time of derailment meant that the rail was in compression with a greater likelihood of a track-buckling event.

Dynamic rail forces

The long-term effect of trains moving along a section of track can result in rail movement (creep) and an associated redistribution of longitudinal rail stresses. Typically, a train slowing into a fixed

[13] Substantial misalignment contributed to by longitudinal thermal stresses overcoming the lateral or vertical resistance of the track. *Glossary of Railway Terminology.*

[14] Track Buckling Research in CWR from US DOT's Volpe Center. www.volpe.dot.gov/coi/pis/work/archive/buckling.html

point (for example a railway crossing or bridge structure) encourages bunching of the rail in the direction of train movement, thereby increasing the compressive forces within the track.

The Mt Brockman Road railway crossing was a fixed point in the track structure. The point of derailment (PoD) of the south-bound train ND575 was about 38 m south of the crossing on the east mainline.

During the period 19 November through to 13 December 2015, 666 loaded ore trains travelled in a northerly direction on the east mainline, compared to just 16 empty trains travelling in a southerly direction. The predominant traffic tonnage was therefore travelling north towards the Mt Brockman Road railway crossing. These loaded ore trains were also approaching the railway crossing on a slight downhill gradient and in trying to maintain a track speed of 80 km/h were probably braking. Therefore, with trains braking and the predominant traffic tonnage into the crossing, this would cause rail bunching (high compressive forces) on the southern side of the crossing.

On 11 December 2015, four days before the derailment, data from the track geometry car US6 showed evidence of worsening[15] horizontal track misalignment just south of the Mt Brockman Road railway crossing.

Observations (post derailment) between the PoD and Mt Brockman Road railway crossing clearly showed evidence of rail creep (Figure 9) through the resilient fasteners, and towards the railway crossing. The magnitude of the creep would have resulted in a significant increase in longitudinal compressive rail forces, exposing the track to an increased risk of buckling.

Lateral track resistance

Buckling resistance in the horizontal plane is contingent on the frictional interrelationship between sleepers and the surrounding ballast.[16] A buckle will develop when the lateral force exerted on the track structure exceeds the track's ability to resist those forces. If the frictional bond between the sleepers and ballast is reduced, the lateral force required to generate a misalignment is lowered. This may result in a track-buckling event, even in areas that were previously stable.

The track's ability to resist lateral forces is influenced by:

- sleeper type and weight
- ballast quality
- compaction of ballast between sleepers
- ballast shoulder geometry.

Ballast quality (angularity/sharpness of the ballast stone) is of critical importance in maximising lateral track stability. Where the ballast within the crib, and/or shoulder, is deficient or in poor condition, the track will be more susceptible to misalignment due to a lack of lateral resistance.[17]

Post derailment, the ballast and ballast profile was examined and found to be in good condition and was unlikely to have been a primary factor contributing to the derailment. However, there was evidence of increasing ore car bounce through this area (recorded by the IOCs in the eight months prior to the derailment). The bouncing of the ore cars would almost certainly cause a degradation of the frictional bonding between the ballast and sleepers, resulting in a reduction in lateral track resistance.

In conclusion, the pathing of a large number of loaded ore trains (travelling to Dampier) on the east mainline probably caused a redistribution of longitudinal rail stresses in a northerly direction towards the Mt Brockman railway crossing. The redistribution of rail stresses, coupled with the hot weather, and a degradation in track quality meant the track had a reduced capacity to withstand lateral forces increasing the likelihood of a track-buckling event.

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15 All measured data was below maintenance response requirements.
16 Track Stability and Buckling - Rail Stress Management - Zayne Kristian Ole.
17 'Improved knowledge of CWR track' - Coenraad Esveld.

Findings

From the evidence available, the following findings are made with respect to the derailment of train ND575, on the east mainline, about 50 km north of Tom Price, Western Australia on 15 December 2015. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- The integrity of the east mainline was compromised by a small horizontal track misalignment near 234.373 km. The misalignment probably grew under train ND575, becoming large enough to cause the train derailment.

Other factors that increased risk

- The pathing of a large number of north bound loaded ore trains, on the east mainline, probably caused a redistribution of longitudinal rail stresses south of the Mt Brockman railway crossing.. The redistribution of rail stresses, coupled with the extreme hot weather, and horizontal track misalignment (234.373 km) meant the track had a reduced capacity to withstand lateral forces, thereby increasing the likelihood of a track-buckling event near the point of derailment.
- There was evidence of a growing track misalignment near the point of derailment, however, available management systems were ineffective in alerting maintenance staff to the heightened risk of a track-buckling event.

Other findings

- The track was regularly inspected in accordance with Rio Tinto maintenance requirements.
- Train handling and driver performance were very unlikely to have been factors that contributed to the derailment.
- It is unlikely that the condition of rolling-stock was a factor that contributed to the derailment.

Safety issues and actions

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety actions in order to reduce their safety risk. The ATSB has been advised of the following proactive safety actions in response to this occurrence.

Additional safety action taken by Rio Tinto

Rio Tinto has advised of the following proactive safety actions:

- Update the track geometry condition management process to consider minor irregularities in multiple geometry parameters.
- Utilise the instrumented ore car fleet for identification of sites at risk of rapid failure due to deterioration of minor irregularities in multiple ore car response parameters.
- Develop and implement an improved rail stress management process.
- Implement a tonnage balance strategy and deviation authority process.

General details

Occurrence details

Date and time:	15 December 2015 – 1615 WST	
Occurrence category:	Incident	
Primary occurrence type:	Derailment	
Location:	Near Tom Price, Western Australia	
	Latitude: 22° 16.846'S	Longitude: 117° 41.191'E

Train details

Train operator:	Rio Tinto	
Registration:	ND575	
Type of operation:	Bulk iron ore service, 3 locomotives, 224 ore cars, gross trailing mass 4,704 t, total length 2,160 m	
Persons on board:	Crew – 1, driver only operation	Passengers – nil
Injuries:	Crew – nil	Passengers – nil
Damage:	Substantial	

Sources and submissions

Sources of information

The sources of information during the investigation - Rio Tinto

References

- RISSB National Guideline - Glossary of Railway Terminology
- Bureau of Meteorology - Weather Observations for Paraburdoo, Western Australia (15 December 2015)
- Rio Tinto: Asset Management Design Criteria – Rail Railway Route Infrastructure Civil & Track (DC-R001)
- Rio Tinto: Asset Management Design Criteria – Rail Railway Route Infrastructure Civil & Track (DC-R001, 30 August 2010)
- Rio Tinto: Incident Findings and Recommendations Report – Empty Train Derailment at 234.373km MLETP (16 February 2016)
- Rio Tinto: Code of Practice – Track and Civil, Volume 5 Track Geometry (GN-R105, 24 December 2014)

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:

- Driver of train ND575
- Office of the National Rail Safety Regulator
- Rio Tinto

Submissions were received from Rio Tinto (incorporating the driver of train ND575) 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 operations involving the travelling public.

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

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Investigation

ATSB Transport Safety Report
Rial Occurrence Investigation
Derailment of ore train ND575 near Tom Price, Western Australia,
15 December 2015

RO-2015-025
Final– 11 December 2017