RAIL SAFETY INVESTIGATION REPORT

DERAILMENTS OF TRAINS 5M28 AND NP23

CURRABUBULA

31 JANUARY 2014
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EXECUTIVE SUMMARY

At approximately 1525\(^1\) on 31 January 2014 while travelling between Werris Creek and Tamworth in the Down direction, the driver of NSW Trains’ Xplorer passenger service NP23 saw a slight ripple within the track ahead followed in close proximity by a significant misalignment. The train was travelling at approximately 100 km/h with 80 passengers and a crew of five on board. The driver immediately applied the emergency brake but was unable to stop short of the misalignment which resulted in the lead wheel-set of the third carriage derailing. Six passengers were treated for minor injuries and another was hospitalised due to a fractured shoulder.

About 72 minutes prior, Southern Shorthaul Railroad empty ballast train 5M28, while travelling in the opposite (Up) direction, had experienced a wagon uncoupling at the same location. It was later found that a wagon had derailed and subsequently re-derailed. The misalignment struck by NP23 formed during the passage of 5M28.

The misalignments resulted from the track not being able to contain a build-up of excessive compressive forces within the rail. Evidence indicated this was due to a combination of one or more of the following:

- the consequences of hot conditions prevailing throughout January 2014
- track adjustment policy and procedures not being implemented fully
- the track being adjusted incorrectly
- deficiencies in maintenance responsiveness due to incorrect calculations.

5M28 was travelling approximately 24 km/h over the maximum speed designated for the type of wagons it was hauling and 14 km/h over the posted speed for the section of track. The extent to which this may have contributed could not be established.

Difficulties were encountered in deploying the Xplorer’s emergency ladder but emergency services arrived on site within minutes of the derailment and effected a successful evacuation of passengers. Unsecured luggage also partially blocked some areas at one end of the derailed carriage.

The key recommendations are directed to John Holland Rail, the rail infrastructure manager, and relate to a range of track maintenance issues identified in the process of the investigation. John Holland Rail has advised having completed the

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\(^1\) All times referred to in this report are in Australian Eastern Daylight-saving Time (UTC+11 Hours).
implementation of a number of remedial actions since the incident and those completed by the end of 2014 are listed in paragraph 2.80 of the Report.

Recommendations have also been directed to Southern Shorthaul Railroad in relation to driver training and the process of rectifying faulty instrumentation. Southern Shorthaul Railroad has replaced its locomotive speedometers with an alternative model, and installed equipment which gives a secondary source of speed indication independent of the locomotive speedometer.

Two recommendations are directed to NSW Trains in relation to passenger evacuation and luggage stowage.

The full details of the Findings and Recommendations of this rail safety investigation are contained in Parts 3 and 4 respectively.
PART 1 FACTUAL INFORMATION

Overview

1.1 At approximately 1525 on 31 January 2014, while travelling between Werris Creek and Tamworth in the Down direction, the driver of NSW Trains’ passenger service NP23 saw a slight ripple within the track ahead followed in close proximity by a significant misalignment. At the time the train was in the vicinity of the township of Curraububula (see Figure 1) and travelling at approximately 100 km/h with approximately 80 passengers on board. The driver immediately applied the emergency brake but was unable to stop short of the misalignment which resulted in the lead wheel-set of the third carriage derailing.

1.2 The driver reported the incident to the John Holland Network Control Centre North West at Mayfield, Newcastle, and advised that he believed two of the passengers had sustained injuries and required medical attention.

1.3 About 72 minutes prior to the derailment of NP23, Southern Shorthaul Railroad (SSR) ballast train 5M28 travelling in the Up direction had experienced a wagon uncoupling at the same location. It was later learned that a wagon had derailed and subsequently re-railed before the uncoupling.
Location

1.4 The derailments occurred at Currabubula, a township between Werris Creek and Tamworth in the North West Slopes region of NSW. It is located at 424.500 km,\(^2\) approximately 14 km to the north of Werris Creek and approximately 30 km to the south of Tamworth. The countryside is generally undulating but with some steep rail gradients. In particular, NP23 had traversed a steep 1 in 42 downward gradient just prior to the derailment site (see Figure 2).

1.5 There was a railway level crossing on the southern outskirts of Currabubula just before the location of the misalignment.

Figure 2: Gradient chart of the derailment location

Train Crews

SSR Train 5M28

1.6 The crew of 5M28 consisted of a driver and co-driver. The driver had been a fulltime employee of SSR since September 2010. The co-driver had been employed as a fulltime driver by SSR since October 2010 and had qualified for the route in September 2013. Neither crew member had prior driving experience before being employed by SSR. On the day of the derailment they had signed on at 1300 at West Tamworth. At the time of the derailment

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\(^2\) All km posts in NSW are measured from the buffer stop at No1 platform, Sydney Terminal, Sydney.
the co-driver was at the controls of 5M28 and so is referred to hereafter as the driver.

**NSW Trains NP23**

1.7 NP23 had a crew of five - driver, passenger service supervisor (PSS), supervisor passenger attendant (SPA), shadow (trainee) passenger service supervisor (SPSS) and passenger attendant (PA).

1.8 The driver had been driving since 1989 and had been employed with NSW Trains since 1 July 2013. On the day of the derailment he had signed on at 1442 at Werris Creek. He was to work NP23 from Werris Creek to Armidale, where he was to stable the train and return the next morning to Werris Creek on NP24. He took over NP23 when it arrived at Werris Creek at 1500 and departed on time at 1515.

1.9 The PSS had worked on NSW country trains for four years having previously worked in the airline industry. His role involved overseeing the passenger service staff, attending to passengers and also carrying out safeworking duties under the instructions of the driver when required. On the day of the derailment the PSS had signed on with his staff at 0840 at Central Station, Sydney.

**Train Information**

**SSR 5M28**

1.10 5M28 consisted of four locomotives; 4911, T363, 4708 and 4910. Locomotive 4708 was not running at the time of the incident. 5M28 was hauling 27 empty wagons consisting of 25 NHBF ballast wagons and two NZBF plough wagons. The plough wagons were located at each end of the train to spread ballast while conducting ballast operations. The overall length of the train was 391.4 metres with a gross mass of 857.3 tonnes. The ballast wagons had been hired by John Holland Rail from Sydney Trains.

1.11 SSR was engaged solely to hook and haul the train to Armidale for ballasting operations. After conducting the required ballast dumping the train was to return to Parkes.
1.12 Due to the classification of the wagons the train was restricted to a maximum speed of 80 km/h.

**NSW Trains NP23**

1.13 NP23 was a four car Xplorer set consisting of a leading EA driving/buffet car, two EB seating only cars and an EC driving car with a large luggage compartment for booked luggage (see Figure 3). Its overall length was 99.9 metres.

![Figure 3: Xplorer cars (left to right) EA2505, EB2512, EB2514, and EC2521](image)

**Track**

1.14 The track between Werris Creek and West Tamworth was standard gauge class 2 track consisting of 110 metre lengths of continuous welded predominantly 53 kg/m rail affixed to steel sleepers with standard track lock fasteners. The ballast was sharp medium grade 60 mm nominal size aggregate and most steel sleeper cribs were three quarters full to full.

1.15 The track between Werris Creek and Currabubula was in open, undulating countryside. The track speed varied primarily between 85 and 140 km/h. Both derailments occurred on the lower, inside curve rail (Up rail).

1.16 The track speed through Currabubula changes at several locations due to the tightness of the respective curves. The track speed on approach to Currabubula in the Up direction was 90 km/h at 425.384 km then changed to 100 km/h at 424.496 km, near the level crossing.

**Safeworking**

1.17 The safeworking system in place for the Werris Creek to Tamworth bi-directional single line was train order working.

1.18 Prior to the passage of NP23, 5M28 had travelled through the section from Tamworth to Werris Creek on train order No.40261. It had been fulfilled at Werris Creek at 1508 after which train order No.40266 was issued to NP23.
Environmental Conditions

1.19 The locality of Currabubula is prone to hot weather conditions in the spring and summer months and this was the case in January 2014. At Tamworth Airport the Bureau of Meteorology registered a high of 43.3°C on 3 January. The mean maximum for the month was 33.5°C with only five days recording a maximum temperature below 30°C. On 31 January the maximum temperature recorded at Tamworth was 37.1°C at 1630, but at 1500 it was recorded as 35.2°C.

Initial Site Inspection

1.20 In response to the report of the derailment of NP23, investigators deployed to Currabubula, arriving at the site at approximately 0800 on 1 February 2014. A misalignment in the track was clearly visible at 424.634 km (see Photograph 1).

Photograph 1: Misalignment in the track

1.21 It should be noted that the magnitude of the misalignment experienced by the driver of NP23 may have differed from that seen in the photograph. A train
striking a misalignment can alter the shape of the misalignment even to the extent of straightening it. Changes in temperature affect forces within a track and so can also change the subsequent shape of a misalignment.

1.22 During the initial inspection of the NP23 derailment site at 624.631 km, evidence of another derailment was identified approximately 28 metres from the point of NP23 derailment at 624.603 km (see Figure 4 on page 16 for site layout). Following discussion with the network control officer (NCO) it was identified that 5M28 was the train involved. This was confirmed when 5M28 was inspected later in the day on 1 February 2014.

Before Derailment of 5M28

1.23 Ballast train 5M28 departed West Tamworth at 1352. The train was to travel to Werris Creek where it would be required to conduct shunting operations. When interviewed, the co-driver stated that, as 5M28 was approaching Currabubula on a slight downward 1 in 289 gradient, he sensed that the train was travelling faster than normal and questioned the driver at the controls as to what speed the train was travelling. The driver replied that the speedometer was indicating 69 km/h but was alternating between 69, 71 and 81 km/h.

1.24 The co-driver then turned his head and noted that his speedometer was fluctuating between 81 and 91 km/h.\(^3\) He immediately relayed this to the driver. The co-driver then proceeded to use an application on his notebook mobile phone to confirm their speed. The location of the train could be accurately established as the co-driver noted they were passing a car at a level crossing later identified as the crossing on the southern side of Currabubula at approximately 424.500 km.

1.25 The phone initially displayed 95 km/h but then stabilised at 81 km/h though, by this time, the train was beginning to travel up a grade. While the crew were discussing the matter, the driver of the train noted a rapid loss of brake pipe air pressure. At this point, with the time at approximately 1423, the train

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\(^3\) 49 class locomotives are equipped with two driving stands so that they can be driven in either direction from the one cab. Each driving stand is equipped with its own independent speedometer but they are not positioned directly in front of either driver position. Co-drivers have to turn sideways or around to see their speedometer. To see the driver’s speedometer, they have to stand up and look over the driver’s stand (see Photograph 2).
had just passed through Currabubula and the level crossing. At interview, the driver stated that he did not observe a ripple or any form of misalignment within the track.

**Photograph 2: Cab layout of 49 class locomotive**

**Derailment of 5M28**

1.26 Markings on the rails revealed that, at approximately 424.607 km, the wheels of the leading wheel-set of the third last wagon of 5M28 mounted the Up rail in the Up direction (point of mounting (POM)). They then travelled for approximately four metres before dropping off and derailing at 424.603 km (point of derailment (POD)) (see Photograph 3).
The train travelled for approximately 100 metres in a derailed state causing significant damage to the track fastenings and associated components as well as the wheel-set of wagon NHBF1568. After striking the leading edge of the level crossing road plates located at 424.485 km, the wheel-set bounced onto the rail head of the Up rail, travelled for a further 10 metres, then re-railed (see Photograph 4). This accorded with an eyewitness report from a local resident who was standing near the level crossing at the time of the incident.

1.28 The train travelled a further 1.3 km during which the air hoses parted and depleted the brake pipe air pressure to atmosphere resulting in an automatic full application of the train’s brakes. The train came to a stand at approximately 423.200 km.
Post Derailment of 5M28

1.29 The co-driver immediately walked back along the train and noticed that the last three wagons had detached from the train. (The bouncing action of the derailed wagon striking the leading edge of the level crossing road plates would account for the detaching of the rear three wagons.) The rear portion of the train was sitting approximately 100 metres from the first portion of the train, with the lead of the rear wagons positioned at 423.700 km.

1.30 The co-driver walked around the detached wagons and noted that the lifting pin used to uncouple wagons was in the upward (open) position on the lead wagon of the rear portion.

1.31 The co-driver secured the last three wagons by applying handbrakes. He then quickly looked around the immediate area and noted there was no obvious damage to the track or rolling stock. He also took photographs to record the location of the train (see Photograph 5). Damage to the derailed wagon was also not obvious during an inspection later in the day until an
investigator inspected it from underneath. Significant damage was then evident.

![Photograph 5: Co-driver’s photograph taken from the rear of 5M28](image)

1.32 At this time the driver, who had been relieved by the current crew at West Tamworth, saw the train standing on the track as he drove past returning to Werris Creek. He (previous driver) stopped to render assistance.

1.33 After seeking permission from the NCO, the co-driver instructed the driver to reverse so he could re-couple the rear portion of the train. Once coupled, he had the driver of the train reverse approximately 50 metres more and then haul the train forward to ensure that there were no irregularities within the train’s consist.

1.34 The co-driver and the previous driver conducted a modified continuity test to ensure the integrity of the braking system. The previous driver then drove the co-driver to the front of the train. Nearby, there was a small level crossing from which the previous driver further assisted the crew by giving the train a roll-by inspection as they departed. He reported no concerns.

1.35 Meanwhile, the driver of the train had been communicating with the NCO who was aware that NSW Trains’ passenger service NP23 would be
departing soon from Werris Creek and requested permission to resume their journey. They departed at approximately 1446, arriving at the Werris Creek yard at 1507. Examination of the voice recordings did not identify any reports by the crew to the NCO about concerns with the track infrastructure on approaching or after departing Currabubula.

1.36 While they were shunting they could hear radio conversations between the NCO and the driver of NP23. They continued their shunting operations and noted NP23 departing Werris Creek at 1515.

Before Derailment of NP23

1.37 NP23 was a Sydney to Armidale and Moree service. It arrived at Werris Creek at 1500 where the train consist was divided into two, forming a four car set continuing to Armidale as NP23 and a two car set travelling to Moree as NP43. NP23 departed Werris Creek at 1515. Due to unforeseen circumstances the Moree service was cancelled and train NP43 remained at Werris Creek.

1.38 At approximately 1535, 49 minutes after 5M28 had departed the Currabubula area; NP23 was approaching Currabubula in the Down direction. As the train negotiated a steep downward gradient the driver utilised a small amount of electro-pneumatic (EP) brake to regulate the train speed from approximately 110 km/h in anticipation of a 100 km/h posted speed board located at 424.496 km. As the train approached the speed board the driver observed a slight misalignment within the track ahead followed in close proximity by a significant misalignment.

Derailment of NP23

1.39 Immediately on seeing the misalignment the driver applied the emergency brake but was unable to stop the train short and it struck the misalignment at a speed of approximately 100 km/h. The first carriage reportedly swayed violently almost throwing the driver out of his seat. The second carriage stayed on track but the lead wheel-set of the third carriage derailed. The train came to a stand within 220 metres of the misalignment. The driver
immediately contacted the NCO and reported that NP23 had been involved in a mainline derailment.
Markings on the rails revealed that the wheels of the leading wheel-set of the first bogie of the third car struck the misalignment and derailed at 424.634 km. The right front wheels derailed on the outside of the Up rail in the direction of travel while the left front wheels derailed on the inside of the Down rail, in the Down direction (see Photographs 6 and 7).

The second and fourth cars remaining on track held the wheels of the third car bogie tight against the rails on the right hand curve. This assisted in keeping the third car upright but the rubbing of the derailed wheels against the inside of the Down rail resulted in significant damage to the wheels of the lead bogie (see Photograph 8).

Photograph 8: Lead derailed wheel on NP23
(Note: Severe marking caused by the wheel riding hard against the Down rail head and track fasteners.)

Photograph 9 shows a diagrammatic representation of a conventional bogie superimposed over the misalignment to demonstrate how the rubbing effect of the wheels against both rails is caused by the derailed wheels resisting the curvature in the track.
Photograph 9: Conventional bogie superimposed over location of misalignment
(Note: Leading wheel-set having dropped off is riding against Down rail in the Down direction.

Post Derailment of NP23

1.43 When the driver reported the derailment, the NCO asked if he would require emergency services. The driver advised that some passengers were injured but he did not know the extent of the injuries. In response, the NCO immediately contacted NSW Police, SES and NSW Ambulance Service in turn. They arrived at the scene within minutes of the derailment. Meanwhile, the driver walked through the carriages to check on the passengers and ascertain the extent of damage to the train.

1.44 When NP23 struck the misalignment the PSS was almost thrown out of his seat due to the violent action of the trailing car passing over the misalignment. At interview he stated that, immediately after the train came to a stand, he tried to contact the driver but the phone was busy (because the driver was talking to the NCO). He then attempted to make his way to the front of the train.
1.45 When emergency crews arrived the first response was to remove two of the more seriously injured passengers from the third carriage. Emergency crews were hampered by the train’s emergency deployment ladder not correctly aligning with its locating pins. The PSS stated that this also further impeded the subsequent evacuation of passengers.

1.46 Due to the superelevation of the track the emergency ladder could only be utilised on the Up side of the track because it did not reach the ground on the Down side. The SES crew affixed their own heavy duty aluminium ladder on the Down side as it did reach the ground so passengers were evacuated to both sides. Evacuation proceeded under the control of the SES and PSS while the staff members on board the train tended to the needs of the passengers. An off duty NSW Trains’ driver who was passing by at the time also assisted the train crew and the driver.

1.47 The NSW Trains’ liaison officer from the Daily Operations Continuity Centre within the Rail Management Centre arranged for two coaches to go to the location to convey passengers to Tamworth. Family and friends of some passengers arrived at the scene from Tamworth (some 30 km and 30 minutes drive away) having been alerted to the incident by mobile phone.

Injuries

1.48 Seven passengers were treated initially at the derailment site then transferred to the Tamworth Base Hospital by ambulance for further observation. Six of the seven were treated for various minor injuries at the hospital and released the same night. An 80 year old woman remained in hospital for one week with a fractured shoulder. The PSS sustained some minor injuries to his ribs during the derailment but did not require medical attention.
Figure 4: Site layout of Currabubula
PART 2  ANALYSIS

Environmental Conditions

2.1 In very hot conditions it is common for rail temperatures to exceed the ambient temperature by 30-40°C and retain some residual heat from the previous day. Therefore, the rail would have been experiencing compressive forces as a result of thermal expansion within the track.

2.2 Railway operators and track infrastructure managers predominantly rely on the Bureau of Meteorology (BOM) for the forecast and recording of temperatures. If sought, temperatures at particular locations have to be interpolated from the recordings from the nearest weather stations. Weather stations tend to be located in the vicinity of towns, city centres and airports. Recording units are usually located several metres off the ground and so do not truly represent the environmental conditions to which rail locations are subjected.

WOLO Conditions

2.3 One of the strategies for mitigating risk associated with hot weather is the imposition of speed restrictions when the BOM forecasts air temperatures of 38°C and above, referred to as ‘WOLO conditions’. With some exceptions this applies to all classes of track within NSW. In most circumstances, the speed restriction is a reduction in the allowable train speed of 10 km/h.

2.4 The intent of declaring WOLO conditions is to minimise the potential for a derailment due to a misalignment in circumstances of high temperatures. A reduction in the allowable train speed due to a predicted or actual temperature above 38°C reduces the likelihood of a misalignment by reducing the impact forces that rolling stock imposes on the track. A lower speed also gives a driver more time in which to react to the presence of a misalignment.

2.5 WOLO conditions had not been declared at the time of the derailments. However, within about an hour of NP23 departing Werris Creek, the Australian Rail Track Corporation (ARTC) NCO issued a WOLO using a
Condition Affecting the Network (CAN) form which included the section to be travelled by 5M28 in its subsequent 15 km journey from Werris Creek to Spring Ridge.

2.6 The manner in which WOLO conditions are implemented has been discussed in several OTSI investigation reports, in particular in relation to a derailment at Rennie on 3 January 2013. The ideas of imposing WOLO conditions at forecast temperatures below 38°C and implementing a “sliding WOLO scale” were put forward in the Rennie report. The report recommended that the Rail Industry Safety and Standards Board (RISSB) “strongly encourage the rail industry to reinvigorate” work on a partially completed project “with the aim of producing guidelines for the mitigation of the risk of rail buckling in heat conditions, taking into account the broadest possible set of parameters including ambient temperature, speed of rail traffic and type and condition of track”.

2.7 The issue of managing track in hot conditions is a challenge for the rail industry as a whole.

2.8 JHR’S CRN Track Engineering Manual CM 211 *Track Geometry and Stability* provides guidance for applying speed restrictions (Section C7-3 *Heat speeds*) when high ambient temperatures below WOLO conditions occur in areas where track is experiencing significant stability loss. Although temperatures were high and there were known stability problems around the time and place of the derailment, no speed restrictions were imposed under CM 211 provisions.

2.9 On single line sections of track, speed restrictions are imposed from both directions using special warning and inner caution boards to bring drivers of all trains to a set caution speed. Had a ‘heat speed’ restriction been posted around Currabubula the crews of both trains would have had more than 2500 metres in which to reduce speed.

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Track Conditions

2.10 Derailments caused by track buckling are identified within the rail industry as a high risk. There are a number of contributing factors that can lead to track misalignments. In general, without rail traffic forces being a factor, the causes of misalignments are excessive compressive forces within the rail and/or weaknesses in the constraint provided by track components.

2.11 Rail tracks in NSW under the control of JHR are designed to be free of either tensile or compressive forces at a temperature of 35°C, the neutral or stress-free temperature (SFT). If the rail temperature is higher than 35°C then the track will be in compression. Alternatively, if the rail temperature falls below the SFT, the track will be in tension with less likelihood of track misalignment. However, tension must also be monitored as in the cooler months track breakage can occur as a result of excessive tension within the track.

2.12 The relationship between stress-free temperature and welded track is complex in its structure with high levels of co-dependence between components. Any deficiency in a component affects the strength and rigidity of the track as a whole. In the absence of strength and rigidity, stresses cannot be contained within the rail. Hot conditions further add to the complexities of maintaining rigidity and alignment in track.

Sleepers

2.13 The rail in the vicinity of the derailment site was attached to steel sleepers. Steel sleepers have been used extensively throughout NSW and are a cost effective alternative to timber or concrete sleepers and easier to handle and to stack. In order for steel sleepers to be effective they must be inserted within the track infrastructure correctly. This includes the tamping of ballast within the hollow section underneath the steel sleeper. This tamping facilitates the binding of the sleeper with the ballast to maximise the transfer of load to and friction with the track ballast substructure.

2.14 Steel sleepers have holes which allow for visual or physical inspection to check the level to which the sleeper pods have been packed with ballast (see Photograph 10). An inspection of the steel sleepers over the one kilometre
leading up to the derailment site and 500 metres beyond found the ballast within the pods to be in accordance with JHR’s CRN Track Engineering Standard CS 230 *Sleepers and Track Support*. Section 9.3 of the Standard requires that, following resurfacing, “the height of the ballast in the sleeper pods shall be such that the gap between the underside of the sleeper deck and the ballast in the sleeper pod shall be \( \leq 25 \text{ mm} \)” and “the ballast within the steel sleeper shall be ‘tight’”. Other than at the derailment point, the rails were observed to be securely fastened to the sleepers.

Photograph 10: Steel sleeper pod inspection hole

**Ballast**

2.15 Ballast is a significant component of the track substructure, providing load transfer, support, restraint and drainage to the track. It supports the dead weight of the track and the live loading from rail traffic. The track between Werris Creek and Armidale is designed to support individual axle loads up to 21 tonnes. Hard, angular and well graded aggregate is specified for ballast so as to maximise inter-locking and resistance to in-track forces.

2.16 For class 2 tracks, JHR’s CRN Track Engineering Standard CS 240 *Ballast* calls for a minimum depth of ballast below the underside of sleepers of 270
mm and a minimum shoulder width of 400 mm. The physical characteristics of the ballast required are detailed in JHR’s CRN Track Engineering Specification CP 241 Ballast.

2.17 An inspection of the track, in particular the ballast profile, was conducted in the Down direction over approximately 1 km leading up to the derailment site. The ballast profile was found to be within specification. However, the ballast just prior to and just beyond the misalignment was below specification with depth averaging 250 mm and shoulder width ranging from 230 to 390. At approximately 50 m past the point of derailment there were signs of some form of vehicle movement having caused erosion of the ballast shoulder. Beyond this point the ballast was consistent with Standard CS 240 and Specification CP 241.

2.18 The shoulder on the Down side at the derailment site was observed to be well under specification at an estimated width of approximately 150 to 250 mm. JHR track documentation covering the area within 500 m in both directions from the misalignment did not contain any record of ballast deficiencies although areas below standard existed. An accurate assessment of the situation was not possible as JHR did not use equipment and techniques such as laser profiling to identify ballast deficiencies prior to the derailment.

Track Alignment

2.19 Management of track requires simultaneous maintenance of a number of components in order to maintain track lateral stability. One of those critical components is track alignment. Management of alignment on curves is important as track infrastructure will be weakened by excessive pulling in (tendency to increasing the radius of the curve) and pulling out (tendency to reducing the radius of the curve) of the track. The derailments occurred on a curve with a radius of 590 metres.

2.20 A poorly aligned track can alter stresses within the track infrastructure and will affect the SFT of the track section. A number of issues with the track in the location at Currabubula not being correctly aligned were identified from records dating back to July 2012.
2.21 The alignment of the track at Currabubula was taken from surveyor monuments located on the outside of the Down side, set at 2500 mm from the Down rail. Documentation in relation to track alignment provided by JHR indicated that in July 2012 at 424.820 km the track was off its design alignment by -15 mm.\(^5\) Nearer to the POD at 424.640 km the track was also off its design alignment by -55 mm.

2.22 Later in August 2012 JHR replaced all remaining timber sleepers in the Werris Creek to Tamworth section with steel sleepers. On completion of the work a ‘Resurfacing Before and After’ measurement sheet was produced. This recorded the design, actual and final measurements of the track alignment. The design alignment is established by engineers and surveyors. The actual alignment is measured after the sleepers have been inserted and before any stabilisation processes. The final alignment is measured after stabilisation processes have been completed. The record showed that, at 424.820 km, the actual alignment was off its design alignment by +25 mm but the final alignment was to design. Nearer the POD at 424.640 km the actual alignment was off its design alignment by +60 mm while the final alignment was off the design alignment by -20 mm.

2.23 On 9 August 2013 there had been a number of issues with the track not being correctly aligned. Documentation in relation to track alignment provided by JHR indicated that at 424.820 km the track was initially off its design alignment by +130 mm. Nearer to the POD at 424.640 km the track was off its design alignment by +60 mm. On 3 October 2013, while measurements were being taken for a track stability assessment at the same locations, the track was recorded as still being off the design alignment with deviation in the order of +60 mm.

2.24 Track will move (go off alignment) over time to alleviate in-track forces. For this reason track managers must institute maintenance regimes which provide for the detection then rectification of anomalies through adjustment of track alignment. JHR’s CRN Track Engineering Manual CM 223 Rail

\(^5\) A negative variation indicates a contraction in the rail and so an increase in the radius of the curve. (The tendency has been a straightening of the curve.) Conversely, a positive variation indicates an expansion in the rail so a decrease in the radius of the curve.
2.25 Adjustment states that; “prior to adjusting any rail on curved track the track alignment should be reviewed. Any requirement for alignment correction should be reviewed by the Civil Maintenance Engineer before the commencement of work”. This was not done at Currabubula.

2.26 CM 223 also makes provision for track adjustment to be undertaken when the track is off its correct alignment. The technique is known as ‘smooth lining’ and was being employed at Currabubula. However, at the same time, the manual recommends against it (Section C2-1): “Although adjustment of rails that are not on correct alignment is permitted provided follow up re-alignment and re-adjustment is carried out, it should be avoided because of the potential for follow up works to be interrupted”.

2.27 JHR policy requires that smooth lining only be undertaken with the written authority of the Civil Maintenance Engineer. On receipt of a request the Engineer would undertake a risk assessment which could include consideration of risk mitigating strategies. Engineering interventions to mitigate the risk of the track misaligning could include:

- imposing a ‘heat speed’ restriction post smooth lining
- adding extra ballast to reinforce and add mass to the track
- cutting the rail and introducing mechanical joints.

2.28 At interview, the Civil Maintenance Engineer based at Bathurst confirmed the policy requirement. He also confirmed that his formal written permission was not sought to smooth line at Currabubula.

2.28 Allowing the track to be off alignment without the Engineer’s knowledge meant that critical factors affecting track stability calculations were not taken into account. As a result the priority for adjustment work at Currabubula was determined to be Priority 3 (P3). In accordance with JHR’s CRN Track Engineering Manual CM 203 Track Inspection, a P3 defect should be inspected and verified within 7 days, and action taken to program for repair and monitor. If the track supervisor had based calculations on the track being on alignment, the need for a Priority 1 (P1) response would have been determined. A P1 defect would have to have been inspected and verified within 24 hours, and repair action taken within 7 days.
Track Adjustment

2.29 On 8 November 2013 an adjustment was undertaken on the section of track between 424.500 km and 425.000 km. The adjustment was recorded on a Form RA1 Rail Adjustment Return (see Appendix 2). On examination a number of anomalies were found in the adjustment return. The first error noted was that, contrary to the requirements of CM 223, the track had not been correctly aligned before the commencement of the rail adjustment nor had permission been obtained for an off alignment adjustment.

2.30 Errors were identified in the Adjustment Gap Required values when checked against the Rail Gap Table in CM 223. For a 250 m section of track at 15°C the gap should be 58 mm. However, the adjustment return recorded the gap required as 50 mm. Further, for the same length of track at 24°C the gap should be 32 mm, but the adjustment return recorded the gap required as 28 mm. The data used by the welder was either incorrectly sourced or reference tables were misinterpreted. Use of the correct data is likely to have made it more obvious that removal rather than insertion of steel was necessary.

2.31 An independent estimate of the adjustment necessary, based on documentation available and an examination of the site, indicated that in the order of 8 mm of steel should have been taken out of the track. Instead, 19 mm was added to the Up rail while 12 mm was added to the Down rail (see Photographs 11 and 12). The effect of adding steel rather than removing it is to lower the SFT so increasing the track’s vulnerability to build up of compressive forces in hot prevailing conditions.
Photograph 11: Measurements noted by rail adjuster on Up rail (19mm of steel added)

Photograph 12: Measurements noted by rail adjuster on Down rail (12mm of steel added)
2.32 The welded track stability analysis (WTSA) is a process by which measurements and observations of track components are made in a structured manner leading to an assessment of any losses in track stability. According to the CRN Track Engineering Manual CM 203, when a collective loss of stability reaches or goes beyond 55%, immediate attention is required to rectify the contributing faults to a level that brings losses below the score of 55% prior to the start of hot weather (taken nominally as 1 November of each year).

2.33 A 65% stability loss within the track was determined from the WTSA Secondary Analysis completed at the end of September 2013 (see Appendix 3). A revision of the WTSA stability loss calculation was then undertaken resulting in a final stability loss estimation of 62.9% for the section where the derailment occurred. In the vicinity of the derailment 35% of the stability loss in the track had derived from creep and alignment anomalies. Though the WTSA score was clearly in excess of the 55% threshold, no immediate action to manage the track deficiencies was taken until a welder was tasked to undertake track adjustments on 8 November 2013.

2.34 The correlation between creep and the reduction in stress free temperature in relation to the stability loss in the same section of track was examined from the WTSA analysis form for 9 August 2013. The result was a 12.9°C reduction in stress free temperature in the Down rail and 1.6°C in the Up rail. Creep in relation to the measured alignment would have contributed 33% to the loss of stability for the Down rail and 3.5% to the loss of stability for the Up rail. That is, creep combined would have contributed 36.5% of the loss of stability, more than half the recorded WTSA score of 65%.

2.35 The same calculations were conducted for the values obtained for creep and alignment from the WTSA analysis form completed for 3 October 2013. The result was an 8.5°C reduction in stress free temperature on the Down rail and 3.5°C reduction on the Up rail. This creep in relation to the measured alignment would have contributed 21% to the loss of stability for the Down rail and 9% to the loss of stability for the Up rail. That is, creep combined...
would have contributed 30% of the loss of stability, just under half the recorded WTSA score of 62.9%.

2.36 The WTSA calculations did not take into account the track was off alignment. If this is considered along with the lower stress free temperatures as a result of the addition of steel by the welder, the WTSA score would be well in excess of the threshold for immediate action.

2.37 Given that the track was not re-aligned prior to the commencement of a rail adjustment, it is not possible to gain a true and precise appreciation of the in-track forces that would have been prevailing. However, it is most likely that excessive compressive forces were building up in the track due to the hot prevailing conditions and the addition of steel to the rails. The effect was masked by errors in documentation.

2.38 On 9 August 2013 it was observed that the rail within the section 424.500 km to 425.000 km was creeping into the section from both directions. As a result of this the track was moving off line towards the outside of the curve. The creep in on the Down rail was recorded as 80 mm and on the Up rail as 15 mm. In October the creep was recorded as 52 mm on the Down rail and 23 mm on the Up rail. The difference between the two sets of figures is beyond expectation given the short intervening period and the fact no adjustment of the alignment had been undertaken. It is therefore concluded there may have been errors in the creep measurements.

2.39 As a result of finding discrepancies between the first and second WTSA JHR conducted a third WTSA. The result obtained for the third WTSA was similar to that of the second WTSA. On this basis JHR concluded that inputs into the initial WTSA score were either miscalculated or misread.

**Defect Management System (MAXIMO)**

2.40 JHR utilises MAXIMO, a comprehensive enterprise asset management system, for its asset and defect management. Only nominated individuals are permitted to input data into the system, predominantly the track supervisor/manager, but in some cases the area engineer.
2.41 Work orders are generated in the system, as necessary, based on the input information. Work orders are prioritised e.g., based on the results of a WTSA. When a work order has been fulfilled, the relevant documentation, e.g., track adjustment records, is lodged for close off in the system by a track supervisor or engineer.

2.42 Like all such systems, MAXIMO relies on the accuracy and completeness of the input data. Items such as a WTSA score rely heavily on subjective assessments of various track conditions as well as accuracy of measurements such as those of accurately located creep. The system is also vulnerable to human error in data input. Regular auditing of documentation and MAXIMO records to identify and correct errors is therefore important.

2.43 MAXIMO cannot account for absent data. Form RA1 only had a provision for recording steel cut out in an adjustment; there was no provision for recording steel added. The adjustment return for 8 November 2013 correctly recorded that no steel was cut out but, as it was not subjected to any further scrutiny, the erroneous addition of steel was not detected.

Wagon Inspection

2.44 On 1 February 2014, an OTSI investigator examined the wagons from 5M28 at Spring Ridge where they had been taken and stabled after the derailment. The third last wagon, NHBF 1568Y, was identified as the wagon that had derailed then re-railed. Damage to the trailing wheel-set of the wagon was consistent with it having been involved in a derailment. Damage to the Up side wheel was consistent with it having run on top of rail fasteners (see Photograph 13). The opposite Down side wheel sustained less damage but the damage was clearly due to it having run on ballast (see Photograph 14).
Photograph 13: Damaged Up side wheel of NHBF 1568Y

Photograph 14: Markings on Down side wheel
2.45 Flanges and tread profiles of all wheels were inspected as deficiencies in these can cause hunting, a common precursor to wagon derailment. All were within specification. Wheel back-to-back measurements were also all within specification. An inspection of king castings confirmed that all wagon bodies were securely seated and correctly aligned. The condition of side bearers was also checked and all were found to be in good condition.

2.46 The height of couplers was checked for signs of low couplers. No anomalies in condition or height were found so couplers could be eliminated as causing or contributing to the train derailing and/or parting. It was concluded that the wagons parted as a result of the derailment and subsequent collision with the level crossing infrastructure.

2.47 All wagons were checked for any residue of their payload (ballast) the presence of which could have caused wagons to travel in an unbalanced state. All were found to be completely empty.

2.48 Further inspection was not practical due to the lack of adequate facilities at the site. However, the wagons were in good condition with the components examined found to be within the required standards and tolerances. At the end of the inspection, the wagons were released so they could be conveyed to a more suitable location for a more detailed inspection.

2.49 On 7 and 8 February 2014, bogie experts from the directly interested parties conducted a detailed inspection of all the wagons from 5M28 at railway facilities at Trundle and Parkes. A visual inspection of the following was undertaken:

- spring fitment for signs of displacement and or rubbing
- side bearer condition
- king casting condition
- axle box seating on side frames and against horn cheeks
- wheel flange and tread condition
- friction wedges height and wear surfaces
- bolster and gib wear surfaces
- coupler jaw condition
- coupler headstock condition
• coupler shank in relation to wear against the headstock.

The inspection did not identify any wagon defects or telltale signs that would suggest a wagon had been hunting over an extended period of time though wagons were not lifted off their castings. The wagons were considered to be serviceable and in good overall condition.

2.50 Further, maintenance records revealed that half the fleet had undergone maintenance a month prior and that all wagons were within the required due date for their next maintenance inspections R1 (basic inspection of physical condition) and R2 (detailed inspection of components).

Train Handling

2.51 Three members of the public from the township of Currabubula made unsolicited statements to the effect that, a short time before the derailment of NP23, a freight train travelled through the township in the opposite direction at excessive speed. One resident stated that he had never witnessed a freight train travelling so fast through the township in the 18 years that he had lived there.

2.52 The four locomotives from 5M28 - 4911, T363, 4708 and 4910 – were quarantined pending investigation at the township of Spring Ridge where they were stabled after the incident. Lead locomotive 4911 was equipped with a recently fitted UGL data logger and digital speedometer. The other three were fitted with Hasler event recorders, an older style analogue data logger. On 1 February 2014, OTSI took possession of the Hasler recording tapes from the three locomotives. On request SSR also provided a download from the digital data logger from 4911 on the same day.

2.53 The speed and time traces on the tapes from locomotives 4708 and 4910 were legible but the traces on the Hasler tape from T363 were almost invisible. However, with the use of computer software, faint but useable traces from T363 were extracted. The necessary data was readily available in the data logger download from 4911.

2.54 To obtain the true measure of speeds, it is necessary to perform a calculation that takes into account the difference between the actual wheel diameter and
the nominal half-life diameter which is set as the baseline reference for data loggers.\textsuperscript{6}

2.55 The following speeds were obtained from analysis of the data logger evidence from the respective locomotives:
- Locomotive T363 – 107.4 km/h
- Locomotive 4708 – 103.5 km/h
- Locomotive 4910 – 103.6 km/h
- Locomotive 4911 – 104.2 km/h

These figures suggest that 5M28 was travelling in the order of 104 km/h when it derailed then re-railed at Currabubula. This speed is well in excess of the maximum speed of 80 km/h allowed for the type and configuration of the ballast wagons being hauled by 5M28.

2.56 At interview, the driver stated that his speedometer was displaying approximately 75 km/h as he passed through Currabubula. Conversely, the co-driver noted a speed of approximately 100 km/h displayed on his speedometer at the time.

2.57 A further analysis of data logger evidence covering the journey from West Tamworth to Werris Creek revealed that the driver abided by the speed designated for the train and by the posted speed boards along the route for most of the journey. However, while traversing a steep section of the line eight minutes prior to reaching the derailment site, the co-driver allowed the train to reach a speed of 90 km/h. Later, while travelling on the down grade into Werris Creek, the driver allowed the train to again reach a speed of 90 km/h. At interview the driver stated that he was obeying the speedometer the whole time and was not aware of exceeding the speed limit at any time.

2.58 A 90 km/h posted speed board was positioned at 425.384 km. Between there and the 100 km/h posted speed board at 424.496 km, 5M28 also exceeded the speed limit.

\textsuperscript{6} Wheel diameters reduce over the lifetime of a wheel due to wear and the results of machining to maintain an optimum profile.
**Effects of Speed upon NHBF/NZBF Wagons**

2.59 In the late 1970s a series of dynamic tests was conducted to measure and analyse the performance of certain types of bogies negotiating different types of track. As a result a series of industry standards were developed setting maximum allowable speeds for new wagon types and bogie configurations. Details of maximum wagon speeds are available to train crews from Train Operating Conditions (TOC) manuals.

2.60 The maximum allowable speed for the wagons being hauled by 5M28 was 80 km/h. The 1970s tests demonstrated that wagons similar to these began to hunt at speeds over 80 km/h. A number of factors were found that affected the degree to which wagons hunted. Some of these findings were:

- performance deteriorated with wheel wear. (Up to 70 km/h, all bogies/wheels tested performed similarly. At higher speed the vehicles with worn wheels showed a large increase in their lateral accelerations (up to +/- 0.7g at 100 km/h) as bogie hunting started and became more severe. The same vehicles/bogies with newly turned full flange profiles exhibited no hunting up to 110 km/h.)
- the hunting motion was influenced by the type of springs used
- wagons with constant side contact dampers show little sign of hunting
- loaded wagons hunted less than empty wagons
- less hunting occurred on tight curves than on tangent sections of track.

2.61 The investigation considered these factors, bogie expert inspection reports, maintenance records, the terrain and the curve on which the derailment occurred being of radius less than 600 metres. Although 5M28 clearly exceeded the maximum speed limit set for the wagon/bogie configuration as set out in the TOC manual, it is concluded that speeding was a contributing factor but not the primary cause of the track misalignment at Currabubula.
Locomotive Instrumentation

2.62 Lead locomotive 4911 underwent a complete refurbishment in 2012. As part of the upgrade it was fitted with a UGL DL-230f data logger and a ME-250c speedometer. An examination of the locomotive’s logged faults revealed that there had been 14 faults with either the data logger and/or the speedometer since 17 August 2012. On each occasion the faults were rectified and monitored for a period of time, however, the faults continued to reoccur sporadically.

2.63 At interview the driver was adamant that the locomotive was displaying 75 to 81 km/h on approach to Currabubula. The crew also stated that the speedometer was displaying fluctuating speeds of up to 181 km/h while stationary in Werris Creek yard. However, the data loggers on all locomotives recorded zero km/h while they were stationary at Werris Creek yard.

2.64 SSR management advised that, after the incident at Currabubula, a number of drivers reported having encountered erratic or spasmodic fluctuations in the displays on 4911’s speedometer.

2.65 At Lithgow on 14, 18 and 19 February 2014, UGL technicians tested the data logger, speedometer, Hasler Q-Tron axle speed transducer and associated wiring and interfaces on locomotive 4911. The aim was to identify any issues or failures with the equipment which may cause the driver’s speedometer unit to display a speed less than actual.

2.66 The testing required simulation of the train travelling at 100 km/h. Taking into account the actual wheel diameter the displays would be expected to show 101.6 km/h. The result obtained for the driver’s speedometer was a recording of 102 km/h on the digital readout and approximately 102 km/h on the analogue readout. The co-driver’s speedometer recorded 101 km/h and 103 km/h respectively. The differences were well within the specified tolerance.

2.67 After several days of testing including removing the data logger and two speedometer units and having them bench tested in a controlled environment at their Milperra (Sydney) workshops, UGL found a number of faults
primarily with cabling and wiring connections, terminations and selection which had not been installed by UGL. In addition, the LEDs on the driver’s speedometer analogue display between 72 and 82 km/h were not illuminated (see Photograph 15). The digital display functioned correctly.

2.68 UGL recorded the following observations in relation to the speed display from its testing:

- Data Logger shows no faults related to the measurement of speed by axle transducer
- Due to improper cable selection and shielding the data logger was not able to synchronise the wheel diameter setting with the two speedometers
- The driver speedometer analogue display is missing some segments. The digital display functions correctly
• The speedometers when calibrated for actual wheel diameter indicated a speed 1.6% higher than measured speed.

2.69 While the testing did not identify a single fault to which intermittent speedometer fluctuations could be attributed, a number of the inadequacies in the cabling and wiring found by UGL could result in interference with the electrical signals between components. It may be concluded from this, the number of previously logged faults and the anecdotal evidence from drivers that the speedometer was experiencing intermittent fluctuations. Such fluctuations may not necessarily be recorded by the data logger. Additionally, they may have been occurring at speed with the increased vibration of the locomotive.

Fatigue

2.70 An examination of the rosters of all the crew members involved for the preceding two weeks revealed no evidence that fatigue was an issue. Both crew members of 5M28 had low fatigue scores and had had several days rostered off prior to the day before the derailment.

Other Safety Matters

Condition Affecting the Network

2.71 After departing Curraubula, the crew contacted the NCO and advised that 5M28 was in good running condition. A train parting is not an unusual event and can be due to a number of reasons; poor train management, defective rolling stock or track infrastructure defects. The crew had checked the train and observed no visible damage. There was no obvious evidence of the train having derailed and re-railed.

2.72 Neither the crew nor the NCO considered the occurrence further despite there being no obvious reason for the train parting. An opportunity existed for an NCO to seek and to have the track checked in the general vicinity of the occurrence. This could have been done by completing a Condition Affecting the Network (CAN) form and issuing it to the next train through. This would have required the driver (of NP23 in this case) to exercise caution
in approaching the area. Consequent decreased speed and heightened vigilance may have resulted in the misalignment within the track being detected in time for NP23 to stop short of it.

**Restraint of Luggage**

2.73 During the investigation the PSS highlighted concerns with luggage storage arrangements.

2.74 At the time of the derailment of NP23 the PSS was sitting on one of the crew seats in the trailing driver/crew (EC car) cabin (see Figure 3). The EC cars differ from other cars as they have a large luggage compartment for booked luggage and non-standard items such as surf boards and bicycles (see Figure 5).

![Figure 5: EC car configuration](image)

2.75 The PSS encountered considerable resistance when trying to open the door to exit the cabin. Apart from the non-standard items that were restrained, the luggage had spilled out into the luggage compartment aisle and had rolled in front of the cabin door (see Photographs 16 and 17). The rear doors on all the EC driver/crew cabins open outwards into the vestibule/luggage area and provide the only avenue of escape from the cabin in an emergency.

2.76 The PSS explained that not only was luggage at the crew cabin door and in the small vestibule area, it had also piled up to approximately waist height within the aisle. After forcing the door to exit the crew cabin, he then had to climb over the luggage to access the entrance door to the seating section.
Photograph 16: Luggage compartment showing EC driver’s/crew compartment door

Photograph 17: Restraints utilised for large non-standard items
2.77 The PSS added that, as he made his way to the front of the train, he noted that luggage in each car had spilt out from the overhead luggage racks into the middle of the aisle. This had the potential to cause serious injury even though the heavier items had remained within the luggage racks. Previously the PSS had worked for two major airlines in Australia and noted the airline industry’s approach to stowage arrangements for luggage so as to minimise the potential for injury to passengers in the event of turbulence.

2.78 Overhead luggage racks are of a similar design in all Xplorer cars, and also in Endeavour cars. The racks slope slightly downwards back to the sides of the cars which provides the only method of restraint. When a lateral force greater than required to overcome the gravity holding the luggage in place, the luggage will slide out into the aisle (see Figure 6). This was the case when NP23 was thrust sideways on encountering the misalignment at speed and derailing.

2.79 Additional methods of luggage restraint are available that could potentially be applied to passenger trains. In so doing the risk of injury to passengers and entrapment of crew could be mitigated in the event of a serious incident such as a derailment or collision.
Figure 6: Typical layout of an EB car and luggage racks

Remedial Actions

2.80 JHR has advised that the following remedial actions had been completed in response to the incident as at the end of 2014:

- Reviewed and reissued CRN Track Engineering Manual CM 223 Rail Adjustment.
- Reviewed the current method of delivery for the summertime working instruction, and ensured that all persons were made aware of it and that its requirements were being correctly implemented.
- The CRN Rail Safety Manager had met with NSW Trains to discuss observations from JHR’s investigation report into the recovery of passengers from NP23.
- Investigated the possibility of installing remote temperature monitoring sensors at isolated locations on the CRN. A remote air temperature monitoring station had been established at the Currabubula level crossing as a trial. The station automatically
sends messages to infrastructure staff when certain threshold air temperatures are reached. The system was operational.

- Reviewed County Network Instruction (CNI) 32 Report Network Control Incidents which deals with the most efficient method of obtaining site information for emergency response agencies to enable correct response without causing additional delay. NCOs and Operations Managers have been provided with a briefing on CNI 32.

- CRN Network Operations had developed a new CNI to define how NCOs must implement mandatory controls for potential network integrity risks. The CNI had been briefed out to all NCOs and Operations Managers.

2.81 Southern Shorthaul Railroad has advised that the following remedial action had been completed in response to the incident as at the end of 2014:

- As a result of ongoing complications with the interfacing of the UGL ME 250c speedometer, SSR removed the UGL speedometer and reinstalled the previous older model Hasler speedometer.

- SSR was in the process of having its whole locomotive fleet retro-fitted with In-Cab Communication Equipment (ICE radio system), which possesses the ability to indicate speed, separate from the locomotive speedometer. The purpose was to give crews a secondary source of speed indication.
PART 3 FINDINGS

Causation

3.1 SSR ballast train 5M28 derailed a wheel-set of its third last wagon when it traversed a misalignment in the track which formed under the train in the vicinity of 424.603 km. The wagon subsequently re-railed and the train parted as a result of the derailed wheels striking road plates at a level crossing at 424.485 km.

3.2 The leading bogie of the third car of NSW Train passenger service NP23 derailed as it traversed a misalignment at 424.634 km. This misalignment formed during the passage of 5M28.

Contributing Factors

3.3 The misalignments resulted from track not being able to contain a build-up of excessive compressive forces within the rails due to a combination of one or more of the following:
   - consequences of hot conditions prevailing throughout January 2014
   - track adjustments being undertaken without prior alignment (smooth lining) and without the necessary approvals
   - the track being adjusted with steel being inserted instead of being removed from the Up rail
   - deficiencies in maintenance responsiveness due to incorrect calculations in the secondary track stability analysis.

3.4 JHR Rail Adjustment Return (Form RA1) had no provision for recording steel added in a rail adjustment.

3.5 5M28 was travelling approximately 24 km/h over the maximum speed designated for the type of wagons it was hauling and 14 km/h over the posted speed for the section of track. The extent to which this may have contributed could not be established.
3.6 The driver of 5M28 did not identify the train was speeding from the characteristics of the train attitude nor implement alternative speed checking strategies.

**Other Findings**

3.7 According to drivers the speedometer in locomotive 4911 displayed significant, intermittent fluctuations though post-incident testing proved inconclusive.

3.8 The track was in good condition though ballasting was below standard in width in places.

3.9 Local conditions in the vicinity of Currabubula may have justified a declaration of WOLO but this was not provided for under current practice.

3.10 No action was initiated to provide for a check of the track for possible clues to the reason for 5M28 parting which, for example, could have been achieved through the issue of a Condition Affecting the Network to the driver of NP23,

3.11 The evacuation process was impeded due to the Xplorer’s emergency deployment ladder not correctly aligning with its locating pins and not reaching the ground on the higher side of the train.

3.12 The current arrangements for stowage and restraint of luggage on the Xplorer allows luggage to move and obstruct egress from the crew cabin and to fall on to passengers from overhead racks in the event of a serious accident such as a derailment or collision.
PART 4 RECOMMENDATIONS

The following recommendations are made in relation to matters identified in the course of this investigation.

Southern Shorthaul Railroad

4.1 Implement a more robust process for identifying and rectifying repetitive faults reported in critical instrumentation.

4.2 Provide training to drivers in the use of alternative strategies for gauging speed in the event of a speedometer failure.

John Holland Rail

4.3 Undertake a comprehensive risk assessment of the practice of adjusting track without first correcting alignment (‘smooth lining’).

4.4 Improve track maintenance standards and procedures related to track stability in hot weather so as to facilitate the exercise of appropriate accountability within the track maintenance system.

4.5 Introduce a rigorous checking and auditing program to verify improved track maintenance standards and procedures are being correctly implemented.

4.6 Make provision in Form RA1 for recording steel added in a rail adjustment.

4.7 Implement precautionary Condition Affecting the Network procedures immediately after a train parting incident as a matter of routine.

NSW Trains

4.8 Undertake a risk assessment of evacuation from Xplorer trains in the event of a major incident or accident to ascertain the adequacy and suitability of current procedures and associated rescue equipment.

4.9 Undertake a risk assessment of luggage stowage requirements on Xplorer trains to ascertain the adequacy and suitability of current restraining arrangements in the event of a major accident.
PART 5  APPENDICES

Appendix 1:  Sources and submissions

Sources of information

- John Holland Rail
- NSW Trains
- Office of the National Rail Safety Regulator
- Rail Industry Safety and Standards Board
- Southern Shorthaul Railroad
- United Group Rail Pty Ltd

Submissions

The Chief investigator forwarded a copy of the Draft Report to the Directly Involved Parties (DIPs) to provide them with the opportunity to contribute to the compilation of the Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and to submit recommendations for amendments to the Draft Report that they believed would enhance the accuracy, logic, integrity and resilience of the Investigation Report. The following DIPs were invited to make submissions on the Draft Report:

- John Holland Rail
- NSW Trains
- Office of the National Rail Safety Regulator
- Rail Industry Safety and Standards Board
- Southern Shorthaul Railroad
- Transport for NSW
- United Group Rail Pty Ltd

Responses were received from all the DIPs and were taken into consideration in finalising the Report.
Appendix 2: Rail Adjustment Form

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Country Code</th>
<th>No. of Adjustment Officer</th>
<th>Authority Officer</th>
<th>Adjustment Details</th>
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</table>

<table>
<thead>
<tr>
<th>Track Section</th>
<th>Km From</th>
<th>Anchor Point</th>
<th>Km To</th>
<th>Length (m)</th>
<th>Track Diameter (mm)</th>
<th>Track Laundered (mm)</th>
<th>Track Lateral Spacing (mm)</th>
<th>Rail Gap (mm)</th>
<th>Wear Location</th>
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<td>600</td>
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<table>
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<tr>
<th>DISTANCE ADJUSTED</th>
<th>KM FROM</th>
<th>KM TO</th>
<th>LENGTH (M)</th>
<th>TRACK DIAMETER (MM)</th>
<th>TRACK LAUNDERED (MM)</th>
<th>TRACK LATERAL SPACING (MM)</th>
<th>RAIL GAP (MM)</th>
<th>WEAR LOCATION</th>
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Derailments of 5M28 and NP23, Currabubula, 31 January 2014
### WTSA - Secondary Analysis

#### Revised WTSA Stability Loss

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<th>Location Factor</th>
<th>Value</th>
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<tbody>
<tr>
<td>Minimum Curve Radius (m)</td>
<td>124m</td>
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<tr>
<td>Maximum Track Gradient (°)</td>
<td>1.4°</td>
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<tr>
<td>Bi-directional Winding</td>
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<tr>
<td>Rail Buckling Points</td>
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<tr>
<td>Train Breaking Zones</td>
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#### Track Geometry Condition

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<th>Rail Gaps</th>
<th>Rail Temp.</th>
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<td>14.9</td>
</tr>
<tr>
<td>500 m track section</td>
<td>190 - 250</td>
<td>12.6</td>
</tr>
<tr>
<td>250 - 350</td>
<td>45.2</td>
<td></td>
</tr>
<tr>
<td>500 - 600</td>
<td>12.4</td>
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</tr>
<tr>
<td>Country End</td>
<td>400 - 500</td>
<td>10.8</td>
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#### Curve Alignment

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<th>Curve Type</th>
<th>Activity Type</th>
<th>Date</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Alignment Error</td>
<td>MA-Manual Resleeving, T-Mechanised Res, &amp; Surf...</td>
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<tr>
<td></td>
<td>S-Surfacing no stabilizer, TS-as per &quot;T&quot; with Stabilizer...</td>
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<tr>
<td></td>
<td>SS-Surfacing with stabilizer, B-Ballast Cleaning, RS-as per &quot;R&quot; with Stabilizer...</td>
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#### Details of Planned Works to Rectify WTSA Priority Defect

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<th>Details of Secondary Analysis Assessment of Track Stability</th>
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<tr>
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<tr>
<td>TSW</td>
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<tr>
<td>TSU</td>
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<tr>
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<td>Track Manager</td>
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