**Rail Safety Investigation**

**Report No 2006 / 02**

Derailment

V/Line passenger train 8432

11 km east of Traralgon

12 October 2006

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# **THE CHIEF INVESTIGATOR**

The Chief Investigator, Transport and Marine Safety Investigations is a statutory position established on 1 August 2006 under Part V of the *Transport Act 1983*.

The objective of the position is to improve public transport and marine safety by independently investigating public transport and marine safety matters.

The primary focus of an investigation is to determine what factors caused the incident, rather than apportion blame for the incident, and to identify issues that may require review, monitoring or further consideration. In conducting investigations, the Chief Investigator will apply the principles of ‘just culture’ and use a methodology based on systemic investigation models.

The Chief Investigator is required to report the results of investigations to the Minister for Public Transport and / or the Minister for Roads and Ports. However, before submitting the results of an investigation to the Minister, the Chief Investigator must consult in accordance with section 85A of the *Transport Act 1983*.

The Chief Investigator is not subject to the direction or control of the Minister(s) in performing or exercising his or her functions or powers, but the Minister may direct the Chief Investigator to investigate a public transport safety matter or a marine safety matter.

# **1. EXECUTIVE SUMMARY**

At about 1405**[[1]](#footnote-1)** on 12 October 2006, V/Line passenger train 8432, en route from Bairnsdale to Melbourne, derailed approximately 11 kilometres east of Traralgon. The locomotive and four cars remained upright within the boundaries of the track ballast. There were no reported injuries amongst the 75 passengers or the operator’s four staff members. The rail vehicles received only minor damage but the track was substantially damaged and was not returned to service until 15 October 2006.

At the time of the incident, the rail track between Traralgon and Sale was being upgraded from jointed rail to continuously welded rail. The greater part of the work involved in this process was being conducted overnight to reduce the effect on train operations. On the night prior to the incident the work gang had been working on the track in the area of the derailment.

The investigation concluded that the probable reason for the derailment was rail buckling due to a low stress-free temperature of the rails, inadequate lateral support in the form of track ballast and the high ambient temperature on the day of the incident. The low stress-free temperature of the rail is attributed to the pre-existing condition of the track and the nature of track upgrade works undertaken during the night preceding the derailment. Given the condition of the track and the forecast temperature on 12 October, appropriate speed restrictions had not been placed on the worked section of track.

The report recommends that the current track manager reviews its system of maintenance and staff training with emphasis on lines involved in passenger operations. The report further recommends that the Public Transport Division, Department of Infrastructure conducts risk assessments with the track manager to identify and mitigate derailment risks that may result from maintenance activities. Also, that the rail safety regulator reviews its audit programs as they relate to infrastructure managers.

# **2. CIRCUMSTANCES**

V/Line Passenger Train 8432 was operating the 1245 service on 12 October 2006 from Bairnsdale to Melbourne. The train consisted of an N Class locomotive and four cars including a buffet. It was crewed by a driver and two conductors, one of whom was responsible for operating the buffet. At the time of the incident the train carried about 75 passengers.

The train departed Bairnsdale on schedule and remained on time at the immediate stops of Stratford and Sale.

At Stratford a second driver joined the train. He travelled in the locomotive cab to Sale where he signed on for duty. He then rejoined the train with the intention of travelling to Traralgon where he was to relieve the driver and continue the service to Melbourne.

The train departed Sale and continued toward Traralgon with a scheduled stop at Rosedale at 1357.

At about 1405, when the train was 11 rail kilometres east of Traralgon between rail kilometre posts 170 and 169, the locomotive followed by all cars derailed. The locomotive came to rest about 134 metres after the point of derailment. The locomotive and all cars remained upright within the bounds of the track ballast.

Neither of the locomotive drivers, two conductors nor any of the passengers was reported to have received any injuries.

The train received only minor damage but the track was extensively damaged.

Emergency services and V/Line personnel were quickly on site and the passengers were held on the train with the air-conditioner operating until buses arrived about 40 minutes later. The ambient temperature at the time was about 34 degrees Celsius.

The locomotive and cars were re-railed on 14 October 2006 and sent for maintenance at Newport Workshop, Melbourne. The track was repaired and the line opened for service on 15 October 2006.

# **3. FACTUAL INFORMATION**

## 3.1 Personnel information

### 3.1.1 Train crew

The normal train crew for this service is one locomotive driver and two conductors, one of whom operates the buffet service. On this occasion, another driver was travelling as a passenger in the locomotive cab.

The locomotive driver had been driving for 31 years, being stationed at Traralgon for the last eight years. He was qualified and current on the locomotive he was driving and familiar with the track between Bairnsdale and Melbourne.

Prior to the day of the incident he had had two rostered days off duty. He commenced his shift that morning at Traralgon and drove the same locomotive from Traralgon to Bairnsdale. He received no injuries as a result of the incident but in line with company practice took leave following the incident.

The other driver occupying the locomotive cab had signed on at Sale after travelling in the locomotive from Stratford, where he lives, and was rostered to drive train 8432 from Traralgon to Melbourne. He had worked an almost eight-hour shift on 11 October and had been rostered off duty on 10 October. He received no injuries as a result of the incident.

The conductor was situated at the end of the train in the conductor’s compartment at the time of the incident. He has been a conductor with the company for approximately 12 months and was based at Bairnsdale. He signed on for duty at 1232 on the day of the incident. He had worked as a conductor the previous three days with his last day off duty being 8 October 2006. He received no injuries as a result of the incident.

The second conductor on the train was assigned duties in the buffet and had no other duties associated with the operation of the train.

### 3.1.2 Passengers

At the time of the incident it was estimated that there were 75 passengers on the train. Manifests of passengers are not required on intrastate trains in Victoria. No passengers were reported to have been injured in the incident.

## 3.2 Rolling-stock information

The train consisted of a locomotive and four passenger cars.

The locomotive was an N Class, number N465. It is a diesel-electric type with a mass of 124 tonnes, a power rating of 1846 kW and fitted with an auxiliary generator to provide head end power to passenger cars. This type of locomotive is used extensively on the company’s network throughout Victoria.

The locomotive was reported to have been serviceable prior to the derailment. In the incident all bogies of the locomotive were derailed but it suffered only minor damage which was confined to the wheels, cow catcher and sanders. The locomotive was subsequently re-railed and taken to Newport Workshops for repair and inspection. Post incident inspection found no defects other than the damage sustained as a result of the derailment.

The four cars, designated set FN 8 consisted of car numbers BZN 256, BN 22, BRN 34, and CAN 24. All bogies of each car derailed as a result of the incident. The damage to the cars was minor and mainly to the wheels. All cars were later re-railed and taken to Newport Workshop for inspection before being returned to service. Post incident inspection found no defects other than the damage sustained as a result of the derailment.

## 3.3 Infrastructure information

The track in the area of the incident is part of the Gippsland line of the Victorian broad gauge (1600 mm) country rail network. The line is owned by Victorian Government business enterprise VicTrack and, at the time of the incident, was leased to Pacific National Pty Ltd who is responsible for track maintenance.

The line speed between Sale and Traralgon for locomotive-hauled passengers train is 100 km/h.

### 3.3.1 Conversion of jointed rail to continuously welded rail

At the time of the incident the track between Traralgon and Sale was being converted from jointed rail to continuously welded rail (CWR). In general, CWR is superior to jointed rail in that it provides a smoother ride and reduces maintenance requirements for rolling stock and track infrastructure.

With jointed rail, each length of rail is joined to the next rail by fishplates which are bolted onto either side of the rail through the rail web. The fishplate is designed to transfer bending moments and shear forces developed in one length of rail to the adjoining length of rail. In addition, the joints serve to permit a level of thermal expansion and contraction in the rail.

The conversion from jointed rail to CWR involves the replacement of joints with welded connections, in this case utilising Aluminothermic welding. Welded lengths of rail are completed in modules, usually 330 metres in length.

In the absence of any thermal expansion joints and in order to manage thermally induced stresses within CWR, each module is subject to a de-stressing process. As rail is often installed at low ambient temperatures, this de-stressing process involves the tensing of the rail (using a rail tensor) before completing a closing weld, normally at mid-span. In Victoria, this tensing process is conducted such that the rail is designed to be in an unstressed condition at a rail temperature**[[2]](#footnote-2)** of 38 degrees Celsius. At lower temperatures with the rail under thermal contraction, the completed rail will be in tension, while at higher temperatures with the rail under thermal expansion, the rail will be in compression.

The procedures for laying, welding and maintaining continuously welding track are described in Civil Engineering Circular (CEC) 3/87 issued by a previous track manager, the Public Transport Corporation (PTC), in September 1987. At the time of the incident this procedural document was in use by the track manager for the work on the Traralgon - Sale track.

### 3.3.2 Track condition prior to the works on 11-12 October

The condition of track is typically managed through the periodic inspection of rail and joints and the monitoring of rail creep. In this instance, rail creep data provides a guide to the potential condition of the track prior to commencement of works on 11 October.

Rail creep is the longitudinal movement of the rails caused by the action of rail traffic. It is most likely to take place on grades, places where trains brake, and in the direction of the predominant traffic tonnage on single lines. Creep is recorded by monitoring the movement of the rails against monuments at the side of the track. CEC 3/87 stipulates that creep should be monitored twice a year in March / April and September / October. The track manager complied with this requirement and recorded creep movement for the Traralgon - Sale track in the company Rail Creep Register in April and October each year for at least the last seven years.

The creep reading at the 170 km mark is of particular interest as it is about three quarters of the way down an incline that finishes at about the point of derailment. The track manager’s register notes that there is no peg (creep monument) at the 169 km mark and as a result creep could not be measured at this point. Recent creep readings as recorded by the track manger include those listed below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Kilometre  Post | October  2006 | April  2006 | October  2005 | Differences  Oct 05 to  Oct 06 | Differences  Apr 06 to  Oct 06 |
|  | Up**[[3]](#footnote-3)** Down**[[4]](#footnote-4)** | Up Down | Up Down | Up Down | Up Down |
| 168 (Note) | 0 0 | 50 57 | -2 -20 | N/A | N/A |
| 170 | 122 155 | 110 141 | 81 112 | 41 43 | 12 14 |
| 171 | 50 80 | 55 72 | 49 65 | 1 15 | 5 8 |

Notes:

1/ All creep measurements are in millimetres.

2/ A positive creep value means movement in the “Up” direction.

3/ The track at Post 168 was converted to CWR and restressed in October 2006 (prior to the incident) and accordingly the creep reading reset to zero.

With the exception of the creep readings for the 170 km and 171 km marks, the comments section of the register noted that the track had been “restressed after the rail had been continuously welded” for other kilometre marks between 166 and 175, and as a result the creep for these points was recorded as zero.

Noting that Barrs Lane limits track movement, the creep records suggest that over time there would have been some bunching of the track in the vicinity of the 170 km mark and towards the 169 km mark. This in turn suggests that prior to works on 11-12 October the track is unlikely to have been in an ideal tensed state, and is likely to have had a stress-free temperature lower than the design figure of 38 degrees Celsius.

### 3.3.3 Track ballast

CEC 3/87 specifies a minimum ballast shoulder “400mm wide at least level with the top of the sleeper after compaction”. Post incident inspection indicated shoulder ballast inconsistent with this specification.



**Track adjacent to point of derailment**

### 3.3.4 Other pre-conditions and instructions for the works on 11-12 October

The works being undertaken on the night of 11-12 October were part of a broader program to convert remaining jointed track between Traralgon and Sale to CWR. On previous nights the track had been continuously welded between Traralgon and the 169 km post and other sections had been completed towards Sale, leaving jointed rail requiring conversion to CWR in the vicinity of kilometre locations 169 to 172.

In addition to the general procedures contained in CEC 3/87, specific instruction for the area of works was limited to a “Track Weld Document”. The document sets out diagrammatically the work to be done on the track including the number and position of the fishplate joints to be cut out, the number and position of the welds to be made, and the direction the rails were to be bumped to join with other rails.

To cause a minimum of disruption to rail traffic, the work was to be conducted at night. The work gang consisted of 26 workers supervised by an acting road foreman and included two qualified track welders. The acting road foreman and three other members of the gang were employees of Pacific National with the other members being hired from two labour hire companies that supplied workers with various skills to the rail industry.

The track works were overseen by a company track supervisor and a contracted consulting engineer; however, neither person was on-site for every shift nor were they on-site for the night shift prior to the incident.

### 3.3.5 Works on the night prior to the incident

At 1900 on the evening of 11 October the members of the gang commenced duty at the Sale rail depot adjacent to the Sale Railway Station. The gang was briefed by the acting road foreman on the work to be completed during the night before loading their equipment into vehicles and proceeding to the site situated near the 169 km post, a drive of about 25-30 minutes.

At the work site the gang set up for the night’s work and waited until about 2045 after the last passenger service had passed through the location before occupying the track and commencing work. Work was to progress from the vicinity of the 169 km post in a down direction towards Sale.

Works on the night deviated from the issued Track Weld Document which specifies the cutting out of joints, the bumping of released track to either end of a rail module and the insertion of a single rail closure at mid-span within the module. In completing this closure, normal procedure would require the rail module to be tensed as appropriate for the rail temperature at the time of the works. It is also normal practice that module tensing cannot be commenced until welding and anchoring is completed to the mid-span of the following module. There is therefore normally some lag in tensing behind welding works.

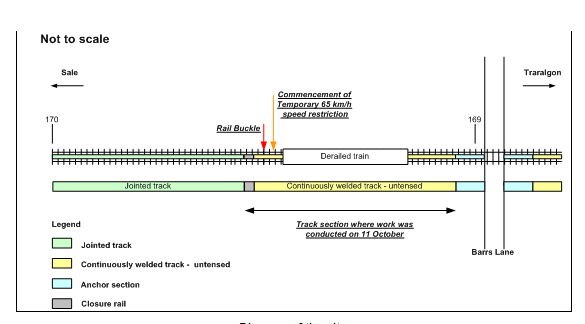
On the night of the works, rather than releasing and bumping the track, each joint in the rail was cut out and replaced with a closure rail of approximately four metres in length, free welded[[5]](#footnote-5) into position. The rail between each joint was not released from its anchors; the aim being to minimise the change to the stress condition of the rail between joints. The gang reported that they had not noticed any significant movement in the ends of the rails as each joint was cut out. This may have indicated to the work gang that there was some level of tension remaining in the rails before the closure rails were welded into position. This was to be an interim arrangement with the rail to be released from its anchors and tensed in accordance with the normal de-stressing process at a later stage.

During the night the task proceeded as described above with one delay when the track had to be made operational for the passage of a Melbourne bound freight train at 0200. The shift was completed at about 0630. The gang completed 16 welds during the shift but did no rail stress adjustments as their rail tensor was unserviceable.

### 3.3.6 Temporary speed restrictions

Temporary speed restrictions are used to reduce the speed at which trains travel on specific sections of track. The restrictions are applied due to deterioration in track condition below that necessary to maintain the designated line speed or when there is a potential for the condition of track to be affected by high ambient temperatures.

Following the night shift a speed restriction of 65 km/h was placed on a section of the newly welded track. The purpose of the speed restriction was to facilitate the day shift undertaking a finishing grind and inspection of the previous night’s welds. This speed restriction did not cover the full length of track worked on during the previous night, as shown below.



**Diagram of the site**

Temporary speed restrictions are also placed on sections of track when ambient temperatures in the area are forecast to exceed 36 degrees Celsius. These temperature related speed restrictions are commonly known as ‘WOLO’. On the day of the incident the temperature in the Traralgon-Sale area was not forecast to reach 36 degrees Celsius and, as a result, no WOLO was placed on the track.

### 3.3.7 Track condition following the incident

An inspection of the site approximately three and a half hours after the incident found that the train had derailed at the end of a downhill section of track and at the derailment point there was evidence of a buckle in the track. There was also evidence that at least one rail vehicle wheel had climbed onto the head of the rail for a short distance before completely derailing. The point of derailment was approximately four metres prior to the 65 km/h speed restriction sign. The speed restriction was at the bottom of the incline in the track.

Following the point of derailment the rails spread and were torn from the sleepers which had themselves split into several pieces. There were two small excavators to the south and well clear of the track. There was no evidence of any vehicle or obstruction being on or infringing the track at the time of the derailment.

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**View of the scene looking in the direction of travel of the train**

### 3.3.8 Instruction issued after the incident

Following the incident, the track manager issued a draft amendment to their Infrastructure Manual entitled, “Interim Tensing of Incomplete Welded Track Modules”. This instruction sets out procedures to be followed if, for any reason, incomplete track modules have to be left un-tensed after the completion of a work shift. The instruction highlights the acute situation that may exist after night welding where track had been left un-tensed and high temperatures were expected the following day.

The instruction states that:

“In the summer period, no track module should be allowed to remain un-tensed and handed over to train operations unless the following precautionary actions are taken:

* the train is flagged over the untensed module**[[6]](#footnote-6)**;
* application of a maximum 30 km/h or less speed restriction over the untensed module until full tensing was completed;
* works supervisor or appropriate manager to make a determination as to the safe condition of the untensed modules and (they) must ensure that the track is safe and reliable for train operations;
* if the track condition has been significantly disturbed or lacks sufficient shoulder ballast then flag trains at 15 km/h.”

The instruction also provides advice on interim tensing of track modules. Particularly relevant to the scenario on the night of 11-12 October is the described methodology for “punch tense welding”. The instruction states,

“In short sections of 82 metre jointed rail track (usually less than three km), it may not be cost effective or feasible to bump the jointed rail to create a gap to insert a four metre closure rail. The closure gap is formed by cutting out a four metre closure length at every joint rather than bump the rail.

At the end of the work shift there may not be sufficient time to fully tense the last module or part of. To ensure full and safe close up of the shift, punch tensing can be used as a safe and fast method of tensing the incomplete welded module.”

The instruction continues:

* “No more than one 82 metres rail length can be left untensed during welding operations.
* Double anchor block the incomplete weld module at the junction of the welded and jointed rail. In short incomplete weld modules of less than 165 metres. The double anchor block can be applied over the jointed rail.
* Punch weld the incomplete weld module in accordance with ENG-TE-SPE-6304 – Punch Tense Welding of CWR Track.
* Make an allowance for the joint gap and follow the principle for the length of closure rail as follows:
  + Closure rail length = (Distance between the rail ends) less (punch mark difference) less two times (weld gap) less five mm allowance.
  + The five mm allowance relates to uncertainties in joint movement in the incomplete weld modules.”

### 3.3.9 Track movements prior to incident

Following the completion of the night shift at about 0630 and before the incident at about 1405, the Centrol**[[7]](#footnote-7)** train graph recorded three rail vehicle movements over the track at the point of derailment. One was a Melbourne bound train at about 0725, one a Bairnsdale bound train at about 1010 and the other a hi-rail (rail works vehicle that can run on both rails and roads) at about 1310. During these movements no problems with the track in the area of the derailment were reported to or recorded by the train controller.

## 3.4 Interview information

Following the incident the locomotive driver, relief driver, the train conductor, the acting road foreman and other Pacific National officers involved in track maintenance were interviewed.

### 3.4.1 Locomotive driver (Sale to Traralgon)

The driver advised that on 12 October he had signed on at Traralgon and travelled with another driver who drove the train to Sale. On that journey, they encountered a speed restriction of 65 km/h in the vicinity of the 168 km mark. Neither of the two drivers was aware of the restriction until encountering the signage beside the track. Apart from the speed restriction the journey from Traralgon to Sale and then Bairnsdale was uneventful.

The return journey was again uneventful until the train approached the 169 km mark where there was a speed restriction of 65 km/h. The driver slowed the train to comply with the restriction. The driver reported that as the train approached the Barrs Road level crossing (km mark 168.96) the train suddenly lurched severely, ran smoothly for a short period and then lurched again. The driver braced himself and the train continued to run in a derailed state before coming to rest upright. He reported that he did not suffer any injury as a result of the incident. He also commented that he had the impression that the locomotive struck something on the track but that he had not observed any object or equipment on the track. Neither did he recall observing any buckling of the track.

After the train stopped, he became aware of two groups of workers, one in the vicinity of Barrs Road and the other group well away from the track about 150 metres from the point of derailment. Neither group reported that there was any equipment close to the track.

Following the incident the driver initiated an emergency call to Pacific National Train Control (Centrol). The call was answered by Centrol in a matter of seconds. The driver remained on the locomotive to facilitate communications until being relieved by the other driver who had accompanied him from Stratford. He was breath tested by the police (with a negative result) and was driven from the site.

### 3.4.2 Relief driver

The relief driver joined the train at Stratford and signed on at Sale. He intended to travel with the driver to Traralgon where he was to take over as the driver of the service to Melbourne.

He reported that the journey to Rosedale was uneventful. After departing Rosedale, the train crested the hill prior to Barrs Road and the driver selected the air brake then the dynamic brake to reduce the train speed for the speed restriction. The co-driver was not aware of the speed restriction until the driver had advised him.

The relief driver was looking across the cabin at the driver when they passed a gang beside the track. There was a loud bang and the locomotive began “riding rough”, veered to the right and ploughed through the ballast before coming to a rest tilting at an angle of about 15 degrees to the right. Prior to the rough running the co-driver did not observe any obstruction on or close to the track and did not see any buckle in the track.

After the incident the relief driver went back along the train to check to condition of the passengers and to talk to the conductor. He observed that all passenger cars were off the track but had remained upright. He reported that the main engine in the locomotive was shut down but that the head end power engine was kept running to facilitate air conditioning for the passengers.

### 3.4.3 Conductor

The conductor was crewing the train from Bairnsdale to Melbourne and reported that the journey up to Rosedale was without incident. After the Rosedale stop he went through the train and sold tickets to boarding passengers then returned to the conductor’s station at the rear of the train. He believed that there were about 75 passengers on the train.

The conductor reported that, a short time after returning to his station, he felt the train brakes apply and observed that the time by his watch was 1402. The train then started to bounce with dust and ballast flying around outside the train. The train came to rest and the conductor said he opened the outside door but could not see anything because of the dust. He then walked through the cars to the front, checking on the passengers as he went and decided that, because of tilt on the forward cars, to move the passengers to the rear car. The conductor then contacted the V/Line control office (commonly known as CARS) but they were already aware of the incident. He advised that there was some confusion amongst passengers as the seals between the cars had been broken allowing dust to enter but that all passengers had remained in their seat and he was not aware of any luggage being dislodged.

The conductor reported that V/Line management personnel and emergency services were on-site within 10-15 minutes. The passengers were kept on the train until buses arrived about 40 minutes later and they were then de-trained to the buses.

The conductor commented that track workers near the derailment site advised him that there was a buckle in the track at the point of derailment prior to the train’s arrival.

### 3.4.4 Acting Road Foreman

The acting road foreman was interviewed at Sale Depot prior to the commencement of a night shift on 25 October 2006. He advised that he commenced working for Pacific National eight months previously and had originally worked for PTC for a number of years before a period of eight years out of the rail industry prior to joining Pacific National. It was while he was with PTC that he gained his track qualifications and experience. Prior to commencing work with Pacific National he obtained his Level 3 Track Safety Awareness qualification. This qualification allows a holder to supervise the safety of others on the track. Since joining Pacific National he had not undertaken formal training but had completed informal on-the-job training under the supervision of a road foreman while conducting track welding operations.

The acting road foreman confirmed that CEC 3/87 instructions were used by the gang to conduct continuous welding works. The acting road foreman also advised that during the night the gang was not able to tense any track as the rail tensor was unserviceable.

At 0630, after the shift had completed its work for the night, the acting road foreman rang his supervisor to advise him that in his opinion there was not enough ballast on the track in the area they had been working to “pull up the shoulders”. (This referred to a lack of ballast at the ends of the sleepers to provide a good formation to correctly secure the sleepers that hold the rail.)

After the interview the acting road foreman invited the investigators to view the track welding operation that night.

### 3.4.5 Interview with Pacific National track maintenance supervisors

The engineer responsible for the continuous track welding and the acting road foreman’s supervisor were interviewed at Pacific National’s Melbourne office. They advised that the continuous welding task on the Traralgon to Sale track was covered by CEC 3/87 which provided procedural guidance for gangs involved in the work. They advised that there were no specific work instructions or other procedures provided for the works. Subsequent to the interview, extracts of the “Track Weld Document” diagrammatically detailing the upgrade works were supplied.

With regard to training for CWR conversion works, the supervisor advised that there was no formal off-site training for gang members or supervisory staff and that training is done on an on-the-job basis. The supervisor advised that the acting road foreman had been placed in that position because of his previous experience and on-the-job training in continuous welding tasks under the supervision of another road foreman since being employed by Pacific National.

The supervisor also advised that, because of the low-light working environment at night, the day shift did the final grinding of the newly welded track prior to an ultrasonic inspection to assess the quality of the welds.

Regarding the temporary 65 km/h speed restriction placed on the section of track adjacent to the derailment, the Pacific National personnel advised that the restriction pertained to the work that was being undertaken by the day shift and that it was not a result of any work by the night shift or because of the expected ambient temperature of the day.

The Pacific National personnel were asked why the continuous welding task was carried out at night and advised that the night work was triggered by service pressures and access availability and that, as a result, night work gave gangs less interruptions during the work shift.

Following the incident, the supervisors reinforced with gangs the procedures for conducting a “rough tense” (prior to track being correctly tensed), ensured that the contracted supervising engineer spent more time overseeing work and drafted company procedures for converting jointed rail to continuously welded rail. They advised that there was a need for more ballast to be placed on the track around the 169 km mark although they believed the track was in safe condition. It was noted that prior to the incident it had been difficult to get enough locomotive drivers to crew ballast trains, but that this situation had been remedied after the incident.

## 3.5 Meteorological information

Weather information provided by the Bureau of Meteorology for Traralgon on 12 October 2006 indicated that during the day the ambient temperature rose from 7.4 degrees Celsius at 0600 to 13.9 degrees Celsius at 0730 and 30.7 degrees Celsius at 1000. It then rose to a maximum of 34.4 degrees Celsius at 1300. At 1400 the temperature was 33.9 degrees Celsius and at 1430 34.2 degrees Celsius. The relative humidity was less than 20 per cent at the time of the incident with a clear sky.

Pacific National staff reported that the shade temperature at 1500 hours was 35 degrees Celsius and that the rail temperature was 38 degrees Celsius at 1530.

The Bureau forecasted maximum temperature for 12 October 2006 for the Latrobe Valley was 32 degrees Celsius. The mean maximum temperature in the area for October is about 20 degrees Celsius.

## 3.6 Train Data Logger

The locomotive was fitted with a Fischer Industries Mark 2 data logger that recorded a number of parameters associated with the performance of the train.

An analysis of the recorded information indicated that the train speed was reduced initially by the use of air brakes and then by dynamic braking to 64 km/h prior to the point of derailment.

# **4. ANALYSIS**

The safe passage of trains is affected by a number of factors including the condition of the track, the condition of the rolling stock and the operation of the train by the crew. In this event the rolling stock did not have any reported defects prior to the event that may have caused it to derail. Also, the locomotive driver was adequately trained and experienced and operated the train in accordance with operating procedures and instructions applicable to the track at the time of the event. Accordingly, the factors that were most significant in the derailment relate to the condition of the track and the subsequent buckling of rail.

### 4.1 Condition of track

Rail buckles are typically caused by a combination of high longitudinal compressive stresses, poor or weakened track condition and train dynamics (vehicle loads). The first two aspects pertain specifically to the general condition of the track.

The key factors contributing to the state of the track at the time of the derailment are considered to be a low rail stress-free temperature and inadequate lateral track support.

## 4.1.1 Low rail stress-free temperature

The track is likely to have had a stress-free temperature significantly below the nominal target value of 38 degrees Celsius due to a combination of the pre-existing condition of the track and works carried out on the night of 11-12 October. A consequence of this low stress-free temperature is an increase in thermally induced compressive stresses in the rail at times of high ambient temperature, such as on the day of the incident, and a consequent increase in the probability of rail buckle.

The pre-existing condition of the track is the consequence of the cumulative effects of time, including the action of rail creep, and the maintenance regime. Monitoring of creep was in accordance with standard practices in Victoria and given the ongoing program of conversion to CWR, remaining residual creep would have been eliminated during this upgrade project.

Regarding the works on the night of 11-12 October, the processes used to convert jointed rail to continuously welded rail deviated from published work instructions. In addition, no sections of rail were subject to full or interim tensing. There was an expectation that the method of replacing each joint with a welded closure would not significantly alter the state of stress in the rail and would therefore suffice for an interim period prior to completion of the full tensing process.

In actuality, it is highly probable that the method used and the absence of full or interim tensing resulted in “excess rail” in the line and a reduced capacity for the rail to tolerate high rail temperatures. This excess rail was potentially due to the loss of any joint expansion capability and a loss of tension in adjacent rail during the joint removal works.

Weaknesses in the procedure used for converting 82 metre jointed rail to CWR on the night of works have to some extent been addressed by the immediate, post-incident release of an interim instruction on “punch tense welding”.

### 4.1.2 Lateral support

Weakened track conditions impacting buckle potential include reduced track resistance and specifically the ability of the ballast, ties and fasteners to provide lateral and longitudinal support. In this instance, it is likely that a lack of shoulder ballast coupled with general track disturbance during the night works contributed to reduced lateral support with a consequent increased vulnerability of the track and rails to buckling failure.

### 4.1.3 Ambient temperature

The air temperature at the time of the derailment was higher than would normally be expected for the time of year although it was forecast to be so. In addition, the temperature had risen relatively quickly from a low temperature during the night. As a consequence and given the state of the track post-works, the high ambient temperature would have the effect of inducing high longitudinal compressive rail stresses and a pre-disposition to rail buckling.

## 4.2 Derailment triggers

While the final trigger for buckling has not been determined with certainty, it is probable that the action of the train on the track contributed to its final formation.

The track had withstood the movement of other trains earlier in the day notwithstanding that the ambient temperature was lower during the earlier transits. Two trains and a hi-rail vehicle passed over the track between the time the night shift finished work and the derailment. This suggests that the buckle was either not present, was of a minor nature or still developing prior to the attempted passage of train 8432 at 1405.

In the context of increasing temperature and corresponding increasing susceptibility to buckling, it is considered probable that the loads placed on the track by the passage of train 8432 under braking was the final trigger for the full formation of the buckle which caused the subsequent derailment.

## 4.3 Speed restrictions

At the completion of works following the night shift no temporary speed restriction was placed on the track by the supervisor of the shift. Prior to the commencement of the day shift on 12 October a 65 km/h speed restriction was placed on the track to cover the track inspection and weld grinding task to be undertaken by this shift. However, this did not cover the entire area of track worked on the previous night, including the track closure immediately prior to the point of derailment. While the speed restriction had the effect of reducing the speed of the train and probably prevented a worse outcome, it did not provide for the safe passage of the train.

The track manager has gone some way to remedy this procedural gap through the immediate, post-incident release of an interim instruction on appropriate speed limits for temporary operations over un-tensed rail.

It was fortunate that the derailment occurred at a relatively low speed compared to the normal line speed in the area. This lower than normal speed probably contributed to the locomotive and cars remaining within the confines of the track ballast thus avoiding the soft terrain beyond the ballast. Entering the soft terrain may well have resulted in some or all of the vehicles overturning.

## 4.4 Track maintenance personnel training, instructions and supervision

To complete a task properly it is necessary to have staff that are sufficiently trained and experienced and for them to be adequately instructed on how the task is to be completed and what the expected outcomes are to be. In addition, the task needs to be supported by supervision commensurate with staff knowledge and the level of procedural instructions.

In this case, evidence suggests that the track manager did not have a robust method of determining and recording the experience and training of the members of the work gang. In addition, instructions did not adequately specify the exact procedure to be taken in completing the CWR task and actions to be taken if, for whatever reason, the task could not be completed in accordance with provided instruction or within prescribed timeframes. Finally, the level of supervision was inconsistent with these system weaknesses.

Inadequacies in the systems supporting the works are believed to have increased the likelihood of the track being returned to service in a condition that did not guarantee the safe passage of trains under all conditions.

# **5. CONCLUSIONS**

## 5.1 Findings

1. The members of the train crew were experienced, appropriately qualified and medically fit to operate the train.

2. The locomotive and passengers cars of train 8432 were serviceable prior to the derailment.

3. The speed of the train at derailment was 64 km/h having been slowed to comply with the temporary speed restriction.

4. The train was operated in accordance with the designated procedures and speed restrictions in force at the time of the derailment.

5. The train was in possession of the necessary safe working authority for the Sale-Traralgon section of track.

6. The track was being upgraded by the track manager from jointed rail to continuously welded rail.

7. The temporary speed restriction placed on the track to facilitate the finishing grinding by the day shift did not cover the full area of works.

8. Notification of the derailment was provided to Pacific National Train Control and responded to in a timely manner.

9. Response from emergency services, V/Line and Pacific National staff was prompt and appropriate.

## 5.2 Contributing factors

1. The vulnerable condition of the track following upgrade works including a lowered stress-free temperature and inadequate shoulder ballast.

2. The ambient temperature at the time of the derailment.

3. The track being returned to service after upgrade works without temporary speed restrictions commensurate with the condition of the track and forecast temperatures.

4. The inadequacy of the process used to return track to service after welding operations.

# **6. SAFETY ACTIONS**

The derailment of a train and in particular a passenger train has the potential to cause significant loss of life and serious injury to passengers, train crews, and in some circumstances other members of the public. The derailment of a train that results from works undertaken on the track is preventable and rail infrastructure managers should create a system that guards against the potential for derailment.

## 6.1 Safety actions taken since the event

Following the derailment, the track manager, Pacific National, issued draft instructions titled “Interim Tensing of Incomplete Welded Track Modules” to address the potential return to service of incomplete welded track modules that had not yet been tensed in accordance with the required standards for CWR. While these instructions improve the management of track works and the return to service of the track they do not address the supervision of post maintenance return to service of the track by more senior levels of management.

## 6.2 Recommended safety actions

### 6.2.1 RSA 2006005

It is recommended that the Pacific National successor as track manager, V/Line Passenger Pty Ltd, reviews processes as they relate to the installation, upgrade and maintenance of track. Such a review should pay particular attention to those sections of track used for passenger carrying operations and to the creation of a system incorporating review and approval by senior management prior to track being returned to passenger operations.

### 6.2.2 RSA 2006006

It is recommended that the Pacific National successor as track manager, V/Line Passenger Pty Ltd, reviews the training of track infrastructure managers, maintenance supervisors and work gangs to ensure that they are competent in assessing all relevant factors to be addressed prior to returning track to service.

### 6.2.3 RSA 2006007

It is recommended that the Department of Infrastructure, Public Transport Division, in conjunction with the track manager, conducts risk assessments of critical maintenance processes related to the risk of derailment from maintenance activities with a view to mitigating the identified risks.

### 6.2.4 RSA 2006008

It is recommended that Public Transport Safety Victoria reviews its annual audit and compliance inspection programs to satisfy itself that they effectively appraise maintenance undertaken by rail infrastructure managers.

1. All times are denoted in Australian Eastern Standard Time adjusted for Daylight Saving. [↑](#footnote-ref-1)
2. Rail temperature is recorded on the shade side of the rail web using a rail thermometer. [↑](#footnote-ref-2)
3. The rail to a person’s LEFT when standing in the middle of the track facing Melbourne. [↑](#footnote-ref-3)
4. The rail to a person’s RIGHT when standing in the middle of the track facing Melbourne. [↑](#footnote-ref-4)
5. Free welding is welding without the use of a rail tensor (source CEC 3/87, 1987). [↑](#footnote-ref-5)
6. Flagging involves signalling by track workers to train drivers to indicate the speed trains should be driven over certain sections of track. [↑](#footnote-ref-6)
7. Centrol is the track manager’s control centre for train on the Victorian broad gauge network. [↑](#footnote-ref-7)