Office of the Chief Investigator
Transport Safety

Rail Investigation
Report No 2009/13

Derailment

Passenger Train 8235

Footscray

15 October 2009

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THE CHIEF INVESTIGATOR

The Chief Investigator, Transport Safety is a statutory position under Part 7 of the *Transport Integration Act 2010*. The objective of the position is to seek to improve transport safety by providing for an independent no-blame investigation of transport safety matters consistent with the vision statement and the transport system objectives.

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 (Compliance and Miscellaneous) 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 transport safety matter.

EXECUTIVE SUMMARY

On Thursday 15 October 2009, the down Marshall V/Line train derailed and re-railed between South Kensington and Footscray stations. The train was brought to a stop under emergency braking when the driver became aware of abnormal running. There were no injuries to any of the passengers or the crew of the train.

A track inspection revealed a broken rail, damage to the facing points in the turnout and several fractured short screws and dislodged spring clips. The evidence indicated that the down leg had rolled and the wheel flange had ridden on it. The investigation concluded that as the train approached the turnout the rail rolled and fractured as a result of excessive torsion.

The train was inspected and allowed to resume its scheduled service. A detailed inspection of the train the following day revealed severe wheel damage. The track was repaired and services resumed the following morning.

The investigation concluded that the train derailed due to loss of gauge and re-railed on impacting the toe of the turnout point blade. It was identified that the track was in poor condition and detailed track inspections and maintenance as required by the track manager's procedures were not carried out. The train speed exceeded the curve board speed restriction and was considered contributory to the derailment.

The report recommends that the present track manager ensures that their Safety Management System (SMS) incorporates processes to identify and mitigate derailment risks and reviews the training of track inspectors to ensure that they are competent in assessing and identifying track faults.

The report also recommends that trains involved in incidents are subjected to a comprehensive safety examination prior to resuming their service and that the operator ensures that procedures are established articulating clear lines of communications and authority with respect to approving trains to continue their service after incidents.

1. CIRCUMSTANCES

On Thursday 15 October 2009, V/Line train 8235 was operating the 1729 service from Southern Cross Station to Marshall Station. The service was on schedule and at about 1738 the driver reported that the train had travelled over a broken rail between South Kensington Station and Footscray Station. The driver applied the emergency brakes and after travelling about 113 metres, the seven-car train came to a halt with the fifth carriage across 661 points.

At the time of the incident the train was carrying 706 passengers. There were no injuries to any of the passengers or the crew of the train.

A track inspection team carried out an initial inspection of the track and determined that the train could be moved clear of the points as it was still on the rails. A later track inspection revealed a broken rail, damage to the facing points, several fractured short screws and dislodged spring clips. On discovering the track damage the Train Services Officers (TSO) advised the driver of the train to proceed to Newport station for a train examination. After the examination the maintenance staff authorised the train to depart for Marshall.

The track repair was completed and included the replacement of approximately 40 metres of rail, the installation of a new set of points, and the reinstatement of the fastenings. Rail services were resumed the following morning.

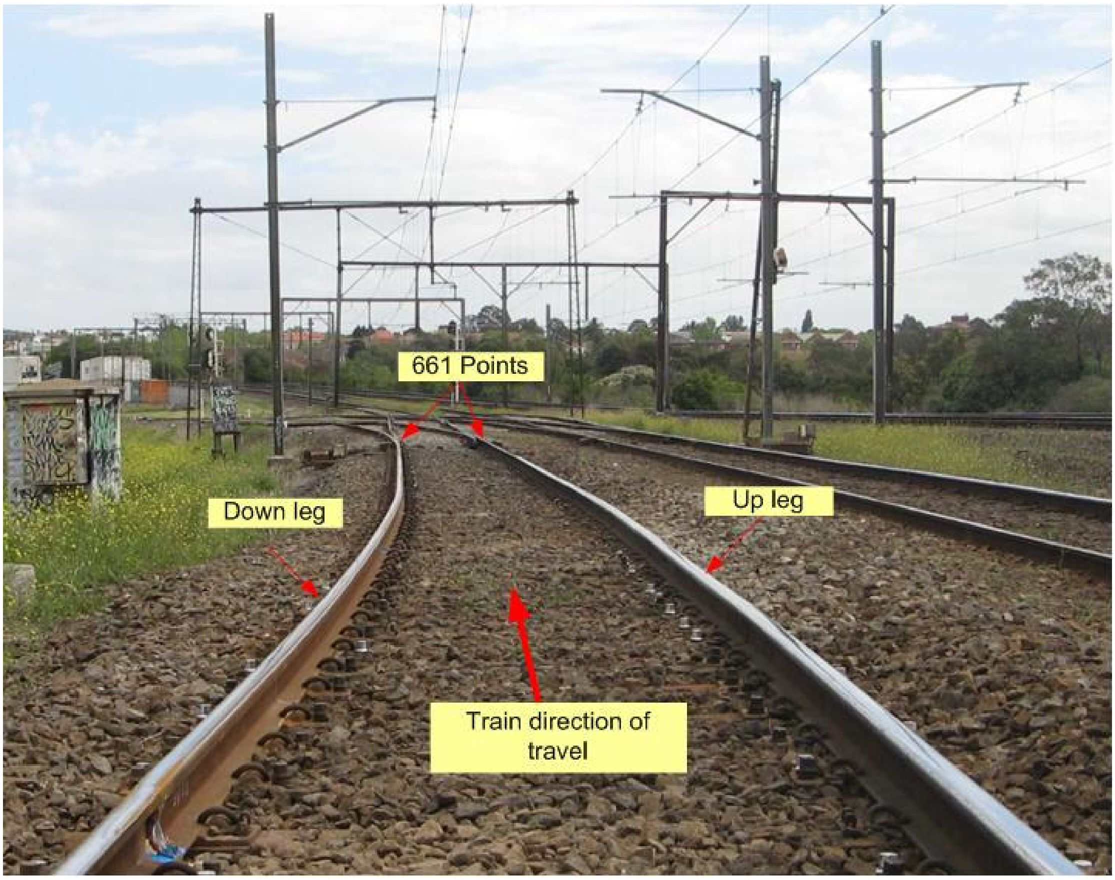

Figure 1 - Derailment site

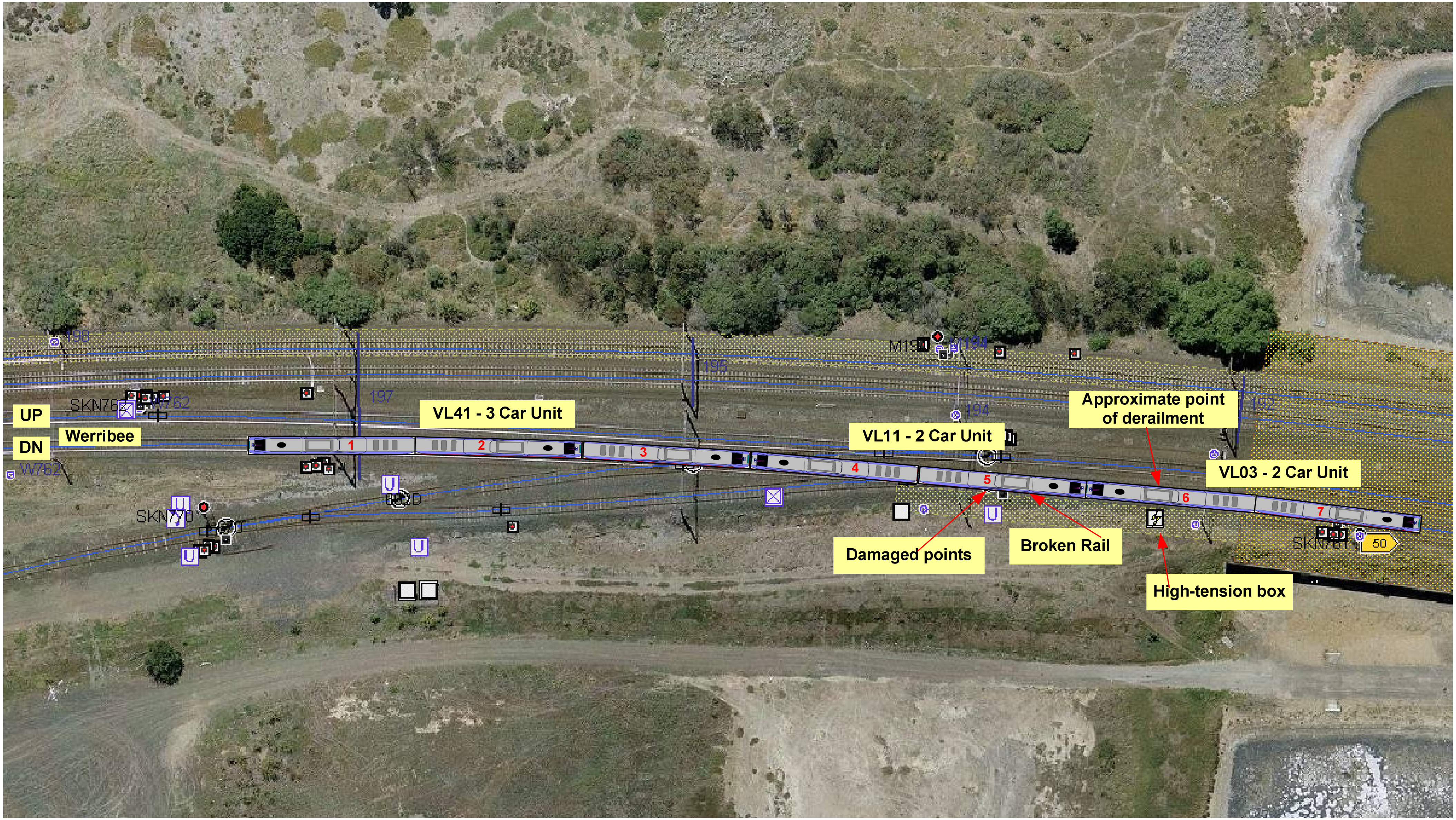

Figure 2 - Location of 7 Car VLocity stopped after emergency braking

2. FACTUAL INFORMATION

2.1 Train

The train consisted of two DM(D) driving motor railcars coupled to three TM trailer railcars that were coupled to two more DM driving motor railcars. The total length of the seven-car set was 176.24 metres. Car VL1241 was the lead car of the VL 41 set.

The VLocity unit 41 was commissioned in April 2008 and was within its overhaul periods. It was last inspected on 13 October 2009 and the wheel profiles were within the service specifications.

2.1.1 Data logger

Information downloaded from the train data logger shows it departing Southern Cross Station at 17:29:35 and stopping at a signal and North Melbourne Station before arriving at South Kensington Station at 17:37:15. It departs South Kensington at 17:37:36 and accelerates to a maximum speed of 74 km/h. At 17:38:25 the service brake is applied when the train was travelling at approximately 70 km/h. The emergency brake is applied 10 seconds later and the train came to a stop at 17:38:51.

2.1.2 Train damage

The empty train returned from Marshall and was inspected at the West Melbourne Depot on 16 October 2009.

Figure 3 - Wheel 7 scuff marks and indentation

The flange of wheel 7 was observed to have a deep indentation and scuffing was observed on the tread corner and side of the rim surface.

Figure 4 - Wheel 8 scuff marks and indentation

The flange of wheel 8 was observed to have two deep indentations and scuffing was observed on the tread corner and side of the rim surface.

The investigation was advised by the operator that "wheels Nos.7 and 8 on the leading bogie of rail car VL 1241 were significantly damaged to warrant replacement and the damaged wheels were replaced before the vehicle resumed its service".

2.1.3 Post incident operation of train

Once the track inspection was completed by the track maintenance personnel and it was determined that the train was still on the rails, the vehicle was moved over the broken rail and allowed to proceed to Newport Station. At Newport the train was examined and a roll by inspection was conducted by the rail maintenance providers. The investigation was advised that after consulting the train manufacturer and "with engineering advice provided by mobile phone by the manufacturer" the train was cleared to proceed to the Marshall Station with a maximum speed restriction of 130 km/h (Maximum line speed between Newport to Marshall is 160km/h). V/Line was unable to clearly articulate on whose authority the train was allowed to proceed to Marshall Station.

2.2 Train driver

The train driver was appropriately qualified and his certification was current in all required aspects. The driver had completed a route knowledge training program in 1981 and a VLocity training course in 2005. These courses included information such as line speeds, curve locations and speeds, location of points and signals of specific routes. The driver had also been subjected to six-monthly audits by V/Line.

The driver was within fatigue assessment limits, and had a current medical certificate.

The train driver reported that at about 1735 the train had travelled over a broken rail between South Kensington Station and Footscray Station and that he had stopped the train. He stated that approximately 50 minutes later a Train Service Officer (TSO) arrived at the site, inspected the track and determined that the train could be moved clear of the points. After a roll-by-inspection of the train the TSO authorised the train to depart. The driver stated that he was en-route to Newport when he was contacted by the Connex block-and-signal inspector and advised that the train had previously derailed and requested him to stop for a train inspection. He said that the maintenance fitters carried out an inspection and also spoke to the manufacturer before declaring the train fit for further service. He stated that the maintenance fitters then asked him to proceed to Newport platform, where they carried out a further inspection and then asked him to proceed to Marshall.

2.3 Infrastructure and track

Rail lines were originally classified by the Public Transport Corporation of Victoria and were categorized into five major classes; High-speed passenger lines, Major passenger lines, Minor passenger lines, Major freight lines and Minor freight lines. V/Line and MainCo (now MTM) incorporated these classifications into their operating and maintenance procedures. Classification of major rail lines is based on infrastructure parameters and nominal operating speeds. The track structure in the incident section consisted of four broad gauge (1600 mm) class 3 lines[1], with turnouts on the Werribee lines leading to the Maribyrnong sidings.

2.3.1 Curve speed boards

Curve Speed Boards indicate the maximum train speed allowed when negotiating a curve. Track geometry and condition are the factors that limit the maximum allowable speed for a curve. V/Line operating instructions specify that trains should operate within the curve board speed limits and should not accelerate until the entire train is clear of the curve.

Curve boards are required to be located at an entrance to a curve, on the left hand side of the track facing the driver. In this instance the curve speed board specified 50 km/h and was appropriately located.

2.3.2 Derailment site inspection

The derailment occurred on the Werribee line between South Kensington and Footscray. The derailment site is approximately 826 metres west of the South Kensington Station and occurred on the down track. The incident section of the track is on an embankment on the down side of the Maribyrnong River Bridge and is a curve of approximately 370 metres radius. The approximate length of the incident curve is 90 metres comprising of an up-end design transition length of 60 metres and a down-end design transition length of 30 metres.

The section consisted of ballasted track with 53 kg continuously welded rail fastened onto timber sleepers. There is a train stop[2] about 34 metres from the curve board and 661 points are located about 25 metres from the train stop. The rail fastenings consisted of a combination of dog spikes and anchors on double shoulder sleeper plates fastened to the sleepers with lock spikes, 'S'[3] and 'R'[4] screws and clips. The fastenings on the curved section of the track mainly consisted of plates fastened to the sleepers with lock spikes, 'S' and 'R' screws and clips.

[1] Nominal requirements: Operating speed of 80 km/h for passenger trains of up to 23-tonne axle load; 47 kg/metre jointed rail of maximum 82 metres length, timber sleepers, non-resilient rail fastenings, and track ballast of 300 mm depth and 400 mm shoulder width.
[2] A train stop is a train protection device that automatically stops a train that passes a signal when the signal aspect prohibits such movement.
[3] Screw of 140mm length.
[4] Screw of 180mm length.

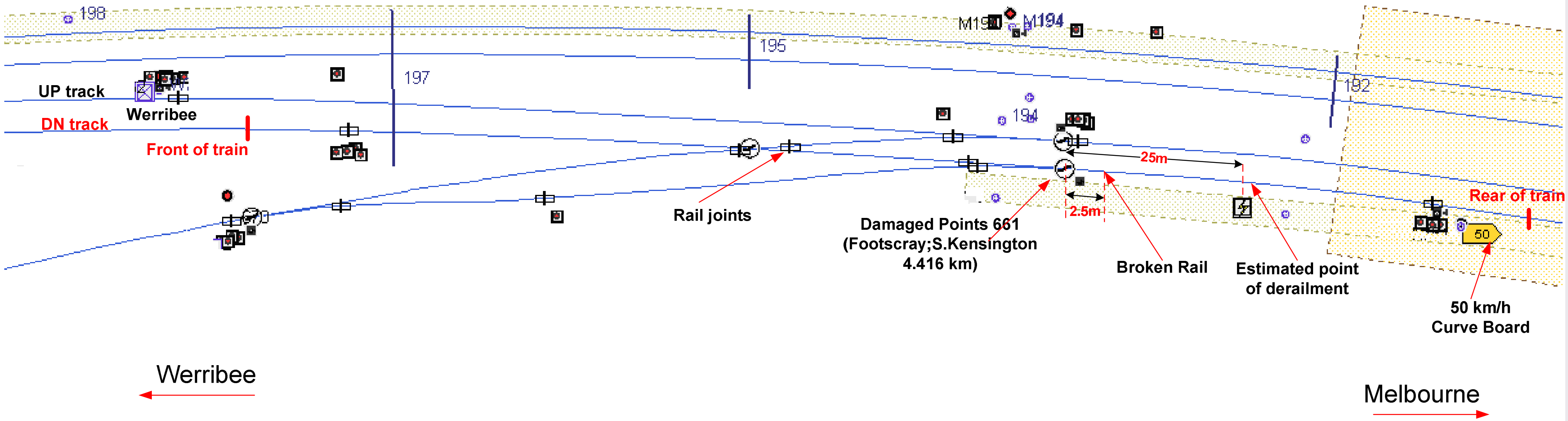

Figure 5 - Track layout, damage and final position of train

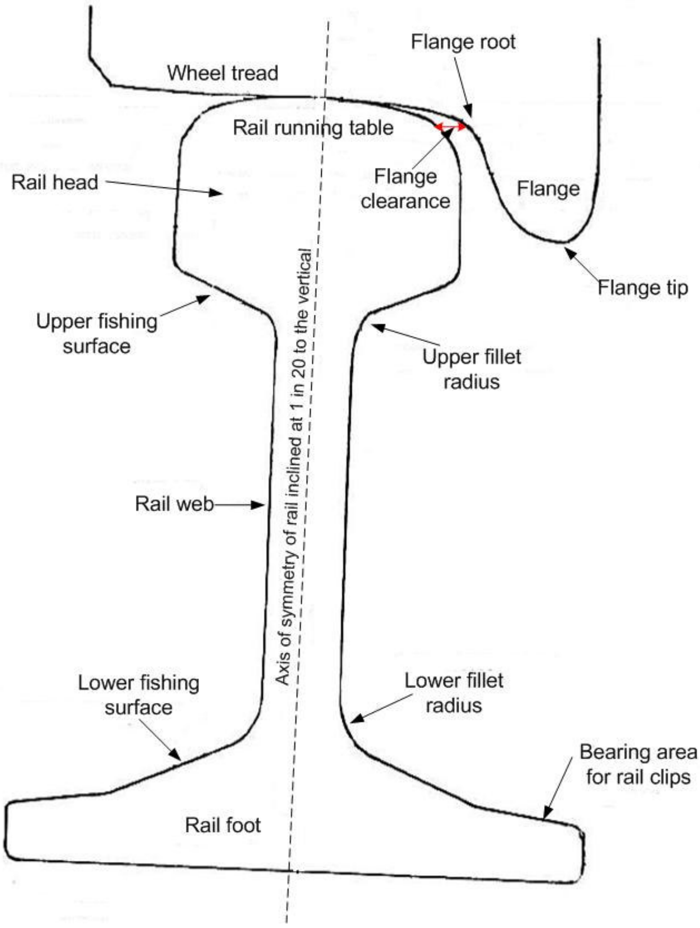

Figure 6 - Wheel profile running in central position on rail

A broken rail was observed on the down leg[5] of the track approximately 2.5 metres from points 661. The break was observed to be at a welded rail joint. The rail head was split and the crack extended for about 20 millimetres vertically into the web before tapering off at an angle to the foot of the rail. A triangular section of metal had fractured off the foot of the rail.

Figure 7 - Rail and Points damage

[5] Down leg - Left rail heading away from Melbourne
Up leg – Right rail heading away from Melbourne

A further 20 metres of rail was found to be battered and crippled[6] due to the impact of running wheels and the leading edge (toe) of the point blade on the down leg also sustained wheel impact damage. Several severely corroded and fractured 'S' and 'R' screws, dislodged lock spikes and clips and damaged timber sleepers were also found at the incident site. It was also observed that several screws did not have spring washers.

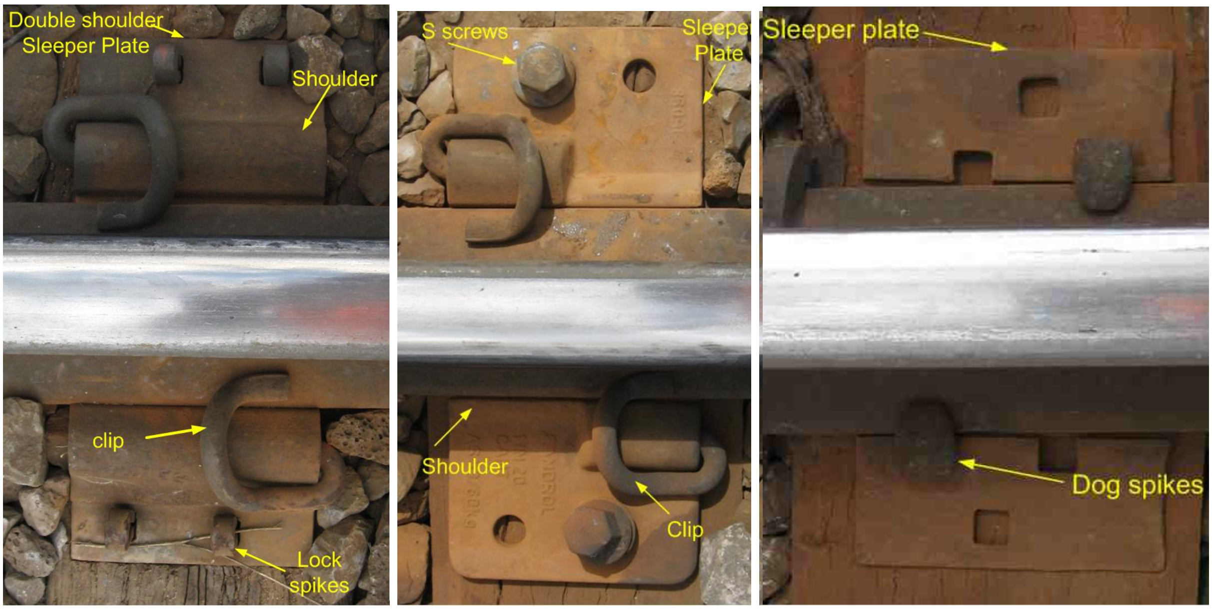

Figure 8 - Securing arrangements at site

Figure 9 - Corroded 'S' Screw showing bearing wear on shank

2.3.3 Metallurgical failure analysis

Visual examination of the screws indicated that heavy corrosion had resulted in necking and some screws had fractured. The screws also exhibited bearing wear on the shank. The wear bands were located from 10-35 mm below the head of the 'S' screws and 15-40 mm below the head of the 'R' screws.

Microscopic and metallographic examinations were carried out on several fractured 'S' and 'R' screws. The examinations indicated evidence of pitting corrosion and heavy oxidation in the vicinity of the fracture surfaces. The fracture surface was also oxidised and the lack of fresh metallic surface indicated that the screws had fractured some time prior to the incident.

[6] Hammering and flattening of the rail.

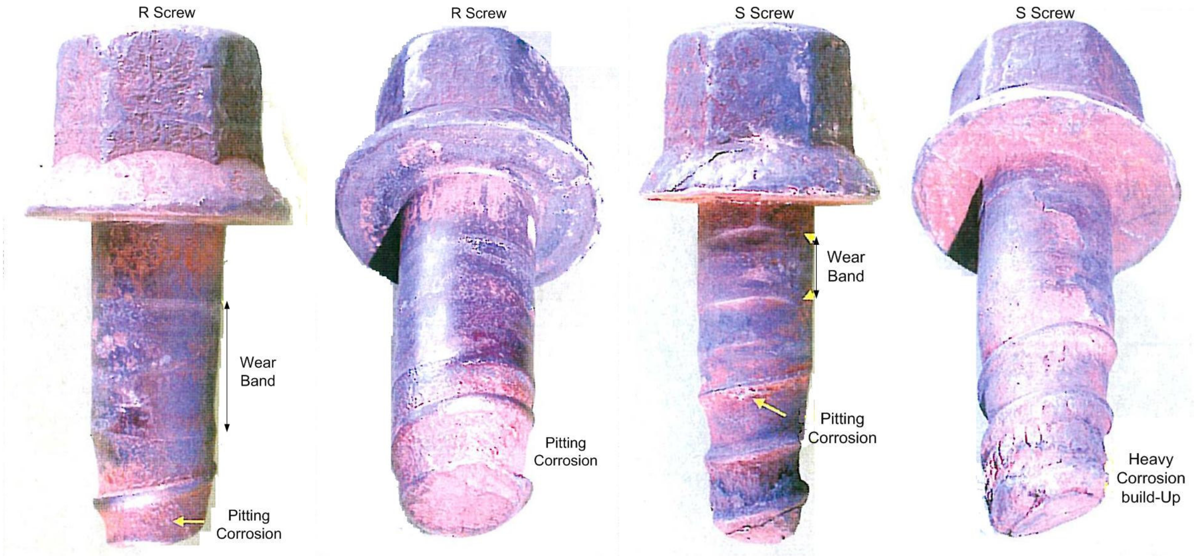

Figure 10 – Broken 'R' and 'S' Screws

The fracture surface of the screws was pitted and abraded around the circumference of the fracture. Cracks were detected at the root of the threads adjacent to the fractures.

Figure 11 - Fracture surface of 'R' and 'S' screws

The Australian Standard for railway track materials specifies the material and testing requirements for rail fastenings. Tests indicated that the material of the screws was consistent with the Australian Standard requirements. Screws used for rail securing are required to be of galvanised steel. Despite the severe corrosion the screws that were tested still had some galvanising present.

The screws were tested for tensile strength and hardness and the results exceeded the minimum requirements specified in the Australian Standard. Microstructural evaluation of the screws did not indicate any evidence of any metallurgically undesirable features or inclusions.

2.4 Organisations

2.4.1 V/Line Passenger Pty Ltd

V/Line is the Victorian State's regional rail public transport provider operating about 1400 train services per week. The down Marshall VLocity TD 8235 involved in the incident was a service provided by V/Line.

V/Line advised the investigation that when a train is involved in an incident a Train Examiner conducts an inspection of the train prior to resuming its service. In this instance V/Line advised that it was in the process of arranging either an alternative road coach service or another VLocity train to continue the service from Newport Station when they were advised by the maintenance staff that the train involved in the incident was in a fit state to resume its service.

The V/Line safety management system has a procedure that details a post-derailment-examination. The procedure requires that a train that has derailed is subjected to a comprehensive 'field examination' and a 'depot examination' by appropriately qualified staff. In this instance although the train was inspected at Newport Station, no 'depot examination' was carried out.

2.4.2 MainCo

At the time of the incident MainCo was the organisation responsible for asset maintenance (preventative and reactive maintenance, and renewals) of the metropolitan railway network. MainCo was a joint venture between the metropolitan rail operator Connex Melbourne Pty Ltd (Connex) and United Group Ltd. Specific areas of responsibility include the track structure, the overhead electrical distribution system and substations, signalling systems, communications, including centralised control facilities such as Metrol (Metropolitan Train Control centre) and Electrol (Electric Traction Power Control centre), rolling-stock and structures and facilities.

2.4.3 Metrotrains Melbourne (MTM)

MTM took over the operation of the Melbourne metropolitan train network on 30 November 2009. MainCo's maintenance responsibilities were also taken over by MTM on the same date.

2.5 Track maintenance

Minimum track inspection and maintenance standards are specified in the asset manager's procedures. *Track Maintenance Instruction MTMI 3.03* outlines the minimum track inspection and patrolling frequencies. The instruction specifies three levels of inspections; *patrol for safety and quality*, *close inspections* and *detailed inspections*. The instruction also specifies that suburban passenger main lines are required to be 'patrol' inspected either by train or by foot once every day Monday to Saturday and closely inspected on foot once every three weeks. A detailed inspection of main line curves is required to be carried out once every three months. The instruction also states that the track manager may require more frequent inspection of known areas of high risk, taking into account factors such as radii of less than 380 metres, timber sleepers, ability to hold gauge, cant and rail wear rate. Main line crossingwork is also required to be closely inspected at least once every week.

Track Maintenance Instruction MTMI 3.01 outlines the track inspection standards. Twist, gauge and cant are considered key parameters as they affect the safe running of trains. Measurements of these parameters are carried out by the EM100 Track Recording Car (TRC). The instruction sets out two maximum allowable limits 'A' and 'B' for each track geometry parameter. A deviation exceeding the 'A' limit requires priority corrective action (generally within seven days) while a deviation exceeding 'B' limit requires monitoring and is to be considered when planning maintenance programs.

2.5.1 Inspection and records

A review of the maintenance records indicates that patrol inspections had been carried out as required and recorded on a weekly basis. It is unclear whether these inspections were carried out by travelling on trains or by foot patrols. No track faults were recorded from July 2009 to October 2009. Further, a review of the records from March 2009 does not indicate that maintenance work or repairs were carried out on this section of track. There were no records or evidence that *close inspections* or *detailed inspections* had been carried out on this section of track.

Records indicate that on 28 August 2009, the TRC was used to check the track geometry of the incident section of track. Due to the trolley of the TRC derailing during the assessment no credible data was obtained. The position of the TRC derailment is not indicated in the maintenance records. Further, no reason has been attributed to the derailment of the TRC trolley. A previous assessment of the track carried out in May 2009 indicates that a 'B' fault was identified, but there was no evidence that any action was taken by the asset manager.

2.6 Train and track interaction

When a train is in motion varying forces are applied to the track. As the outer wheel traverses a curved rail, it is displaced and the flange clearance (Figure 6) is taken up. This results in a lateral force being imparted on the rail head that can result in 'gauge spreading' if the track is not firmly secured. The magnitude of the lateral force is a function of the speed of the vehicle, the curve radius and track cant. Higher speeds and tighter radii generate higher lateral forces. The degree of track cant modifies the curving behavior of a vehicle and alters the magnitude and balance of the lateral forces. The design cant specified in the curve register for this section of track is 30 millimetres. The measured track cant for the section was between 26 millimetres and 29 millimetres. Higher speeds and lower track cant could result in a cant deficiency that would result in a higher load on the high rail and a decreased load on the low rail contributing to track spread.

2.7 Rail Safety Regulation

Transport Safety Victoria (TSV) (formerly Public Transport Safety Victoria) monitors compliance with the *Rail Safety Act 2006* and the Rail Safety Regulations 2006. Part 9 of Schedule 2 of the regulations requires rail safety operators to have in their Safety Management System 'processes to ensure, so far as reasonably practicable, that corrective action is taken in response to any safety risks identified following inspections, testing, internal audits, investigations and reporting of hazards or incidents undertaken by the rail operator'. TSV monitors operator compliance with Part 9.

TSV conducted an audit of Connex in May 2009 and the audit focussed on areas related to the management of track buckling. As a result of the audit Connex was issued with compliance notices relating to deficiencies in the risk register, non-compliance with procedures related to creep monitoring, deficiencies with respect to detecting track defects and failure to act on deficiencies identified in the SMS. TSV advised the investigation that they have had ongoing discussions with Connex and with the current infrastructure manager MTM from 30 November 2009 to ensure that deficiencies identified in the safety audits were being addressed adequately.

2.8 Environment

At the time of the incident the weather was fine with light winds and the temperature was approximately 17 degrees Celsius. At the time of the derailment the sun was setting and the train was heading in a westerly direction.

3. ANALYSIS

3.1 The Incident

The train approached the incident section of track at about 70 km/h and derailed approximately 34 metres after the 50 km/h curve board. The evidence suggests that the up leg of the track spread; the right wheels of the train stayed on the rail and the left wheels derailed about 25 metres before the 661 points. Approaching the turnout, the rail is fastened more securely. Due to this, the down leg stayed upright at the turnout end, and as the train approached the turnout the rail fractured as a result of the excessive shear stress developed due to torsion. Marks on the web of the down leg indicate that the rail rolled and the wheel flange had ridden on it. The train travelled approximately 2.5 metres from the point of fracture before the left wheel impacted the toe of the turnout point blade and in the process climbed the rail and re-railed. It is most probable that the impact of the wheel at the toe of the point blade alerted the driver to the abnormal condition and the train was brought to a stop.

3.2 Track Condition

The safe operation of trains is incumbent upon factors such as the condition of the track, the correct operation of the train by the crew and the condition of the rolling stock. No defects were identified with this train prior to or after the event that may have caused it to derail.

The function of the screws is to locate and anchor fastening systems onto the sleepers. Railway securing screws are subjected to withdrawal, vibration, bending and shear forces due to the passage of rolling stock. Further, they are subjected to thermal expansion and contraction due to variations in environmental conditions. The screws are required to hold the sleeper plate firmly to the sleeper. In this instance the rail securing arrangement of the Up leg was severely weakened due to the corroded and fractured screws and the evidence indicates lateral movement of the Up leg resulted in track spread and derailment.

The bearing wear and transverse depressions observed on the screws resulted from metal to metal contact and relative movement between the sleeper plate and the screws. The material of the screws or metallurgically undesirable features or inclusions did not contribute to the failure of the screws. There was minimum galvanizing on the screws indicating that they had been in service and subjected to corrosion for a significant period of time.

Optimal tensioning of the screws and the condition of the spring washers is critical in countering the impact of the dynamic conditions that can initiate relative movement between the securing assembly elements. The fact that the screws were not tensioned consistently and some screws did not have washers would be the most likely reason for the movement and failure of the screws. It is evident that these deficiencies were not detected during the patrol inspections conducted by the track manager.

The TRC employed to check the track geometry derailed during the last track inspection and no credible data was recorded. The position of the TRC derailment on the curve is also not indicated in the records. Further, no reason has been attributed to the derailment of the TRC trolley. It is probable that the TRC trolley derailed due to existing wide gauge of the track.

3.3 Track operation and maintenance

The train was exceeding the specified speed for this curve. Higher speeds result in higher lateral vehicle loads and in this instance may have contributed to the track spread.

It is evident that the track manager did not have a robust inspection and maintenance regime for managing the track infrastructure. Although the maintenance procedures outline the track inspection requirements and frequencies, there is no evidence that they were comprehensively complied with. The poor track condition was also not identified during patrol inspections. Further, the maintenance records were not sufficiently detailed or consistently maintained. The track fault management procedures outline the corrective action required to be taken when track faults are identified. There is no evidence that these procedures were followed whenever track faults were identified.

3.4 Post incident inspection and operation of train

The V/Line safety management system requires that a train that has derailed is comprehensively examined prior to it resuming its service. In this instance it appears that the procedure was not followed as the train was not comprehensively examined prior to it being allowed to proceed to Marshall Station with passengers.

It is evident that the train wheel damage was not detected at Newport, or if it was detected the severity of the damage was only recognised when the train was inspected on its return to West Melbourne Depot. The train was allowed to travel from Newport Station to Marshall Station carrying passengers at a relatively high speed of 130km/h. The operator was unable to articulate their decision making process or on whose authority the train was allowed to proceed. The damage to the wheels was significant and could have resulted in consequential damage to the train or the track and posed a serious risk to the passengers. The train operator should have ensured that a detailed inspection of the train was conducted by qualified staff as required by their procedure prior to it being allowed to travel to Marshall Station.

4. CONCLUSIONS

4.1 Findings

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

2. The train was serviceable at the time of the incident and was appropriately maintained.

3. The train derailed on a curved section of track due to loss of gauge.

4. The incident train was allowed to resume its scheduled service after the derailment despite significant damage to two train wheels.

5. The incident section of track was in poor condition.

6. The poor track condition was not identified by the track manager.

7. The down leg of the track rolled and fractured.

8. The left forward wheel impacted the toe of the turnout point blade damaging it.

9. The train re-railed after impacting the point blade.

10. The train was brought to a stop under emergency braking when the driver became aware of the abnormal running condition.

11. The track manager did not carry out detailed track inspections or maintenance as required by the track inspection and maintenance procedures.

12. Due to the trolley of the Track Recorder Car derailing during assessment of the track, no credible data was obtained. The point of derailment of the Track Recorder Car was also not documented.

13. The train was travelling at approximately 70 km/h in a 50 km/h speed zone specified by a curve board.

14. Two train wheels were severely damaged in the incident.

4.2 Contributing Factors

1. The track was not appropriately inspected and maintained.

2. The track was defective and resulted in loss of gauge.

3. The train was not operated in accordance with the speed limit specified for the section of track.

5. SAFETY ACTIONS

5.1 Safety Actions taken since the Event

MTM has conducted a detailed inspection of nominated locations on curved track and identified and replaced broken screw fastenings. MTM advised that an ongoing inspection and monitoring program has been implemented to manage the risk of future defective screw spikes.

5.2 Recommended Safety Actions

Issue

The track manager did not carry out detailed track inspections or maintenance as required by the track inspection and maintenance procedures.

RSA 2010020

That MTM ensures that the Safety Management System (SMS) identifies and mitigates derailment risks and track inspections and maintenance procedures are complied with.

Issue

The poor track condition was not identified by the track inspectors.

RSA 2010021

That MTM reviews the training of track inspectors to ensure that they are competent in assessing and identifying track faults.

Issue

The train was allowed to resume its scheduled service despite significant damage to its wheels.

RSA 2010022

That V/Line ensures that trains involved in incidents are subjected to a comprehensive safety inspection prior to resuming their service.

Issue

The operator was unable to articulate its decision making process or on whose authority the train was allowed to proceed.

RSA 2010023

That V/Line ensures that procedures are established articulating clear lines of communications and authority with respect to approving trains to continue their service after incidents.

Issue

The train was travelling at approximately 70 km/h in a 50 km/h speed restricted curve.

RSA 2010024

That V/Line monitors driver compliance with track speed limits and if necessary takes appropriate action to ensure compliance.