Australian Government
Australian Transport Safety Bureau

Safe Transport

RAIL SAFETY INVESTIGATION
2003/002

Derailment of Pacific National Freight Train 1SP2N and the Subsequent Collision of V/Line Passenger Train 8318

near Chiltern, Victoria
16 March 2003

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EXECUTIVE SUMMARY

On Sunday 16 March 2003, at about 1508:45 Eastern Summer Time, a Pacific National freight train 1SP2N travelling from Sydney to Perth via Melbourne derailed at the 265.115 kilometre point, a location 7.112 kilometres south of Chiltern railway station on the standard gauge railway line. The train was carrying steel products and various other goods.

At about 1512 a V/Line locomotive hauled passenger train 8318, travelling from Albury to Melbourne on the broad gauge railway line, collided with wreckage from derailed train 1SP2N. The collision derailed the locomotive and two carriages of train 8318.

No serious injuries were reported by either train crew or passengers.

Chiltern is located on the main railway corridor between Sydney and Melbourne, approximately 272.227 kilometres from Spencer Street Station. The rail corridor contains two tracks, one broad gauge and one standard gauge. The standard gauge track is controlled and managed by the Australian Rail Track Corporation (ARTC) located in Adelaide. The broad gauge track is controlled and managed by Freight Australia located in Melbourne.

The derailment of train 1SP2N was caused by a 'screwed journal' on a wagon located in the 15th position of the train consist. The wagon had reportedly been in storage for several years and had been re-introduced into service. The screwed journal was the result of a failed wheel bearing due to a loss of interference fit on the axle journal. Heat (from friction) built up to a point at which the bearing seized and the journal detached from the axle. The wheelset then became unstable causing the derailment.

FIGURE 1:
Screwed journal within bogie

Maintenance schedules for the bearing were based on distance travelled, rather than a combination of distance and time. The maintenance history for the wagon was significantly degraded as a result of time and changes of ownership. The lack of bearing history allowed an ineffective analysis of the history and points to a deficiency in the system that may indicate poor practice at that time.

There was an about two minute window from the time train 1SP2N came to a stand, up to the time the driver of train 8318 applied the emergency brake, to try and stop train 8318 before the derailed train. In that time the drivers from train 1SP2N had repeatedly tried to warn train 8318, but were unsuccessful. The drivers also followed procedure by notifying ARTC train control but the message was delayed by four minutes before being relayed to the broad gauge train control (Centrol), not in time to prevent the collision.

A number of reports from previous incidents at Hexham, Elders Block Point and Wodonga were reviewed by the investigation team for any similar factors. In both the past incidents and the derailment at Chiltern, deficiencies were evident in the emergency communications between train control centres.

The investigation identified a number of contributing factors including wagon maintenance; inadequate industry standards or 'best practice'; and communication systems, condition, procedure and use.

Pacific National has already initiated changes to the maintenance procedures for wagons.

The report makes a number of safety recommendations in Section 6.1 relating to:

- Bearing maintenance based on distance and time;
- Reviewing procedures for rolling stock entering service after extended periods of storage;
- A review of communications procedures between train control centres;
- A review of emergency train radio procedure training;
- Consideration of communication system update and/or upgrade; and,
- Consideration of the implementation of minimum standards for roller bearings.

1 INTRODUCTION

1.1 Terms of reference

The Victorian Minister for Transport, the Hon Peter Batchelor, requested the Australian Transport Safety Bureau (ATSB) to undertake an independent investigation to investigate the circumstances of the derailment of a Pacific National freight train and subsequent collision of a V/Line Passenger train with the derailed freight train on 16 March 2003. The investigation was conducted in accordance with the provisions of the Transport Act 1983 (Victoria) as amended.

The terms of reference for the investigation are as follows;

> The investigation will examine all relevant matters including:
>
> 1. The events leading to the derailment of the Pacific National freight train no: 1SP2N with identification of any contributory factors.
> 2. The events leading to the collision of the V/Line Passenger train no: 8318 with the derailed freight train no: 1SP2N with identification of any contributory factors, but especially focussing on the existence of any communication issues.
> 3. Freight train wagon maintenance regime and maintenance and servicing history of relevant equipment.
> 4. General communication procedures and effectiveness of equipment
> 5. Relevance (if any) to the recommendations from previous occurrences of train derailments leading to a near miss or train collision, e.g. Hexham derailment, Elders Block Point derailment, Wodonga XPT Derailment.
> 6. Final Report format to follow the model Guidelines for railway safety investigation as detailed in AS 5022.
> 7. A final copy of the report should be made available at an agreed date following completion of the investigation scoping.

2 INVESTIGATION METHODOLOGY

The purpose of this investigation was to enhance rail safety in the Victorian and Australian Rail Track Corporation rail networks, by determining the sequence of events which led to the accident and the factors which may have influenced those events. Of particular importance is the need to understand what the accident revealed about the environment in which this particular rail operation was being conducted, and to identify deficiencies with the potential to adversely affect future safety.

The analysis of this accident is based on the Reason Model[1] of accident causation in modern technological systems. The report was written using the format contained in the Australian Standard 5022-2001 'Guidelines for rail safety investigation'.

During the investigation, information was obtained and analysed from a number of sources, including:

- visits to the accident site;
- inspection and analysis of the rolling stock involved in the derailment;
- recorded train and train control information;
- track and rolling stock maintenance records, procedures and standards;
- interviews with personnel directly associated with the accident;
- interviews with management and safety personnel of organisations relevant to the accident;
- a review of organisational documentation;
- a review of communications procedures; and
- in-cab testing of radio equipment.

In addition, technical analysis and reports were provided from independent experts on aspects of metallurgy.

The investigation team acknowledges the full cooperation received from all parties to the investigation, both individuals and organisations.

1 REASON, J. 1990, *Human Error*, (Cambridge University Press: Cambridge) ; REASON, J. 1997, *Managing the Risks of Organisational Accidents*, (Ashgate Publishing Limited: Aldershot).

3 FACTUAL INFORMATION

3.1 Background

Chiltern[2] is located south of Albury on the main railway corridor between Melbourne and Sydney, 272.227 kilometres from Spencer Street station Melbourne. The rail corridor contains both the standard gauge line and the Victorian broad gauge line. The standard gauge line is managed by the Australian Rail Track Corporation from Adelaide and the broad gauge line is managed by Freight Australia based in Melbourne through Centrol.[3]

On the afternoon of 16 March 2003, Pacific National freight train number 1SP2N travelling from Sydney to Melbourne became derailed 7.112 kilometres south of Chiltern on the standard gauge track. Twenty one wagons from train 1SP2N derailed, the majority spilling onto the rail reserve away from the broad gauge track. However, some wreckage fouled the adjacent broad gauge track. A short time later a V/Line passenger train 8318 consisting of a locomotive and three passenger cars, travelling on the broad gauge line, collided with the fouling wreckage. The collision derailed the locomotive and two carriages of train 8318.

A damaged axle journal from a wagon off train 1SP2N was found adjacent to the track in a position close to, but on the Albury side of where the train started to derail. The separated axle journal was sufficiently hot to ignite a grass fire in the adjacent field. The axle journal had screwed off[4] the axle causing instability within the wheelset, leading to the derailment.

3.2 Sequence of events[5]

The Perth bound Pacific National train 1SP2N, travelling on its Sydney to Melbourne journey, departed Junee at 1200[6] after a scheduled crew change. The train stopped at Wagga Wagga from 1230 until 1238 to allow another train to pass through on the single main line. The train continued towards Melbourne passing through Albury at 1430. As the train passed through Albury station, the crew saw the stationary V/Line passenger train 8318 at a platform. The crew, who had travelled this route regularly, knew that the passenger train was shortly due to depart, and would follow their train on the adjacent broad gauge line.

As train 1SP2N passed through Albury, the driver of train 8318 visually inspected the right side of the passing train for problems. This is a standard operating procedure called 'roll by inspection'. The driver of train 8318 notified the crew on train 1SP2N, by radio, that the train was complete with no visible problems. The crew on train 1SP2N acknowledged the driver of 8318.

At 1445 train 8318 departed Albury station travelling to Melbourne on the broad gauge line.

At approximately 1507, when on the Melbourne side of Chiltern, the driver of train 1SP2N noted that the train jerked suddenly. The crew observed through the locomotive mirrors that

2 See Chiltern locality map, appendix 8.3.

3 Centrol is the train control centre for the country Victorian broad gauge system.

4 Progressive failure of the bearing unit resulted in heating (from friction) of the axle journal. Seizure of the bearing then resulted in the journal 'screwing off' the axle.

5 See appendix 8.2 for a timeline diagram.

6 All times in this report are in Eastern Summer Time format.

wagons were derailing to the field side of the track. The driver applied the emergency train brakes and the train was brought to a stand at 1508:45.

The driver of train 1SP2N immediately tried to contact train control in Adelaide by emergency call, to advise them of the derailment. Twenty seven seconds later at 1509:12 contact was established with the ARTC train control centre using the 'A' panel radio. At the same time the second driver was trying to call the driver of the passenger train 8318 using the end – to – end (local) radio on 'B' panel. The second driver made several attempts to contact the driver of train 8318, without apparent success. At about 1510 the second driver alighted with a hand – held radio and started to walk to protect the rear of the train. As he walked along the field side of the train he continued to try and contact the driver of train 8318 using the hand-held radio.

After the ARTC train controller in Adelaide completed his conversation with the driver from train 1SP2N, he momentarily left the workstation to report the derailment to his direct supervisor. He then returned and made two attempts to contact Centrol, the train control centre for train 8318, both attempts were unsuccessful.

At about 1511, as train 8318 approached the left curve transition travelling at a permitted train speed of 115 km/h, the driver noticed a fire beside the track and dust flying up adjacent to train 1SP2N. The driver of 8318 applied the emergency brake to stop his train. As the driver of train 8318 was taking this action he heard someone on the end – to – end radio. The driver then realised that his line, the broad gauge, was fouled and braced himself for the impact. At about 1512 train 8318 collided with wreckage from train 1SP2N at a speed of about 80km/h. Train 8318 derailed and travelled approximately 100 metres before coming to a stand with the locomotive and the two leading carriages derailed in an upright position. The driver left the cab to assess the damage and any injury.

At 1512:02 Centrol received a call from the Emergency Services 'hotline'. The caller advised of fire and smoke near the railway line, next to a stationary train, at Chiltern.

At 1512:32 the ARTC train controller made a third attempt to call Centrol but was interrupted by an inbound call from 1SP2N, this call lasted 20 seconds. At 1513:02 the ARTC train controller attempted a fourth call to Centrol, but a train driver from Dimboola answered. After a short discussion with the Dimboola driver the train controller ended the call at 1513:42. At 1513:52 he initiated a successful fifth call to Centrol, lasting about 60 seconds, in which details about the incident were exchanged.

From about 1515, Centrol made repeated attempts to contact the driver of train 8318. During this time the driver was assessing damage to the train and passengers. The driver advised Wodonga signal box of the collision by a mobile phone requesting emergency services to attend.

At 1515:02 the signaller from Wodonga called Centrol and advised of a train derailment.

At 1520:33 Centrol called '000' emergency for assistance at the site.

At 1525:08 the driver of 8318 advised Centrol of the collision and that emergency services had arrived. Fuel was leaking from the locomotive, the locomotive and two carriages were derailed, and passengers were being detrained.

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7 See appendix 8.1

3.3 Injuries

There were no serious injuries. A few passengers experienced mild shock. One elderly passenger became distressed due to the heat of the day and was treated by the ambulance service on site but not taken to hospital. The train conductor from train 8318 assisted with passenger comfort by providing bottled water.

3.4 Damage

3.4.1 Damage to Pacific National Train 1SP2N

Damage to the rolling stock was extensive as a result of the derailment. Twenty one wagons, from the 14th to 34th position, were derailed. Wheelsets and bogies were dislodged from their position on a number of wagons. Train 1SP2N was transporting various goods including steel coil, steel pipes, steel slab, and sugar hoppers. The derailment dislodged steel pipes and coils, which were thrown from their loaded position within the wagons and scattered throughout the derailment site. A number of wagons were damaged beyond repair.

FIGURE 2:
Derailment site

3.4.2 Damage to V/Line Passenger Train 8318

V/Line passenger train 8318 struck wreckage from train 1SP2N. The locomotive, N474, showed strike mark evidence on the front 'cow catcher' and along both bogies. The locomotive and first two passenger carriages also had minor damage to wheel sets as a result of derailing. The locomotive fuel tank, containing diesel fuel, was punctured allowing fuel to leak onto the track.

FIGURE 3:
Damaged locomotive N474

3.4.3 Damage to Infrastructure and surrounds

The initial derailment of train 1SP2N caused substantial damage to the standard gauge track. About 503 metres of standard gauge track was damaged and/or destroyed as a result of the derailment.

The subsequent collision and derailment of train 8318 caused approximately 120 metres of broad gauge track to be displaced with associated sleeper damage.

About one hectare of adjoining land on the field side (eastern side of track) was burnt, ignited by molten steel from the screwed axle journal from train 1SP2N.

Track repairs required 456 metres of new 50 kg/m rail, 650 new wooden sleepers and associated rail fasteners, 500 tonnes of track ballast as well as the creation of 41 rail welds.

The standard gauge and broad gauge tracks were both reopened for the passage of trains at 0700 on 18 March 2003.

3.5 Rail safety worker details

3.5.1 Pacific National train 1SP2N

Both Pacific National drivers had over twenty years railway service. Both had been employed at Junee depot, driving trains on the Junee – Melbourne route, since 1994.

Table 1:
Train 1SP2N driver details

	1st Driver 1SP2N	*2nd Driver 1SP2N*
Gender	Male	Male
Classification	Driver	Driver
Medical Status	Medically fit	Medically fit
Training	Current	Current
Time On Duty	4 hours	4 hours

3.5.2 V/Line passenger Train 8318

The train driver of train 8318 had 20 years service of driving passenger trains on the Albury – Melbourne route. The conductor also had substantial experience on V/Line passenger services, being a guard until 1988, when the position was abolished, and then re-trained as a train conductor.

Table 2:
Train 8318 crew details

	Driver 8318	*Conductor 8318*
Gender	Male	Male
Classification	Driver	Conductor
Medical Status	Medically fit	Medically fit
Training	Current	Current
Time On Duty	2 hours	7 hours

3.5.3 Train control centres

Table 3:
Train Controllers details

	ARTC	*Freight Australia*
Gender	Male	Male
Classification	Train Controller	Train Controller
Medical Status	Medically fit	Medically fit
Training	Current	Current
Time On Duty	7 hours 38 minutes	8 minutes

3.6 Pacific National train information

Pacific National train 1SP2N is a freight service that travels between Sydney and Perth via Melbourne on a regular timetable. Train 1SP2N consisted of three 'NR' class diesel electric locomotives (NR66, NR13 and NR110) hauling 41 loaded wagons containing steel products and sugar. The total train weight was 3622.99 tonnes and it had a total length of 899.15 metres. Train 1SP2N was limited to a maximum speed of 80 km/h, although the standard gauge line is rated for higher speeds in the area of the accident site.

FIGURE 4:
1SP2N train consist

Position	*Rolling stock*	*Length (m)*	*Mass (t)*	*Freight*
1	NR66	22	-	-
2	NR13	22	-	-
3	NR110	22	-	-
4	RKKY	43.5	64.2	-
5	RKKY	43.5	64.57	-
6	RKKY	43.5	65.32	-
7	RKKY	43.5	64.59	-
8	RKKY	43.5	68.21	-
9	ROKX	23.724	77.8	-
10	ROKX	23.724	77.6	-
11	ROKX	23.724	77.8	-
12	ROKX	23.724	77.8	-
13	ROKX	23.724	74.6	-
14*	ROKX02952L	23.724	75.1	Pipe
15*^	RKTF02955X	23.724	73.1	Pipe
16*	ROKX02160Y	23.724	73.6	Pipe
17*	ROKX02950Q	23.724	73.1	Pipe
18*	ROOX02963R	23.724	77.1	Pipe
19*	RCQF20268N	15.1	69.63	Coil
20*	RCQF20587S	15.1	69.99	Coil
21*	RCQF20487J	15.064	74.84	Coil
22*	RCQF20608Q	15.1	71.22	Coil
23*	RCQF20489G	15.1	60.63	Coil
24*	RCQF20595X	15.1	72.52	Coil
25*	RQKY02049L	20.093	64.12	Coil
26*	RCQF85162M	15.1	62.7	Coil
27*	RCQF20935L	15.1	62.66	Coil
28*	RCQF20217K	15.1	45.98	Coil
29*	RCSF00044M	12.287	62.63	Coil
30*	RCSF00013C	12.287	72.35	Coil
31*	NGGF35740P	14.276	81	Sugar
32*	NGGF35762D	14.276	81	Sugar
33*	NGGF35710Y	14.276	81	Sugar
34*	NGGF35739T	14.276	81	Sugar
35	RCWF	13.055	75.41	-
36	RCWF	13.055	75.02	-
37	RCWF	13.055	74.61	-
38	RCWF	13.055	74.69	-
39	RCWF	13.055	75.11	-
40	RCOF	15.1	79.01	-
41	RCOF	15.1	79.11	-
42	RCOF	15.1	79.07	-
43	RCOF	15.1	79.95	-
44	RCOF	15.1	79.43	-

* denotes derailed, ^ denotes screwed journal

3.7 V/Line train information

V/Line passenger train 8318 consisted of an 'N' class diesel electric locomotive N474, and carriage set N2 consisting of 3 passenger carriages (ACN6, BRN50 & BN5). The conductor was in the crew compartment in the front carriage immediately behind the locomotive. The gross weight of the train was 230 tonnes and a total length of about 75 metres. The train was permitted to travel at designated line speeds.

Locomotive N474 and carriages ACN6, BRN50 derailed remaining upright.

Train 8318 was in serviceable condition before the collision and derailment.

Locomotive N474 was fitted with a Hasler recording scroll which records such data as speed, brake cylinder pressure, and time. The scroll was removed from the locomotive and sent to V/Line for analysis. The scroll subsequently could not be located, therefore no information was available to the investigation team for analysis.

The condition of the locomotive and/or the passenger carriages is not considered to be a contributing factor to the collision.

3.8 Train communication

3.8.1 Background

There are several communications systems used in Victoria. (see appendix 8.1)

Train operators on the standard gauge line communicate through the ARTC train control centre based in Adelaide. Pacific National trains on the standard gauge line communicate via the 'AWARE' train radio system and 'Wedge' system when travelling in Victoria. The end – to – end radio system is used as a secondary system to communicate locally.

The V/Line passenger service uses the NUTR through base stations along the track to communicate train control (Centrol). To communicate locally with other trains the end - to - end radio system is used, this is an open channel radio system.

3.8.2 Train radio – Pacific National

AWARE and Wedge are owned by Pacific National and are designed to automate the communication process for the train driver.

All three NR locomotives were fitted with the AWARE[8] train radio system that use GSM and satellite for data and voice communications. The AWARE train radio system is a permanent system installed in the locomotive cab. The system has two touch screen displays, one for the driver (A panel) and one for the observer (B panel), see figures 7 and 8 page 23.

As part of the AWARE system a local radio function is programmed into the system. The local radio channel may be programmed with various train radio open channels, such as the end – to – end open channel for Victoria (PTC 1).

The leading locomotive, NR66, was additionally fitted with a 'Wedge' train radio system. The Wedge train radio system is a supplemental system for use in Victoria that uses repeater stations to transmit the voice signal to ARTC train control in Adelaide.

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8 See appendix 8.1 for a diagram of how AWARE communicates

During an emergency call activated by the driver on 'A' panel, the AWARE system is designed to send a data message to the Pacific National Communication Control Centre (CCC) and the Train Management System (TMS) via GSM or satellite. During this time all other functions of the system are disabled, except for the local radio, until the emergency message is sent or cancelled. The 'B' panel mimics the display of the 'A' panel. The 'B' panel may be used for local radio communications. After the emergency message has been sent, the GSM and satellite functions are released for further communications. During an emergency activation no inbound messages via GSM or satellite are accepted. The Wedge system communicates with the repeater station to relay the information to the ARTC train controller at Adelaide.

Each locomotive is also equipped with a hand-held radio programmed with various open channel frequencies. The hand-held radio is not programmed with the appropriate protocols to activate the Non Urban Train Radio (NUTR) repeater stations. It is essentially a 'line of sight' radio system.

3.8.3 Train radio – V/Line

The driver of train 8318 had two radio systems available for use, the NUTR and the end – to – end system. Base stations are situated track side to repeat the NUTR signal to and from the source and train control centres at Centrol and ARTC Adelaide. In the event of an emergency this NUTR system is used to transmit information and warnings. The end – to – end system is also used to broadcast information locally i.e. line of sight.

3.9 Train control

Train Control for the standard gauge track was coordinated by ARTC, located in Adelaide, by Centralised Traffic Control (CTC). CTC is a remotely controlled system of absolute and permissive signals with crossing loops placed at strategic locations.

Train control for the broad gauge is coordinated by Freight Australia, located in Melbourne, by the Train Order (TO) system of safeworking. TO working is a manual authority designed, under normal operating conditions, to prevent more than one train travelling over a single line section of track at any one time.

A 'hotline' phone link exists between the two train control centres to enable quick communication between them in an emergency. Information from the train controllers indicates that the 'hotline' phone link is unreliable.

3.10 Track and other infrastructure

The broad gauge track consists of 47 kg/m continuous welded rail. The standard gauge track is 60 kg/m continuous welded rail. Both tracks were anchored on timber sleepers with elastic fastenings using standard sleeper plates. The track speed at the point of derailment was 115 km/h for the broad gauge track and 115 km/h for the standard gauge track in both directions.

The area of the derailment and collision is a straight section transitioning into a left hand curve (in direction of travel on the standard gauge line) with a 1589 metre radius on a 1:149 incline.

The design and condition of track infrastructure is not considered to be a contributing factor to the derailment or collision.

3.11 Environmental factors

The derailment and collision occurred on a mainly fine dry day with an ambient air temperature of 31 degrees Celsius. At the time of the collision the sun had an azimuth[9] of about 320 degrees and an elevation[10] of about 49 degrees. Based on the geometry of the track and the time of the collision, the sun would have been fairly high in the sky not obscuring the driver's view.

The environmental conditions are not considered to be a contributing factor to the derailment or collision.

3.12 Medical and toxicology

The two drivers of the Pacific National train signed on 'fit for duty' in accordance with the rules and regulations of their employer Pacific National. The V/Line driver and conductor were signed on 'fit for duty' by their employer NX V/Line Passenger Pty Ltd (RMA). All train crews were up to date with their medical examinations and assessed as medically fit for duty by both organisations.

Both train crews were breath tested and assessed for illicit drug use after the accident on site by Victoria Police and all returned zero readings.

The condition of train crews was not considered to be a contributing factor to the derailment or collision.

3.13 Organisational context

3.13.1 Background

Pacific National Pty Ltd is an above rail operator that carries interstate and intrastate freight in all mainline States of Australia. This company also provides locomotives and crews for several rail operators of long distance passenger trains. Australian transport logistics companies Toll Holdings and Patrick Corporation are joint owners of Pacific National.

V/Line is the country passenger arm of National Express based in Melbourne.

Track access and maintenance are managed by ARTC for the standard gauge, and Freight Australia for the broad gauge line, either directly or through contractors.

The radio network infrastructure, such as base station repeaters, are managed and maintained by VicTrack Comms.

3.13.2 Accreditation and audit

The Victorian rail system operates on the principle of 'Co-regulation'. The state regulatory authority, the Department of Infrastructure, accredits rail operators based on the regulator's approval of a company's safety management system.

Pacific National, V/Line, ARTC, Freight Australia, and VicTrack Comms have been regularly audited by the Victorian Department of Infrastructure. A review of recent audits was conducted by the investigation team. No adverse comments, in relation to the accident, were noted by the audit team.

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9 Azimuth is the clockwise horizontal angle (in degrees, minutes, and seconds) from true north to the sun/moon.

10 Elevation is the vertical angle (in degrees, minutes, and seconds) from an ideal horizon to the sun/moon.

3.13.3 Rostering and fatigue management

Pacific National, V/Line, Freight Australia, and ARTC have a fatigue management system in place. Fatigue is primarily controlled and monitored through the rostering system.

One Pacific National driver had four days rostered off followed by three mid morning shifts including the derailment shift. The other Pacific National driver had four days rostered off followed by four mid-morning shifts, including the shift on 16 March 2003.

The V/Line driver had three days off followed by three days rostered for duty, then one day off, and three days rostered for duty (including the day of the collision).

The conductor on the V/Line passenger train had worked five days including the day of the derailment with two rostered days off prior to that.

The train controllers' rosters for the previous seven days were also analysed.

The employee's work and rest routine was analysed using Fatigue Audit InterDyne (FAID) software developed in conjunction with the Centre for Sleep Research at the University of South Australia. Research by the Centre for Sleep Research suggests that a fatigue score of 40–80 is moderate, 80–100 is high with scores 100–120 being very high. High fatigue scores of 80–100 have been shown to produce individual performance impairment equivalent to a blood alcohol concentration over 0.05%. The FAID software enables the quantitative assessment of an individual's level of fatigue at a point in time based on work hours for the previous seven days. It cannot measure the emotional or other psychological causes of fatigue; neither can it differentiate in terms of the level of physical exertion. The resultant individual fatigue 'score' may be used as a guide to indicate what effect fatigue may have had on an individual's performance.

The FAID software was used to analyse the employee's rostered work hours from 4 March 2003 to the time of the accident on 16 March. The FAID program gave a maximum fatigue score, for all employees, not exceeding 65 at the time of the accident.

Rostering and fatigue management methods were not considered to be a contributing factor to the derailment or collision.

3.13.4 Qualifications and training

Train drivers are required to qualify in all systems of safeworking that they may operate under. They must also be qualified in the management and operation of various types of locomotives that they are required to drive, and route knowledge.

It is a requirement of V/Line and Pacific National that recertification of train drivers' qualifications are carried out on an ongoing basis.

Both the Pacific National drivers had completed refresher courses and re-qualification in the relevant units from December 2002 until March 2003 and were fully compliant to carry out their duties.

The V/Line driver had been safety audited at six monthly intervals prior to the collision. The driver had also completed continuation training.

The V/Line conductor had last been trained in emergency services in January 2000 and was Level 2 First Aid qualified. The conductor is not required to be qualified in any systems of safeworking.

3.14 Emergency response

Emergency services attended the collision promptly. A Victoria Police Officer nearby noticed dust and smoke in the vicinity of the railway line and notified the Police radio room. The Victoria Country Fire Authority (CFA) also reported seeing smoke in the vicinity of the railway line from an observation tower located at Mt Pilot. Victoria Police, Country Fire Authority (CFA), State Emergency Service, and Ambulance service responded from Chiltern and surrounding areas to the accident site. The site was accessed via a nearby public road.

After the collision the driver of train 8318 walked back and checked for passenger injuries. A decision was made to evacuate the passengers via the rear carriage into an adjoining field.

The fuel tank on of the V/Line N Class locomotive had been punctured by the impact and fuel had spilt at the site. The driver of the V/Line train had used rags from the locomotive to initially plug up the hole, the CFA affixed temporary plugs until decanting of the fuel could take place. An amount of diesel fuel had leaked onto the track ballast.

A tanker truck arrived on site to decant the locomotive fuel, but was unable to do so because the tanker's equipment was incompatible. Some delay was experienced until a suitable tanker with compatible equipment could be located to safely decant the locomotive fuel. The CFA liaised with the driver of train 8318 to identify potential ignition sources. Appropriate measures were taken to prevent fuel ignition.

4 ANALYSIS

4.1 Introduction

The first wagon in the consist to derail was the 15th wagon on train 1SP2N identified by number RKTF02955X. The evidence is that it was the failure of a roller bearing on the leading wheelset of the leading bogie of the 15th wagon that actually caused the wagon ahead and the following 19 wagons to derail. No other wheelsets showed evidence of failure. There was no other evidence in terms of track or wagon deficiencies to suggest any alternative initiating mechanism. The condition in which the 15th wagon was found also supports the proposition that this wagon initiated the derailment.

The issue of roller bearing maintenance and monitoring is extremely important. A roller bearing unit is a fundamental component of safe and efficient train operations. Any indication of an imminent failure requires the bearing unit to be replaced before complete failure otherwise a derailment is inevitable.

The collision of the passenger train 8318 with debris from train 1SP2N could not be avoided by the actions of its driver. From the time 1SP2N came to a stand at 1508:45 to the application of the emergency brake by the driver of train 8318 was about two or two and a quarter minutes. In the absence of any signal or track warning device communications had to be established between train 1SP2N and ARTC train control; ARTC train control and Centrol; Centrol and train 8318; and trains 1SP2N and 8318. It took 27 seconds for the crew on train 1SP2N to contact ARTC train control. A further four minutes and 40 seconds elapsed before effective communications were established between ARTC train control and Centrol. By that time train 8318 had already collided with debris from the derailed train 1SP2N. Train 8318 collided and derailed as a direct result of the component failure on train 1SP2N.

Component failure was the significant causal factor of the derailment of train 1SP2N. Significant factors associated with the collision were train control and the associated communications, and time constraints.

4.2 Bearing failure

The leading bogie of wagon 15 (RKTF2955X) was identified by the unit number RQFE335. The journal that failed was on the left hand side of the leading axle, on the leading bogie, in the direction of travel.

Examination of the damaged components was performed at the Australian NDT Scientific Services Division Laboratory in Newport Victoria. The following is a summary of the results of the metallurgical investigation report.

> The bogie was damaged in the derailment but apart from the damage the bogie appeared to be in good condition. The bogie did not exhibit excessive gib clearances and most of the damage was considered to be an effect of the derailment and not a cause. It was considered that wear of the bogie had not contributed to the failure and subsequent derailment.
>
> The back to back wheel measurement of the wheelsets in bogie RQFE 335 exceeded the ROA specification requirements. The wheels were in worn condition but the tread profiles were within ROA specifications. The intact axle journal on the failed wheelset was close to minimum permissible diameter. The wheelsets had been last overhauled in 1992. Current Pacific National maintenance procedures for this vehicle type should indicate if this service interval was acceptable.

> The railway bearing unit (RBU) from the axle journal opposite the failed RBU was removed and examined as part of this investigation. The RBU was in good condition apart from the mechanical damage that had occurred as a result of the derailment. It did not show any evidence of internal component damage that could indicate the cause of the failure at the opposite axle journal. The RBU contained an adequate quantity of grease in good condition. The RBU interference fit on the axle journal was minimal as the axle journal was close to the minimum permissible size and the RBU roller assembly bores were close to maximum size.
>
> The failed railway bearing unit (RBU) had experienced a loss of interference fit on the axle journal. The RBU failure led to the axle journal failure and subsequent derailment. There are a number of potential contributing factors to loss of interference fit for RBUs. These are discussed in the body of the report in Section 5.4. Considering all of the investigation evidence the most likely cause of the RBU failure was outboard roller assembly inner ring loss of interference fit on the axle journal.
>
> The service operating temperature of the RBU is considered to be a potential contributing factor to the loss of interference fit. Loss of lubricant or lubricant degradation and overload or over speed operation of the RBU are likely contributing factors to increased RBU operating temperatures in service.
>
> The level of interference fit of the RBU bore to the axle journal at assembly is considered to be likely contributing factor to the loss of interference fit. The report recommends the installation records for this wheelset (Axle Number 70974) should be examined to ensure there was adequate interference fit of the RBU to the axle journal at assembly.

The Australian NDT report identified possible lubricant degradation of the bearing while in storage and possible overloading and over-speed events, that would affect interference fit on the axle journal. Both over-speed and overloading of train 1SP2N on 16 March 2003 can be discounted.

Pacific National 'NR' class locomotives are fitted with data recorders that record speed, brake application, throttle position, and other parameters throughout the train. The analysis of the NR66 locomotive data recorder showed that no significant over speed events had been recorded from the departure at Enfield (Sydney) to the accident site.

Information contained in the train manifest report indicates that wagon RKTF2955X was not overloaded (73.1 tonnes) on this journey. The maximum gross tonnage for this class of wagon is 76 tonnes with no restrictions.

As a defence to failing bearings in New South Wales, a number of 'hot box detectors' are located track side to detect hot bearings as a train passes. Any hot bearings detected are alerted to Train Control and relayed to the train for inspection. On the route followed by train 1SP2N from Enfield to Albury there is one hot box detector located at Moss Vale. No alerts were recorded by the hot box detector for the passage of train 1SP2N. Additionally, no signs of a hot bearing such as smoke, noise, and/or smell were detected as the train passed through Albury during a roll by inspection by the driver of train 8318. However, the driver of 8318 was on the opposite side of the failing bearing.

The action of the failed bearing caused the wheelset within the bogie to become unstable during normal operating conditions, the result was a derailment.

The axle journal had screwed off the axle due to bearing failure. The loss of bogie stability combined with the weight of the vehicle and load caused instability within the wheelset, loss of tracking ability and subsequent derailment of the vehicle.

4.3 Wagon maintenance

4.3.1 Background

The Pacific National wagon, RKTF2955X, was classified as an open goods wagon. It had entered service in 1975. In 1992 the wagon underwent maintenance at Islington (South Australia) which included sealed roller bearing unit (SRBU) replacement. The wheelset that failed was fitted with two different brands of SRBU's, (Timken and Brenco) one on each axle journal, although this is generally not recommended by bearing manufacturers. The failed bearing was maufactured by Brenco.

4.3.2 Maintenance history of bogie

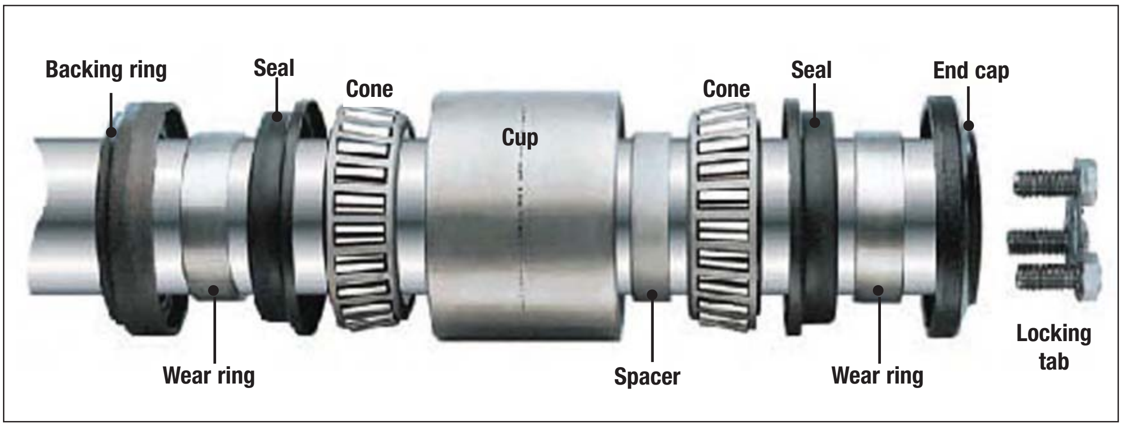
The Australian NDT report recommended that the installation records be examined, this was not possible. Wagon RKTF2955X had an irregular history of operational use and storage. According to the plate stamp on the end cap, the roller bearing unit had been replaced in October 1992. A short time later the wagon was placed in long term storage at Alice Springs. The wagon re-entered service on 13 June 2000. On 28 November 2000 the wagon underwent a programmed maintenance inspection. The inspection was conducted as a 'P' examination, which includes a visual external bearing inspection. No faults were recorded. Since re-entering service on 13 June 2000 the vehicle had travelled approximately 111,277 kms. Under normal operating conditions this is a relatively small distance. No maintenance records or usage reports for wagon RKTF2955X could be produced to the investigation team for the period prior to 13 June 2000.

FIGURE 5:
Brenco sealed roller bearing unit (cut out)

The maintenance records for the wagon and bogie were incomplete with no record covering the period from 1975 to June 2000. For this reason it is unclear if the failed bearing was new or requalified (reconditioned). At that time (October 1992) the wagon was owned by Australian National (AN). Over the following years ownership of the wagon transferred from AN to National Rail (NR) then recently to Pacific National in February 2002. During this time the wagon had sporadic use and was (reportedly) mostly kept in storage.

The lack of historical information for wagon RKTF2955X from previous owners/maintainers is considered to be a system deficiency. It does not allow an effective analysis of the history of a critical unit.

FIGURE 6:
Sealed roller bearing unit assembly



4.3.3 Pacific National maintenance schedules

Pacific National schedule maintenance for this type of wagon was based on a distance travelled scale. There are four different programme maintenance schedules and three levels of inspection, P, A, and B. Each schedule is distance based, except schedule 4, which relates to specific vehicle types.

Wagon RKTF2955X is classed as an open goods wagon maintained under schedule 1 of the Pacific National Wagon Manual dated March 2001. Schedule 1 of that manual shows:

> 7.1.1 Schedule 1
>
> Unless otherwise specified in 4.1.2 to 4.1.4, wagon maintenance shall be planned and controlled through a programme maintenance system used to schedule wagons after they have travelled distances as follows.
>
> a) 150,000 km service (P exam);
>
> b) 300,000 km service (A exam);
>
> c) 900,000 km service (B exam).
>
> The 'A' exam is conducted during every second programmed maintenance activity, and the 'B' exam is conducted during every third 'A' exam activity.
>
> When any schedule 1 wagon exceeds its 'pm due' km by more than 50,000 km, the wagon shall be worked to an appropriate location where they shall be red carded on arrival.

Wagon RKTF2955X had been in service with Pacific National for 13 months.

Based on the distance travelled by wagon RKTF2955X, it was not due for a schedule one examination for another 38,000 kilometres. The bearing would generally not be removed and inspected until the wheelset was due for maintenance. Wheelsets will normally last about one million kilometres before maintenance is required. Packaged wheel bearings are expected to outlast wheelsets.

The Association of American Railroads (AAR) standard (used as a guide in Australian rail operations) specified that wagons with friction bearings be moved one wagon-length every 30 days when in storage. However, there is no official AAR standard, or Australian standard, for the storage of roller bearings.

Officially, Brenco (the manufacturer of the failed bearing) 'has only addressed long-term storage issues for bearings still packaged and located in a warehouse'. A Brenco Technical Forum paper 98-1 recommends a maximum bearing shelf life of two years. This applies to bearings in a controlled environment with low dust and humidity where the major limiting factor is grease separation.

For bearings already mounted and out in storage or under wagons, the situation is different. Although the bearing is sealed, hot and cold, dry and wet weather cycles cause the bearing to 'breathe'. The air that passes in and out of the bearing over time includes moisture from the air. Over time, the lubricant film on the internal bearing surfaces may thin and allow moisture to react with the surfaces. Moisture condenses out into the bearing and collects where the rollers meet the inner and outer races. If left too long, this can lead to lines of water etch across the raceways.

The manufacturer of the failed bearing, Brenco, has recommended that;

> Rotating the bearings by hand or moving the wagon allows the grease that is slumped in the bottom of the bearing to replenish the raceway surfaces. While there is no 'official' Brenco position, Brenco Service Engineers normally recommend turning all bearings at least two revolutions and moving all cars at least one car-length every 30 days of storage. For non-severe weather conditions, performing this task every 60 days should be adequate. For any bearing that has remained stationary in the field for a period exceeding six months, bearing removal and reconditioning should be considered.
>
> The '30 to 60 day turn' recommendation will significantly decrease the potential for corrosion thus assuring maximum bearing performance and protecting a customer's investment.

The Pacific National maintenance standards current at the time of the derailment were considered to be inadequate by the investigation team in the context of wagons being stored for extended periods and reintroduced into operational service. This has since been addressed by Pacific National.

4.3.4 Industry maintenance standards

The rail industry operates on a 'best practice' principle of maintenance based on the Railways of Australia (ROA) manual and the Association of American Railroads (AAR) standards. There are no standards for rail vehicle maintenance that provide a benchmark for industry to build on.

Individual companies are responsible for specifying maintenance standards. Each company, in a co-regulatory environment, must establish agreed standards which form part of the Safety Management System (SMS) documents. The organisational SMS is periodically audited, by the State regulatory body, for compliance with standards. The regulatory audit for Pacific National and V/Line indicates that their respective SMS's were in place, followed, and working at the time of the accident. However, the SMS or its supporting documentation may not have been adequate in regard to roller bearing maintenance.

A number of operator and maintenance organisations throughout the country have been approached by the investigation team. The investigation team has noted that there were no consistent standards used for roller bearing maintenance.

Australian rail industry standards are inconsistent from State to State and operator/maintainer to operator/maintainer. No national standards exist to establish a minimum standard for rolling stock maintenance, particularly roller bearing units.

Maintenance in this case was carried out in accordance with standards set by Pacific National within the SMS.

4.4 Communications

4.4.1 System interfaces and design

In Victoria the AWARE train radio system uses the Wedge radio for voice communication with ARTC Train Control.

The AWARE train radio system is configured to send emergency calls from the locomotive to Train Control centres and the Pacific National Train Management System (TMS). In an emergency the driver can initiate an emergency call to the train control centre by pressing a single (red) button. In the event that the driver fails to respond to a vigilance signal, and a penalty brake is applied independent of the driver, an automatic emergency signal is transmitted without train crew intervention. An emergency brake application made by the driver will not initiate an emergency call to either train control or Pacific National TMS. When the emergency communication system is activated the AWARE system immediately clears any calls in progress to allocate all available radio and telephone resources to emergency mode. A GPS location is recorded and an emergency dialog box is displayed on the AWARE screens showing the status of the voice and data calls.

In areas where the emergency voice call to train control uses terrestrial radio, AWARE will simultaneously commence a data emergency call to the Pacific National TMS system, using either the Telstra GSM mobile network or Optus Mobile Sat networks. AWARE will switch between the GSM and satellite networks using an infinite number of data call retries until a successful data call has been made.

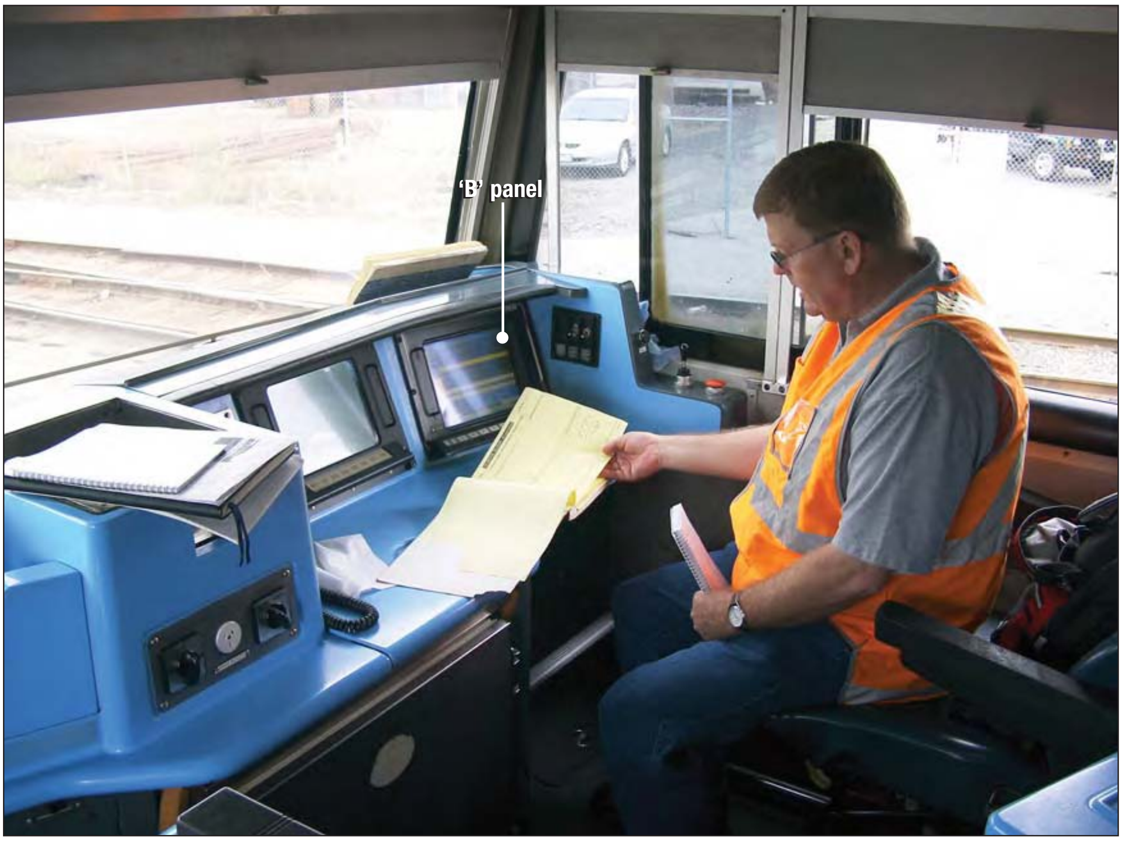
Communication in an emergency is through the relevant train control centres which relay information back to the relevant trains. Between trains in close proximity communication is by the end – to – end radio system. In an emergency, train controllers in each relevant train control centre communicate by a 'hotline' phone system.

After train 1SP2N had come to a rest, the driver initiated an emergency call on the 'A' panel. The drivers on train 1SP2N knew that train 8318 was following them on the broad gauge line. They were not sure if their train was fouling the broad gauge line or not, but tried several means by radio to broadcast an emergency call to alert the driver of train 8318. The second driver tried to contact the driver via the end – to – end radio on the 'B' panel. The second driver was unsure if the 'B' panel was functioning correctly. Despite both drivers being trained in the use of this equipment, under the pressure of the emergency they were not sure how the system worked. Based on the drivers recollection the 'B' panel appeared to be locked out by the emergency call initiation on the 'A' panel. The second driver had activated the end – to – end (local) radio on the 'B' panel several times before using the hand-held end – to – end radio to try and warn the V/Line driver.

The Pacific National drivers knowledge of operating the AWARE 'B' panel during emergencies was not comprehensive.

FIGURE 7:
Driver's work area showing 'A' panel and wedge radio system

FIGURE 8:
Second driver's work area showing 'B' panel



On 26 March 2003 the investigation team tested the function of the radio system on locomotive NR66 in the Pacific National depot at Dynon Victoria. An emergency call was initiated from the 'A' panel while the end – to – end radio was activated on the 'B' panel, both calls were initiated successfully.

FIGURE 9:
'A' panel showing emergency call, 'B' panel showing emergency call and simultaneous end – to – end radio call

It was established that train 1SP2N derailed and came to rest at 1508:45. After the initial notification from train 1SP2N, the ARTC train controller did not immediately contact Centrol, his initial concern was focused on the following XPT service on the same line 40 minutes away standing at Albury. The ARTC train controller made five attempts to contact Centrol, of which three calls were made after train 8318 had collided with wreckage on the broad gauge line. In essence the system had less than two minutes to close the communications loop if train 8318 was to be stopped before reaching the derailment site.

During such emergency conditions it is reasonable to experience a large volume of communications to the train control centres. The train controllers responding to the large volume of calls would normally prioritise incoming calls. This prioritising would primarily encompass their own region of responsibility. The incoming call to the ARTC train controller from a crew at Dimboola was a non-essential call and should have been treated as a low priority call. The call was essentially a distraction to the train controller.

During times of higher than average workload, such as emergency situations, the ARTC train controller's attention would be increasingly focused on issues directly related to the incident. The ARTC train controller would have been unaware of train movements on the adjacent broad gauge line. These movements were not part of his/her responsibility and are not marked on the train control graph[11] in Adelaide train control. On a number of occasions the train crew on train 1SP2N warned the train controller about the train expected on the adjacent broad gauge line. Given the workload, absence of train running information on the broad gauge line, and that Centrol has responsibility of the broad gauge line, the significance of the message from the crew on train 1SP2N may have been overlooked.

If the ARTC train controller had contacted Centrol immediately, the train controller at Centrol would have had only minutes to attempt to prevent the collision.

[11] A train control graph has lines marked diagonally on it, each line representing a train.

In summary, the adjacent railway systems were controlled by different centres and emergency communications between them was not efficient enough and could not respond in time.

4.4.2 Condition of communication equipment

On the day of the accident the communication equipment was function tested on site. That test indicated that the AWARE and Wedge system was functioning correctly. The investigation team also examined the automated TMS communication logs. These logs indicated that the system was functioning correctly at the time of the accident.

Based on reports from the train controllers it is suggested that the 'hotline' phone link is unreliable.

4.5 The collision

The collision occurred because the driver of train 8318 was unaware that his line ahead was fouled by a derailed train. Although he applied the emergency brake at 1511 when he saw smoke from a fire ahead, he was unable to stop his train short of the obstruction. Train 8318 was travelling at a speed of 115 km/h, colliding with the wreckage of train 1SP2N at about 80 km/h. Based on the emergency braking curve[12] for this train it needed at least 720 metres to stop from a speed of 115 km/h. Numerous attempts were made by the crew on train 1SP2N to alert the driver of train 8318. The second driver of train 1SP2N had begun to walk back and protect the site when the collision occurred. Given the length of the train (899.15 m), the second driver had less than two minutes to provide protection (given that it would take 11 minutes to reach the end of his train). The use of fixed signals to stop the approaching train 8318 was also unavailable. Even using line of sight protection (red flags or lights, hand signals) would have been ineffective because of the curvature of the track. The only means available to protect train 1SP2N was via the radio system, either directly and/or through the train control centres.

4.6 Relevance to recommendations from previous occurrences

As part of the investigation process a number of reports from similar occurrences were reviewed. Similarities, with this occurrence, from these reports have been discussed and summarised below.

4.6.1 Hexham (NSW)

On 12 July 2002, at about 0614, an empty coal train derailed, fouling two out of the three adjacent railway lines. A short time later a passenger train collided with the fouling wreckage. The line that the passenger train was travelling on was track circuited but the track remained unbroken, preventing the automatic signals returning to stop. The crew from the coal train tried to contact the local signal box with no success. They also provided trackside protection for two adjacent lines, not for the line that the passenger train was travelling on.

12 Emergency braking curve (supplied by V/Line) of 0.83± 0.05 m/s^2 on dry, clean, and level track. Does not incorporate driver/equipment response time.

The occurrence was investigated and a report was published by Transport NSW.[13] The report into the collision highlighted a number of deficiencies, as a result a number of recommendations were made.

The Chiltern collision is similar to the Hexham collision in some aspects. The report concluded, amongst other things, the importance of the emergency message from the train crew to train control was lost. The train controller did not act immediately on that information to protect the derailment site and approaching trains. The report recommended that:

- Training for signallers and train controllers are reviewed to ensure effective communications.
- The communications facilities [at Hanbury and Maitland signal boxes] be appropriately upgraded.

4.6.2 Elders Block Point (Vic)

On 1 October 1999, at about 2130, a freight train came to a stand at Corio station after a loss of brake pipe air which caused an emergency brake application on the train. On investigation it was found that the train had separated, the rear portion of the train had six wagons derailed approximately two kilometres behind at Elders Block Point Section.

The damaged wagons were fouling the Broad Gauge Line and the standard gauge line with severe track damage to both.

This occurrence was investigated and a report was issued by a joint board of enquiry.[14] The enquiry found that a screwed axle journal had caused a wheel to derail on the mixed gauge diamond crossing of the Elders Siding connection.

The screwed journal is similar to the cause of the Chiltern derailment, loss of interference fit. Communication was a problem between the train controllers of the two different track gauges because information was not immediately passed between them.

The report recommended that:

- All locomotive drivers and train controllers to be instructed that immediately a train comes to a stand on a running line due to loss of air or other unusual circumstances, the driver must inform the train controller who, in turn, must inform the train controller in charge of any parallel lines, so that all trains on the parallel lines can be warned.
- An instruction to be given to train controllers and other employees to ensure that providers of information regarding unusual circumstances affecting the running of trains are questioned sufficiently to obtain accuracy of detail.
- In view of the cost and potential for fatalities resulting from derailments caused by bearing failures, owners and maintainers of wagons to be requested to further address the issue of rectifying those factors that cause or contribute to bearing failures.

4.6.3 Wodonga (Vic)

On 25 April 2001, at about 0743, a Countrylink XPT train travelling from Sydney to Melbourne derailed. There were five crew and 127 passengers on board.

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13 Investigation panel chaired by Transport NSW, with representatives from Pacific National, State Rail Authority of NSW, Rail Infrastructure Corporation, and the Australian Transport Safety Bureau.

14 Joint Board of Inquiry chaired by Amethyst Way Pty Ltd, with representatives from ARTC, Freight Victoria, and Specialised Container Transport (SCT).

The Victorian Department of Infrastructure commissioned the ATSB to conduct an independent investigation into the occurrence. The report found that the derailment occurred as a result of the combination of vehicle – based and track – based factors. The report also comments about the train controllers response to the occurrence:

> When the train was stopped, the driver conferred with the signalman, who subsequently called ARTC train control to notify them of the incident. As a result of this initial notification, train control started the process of notifying the various other parties detailed in their incident management plan and also attended to the issues concerning train traffic on the line. The safeworking procedures applicable on the standard gauge main line at Wodonga are contained in the ARTC document TA020 – Victorian Network Operations. These procedures include safeworking priorities in an emergency. The first priority is to determine if any adjacent line is affected and if so take urgent action to stop any approaching trains. In this derailment, the adjacent broad gauge main line was not obstructed.

There are similarities with Chiltern regarding the protection of parallel lines. On this occasion the adjacent line was protected by the effective communication between the train, Wodonga 'A' signal box, and train controllers. There are no recommendations within the report relating to train control communications.

5 CONCLUSIONS

5.1 Findings

1. No serious injuries were reported by either train crews or passengers.
2. Twenty one wagons from train 1SP2N derailed, some of which fouled the adjacent broad gauge line.
3. Train 8318 collided with wreckage fouling the broad gauge line.
4. The locomotive and two carriages from train 8318 had derailed, but remained upright.
5. Approximately 503 metres of standard gauge track was damaged and/or destroyed.
6. Approximately 120 metres of broad gauge track was damaged and/or displaced.
7. The design and condition of the track infrastructure is not considered to be a contributing factor to the derailment or collision.
8. Train control is not considered to be a contributing factor to the derailment.
9. Train control is considered to be a contributing factor to the collision with regard to effective communications.
10. The environmental condition at the time of the derailment and collision is not considered to be a contributing factor to the derailment or collision.
11. The condition of the train crews involved is not considered to be a contributing factor to the derailment or collision.
12. Rostering and fatigue management methods were not considered to be a contributing factor to the derailment or collision.
13. The emergency response from all emergency services was prompt.
14. A locomotive diesel fuel leak was controlled, although, decanting of the fuel was initially delayed by unsuitable equipment for the procedure.
15. The bearings on the failed wheelset on wagon RKTF2955X were last replaced in October 1992.
16. No maintenance records for wagon RKTF2955X (including bogies and wheelsets) were available for the period before June 2000. This may be attributed to the number of ownership changes.
17. There are no standards for rail bearing maintenance that provide a benchmark for industry to build on.
18. There were no hot bearing alerts detected by track side equipment at Moss Vale.
19. No significant over speed events were recorded by the data logger in locomotive NR66.
20. The train manifest report indicates that wagon RKTF2955X was not overloaded.
21. The drivers of train 1SP2N were unsure of what indication to expect from the train radio user interface during emergency conditions.
22. When tested the radio communications equipment on locomotive NR66 was found to be functioning correctly.
23. There was about three minutes between train 1SP2N derailing and coming to rest and train 8318 colliding with the fouling wreckage.

5.2 Significant Factors

1. A bearing on wagon RKTF2955X, train 1SP2N, failed resulting in a derailment.
2. The failed bearing experienced a loss of inference fit on the axle journal.
3. Pacific National rolling stock maintenance, for this type of wagon, was based on distance only and did not allow for time in storage.
4. Wagon RKTF2955X had been in storage for extended periods.
5. The lack of bearing history allowed an ineffective analysis of the history and points to a deficiency in the system that may indicate poor practice at that time.
6. There was a delay before the train controller in the ARTC train control centre notified the train controller at Centrol of the derailment.
7. Information from train controllers suggest that the emergency 'hotline' phone link between Centrol (in Melbourne) and ARTC (in Adelaide) train control centres is unreliable, affecting efficient emergency communications between the two centres.
8. The driver of the V/Line passenger train 8318 was unable to stop the train before striking the wreckage from train 1SP2N.

6 RECOMMENDED SAFETY ACTIONS AND SAFETY ACTIONS INITIATED

6.1 Recommended safety actions

6.1.1 Victorian Department of Infrastructure

RR200300023

The ATSB recommends that the Department of Infrastructure review all accredited organisation's SMS provisions for the maintenance standards of wheel bearings. Particularly to the maximum bore size of bearings, the minimum journal diameter, storage life and procedures for extending effective service life of the bearing.

RR200300024

The ATSB recommends that the Department of Infrastructure monitor the review of communications technologies between Train Control centres.

6.1.2 Pacific National

RR200300025

The ATSB recommends that Pacific National review rolling stock maintenance schedules to include distance and time based criteria.

RR200300026

The ATSB recommends that Pacific National ensure that stored bearings, separate or mounted, are serviced as recommended by the manufacturer.

RR200300027

The ATSB recommends that Pacific National review the procedures for rolling stock, bogies, or wheelsets entering service after extended periods of storage or inactivity.

RR200300028

The ATSB recommends that Pacific National review training procedures for the use of radio equipment during an emergency.

6.1.3 Freight Australia

RR200300029

The ATSB recommends that Freight Australia review communications technologies to allow for greater reliability between other Train Control centres during emergencies.

RR200300030

The ATSB recommends that Freight Australia review communications procedures with other Train Control centres during emergencies on shared railway corridors.

6.1.4 Australian Rail Track Corporation

RR200300031

The ATSB recommends that the Australian Rail Track Corporation review communications technologies to allow for greater reliability between other Train Control centres during emergencies.

RR200300032

The ATSB recommends that the Australian Rail Track Corporation review communications procedures with other Train Control centres during emergencies on shared railway corridors.

6.1.5 Australasian Railway Association Inc

RR200300033

The ATSB recommends that the Australasian Railway Association consider the implementation of minimum maintenance standards for packaged and boxed axle bearings.

6.2 Safety Actions already initiated

After the accident Pacific National reviewed and implemented new maintenance schedules based on distance and time. Additionally, rolling stock entering service after extended periods have to be inspected, this includes rolling the bearings within a certain time frame to ensure lubrication within the unit.

7 SUBMISSIONS

7.1 Victorian Department of Infrastructure

The Department Of Infrastructure made a number of comments and observations on the draft report issued to directly involved parties. The comments and observations have largely been incorporated into the body of the report.

7.2 Pacific National

Pacific National made a number of comments and observations on the draft report issued to directly involved parties. The comments and observations have largely been incorporated into the body of the report.

7.3 Freight Australia

Freight Australia made a number of comments and observations on the draft report issued to directly involved parties. The comments and observations have largely been incorporated into the body of the report.

7.4 Australian Rail Track Corporation

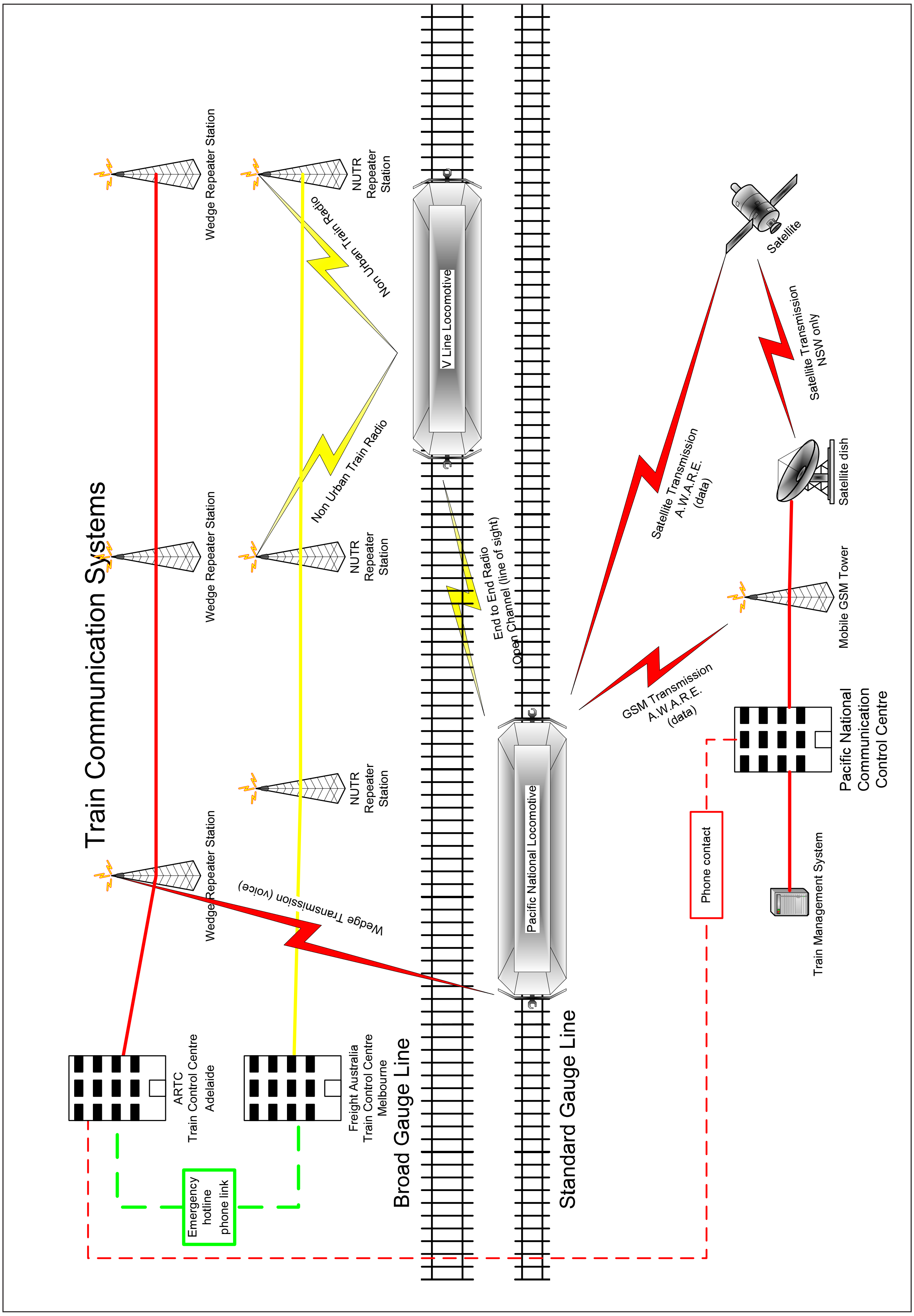
The Australian Rail Track Corporation made a number of comments and observations on the draft report issued to directly involved parties. The comments and observations have largely been incorporated into the body of the report.

7.5 Conductor of Train 8318

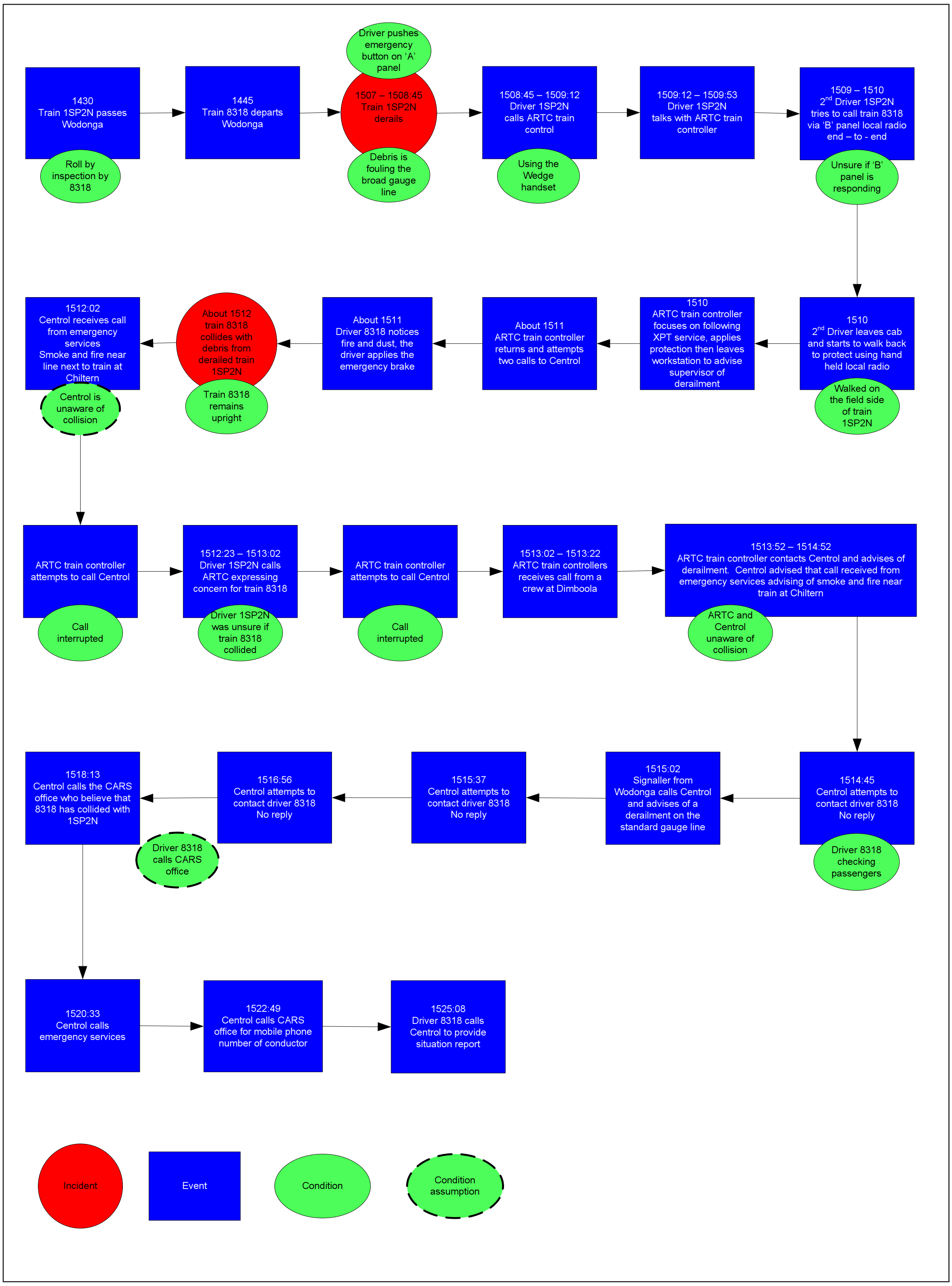
The conductor of train 8318 made a number of comments and observations on the draft report issued to directly involved parties. The comments and observations have been incorporated into the body of the report.

8 APPENDICES

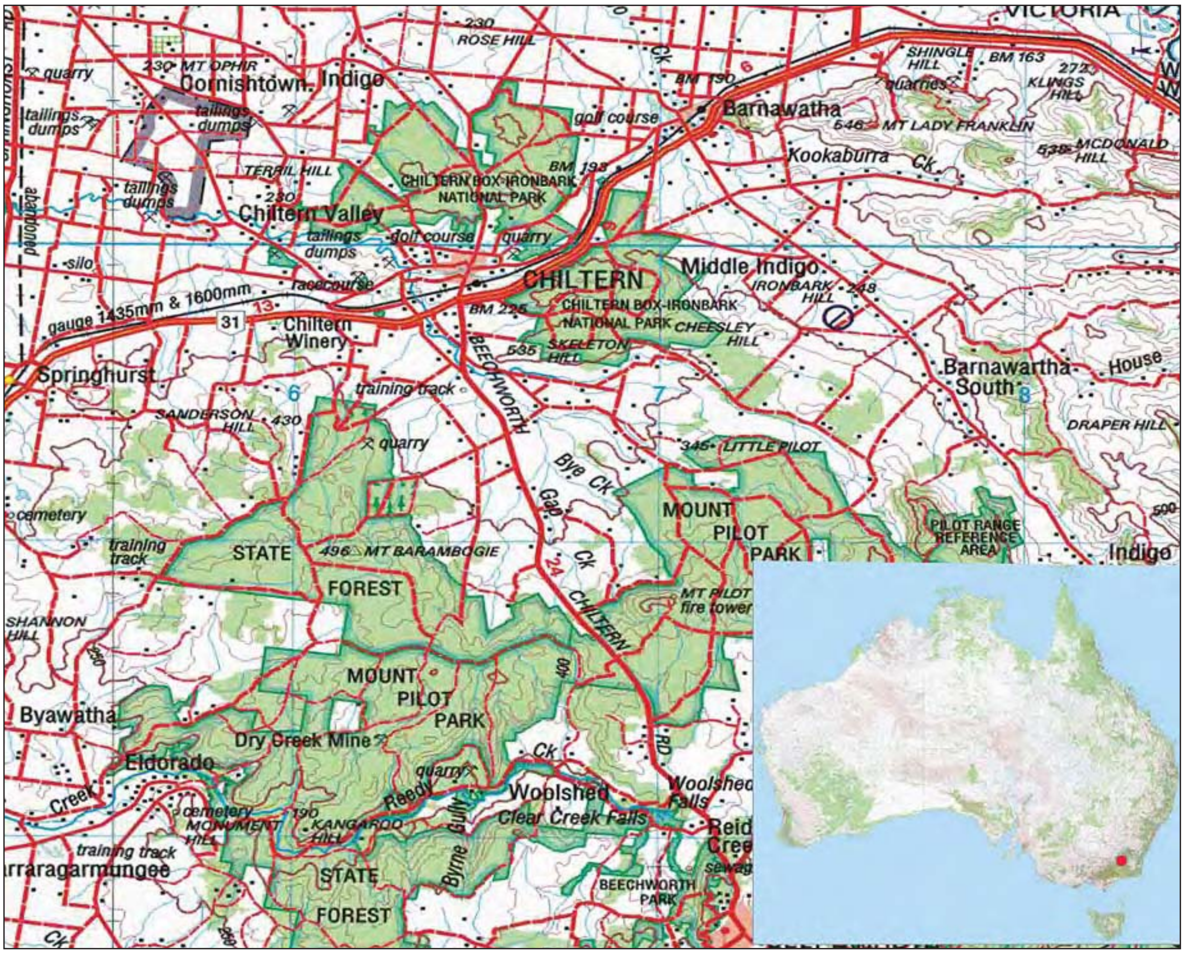
8.1 Communications Flow Chart



8.2 Timeline Diagram



8.3 Map of Chiltern



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Derailment of Pacific National Freight Train 1SP2N and the Subsequent Collision of V/Line Passenger Train 8318 near Chiltern, Victoria, 16 March 2003

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