ATSB
Australian Transport Safety Bureau

AUSTRALIAN TRANSPORT SAFETY BUREAU

RAIL INVESTIGATION REPORT
R1/2000

Collision Between Freight Train 9784 and Ballast Train 9795

Ararat, Victoria
26 November 1999

COMMONWEALTH DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

Department of Transport and Regional Services

Australian Transport Safety Bureau

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Executive Summary

On 26 November 1999, a Freight Victoria Ltd (Freight Victoria) employee moved the points at the Adelaide end of the Ararat yard shortly before a grain train was due to pass through Ararat on the main line. The employee's duties did not require him to move points, nor was he qualified or authorised to do so.

As a result of the employee's actions, the grain train was diverted into the Ararat yard, where it collided with a stationary ballast train.

The employee subsequently reported that he had moved the points in order to be helpful. There was no evidence to suggest otherwise.

The two crew members of the stationary ballast train saw that a collision was imminent and escaped from the locomotive shortly before the impact. They were not injured.

The two crew members on board the moving grain train applied emergency braking when they saw that the points were not set for the main line. They remained on board the locomotive and sustained serious injuries as a result of the collision.

The investigation determined that the system in operation at Ararat was fragile in the face of human error.

The device used to unlock the points and permit their movement, was stored in a metal box near the points. This box was secured with a padlock of a type widely used on the Victorian non-urban rail network. The employee who moved the points had been issued with a key of this type in order to perform his normal duties, even though it was generally considered that personnel with his limited qualifications would not normally be issued with such a key.

There was no system in place to prevent the points from being moved in front of an oncoming train. Such systems are in place at other locations on the Adelaide-Melbourne main line. Additionally, there was no provision to inform Drivers on the main line or Train Control, of the movement or position of the points.

Although this accident was triggered by the unsafe and unauthorised actions of an employee, the accident had its origins in a number of organisational and system deficiencies.

The primary deficiencies identified in the course of this investigation were related to:

- hazard identification and the management of risk;
- safety training;
- interface management;
- system design;
- standardisation of procedures and safety systems;
- the control of safety-critical equipment;
- oversight of the activities of rail organisations; and
- safety promotion.

Both the Australian Rail Track Corporation (ARTC) and Freight Victoria have undertaken a review of their networks and have identified locations where they have concerns about the integrity of main lines. The two organisations are applying risk assessment methodologies to determine whether further measures are required to improve the error tolerance of the system at those locations. Any progress on those reviews has been acknowledged in Section 10.1 *Local safety action*.

Introduction

As a result of a collision between two trains on the intermediate siding at Ararat on the 26 November 1999, the Victorian Minister for Transport, The Honourable Peter Bachelor MLA, directed the Secretary of the Victorian Department of Infrastructure to establish an independent inquiry, in accordance with the requirements of the Victorian Transport Act (1983) and the Transport (Rail Safety) Regulations (1998).

Section 129U of the Act states:

> The Minister may require the Secretary or any other person or body to inquire into, and to report to the Minister, on any railway accident or incident that may affect the safe operation, construction, maintenance, repair or alteration of any rail infrastructure or rolling stock.

The terms of reference for this rail safety investigation are indicated below:

- Establish the facts leading to the accident;
- Examine all the factors, both direct and indirect, technical and human, which contributed to the accident;
- Conduct the investigation consistent with the requirements of the Victorian Transport Act (1983) and the Transport (Rail Safety) Regulations (1998); and
- Consider the wider implications of the accident, for example, what other similar situations on the Victorian rail system have potential to cause train collisions of this type.

The report is to be prepared in accordance with the format described in Australian Standard AS4292 Part 7 Section 2.9.2 (Draft).

Two investigators from the Australian Transport Safety Bureau were appointed, in consultation with the Victorian Public Transport Safety Directorate, to lead the independent investigation. An investigator experienced in systemic investigations was appointed as the investigator in charge, assisted by a specialist investigator with experience in human performance and its role in accidents and incidents.

The independent investigation team was provided with technical and general assistance by:

- the Victorian Department of Infrastructure, Public Transport Safety Directorate;
- Freight Victoria Ltd;
- Australian Rail Track Corporation;
- Victorian Rail Track Corporation;
- Victorian Rail, Tram and Bus Union;
- Great Southern Railway;
- National Rail Corporation; and
- Rail consultants.

Those organisations and individuals provided records, reports, logs of the events leading up to the collision, operating procedures, analysis of recorded train information, and information pertaining to safety management systems and their current roles and responsibilities. Their open participation and cooperation in the investigation process is acknowledged.

It was not the purpose of this investigation to attribute blame or liability to any person or organisation. The aim of this investigation was to identify safety deficiencies in the system, with a view to preventing further similar occurrences.

Investigation Methodology

The purpose of this investigation was to enhance rail safety. First, by determining the sequence of events which led to the accident and second, by determining why those events occurred. Of particular importance was the need to understand what the accident revealed about the environment within which this particular rail operation was being conducted, and to identify deficiencies with the potential to adversely affect safety.

The Reason model of accident causation has become one of the most widely applied systemic approaches to accident and incident analysis[1]. Reason maintains that most accidents result from an interaction of factors, rather than a simple error or violation on the part of operational personnel. Whilst some of those factors, including local task and workplace conditions, can have an immediate effect on the operation being performed, other factors relating to organisational or systemic processes, may remain unnoticed for considerable periods. Individually, each of those factors are generally insufficient to cause a breakdown in safety. However, a combination of organisational and task factors may promote an environment conducive to human error, leading to a safety hazard. Should defences designed to warn and protect against those hazards be absent or inadequate, then a safety breakdown is inevitable. It was therefore necessary to look behind the actions of operating personnel in order to examine other areas with the capacity to influence safety.

The Reason model was used as a framework for the analysis of this accident (see Appendix 3).

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

- A visit to the accident site and other locations associated with the accident;
- In-cab observations of train operations in the vicinity of the accident;
- Recorded train and train control information;
- The history of organisational and infrastructure changes associated with the accident site;
- Company operating procedures and practices;
- Interviews with personnel directly associated with the accident;
- Interviews with management and safety personnel of organisations relevant to the accident;
- A review of operators' and track access providers' risk assessment methodology and application; and
- A study of State rail safety database accident/incident statistics.

Footnote:

1) REASON, J. 1990, *Human Error*, (Cambridge University Press: Cambridge)

1. INCIDENT DESCRIPTION AND FACTORS

1.1 Location

The rail system at Ararat consists of two sidings connected to the ARTC Melbourne–Adelaide standard gauge (1435 mm) main line. A passenger platform is located on the main line. Ararat is also the junction for the Freight Victoria line to Maryborough and Dunnolly (fig 1).

Whilst the main line, including the main-line points at each end of the yard, forms part of the ARTC network, the yard area clear of the main line is part of the Freight Victoria network.

The main-line points are hand operated and are linked to a Hayes derail and wheel crowder (derailer). The purpose of the derailer is to prevent any rail vehicles inadvertently running onto the main line.

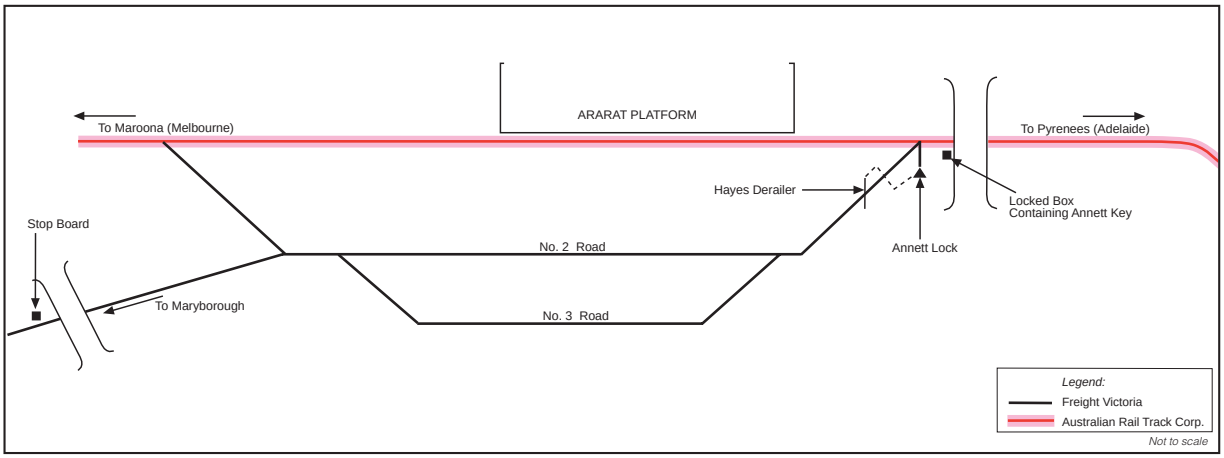
A special lock known as an Annett lock, operated by an Annett key, secures the points. The locking mechanism is not interlocked with the signalling or Safeworking system on the main line.

The Annett key is locked in a metal box located at the base of a road bridge which passes over the main line immediately to the west of the points. The box is known as a Safeworking box and is secured by a Victorian Safeworking (V5PSW) padlock, the keys of which are only issued to authorised personnel.

Standard operating procedures specified when the Annett key was to be used to operate the points and by whom.

Both freight and passenger services pass through Ararat on the main line. The greatest number of train movements each week on that section of the main line occurs on Tuesday and Friday evenings. On the day of the accident, Friday 26 November, six freight trains and two passenger services were scheduled to operate through that location between 1800 ESuT until 0600 the following day. Most of those services, including the two passenger services, were delayed as a result of the accident.

FIGURE 1.
Rail infrastructure layout at Ararat



1.2 Background

Ballast trains, combined with grain trains, had been discharging in the Ararat area for a period of approximately one month prior to the accident. For operational reasons, the ballast trains were required to operate separately to the grain trains on both Thursday 25 and Friday 26 November 1999. Operations on the line between Dunnolly and Ararat were overseen by an Officer in Charge (OIC) who was based at Maryborough. The staff who facilitated those operations and who were also based at Maryborough, included four Freight Operations Employees (FOE), one Train Examiner, and several Drivers and Second Persons.

On Wednesday 24 November, the Train Examiner was informed by the OIC that he may be given the task of transferring a Train Staff from Ararat to Maryborough. The OIC advised the Train Examiner of the possibility that he might need to access the locked box containing the Annett key in case the train had been issued with a clearance to proceed onto the main line before the Train Examiner arrived at Ararat and the train crew had left the Train Staff in the box. The Train Examiner had previously been issued with a V5PSW key by the OIC Maryborough because of a requirement for the Train Examiner to access a storage shed at Maryborough station containing End of Train Air System (ETAS) units. Access to that storage shed formed part of the Train Examiner's daily duties. The OIC provided the employee with a description of the Train Staff, the locked box containing the Annett key, (fig 2) and general details of what the Annett key looked like.

FIGURE 2.
Steel box in which the Annett key at Ararat was housed, as found following the accident

On the day before the accident (Thursday 25 November), the Train Examiner was instructed by a Freight Victoria Freight Operations Employee (FOE) to travel by car from Maryborough to Ararat to collect the Maryborough–Ararat Train Staff from the Driver of a company ballast train. A company freight train was scheduled to operate on the Maryborough–Ararat line following the ballast train and would require the Train Staff in order to obtain a 'proceed' authority on that section of track.

The Train Examiner arrived at Ararat before the ballast train and telephoned the FOE on duty at Maryborough station. He advised that FOE that he was not sure what he had in his hand but thought that it was the Ararat Annett key. The FOE instructed the Train Examiner to return the key immediately to the box and to collect the Train Staff from the Driver of the ballast train. That FOE briefly communicated the details of the incident during a handover briefing to the FOE who had issued the instructions to the Train Examiner earlier that day.

The investigation was not able to establish the location from which the telephone call was made by the Train Examiner. He had not been provided with a method of directly communicating with company personnel, including the crew members of the ballast train. It was established that a company telephone box, located in the centre of the Ararat yard, was not operational at the time the telephone call was made, nor on the evening of the accident.

The ballast train subsequently arrived on the No. 2 Road at the Adelaide end of the Ararat yard and a Section Authority was granted for the train to proceed west onto the main line. The Second Person alighted from the train and gave the Train Staff to the Train Examiner. The Train Examiner then watched as the Second Person removed the Ararat Annett key from the locked box and used it to open the points onto the main line (fig 3). At that time, both the Driver and the Second Person of the ballast train observed three youths on the overhead road bridge immediately to the west of the points, who were watching the Second Person operate the points. The Second Person reported that he heard one youth comment 'Oh so that's how it's done'. The Train Examiner departed Ararat for Maryborough with the Train Staff shortly after the ballast train moved onto the main line. The Second Person then closed and locked the points and returned the Annett key to the locked box. The ballast train subsequently departed for the Pyrenees crossing loop (Pyrenees Loop).

FIGURE 3.
Detail of the Annett lock and key controlling the points at the Adelaide end of the Ararat siding, as found following the accident

1.3 Train Information

The two trains involved in the accident on the evening of 26 November are described below.

Grain train No. 9784 (9784) consisted of a 'G' class locomotive, '517', and 21 grain wagons. The first eleven grain wagons were empty, while the following ten wagons were fully loaded with grain consigned from Rainbow to Portland. The train had a total gross weight of 988 tonnes, and was 337 m in length, excluding the locomotive. At the time of the accident, 9784 was proceeding from the Pyrenees Loop in an easterly direction at a line speed of 74 kph.

Ballast train No. 9795 (9795) consisted of a 'G' class locomotive, '518', and 14 ballast hopper wagons amounting to a total gross weight of 756 tonnes, and with a length of 166 m, excluding the locomotive. At the time of the accident, 9795 was stationary on the No. 2 Road at Ararat.

1.4 Sequence of events

On the afternoon of the accident (Friday 26 November 1999), the Train Examiner who had collected the Train Staff from Ararat the previous evening, drove the crew of 9795 to Elmhurst to relieve another crew. The Train Examiner had commented that he was glad to be out of the office and that it had been very busy with several telephone calls. He had also expressed some frustration that he was not able to do much to assist in dealing with those telephone inquiries nor with operations in general at Maryborough because he was not trained as a FOE.

After delivering the train crew to Elmhurst, it had been arranged that the Train Examiner would drive to Ararat later that evening in order to collect the Maryborough-Ararat Train Staff for the same reason that he had collected it the night before. The same instructions were issued for the collection of the Train Staff as had been issued the day before.

The Train Examiner departed from Maryborough for Ararat, a car journey of approximately 1 hr 10 mins, shortly after receiving a telephone call from the Driver of 9795, advising of the train's anticipated arrival at the Ararat yard. At about the time the Train Examiner arrived at Ararat, he observed a train travelling west on the main line. That train was later confirmed to be 9783, which passed through Ararat at 2039 ESuT. In addition, a policewoman who was in the area at approximately 2045, briefly spoke to the Train Examiner as he waited at the Adelaide end of the siding.

The Train Examiner did not have a method of directly communicating with the crew of 9795, nor with Train Control, while he was waiting at Ararat on the night of the accident.

At approximately 2110, the Driver of 9795 advised Melbourne Train Control (Melbourne Control) that he had stopped his train in order to pick up a small female child that had been observed walking beside the track as he was concerned that the child might fall under the moving train. The Second Person alighted the locomotive cab but before he could reach the child, she fell into a nearby dam. The Second Person acted quickly to rescue her. Police and ambulance attended the scene shortly after the rescue. As a result of that incident, the arrival of 9795 into the Ararat yard was delayed by approximately 30 minutes.

At approximately 2125, the Driver of 9795 advised Melbourne Control that he had stopped his train at the Ararat 'Stop Board' but was unable to contact Adelaide Train Control (Adelaide Control) in order to obtain a Section Authority to the Pyrenees Loop. Melbourne Control then contacted Adelaide Control to coordinate the clearance. Adelaide Control advised that there were no trains shunting in the Ararat yard and that 9784 was ready to depart east from the Pyrenees Loop, a location approximately 3 km to the west of Ararat. Adelaide Control further advised that 9795 was to enter the Ararat yard cautiously as 9784 would be running through Ararat. This information, including authorisation to enter the Ararat yard, was issued immediately by Melbourne Control to the Driver of 9795. The Driver proceeded to move the train onto the No. 2 Road in the Ararat yard and then to seek to obtain a Section Authority to proceed west onto the main line after 9784 had passed through Ararat.

A Section Authority had not been obtained by the time 9795 became stationary at the Adelaide end of the Ararat yard, about one locomotive length before the derailer block. Shortly after his train came to a halt, the Driver reported that he observed the derailer block come off the line and saw someone near the points. Simultaneously, he observed the lights of a train travelling east around the curve on the main line. The

Second Person was still in the cab at that time but was preparing to alight in anticipation of changing the points once a Section Authority had been obtained.

The crew members of 9784 reported that they had obtained a Section Authority to travel east from the Pryenees Loop to Maroona and had also received a 'proceed' indication from the signals at the Melbourne end of the Pyrenees Loop. The 'proceed' indication meant that there were no trains occupying the section of line for which the Authority had been issued and that the train could proceed at the maximum speed for the locality. 9784 was accelerating to the maximum posted speed (75 kph) and was travelling at approximately 74 kph when it reached the curve in the main line shortly before Ararat. The Driver reported that he observed the headlight of 9795 on the siding at Ararat but was not able to see the position of the points in the headlight of his train until shortly before the collision. When he realised that the points were not set for the main line and that a collision was imminent, the Driver immediately selected the emergency brake and moved quickly behind the Driver's seat to brace for the impact. The Second Person did likewise behind his seat. The collision occurred only seconds after the emergency brake was applied. Marks on the No. 2 Road were consistent with heavy braking at the time of the initial impact.

In order to escape the impending collision, the Driver of 9795 jumped from the locomotive cab, shouted toward the person at the points and ran up an embankment. The Second Person of 9795 also left the cab and ran up the embankment.

The collision of the two trains occurred at approximately 2135. Immediately following the collision, the Train Examiner approached the crew of 9795 in an extremely distressed state and repeated the phrase 'What have I done?'

Police, ambulance and emergency services responded quickly to the accident.

1.5 Injuries

The crew of 9795 were not injured during the accident and did not require hospitalisation; however, they were severely shaken by the event.

The Train Examiner who had operated the points suffered from the effects of shock and was admitted to Ararat hospital for observation.

Both crew members of 9784 were seriously injured. The Driver suffered head injuries and multiple lacerations and was admitted to Ararat hospital for treatment. The Second Person suffered serious chest and shoulder injuries and was airlifted to the Alfred Hospital in Melbourne. The mountings on the seat, behind which the Second Person had braced himself for the collision, broke during the impact sequence. The seat mountings on the Driver's seat remained intact.

1.6 Damage

The locomotive of 9784 collided head on at an estimated speed of 74 kph with the locomotive of 9795, which was stationary.

9784 pushed the stationary ballast train (9795) approximately 30 m in an easterly direction.

The two locomotives locked together, the anti-ride bars preventing either locomotive from riding over the other (fig 4). The leading cabs largely retained their shape, although the remaining sections of both locomotives suffered extensive damage during the impact sequence.

FIGURE 4.
View of the leading cabs of the two locomotives showing the anti-ride bars. The impact speed of the collision was approximately 74 kph

1.6.1 Damage to train 9784

The first 12 grain wagons (11 empty and one loaded) of 9784 were projected over the top of its locomotive and came to rest in various positions. Some wagons blocked the main line, while others mounted the embankment on the northern side of the No. 2 Road (fig 5). Few of those wagons remained upright and most sustained extensive impact damage. The locomotive of 9784 was extensively damaged by the impact of the wagons passing over it, and by bogies, wheels, undergear and grain being deposited in the exposed engine room. In addition, the fuel tank on the locomotive was ruptured and its contents spilt.

The 13th wagon came to a stand in a slightly elevated position and lay against the trailing cab of the locomotive of 9784. The trailing bogie remained on the rails but both the leading bogie and wagon body were supported off the rails by the accumulated debris (fig 6).

The 14th to 21st wagon remained upright and on the rails (fig 7). They were subsequently pulled clear from the scene during the morning following the accident.

FIGURE 5.
The accident site as viewed from west to east. The main line is on the right of the picture and is blocked by an overturned grain wagon and several bogies, wheels and undergear. The embankment that the crew members of 9795 ran up to escape the collision, is at the left of the picture

FIGURE 6.
View of the extensive damage to the engine room and rear-cab sections of the locomotive of 9784

FIGURE 7.
The accident site as viewed from east to west. Picture shows the grain wagons at the rear still intact and on the rails under the road bridge

1.6.2 Damage to train 9795

The leading ballast hopper wagon absorbed most of the impact of the locomotive of 9795 being propelled along the No. 2 Road, and caused extensive damage to the trailing cab of the locomotive. The locomotive of 9795 also suffered extensive impact damage from the grain wagons passing over it (fig 8).

The second ballast hopper wagon sustained damage to the underframe and drawgear at the leading end.

The remaining twelve wagons on the ballast train were not damaged and were pulled clear during the morning following the accident.

FIGURE 8.
View of the rear cab of the locomotive of 9795

1.6.3 Damage to infrastructure

Track and signalling infrastructure sustained minor damage as a result of the accident.

1.7 Workers involved

1.7.1 Train crew details, Ballast train 9795

	Driver	*Second Person*
Gender:	Male	Male
Classification:	Locomotive Driver	Second person
Medical status:	Fit for duty	Fit for duty
Continuation training:	Current	Current
Time on duty prior to the accident:	7 hrs 13 mins	7 hrs 13 mins

1.7.2 Train crew details, Grain train 9784

	Driver	*Second Person*
Gender:	Male	Male
Classification:	Locomotive Driver	Locomotive Driver
Medical status:	Fit for duty	Fit for duty
Continuation training:	Current	Current
Time on duty prior to the accident:	6 hrs 15 mins	6 hrs 15 mins

1.7.3 Additional employee

In addition to the personnel on board the two locomotives, another employee, a Train Examiner, was directly involved in the accident sequence.

The Train Examiner had worked in the rail industry since 15 February 1965, a period of almost 35 years. He had been employed since 10 April 1970 as a Train Examiner. Train Examiners are responsible for inspecting rolling stock to ensure that they are in a fit condition for operation.

The Train Examiner had been employed at Maryborough since 16 September 1999, where he performed general duties including clerical tasks, car driving and some train examining as required. Prior to this, he had worked at various other locations on the Victorian rail network as a Train Examiner.

Freight Victoria management intended to retrain this person as a FOE, which would qualify him to perform a wider range of duties than that of a Train Examiner, including shunting and Safeworking. Safeworking encompasses the procedures and technology used to ensure the safe operation of trains and the protection of people and property on or about the railway.

The Train Examiner's supervisor, the OIC Maryborough, had attempted unsuccessfully to have him placed on a Safeworking course in the months leading up to the accident. A class in Safeworking was offered in September 1999 while the Train

Examiner was temporarily assigned to North Geelong in the four months immediately preceding his move to Maryborough. However, due to operational requirements and staff shortages, he was not able to be released from his train examination duties at that time. The OIC had supplied the Train Examiner with training documentation relevant to FOE duties. It was reported that the Train Examiner had completed a limited amount of self-paced learning from that documentation with the assistance of the OIC of Geelong operations. That training documentation included a module on the working of points and signals.

The Train Examiner was the only Freight Victoria employee based at Maryborough who did not possess Safeworking qualifications.

Following the accident, it was reported that the Train Examiner had explained to the OIC at Maryborough that his actions were motivated by a desire to help the crew and himself get the task done quickly. At the time of the accident, the Train Examiner had been working for approximately 11.5 hrs as a result of a number of delays to scheduled operations. He had indicated to the OIC that he was keen, though not anxious, to go home. He had a meal break at approximately 1815 that evening and it is believed that he went to his home during that time. The investigation could not establish whether he had consumed alcohol during that meal break or at any time immediately prior to the accident. The Train Examiner was usually rostered on Monday to Friday day shifts since his arrival at Maryborough and had only occasionally been required to work in excess of his rostered hours.

The Train Examiner advised members of the joint internal investigation (conducted by Freight Victoria and ARTC) that, having observed a train travelling west through Ararat at about the time he arrived there on the night of the accident, he did not anticipate that another train would be travelling through Ararat from the opposite direction for some time.

Note: The Train Examiner was the only person directly involved in the accident who was not interviewed. In circumstances where a person would otherwise be required to answer questions or provide information under Division 3 of the Victorian Transport Act 1983, part 129S of the Act states that 'a person may refuse or fail to give information, produce a document or do any other thing that the person is required to do under this Division if giving of the information, the production of the document or the doing of that other thing would tend to incriminate the person'. In addition, part 129U of the Act is silent on the powers of an authorised investigator to obtain information during the course of a rail accident or incident investigation. Investigators must rely on people's willingness to answer questions or provide other information. The Train Examiner was under legal advice not to be interviewed by the independent investigation team.

1.8 Track details

Ararat is located 264 km from Melbourne (via Geelong) on the standard gauge interstate corridor between Melbourne and Adelaide.

Immediately to the west of the points at the Adelaide end of the Ararat siding, the main line passed under a road bridge then continued in a westerly direction up a gentle grade before curving to the right. That curve had a speed restriction of 75 kph. When the main line was viewed from a location approximating that of a stationary locomotive positioned about one locomotive length before the derailer block on the No. 2 Road at Ararat, trains travelling east on the main line did not come into view until they had completed the curve, a position approximately 200 m from the

stationary locomotive. A train travelling at 75 kph (20.8 m/s) would take 9.6 seconds to cover that distance. The abutments and road structure of the road bridge also obstructed the view of locomotive crews waiting at Ararat although at night, the lights of a locomotive would be visible several seconds before the locomotive itself rounded the curve (fig 9).

FIGURE 9.
Daytime view west toward the Pyrenees Loop from the approximate location of a locomotive waiting to proceed onto the main line from the No. 2 Road at Ararat

The points at Ararat were interlocked with the derailer on the No. 2 Road but were not interlocked in any way with signals or the Safeworking system on the main line, nor were they provided with point indicators to warn Drivers on the main line that the points were not set for the main line.

The crew of a locomotive approaching Ararat from the west at night, would not be able to visually acquire the setting of the points until shortly before arriving at them. Therefore, a Driver would have little opportunity to slow his train if he became aware that the points were not set for the main line (fig 10).

No technical defects of the track or related infrastructure were found that could have contributed to the accident.

FIGURE 10.
Daytime view east toward Ararat from the cab of a locomotive. The No. 2 Road at Ararat commences shortly after the road bridge

1.9 Train control

The Safeworking system in the immediate vicinity of Ararat was in accordance with the Section Authority System, generally referred to as Alternative Safe Working (ASW). ASW currently operates on the interstate corridor between the Pyrenees Loop, 3 km to the west of Ararat, and Newport, a location immediately to the west of Melbourne.

The objective of ASW is to prevent more than one train occupying a defined section of track. This is accomplished by issuing an Electronic Authority for each train movement within the Section Authority territory. The Electronic Authority is displayed in the Locomotive Safeworking Display Unit. Trains must not enter any single line section of track unless the driver is in possession of an appropriate Section Authority.

The ASW system has two main components, the Workstation in the Train Control centre and the Locomotive Safeworking Display Unit in the locomotive. The transmission of Authorities between those components is via a radio network. The system is designed so that it is possible to revert progressively to manual levels of operation in the event of Workstation, Locomotive Safeworking Display Unit or field equipment failure.

ASW is considered to provide a greater level of safety than Manual Train Order Working, as the system is designed to prevent two Section Authorities being concurrently issued for the same section of track. However, system capacity issues exist as a result of the software platform upon which the system has been designed.

ASW is considered to provide a lower level of safety than Centralised Traffic Control (CTC), as ASW does not currently provide for an independent verification of a train's location with the use of track circuitry or other technology. ASW relies largely on Drivers correctly requesting and relinquishing Section Authorities. Although methods have been incorporated to alert Train Controllers of potential anomalies, it is possible for a Driver to inadvertently enter a section of track without a Section Authority. Consideration is currently being given to equipping trains with Global Positioning System units as a means to independently verify the location of trains.

Drivers whose trains are positioned in the Ararat yard and who require access to the interstate main line must contact the ARTC ASW Train Controller in Adelaide to obtain a Section Authority. Drivers whose trains are departing east from the Pyrenees Loop must also obtain a Section Authority from this Controller. The Melbourne end of the Pyrenees Loop marks the point at which a train travelling in an easterly direction passes from CTC territory into ASW territory. In CTC territory, the Train Controller has sole responsibility for the setting of signals and the movement of points. The Controller carries out those functions with the aid of a computerised operating panel. In contrast, a Controller in ASW territory does not have the facility to change points remotely, nor monitor their position. ASW Controllers rely on Drivers or other qualified personnel to move points in accordance with Controller's authorisations.

1.10 Environmental factors

The accident occurred at night. Conditions were described as fine with no impediments to visibility. Weather was not considered to be a contributing factor to this accident.

1.11 Recorded information

1.11.1 Train control

Recorded information from both the Freight Victoria Train Control Centre in Melbourne and the ARTC Train Control Centre in Adelaide, indicated that Authorities had been issued correctly and in accordance with prescribed procedures.

1.11.2 Locomotive Speed Recorders

The speed charts for both locomotives were isolated and later analysed by an authorised Freight Victoria employee.

The speed chart of locomotive 518 (train 9795) indicated that a low brake cylinder application, consistent with the locomotive slowing down, occurred shortly before 2135. The locomotive was stationary at 2135 at a distance of 1,780 m from the 'Stop Board' at the entrance to the Ararat yard, a position about one locomotive length from the derailer block on the No. 2 Road. At 2135.5, the stylus on the brake cylinder reading rose sharply and the brake and speed stylus became erratic. Those indications were consistent with a collision.

The speed chart of locomotive 517 (train 9784) indicated that at 2129, the locomotive commenced to move with the speed increasing from 0 to 74 kph. This was consistent with 9784 accelerating from a stationary position at the Melbourne end of the Pyrenees Loop. At 2134.5, and with an indicated speed of 74 kph, a sudden jolt was recorded and the speed stylus locked at a setting of 90 kph, indications that were consistent with a collision.

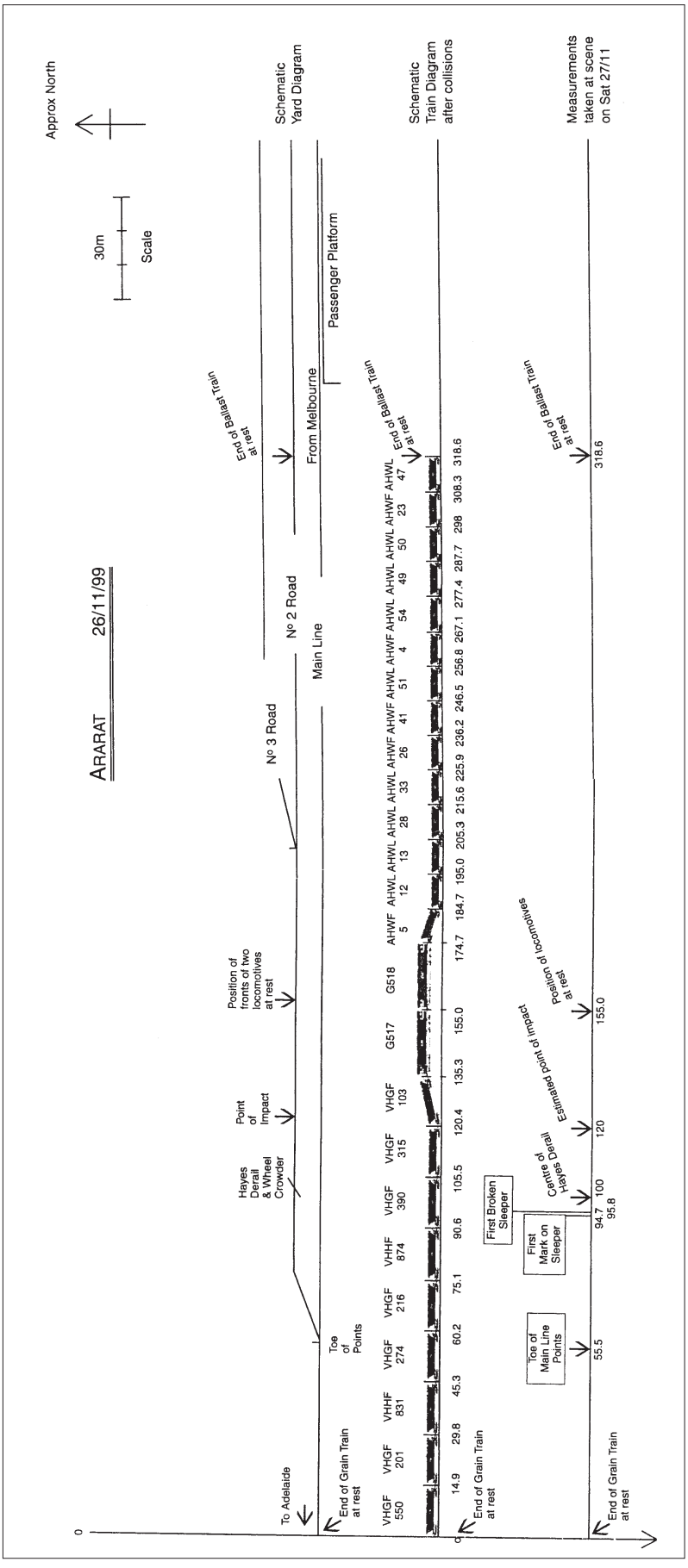
No brake cylinder pressure was recorded on the chart of 9784 prior to the stylus irregularity. The reason for this was due to the normal delay between the time the emergency brakes were first selected by the Driver of 9784 and when those brakes activated on the locomotive. The investigation team was advised that this time delay could vary between just a few seconds in most cases, and up to 9-10 seconds in cases where dynamic braking is in operation at the time the emergency brake is selected. Dynamic braking is not normally recorded on the speed charts of 'G' class locomotives. However, given that 9784 maintained a steady speed of 74 kph while it travelled down the grade into Ararat, it is likely that the dynamic brake was operating at the time the emergency brake was selected by the Driver.

Note – The one-minute difference between the speed recorders of the two locomotives was considered to be the result of differences in the time setting of those recorders.

1.12 Site information

The schematic diagrams shown in figure 11 provide general details of key locations at the accident site, including the location of the stationary locomotive of 9795 prior to the collision, the initial impact point of the two locomotives, and the position of the locomotives following the accident. The resting positions of individual wagons have not been included in those diagrams as photographic evidence was considered sufficient.

FIGURE 11.
Accident site schematic



Provided by Freight Victoria

1.13 Medical issues and toxicology

The crew members of 9795 were subjected to a breath test for the presence of alcohol by personnel from the Victorian Police Transport Operations Group who attended the scene shortly after the accident. The results were negative.

The Adelaide Train Controller was breath tested by authorised personnel at the ARTC Train Control Centre shortly after the accident. The result was negative.

The Driver and Second Person of 9784, in addition to the Train Examiner who had operated the points, were not breath tested by the police, nor were they tested for blood alcohol following their admittance to hospital. Freight Victoria and ARTC believed that blood samples had been taken when those employees were admitted to hospital, but were informed several days after the accident that this was not the case.

Section 97 of the Transport Act refers to 'Blood samples to be taken in certain cases'. That reference states that 'if a worker enters or is brought to a designated place for examination or treatment in consequence of an accident (whether in Victoria or not), the worker must allow a doctor to take from the worker at that designated place a sample of his or her blood for analysis'. The Act does not state that such actions are the responsibility of employers, nor does the Act state that the taking of blood samples in such cases is mandatory.

Hospital staff at both Ararat and Melbourne's Alfred Hospital, advised that while it was a routine procedure to take blood samples following the admittance of motor vehicle accident victims, it was not a routine procedure for those involved in rail accidents. Those hospital staff further advised that it is likely that samples would have been taken had a reasonable request been made to do so. Company procedures specified by rail operators and track access providers normally require that a breath test be conducted following an accident.

Although three employees directly involved in the accident were not tested for alcohol or other drugs, no evidence was provided to the investigation team to suggest that drugs or alcohol were a contributing factor to this accident.

2. ORGANISATIONAL CONTEXT

During the 1990s, the rail industry in Australia experienced rapid change in the way that it was managed and operated. The Victorian rail industry moved from being a wholly owned and operated Government enterprise to privatised 'above and below' rail, involving separate track access providers and operators of the interstate, intrastate and metropolitan networks.

The operators and organisations that were considered relevant to this accident are described below.

2.1 Department of Infrastructure, Public Transport Safety Directorate

The Public Transport Safety Directorate (PTSD) is a unit of the Victorian Department of Infrastructure.

The Directorate manages the accreditation of railway organisations in accordance with the Transport (Rail Safety) Act 1996 Part 2 – *Amendments to the Transport Act 1983.*

In order to gain accreditation, rail organisations must demonstrate that that they have an appropriate safety management system, the competence and capacity to meet the relevant safety standards, and that they possess public risk insurance.

Once accredited, organisations are responsible for managing the safety of their operations. The Australian rail industry in general operates in this type of co-regulatory environment. Therefore, PTSD does not prescribe specific standards and practices. Australian Standard AS4292 Part 1– *Railway Safety Management* and AS4360 – *Risk Management,* are not specifically referred to in legislation but are generally used by PTSD as the guidance documents for the accreditation process.

2.2 Freight Victoria Ltd

Freight Victoria was accredited by the PTSD on 22 April 1999 and commenced operations on 1 May 1999. It owns the rolling stock previously owned by V/Line Freight Corporation, and leases broad and standard gauge track from VicTrack (fig 12). While most of Freight Victoria's operations are within Victoria, it also operates on ARTC controlled interstate lines west to Adelaide and north to Albury, as well as over the Rail Access Corporation network in New South Wales.

Freight Victoria is a wholly owned subsidiary of Rail America Incorporated.

2.3 Australian Rail Track Corporation

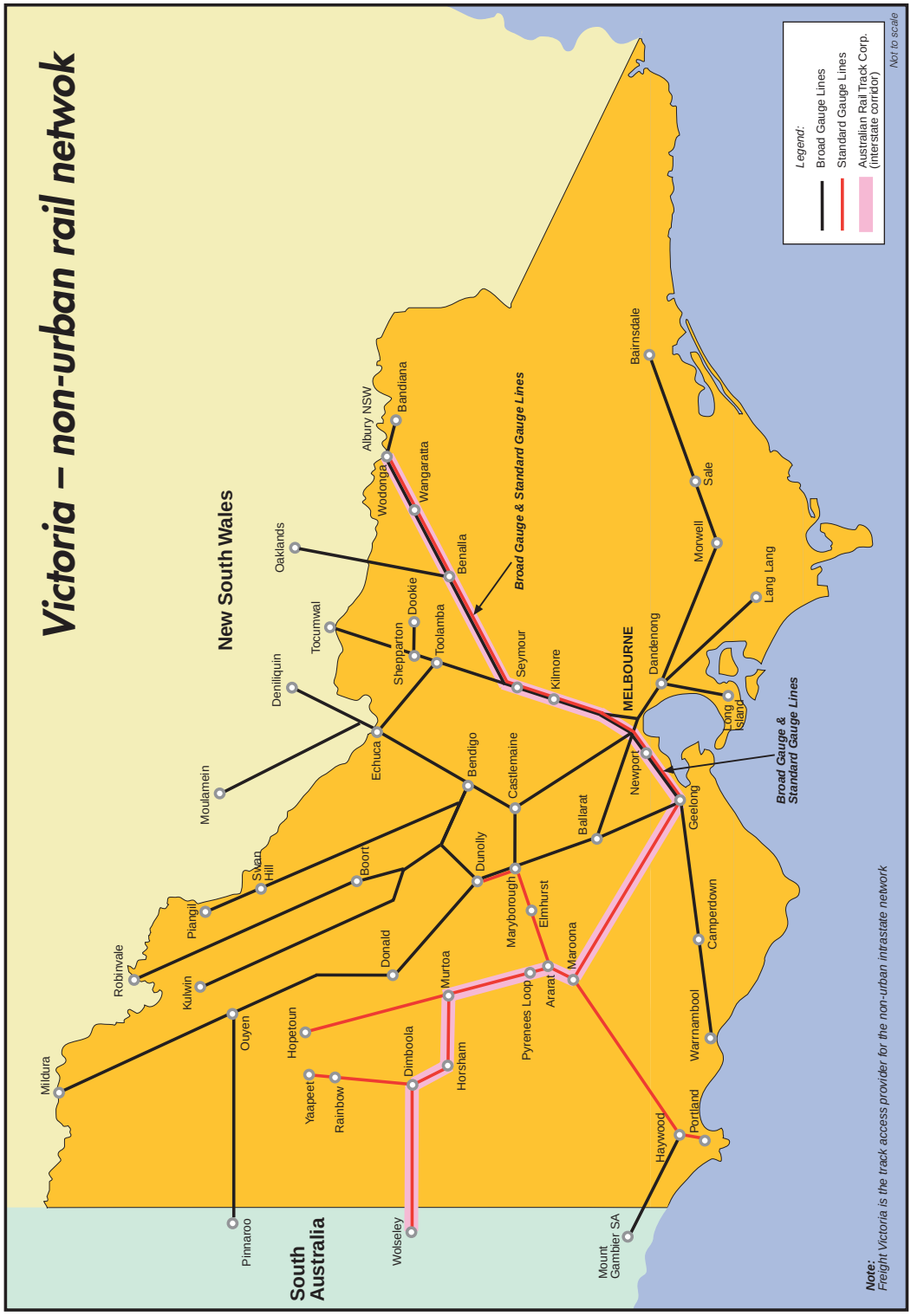
ARTC commenced operations on 1 July 1998 under transitional accreditation provisions and was formally accredited by the PTSD on 1 May 1999.

ARTC owns and manages the interstate rail corridors formerly owned by the Commonwealth, and also leases the Victorian standard gauge track that forms part of the interstate corridors (fig 12). Two key responsibilities of the company are the provision of rail access and train control over the network it manages.

ARTC has been accredited as a track owner by the South Australian, Victorian, New South Wales, Western Australian, and Northern Territory accreditation authorities.

ARTC is wholly owned by the Commonwealth Government.

FIGURE 12.
Non-urban rail network Victoria



2.4 Victorian Rail Track Corporation (VicTrack)

VicTrack owns the rail track previously owned by the Public Transport Corporation (PTC). It is accredited by PTSD as a manager of infrastructure.

VicTrack leases its standard gauge track on the interstate corridors to the ARTC. VicTrack 'head-leases' its intrastate network to the Victorian Department of Infrastructure which, in turn, 'on-leases' that network to Freight Victoria.

In addition, VicTrack provides services to rail operators by agreement, including the maintenance and updating of the PTC rulebook (1994), and the issuing of keys and other safety-related equipment to operators within Victoria.

VicTrack is owned by the Victorian Government.

3. INFRASTRUCTURE CHANGES

Rail operations at Ararat have undergone significant change since the mid-1980s. This has been due to a combination of factors including changes in technology, procedures, the usage of the infrastructure, and as a result of the changing roles and responsibilities of organisations responsible for operations at Ararat. Many of the changes that occurred at Ararat were a reflection of widespread changes that took place in the Victorian and national rail systems over those years.

In the 1970s, Ararat was a major railway facility, employing up to 500 railway employees. At the time of the accident, there were no Freight Victoria employees based at Ararat.

The following table summarises the main infrastructure and procedural changes that occurred at Ararat and the Pyrenees Loop from the early 1980s until the time of the accident on 26 November 1999.

Date	*Status/changes at Ararat*
Pre 1984	• Points and signals at Ararat were mechanically interlocked. • There were two Signal Boxes at Ararat; 'A' at the Melbourne end of the station and 'B' at the Adelaide end. • Electric Staff was in use on the Melbourne-Adelaide main line as well as the line to Maroona. • Staff and Ticket was used on the line between Ararat and Maryborough.
10 Nov. 1984	• The Ararat 'B' Signal Box was removed. The operation of the points and signals at the Adelaide end was conducted from the Ararat 'A' signal box. • Electric Staff working altered on the Adelaide side and the section became Ararat-Great Western crossing loop.
14 June 1985	• Automatic Track Control provided on the Ararat-Great Western crossing loop section.
24 July 1985	• Centralised Traffic Control (CTC) provided on the Adelaide side of Ararat. • Pyrenees Loop commissioned.
1985-April 1995	• Rationalisation of the use and management of the Ararat station yard, facilities and employees on an ongoing basis, consistent with changes to rail operations throughout Victoria.
13 April 1995	• Ballarat-Ararat and Ararat-Maryborough lines closed as part of the Melbourne-Adelaide standard gauge conversion project. • Ararat 'A' Signal box and remaining mechanical signalling removed. • Ararat yard reduced to the main line and a goods siding only. • Rollout protection was provided at each end of the yard.
26 May 1995	• Standard gauge conversion of Melbourne-Maroona-Ararat-South Australia border complete. • Section Authority System (ASW) train control proposed but not completed for the Newport-Pyrenees section of the main line. In the interim, the Safeworking system on that section of the main line was Staff and Ticket.

- The main line points were secured with Train Staff (Staff) locks ie. the points had to be unlocked using the Train Staff for the section.
- Trains that were required to shunt at Ararat were assisted by a Signaller.

1996
- Standard gauge conversion of the Ararat-Maryborough line and the dual gauging of the Maryborough-Dunolly line were completed.
- The Maryborough line joined the No. 2 Road at the Adelaide end of the Ararat yard.
- Operations on the Ararat-Maryborough line recommenced with the method of Safeworking being Train Staff and Ticket.
- The Train Staff for the Ararat-Maryborough line was modified so that it could not operate the Staff locks on the main line points at Ararat.

31 October 1997
- A number of safety recommendations were proposed by VicTrack for the operation of the points at Ararat and the interface between ASW and CTC at the Pyrenees Loop.

1998
- ASW implemented on the Maroona-Pyrenees Loop section.
- Pyrenees Loop was still attended for signalling duties because an interface between ASW and CTC was not available.
- Main line points at Ararat still Staff locked and Signaller from Pyrenees Loop still attended and assisted.

22 June 1998
- Annett key provided under care of Signallers at the Pyrenees Loop as it was considered by VicTrack that the retention of Staff locks at Ararat presented a risk that the train crew could inadvertently use a Master Key to unlock the points at that location.
- Rollout protection at Ararat siding retained.

1 July 1998
- ARTC assume responsibility for the Melbourne-Adelaide corridor; however, most responsibilities contracted to VicTrack as an interim measure before ARTC could become independently accredited in Victoria.

1 May 1999
- Freight Victoria assume business formerly known as V/Line Freight, including management and operation of the siding at Ararat.
- ARTC fully accredited.

May 1999
- Installation of metal Annett key box at the Adelaide end of the Ararat siding in preparation for changes to Safeworking arrangements at the Pyrenees Loop and at Ararat.

24 May 1999
- Signallers removed from the Pyrenees Loop.
- Trains at Ararat to shunt with train crew only.
- Annett keys for the points at both the Adelaide and Melbourne end of the Ararat yard now stored in metal Annett key box secured with a V5PSW lock. (see fig 2 page 2)
- Train Staff Ticket boxes were removed from Ararat and Maryborough, restricting the operation of the line to Train Staff only.

4. RISK IDENTIFICATION

4.1 Safety management systems

The Transport (Rail Safety) Act 1996 Part 2 – *Amendments to the Transport Act 1983*, provides for the accreditation of the managers of rail infrastructure, and providers and operators of rolling stock. The PTSD manages the accreditation of railway operations in accordance with the Act.

Accredited organisations are responsible for rail safety. The PTSD assesses organisations' safety management systems against the relevant safety management standard, generally Australian Standard AS4292 Part 1– *Rail Safety Management*. Both ARTC and Freight Victoria demonstrated to the satisfaction of the PTSD during the accreditation process that they had adequate safety management systems in place.

Risk management is the systemic application of appropriate management policies, procedures and practices to the tasks of identifying, evaluating, treating and monitoring risk. Section 3 of AS4292 Part 1, refers to risk and incident management. Organisations are required to identify risks by establishing:

> procedures for analysing processes, work operations, activities of contractors and business premises lessees, railways safety records, reports and customer complaints to detect potential causes of accidents and incidents.
>
> The procedures shall include-
>
> (a) the analysis and monitoring of incidents to determine problem areas and adverse trends; and
>
> (b) a method of quantitatively identifying the probability and consequences of incidents associated with identified failure modes of safety systems and processes.

Organisations are also required to control risk by establishing:

> procedures for initiating preventative action in relation to problems or potential problems identified, by eliminating the hazards or controlling them to an acceptable level of risk, preventing the potential incidents from occurring or by controlling the consequences. In determining the action to be taken, the organisation shall take into account the likely frequency of an occurrence and its potential consequences (ie. use risk management techniques). This should be established with a full appreciation of the need to balance costs, benefits and opportunities.

Both ARTC and Freight Victoria maintained a database of incidents and accidents in accordance with reporting requirements referred to in Appendix C of AS4292 Part 1, and monitored that database for developing adverse trends. In addition, both organisations used risk modelling similar to that recommended by AS4360 – *Risk Management*, when making risk assessments about intended material changes.

During interviews with management of ARTC and Freight Victoria following the accident, both organisations assessed the probability of a failure to adhere to standard operating procedures, such as occurred at Ararat on 26 November 1999, as being low. Additionally, both organisations considered that the hazard had been controlled to an acceptable level of risk with the use of standard operating procedures. However, there were no measures in place to alert Drivers of oncoming trains or to alert Train Controllers of a developing hazard, nor were there any measures to reduce the consequences of a head-on collision at that location.

Section 1.8 of AS4292 Part 5 – *Operational Systems* refers to hazard identification and risk analysis and states that:

> The level of risk analysis needed for particular factors will not necessarily be the same in all cases. Detailed analysis may not be required where an organisation adopts established practices that have been shown to deliver a satisfactory level of performance under equivalent conditions. Analysis will, however, be required where changes to the practices are proposed. The minimum requirement in such cases shall be a risk analysis on the elements of the changes.

Both ARTC and Freight Victoria expressed the view that they had 'inherited' a rail system that had, for the most part, demonstrated an acceptable level of safety. Following the accident; however, both ARTC and Freight Victoria conducted a preliminary review of their networks. Freight Victoria identified five locations on their network where they hold concerns about the integrity of the main lines. ARTC identified at least four similar locations on its Victorian network. The joint internal investigation conducted by Freight Victoria and ARTC recommended that actions be taken to improve the integrity of main lines. Actions at those locations may include upgrades of infrastructure.

A condition of an organisation's accreditation with PTSD is that:

> any proposed material changes to accredited activities, including operational or technical standards shall:
>
> - be submitted to the Secretary for consideration;
> - provide a copy of the risk management strategy that provides for clear identification, analysis, assessment, treatment and monitoring of all risks associated with the proposed changes;
> - include the impact of the proposed change(s) on all parties affected; and
> - include the risk assessment of the proposed changes.

A review of the PTSD's accreditation files for ARTC and interviews with PTSD staff, revealed that there had been instances when ARTC had not provided PTSD with risk assessments in relation to material changes in a timely manner. The detailed risk assessment for proposed changes to operations at the Pyrenees Loop was still outstanding at the time of writing this report despite the change having been made on 24 May 1999. In addition, PTSD staff and other affected parties including operators, employees and employee unions, raised concerns about the limited lead time and lack of consultation that there had been with ARTC in relation to some proposed changes. Such concerns were not raised in relation to Freight Victoria.

An audit of ARTC's risk assessment process was conducted by the PTSD on 21 December 1999. As a result of that audit, PTSD was satisfied that ARTC is currently maintaining appropriate documentation and are consulting adequately on proposed changes. The audit team did not; however, sight a formal risk assessment of the proposed changes to operations at the Pyrenees Loop. While it did not doubt that ARTC had considered the risks of that proposal, PTSD suggested that if a thorough documented risk assessment had been carried out in accordance with ARTC's own safety management system, it may have uncovered the full range of risks; for example, the potential impact of the changes to the operation of the points at Ararat.

4.2 History of similar incidents

There is currently no national database of rail accidents or incidents. Each State maintains such information separately although a proposal for a national database of accidents and incidents is currently under development. Companies are required to report accidents to their respective accreditation authorities. Those companies are also required to report on incidents, including irregular operations or breaches of Safeworking practices, in addition to mechanical or other technical problems. There appears to be little analysis performed on this information, particularly in relation to human performance failures that present risks to the system.

A review of database information maintained by the States failed to reveal any accidents within Australia that had resulted from a similar chain of events as described in this report, or that had been triggered by the same active failures. However, there was anecdotal information to suggest that there had been some occasions when Drivers or Signalmen had incorrectly set points but where the error had been detected and rectified prior to the situation developing into an accident or incident.

A head-on collision at Koo-wee-rup, Victoria in 1928 contained some similar elements to the Ararat accident. On that occasion, a Porter operated an incorrect lever resulting in a Freight Train colliding with a Passenger Train. Investigation of that accident revealed that concerns about the 'unusual lie of the points from the No. 2 Road to the main line at Koo-wee-rup' were held by the Railways Department prior to the accident. Alterations to those points occurred while the investigation was in progress.

A recent collision at Zanthus, Western Australia on 18 August 1999 between the Indian Pacific passenger train and a freight train, bore some similarities to the Ararat accident. At Zanthus, a driver inadvertently activated the electrically powered points, thereby diverting the Indian Pacific onto the crossing loop where the freight train was standing. The investigation of that accident concluded that there were inadequate safeguards to prevent such an error, or to minimise the consequences should such an error occur. The track access provider, ARTC, has instituted procedural measures to prevent a similar occurrence in the short term pending the completion of a system upgrade.

Similarly at Ararat, there were no safeguards to prevent the points from the Ararat siding being set for the main line in front of an oncoming train.

4.3 Management decisions affecting risk

There was no interlocking between the points at Ararat and the Safeworking system on the main line. Potential problems arising from this were recognised by VicTrack in 1997 during planning for the extension of ASW from Maroona to the Pyrenees Loop.

The conversion of the Safeworking system to ASW on the standard gauge main line east of Ararat was originally managed by National Rail Corporation Ltd as part of the standard gauge conversion project. An interface between the ASW and CTC systems was to be provided. However, that interface did not eventuate as technological difficulties were encountered during efforts to provide a workable solution.

Several alternative solutions for the Pyrenees Loop, which formed the junction between ASW and CTC territory, were later proposed by VicTrack after it assumed responsibility for providing access to and signalling on the Victorian non-urban rail network. That responsibility extended to both the intrastate and interstate lines. Estimated costs for those proposals ranged between approximately $40,000 and $348,000, with estimated potential savings of up to $576,000 per annum based on the

removal of up to six signalling positions at Maroona and the Pyrenees Loop. The potential risk of main-line trains approaching Ararat with the points at Ararat not set for the main line, was addressed by those proposed solutions. A similar proposal was developed by the then Superintendent of Safeworking for the Public Transport Corporation and the then Manager System Safety for VicTrack.

Each of those proposals recommended that the best solution for the interface was interlocking of ASW Authorities with the Melbourne end signals of the Pyrenees Loop, as well as interlocking of the points at the Adelaide end of the Ararat yard. That recommendation was based on a concern that a train, having travelled east for several hundred kilometres on CTC signals to Pyrenees, could inadvertently enter ASW territory without an appropriate Section Authority. In the absence of an engineered solution, that concern was the main reason that the Manager Rail Safety for VicTrack continued to hold the view that the Pyrenees Loop should remain a manned location following the implementation of ASW from Maroona to the Pyrenees Loop. The Manager Rail Safety considered that a Signaller at that location provided a secondary check for the prevention of inadvertent penetration of ASW territory. As ASW did not provide for an independent method of confirming the location of a train through track circuitry or other technology, Train Controllers would not be immediately aware of any developing conflict situations. Although VicTrack considered that it had identified an acceptable solution to de-man the Pyrenees Loop, no change to operations had been implemented at that location at the time ARTC assumed responsibility from VicTrack for access to the Victorian interstate main lines. ARTC assumed that responsibility when it was formed on 1 July 1998.

In late 1998, ARTC sought advice from two independent consultants with experience in rail operations, on their proposal to dispense with the Signallers at the Pyrenees Loop. Both consultants agreed that it was appropriate to remove the Signalmen from the Pyrenees Loop provided that measures were implemented to remind/alert drivers that they were entering a new Safeworking system. In correspondence to ARTC, one consultant reminded ARTC that under their obligations of accreditation, ARTC would need to conduct a risk assessment of the proposed change prior to the implementation of that change. No documentary evidence was found on PTSD files viewed by the investigation team, nor was any documentary evidence provided to the investigation team by ARTC, which demonstrated that a risk assessment had been carried out in accordance with AS4292 or the requirements of accreditation.

ARTC advised that although the Signallers used at the Pyrenees Loop were Freight Victoria employees, the cost of the Signallers was shared between ARTC and Freight Victoria because of the Signallers' dual role in providing assistance at both the Pyrenees Loop for ARTC and at Ararat for Freight Victoria. ARTC indicated that the proposal to alter operations at the Pyrenees Loop would not necessarily impact on operations at Ararat, given that Freight Victoria could choose to retain Signallers at Ararat to assist with shunting operations at that location.

On 8 April 1999, ARTC informed the PTSD that it would be removing the Signallers from the Pyrenees Loop and altering Safeworking procedures at that location on 1 May 1999. ARTC also advised that the decision to do so was based on the advice of the two independent consultants. The notification which ARTC proposed to issue to operators, did not include details of the required changes to the operation of the points at Ararat.

On 11 April 1999, ARTC advised VicTrack that it was fully accredited under the Victorian Rail Safety Act. As such, it would be taking over the custodianship of the operating rules and all associated operating procedures from VicTrack as from 1 May 1999. This included the issue of operating rules and notices including risk assessments on changes to operating patterns, and the interpretation, compliance with and enforcement of rules and procedures.

ARTC discussed the changes at the Pyrenees Loop and finalised arrangements with Freight Victoria on 20 May 1999. On 24 May 1999, ARTC implemented the changes at the Pyrenees Loop in accordance with its earlier proposal and issued Train Notices accordingly. Train Notice 3721 stated that 'as from 1200 hrs Wednesday 26 May 1999 in normal circumstances there will be no signallers or local control at Pyrenees Loop'. That notice also stated that 'special keys for access to Freight Victoria's network are in the custody of Freight Victoria and issue of those keys will need to be arranged by Operators with Freight Victoria'. On 25 May 1999, VicTrack issued a Safeworking Circular, SW1086/99 *Maroona-Ararat-Pyrenees, Alterations to Safeworking Procedures.* That circular detailed the procedures to be followed for trains entering and exiting the main line at Ararat, including who had authority to operate the main-line points at that location. However, the Manager Rail Safety VicTrack maintained his opinion that this was not the best solution at that location and noted on that circular that VicTrack 'no longer has jurisdiction over the interstate corridor, and is therefore not in a position to issue it's normal detailed instructions'. From that date, the Annett key was no longer in the possession of a Signalman at the Pyrenees Loop but was secured in a locked steel box located at the base of the north wall of the road bridge at the Adelaide end of the Ararat siding. The box could be accessed with a V5PSW key; a key normally issued to employees with appropriate Safeworking qualifications.

On 26 May 1999, the Manager System Safety for Freight Victoria advised PTSD that an interface document had been jointly produced with ARTC. The Manager System Safety also advised PTSD that Freight Victoria had contemplated providing a competent employee for shunting operations at Ararat once the Signallers were removed from the Pyrenees Loop but such an arrangement was not considered necessary. Freight Victoria did not consider that the shunting operations at Ararat were any different to shunting operations at other intermediate sidings on the Freight Victoria network. Shunting operations at those locations were normally carried out by train crews without assistance from other qualified staff.

In a letter sent by facsimile to ARTC on 4 June 1999, PTSD expressed a view that while it did not object in principle to the proposed changes at the Pyrenees Loop and at Ararat, it held concerns about the implementation of those changes. PTSD's concerns included issues of terminology, conflicting instructions to Train Controllers and Drivers, delineation of responsibility for the interface arrangements at Ararat, and matters regarding consultation with PTSD. ARTC advised the investigation team that it did not receive that letter.

During the course of the investigation, it became apparent that different opinions were held by ARTC, Freight Victoria and other parties about the ownership and control of the Safeworking equipment at Ararat and the degree of control ARTC should have over access to the interstate corridor. It was ARTC's view that while the points were clearly on the interstate corridor and under the jurisdiction of ARTC, the Annett Lock was considered to be a shared asset between ARTC and Freight Victoria. ARTC considered that the Annett key was the property of VicTrack but with the day to day control of that key being the responsibility of Freight Victoria. ARTC management

indicated that they were comfortable with this arrangement and that they were not aware of previous concerns held about the infrastructure and procedures at Ararat. ARTC also stated that 'it accepts primary responsibility for the management of main-line junctions with adjoining lines, and fulfills its obligations for the integrity of interfaces procedurally, through documented agreements and work procedures'. ARTC believed that the operating procedures specified for Ararat were clear and unambiguous on the issue that only Drivers or competent employees should operate points, and ARTC expected that those procedures would be adhered to.

Another major operator on the interstate corridor between Adelaide and Melbourne indicated that, following the accident, it held particular concerns about operations at Ararat. That operator expressed the view that Ararat was one of up to four locations on that corridor that had interfaces not controlled adequately by ARTC. That operator firmly believed that ARTC should maintain complete control over the access to the main line at such locations in accordance with AS4292 Part 1, which requires a track access provider to ensure the 'integrity of the track and other infrastructure'. Part 5 of AS4292 provides further explanation of that point by requiring that route integrity be maintained, amongst other things, by ensuring that 'points are not moved either under the train or when it is approaching'.

In summary, changes to arrangements at Ararat reflected numerous management decisions over a period of 14 years, taken during a period of broad organisational and infrastructure changes within the Victorian rail system.

Originally, the points and signals at Ararat were mechanically interlocked under the supervision of a Signaller based on site. By mid 1999; however, operations had evolved into a system in which the points were mechanically controlled by Drivers using a piece of Safeworking equipment stored in a box at an unattended location, with no main-line interlocking mechanism, and with no provision to warn Drivers on the main line of the setting of the points.

4.4 Safety oversight and safety regulations

In the past, government rail operations have tended to be self-regulating. When the Victorian rail system was a vertically integrated operator under public ownership, many key safety decisions were based on well-established but unwritten practices or precedents. For example, there were no documented guidelines to indicate who should be issued with a V5PSW key, how Annett keys should be stored, or how new procedures should be designed.

The Victorian (Rail Safety) Regulations 1998 do not set specific standards or practices for the conduct of rail access providers or rail operators. Those regulations refer predominantly to the requirements for accreditation with the PTSD and are intended to create a framework for co-regulation in which the industry and the PTSD work cooperatively to apply external safeguards to an otherwise self-regulated industry. To date, the PTSD has only once exercised its power to require an organisation to 'show cause' why its accreditation should not be removed.

Currently, track access providers and rail operators in Victoria must, as part of their accreditation, comply with the PTC Book of Rules and Operating Procedures 1994. VicTrack continues to maintain and update the PTC rulebook and to issue Safeworking Circulars which advise Drivers and other affected parties of changes to infrastructure and Safeworking procedures. However, ARTC has since developed its own code of practice for operations on interstate lines, based on the proposed

National Code of Practice. The ARTC Code of Practice will incorporate those aspects of the PTC rulebook pertaining to its operations; however, that code has not yet been implemented in Victoria. Freight Victoria and other operators have also expressed a desire to take over responsibility for the rulebook as they believe that it is an overly complex document that is largely irrelevant to their operations. Concerns have been raised by VicTrack and others as to the potential safety hazards of fragmenting the control of operating procedures and practices. To address those concerns, PTSD is currently working with those organisations to establish an acceptable solution that will ensure transparency for Drivers and other parties operating within more than one jurisdiction. Any such proposal is to include a full risk analysis of the proposed changes.

5. OTHER FACTORS RELEVANT TO THE OCCURRENCE

5.1 Management and control of Safeworking equipment

All Safeworking equipment is currently issued and controlled by VicTrack. A loose-leaf register is kept of all Safeworking keys (V5PSW) on personal issue. A computer spreadsheet is used to record information about Master keys. Whilst the spreadsheet appeared to indicate that no Master keys were currently missing, it was difficult to determine if V5PSW keys were missing or to link returned keys with those on issue.

A V5PSW key enables access to a variety of Safeworking equipment including points, Train Staffs and Annett keys. Interviews with Freight Victoria staff and other rail industry personnel revealed differing views about whether the Train Examiner who had operated the points on the night of 26 November 1999, should have been in possession of a V5PSW key. Some suggested that it was appropriate for that employee to have a V5PSW key because of his duties as a Train Examiner. Others believed that a Train Examiner would not require such a key to perform his normal duties. The investigation was not able to identify any written guidance concerning who should have access to V5PSW keys. It appears; however, that only those employees who have appropriate Safeworking qualifications are normally issued with a V5PSW key.

The V5PSW key that had been issued to the Train Examiner was one of two keys issued to the Maryborough Station for general use and was under the care of the OIC Maryborough. As such, there was no record in VicTrack's central register that the Train Examiner was in possession of such a key. The OIC had issued the Train Examiner with a V5PSW key in order that he could access a shed that contained ETAS units. Some of those interviewed did not believe that ETAS units were items of Safeworking equipment. When the Train Examiner was instructed to collect the Train Staff from Ararat, the OIC had mentioned the possibility that it might be in the Annett key box. Therefore, had the Train Examiner not been in possession of a V5PSW key, the OIC would have been required to issue him with one to access the Train Staff from that box, if only on a temporary basis. Following the accident, the OIC Maryborough replaced the V5PSW padlock on the ETAS shed at Maryborough with a standard '5P' key.

Discussions with Drivers and Safeworking personnel from VicTrack, indicated that there had been occasions when V5PSW keys had been lost or had not been returned when personnel left their employment. Two occasions were cited when Annett keys had been lost; one from the Freight Victoria network (described below) and one from a tourist railway at Korumburra. There had also been occasions when Master keys had been left behind at points or had fallen from trains. All Master keys, while being individually numbered and labelled for specified corridors, are the same key and may be used throughout the rail network in Victoria. However, a weekly balance of Master keys is maintained by Freight Victoria Train Control to ensure that they are accounted for in a timely fashion.

When the Signallers were removed from the Pyrenees Loop on 24 May 1999, an 'A' pattern Annett key was placed in the steel box at Ararat. That 'A' pattern Annett key could be used to operate the points at both the Adelaide and Melbourne ends of the Ararat siding. On 1 September 1999, the lock at the Melbourne end was changed to a 'B' pattern lock at the request of Freight Victoria and the 'B' pattern Annett key was

placed in the steel box along with the 'A' pattern key. The 'B' pattern Annett key was lost on 8 September 1999. Freight Victoria acted promptly by 'spiking out' the points at the Melbourne end, thus disabling that part of the siding. To date, that Annett key has not been found, nor has the 'B' pattern lock been reinstated at Ararat.

At another location, SCT, a siding recently commissioned on the main line between Maroona and Newport, a Train Notice had been issued by ARTC on 8 November 1999 which indicated that the 'switchlock stand' and the points at SCT were to be accessed with a V5PSW key. However, a recent incident at that siding revealed that the points and the 'switchlock stand' had been secured with only a '5P' padlock. '5P' keys and padlocks had been removed from service on the non-electrified train lines in Victoria several years ago following security concerns about the lack of control of those items and the ease with which the key could be copied. Following the incident, the keys and padlocks at SCT were replaced by V5PSW keys and padlocks.

5.2 Reporting of accidents, incidents and safety hazards

In Victoria, accredited organisations are required to report accidents and incidents to the PTSD.

An organisation operating in accordance with AS4292 Part 1, is required to nominate a manager, usually referred to as a Safety Manager, to monitor and report on aspects of safety within their company. Where the operations of the company are geographically spread, the OIC of each area normally has responsibility for the reporting of accidents and incidents and for the management of safety on a day to day basis. Most locations also have an Occupational Health and Safety (OH&S) representative who normally performs that role in addition to their other company duties. In addition, most companies have one or more union representatives at those locations who actively participate in safety issues.

Interviews with operational staff from Freight Victoria revealed that they were required to immediately report to Train Control the details of any operating anomalies as well as accidents and incidents. They were also required to complete a standard form (OB12a) and to provide that form to their supervisor as a further record of the occurrence. Concerns about potential safety hazards; however, were often reported to and handled through the union. That approach does not appear to be unique throughout the rail industry in Australia.

Representatives from the Rail, Tram and Bus Union of Victoria considered that the union had a legitimate role to play in rail safety. The union reported that it had experienced difficulties on some occasions when trying to participate in and provide comment on proposed changes that had the potential to impact on the safety of their members. In a letter to ARTC, dated 7 June 1999, the RTBU complained about ARTC's cancellation of three consecutive meetings (27 May, 4 June and 7 June 1999) which had been arranged to discuss, among other things, RTBU's safety concerns related to the changes that had been implemented at the Pyrenees Loop. Several safety concerns were discussed between ARTC and RTBU at a meeting held on 11 June 1999, most of which did not relate to the recent changes at the Pyrenees Loop and at Ararat. However, a concern that a Driver might be issued with a 'proceed' Authority at the Pyrenees Loop when the points at Ararat were not set for the main line, was raised at that meeting. The RTBU did not consider that this concern had been addressed satisfactorily by ARTC .

ARTC maintained that it adequately consulted with stakeholders such as the RTBU and advised that the RTBU had been involved, both through Freight Victoria and directly with ARTC, in the process of risk assessment in relation to the proposed changes at the Pyrenees Loop. ARTC also advised that safety concerns raised by the union in relation to those changes had been addressed.

Other individuals interviewed indicated that while they were not comfortable with the arrangement at Ararat, and had discussed that concern with their colleagues, they had not formalised that concern either through their supervisor, union representative or their company Safety Manager. Those interviewed who advised that they had not formalised their safety concern, were also questioned as to why they had not done so. Those individuals could not offer a reason or were unsure why they had not done so.

Operators interviewed during the investigation provided examples of newsletters and other feedback mechanisms used to communicate information about safety matters and changes to procedures. The examples contained information largely of an OH&S nature. While limited accident and incident statistics were provided in some documentation, little information was provided about emerging rail safety developments and issues such as aspects of human performance and its effects on the capacity of employees to conduct their duties safely.

The only recent Australian rail accident investigation report that has been made publicly available was the report on the collision at Zanthus on 18 August 1999 (see Section 4.2 *History of similar incidents*). The investigation report on a 1997 collision at Beresfield, NSW, was made available through limited distribution and predominantly within NSW. Most other major rail accidents have not been the subject of public reports. Few of those operational personnel interviewed during the course of the investigation had seen or read copies of the Zanthus or Beresfield reports.

6. ACCIDENT RESPONSE

Police responded within a few minutes of the accident. Ambulance and emergency services arrived shortly after. Both the police and ambulance crews who attended the accident site had also attended the incident involving the rescue of the small child from the dam earlier that evening. Freight Victoria Train Control received the initial notification of the accident via mobile telephone from the Driver of 9795 and the emergency response initiated by Train Control was in accordance with the published procedures.

The State Emergency Service released the crew from the cab of the locomotive of 9784. The Country Fire Authority also attended and provided support services in the early stages of recovery.

The police declared the area a crime scene and worked with Freight Victoria to progressively release the area for recovery (fig 13). In addition, they provided crowd control until 1800 on Sunday 28 November.

Comcare was advised about the accident by ARTC at 0045 on Saturday 27 November 1999. The Victorian Workcover Authority (Workcover) was advised by Freight Victoria at 0200 on the same day. The arrival of the Workcover inspector at approximately mid morning on Saturday 27 November, delayed the recovery operations whilst he was appraised of the situation. There was a further delay due to a lack of head protection for people working near the cranes. Workcover held safety concerns about the actions of some of the contract crane operators. Those matters were resolved on site.

Members of the local community, including various volunteer groups, provided support during the initial response phase and during the subsequent recovery.

A diesel fuel spill from the locomotive of 9784 was contained by personnel from a company contracted by Freight Victoria. The contractor acquired the services of the local council and other agencies to provide appropriate absorbent material. The final site clean up was handled by the contractor under the direction of the Environmental Protection Authority.

FIGURE 13.
Recovery operation in progress

7. INITIAL REMEDIATION

Following the accident, the points at the Adelaide end of the Ararat yard were 'spiked' and secured in the 'normal' position with a lockable point clip. A baulk was placed across the line at the Adelaide end of the No. 2 Road. In addition, the points at the Melbourne end of the Ararat siding were recommissioned using an 'A' pattern Annett lock. Access to the Ararat yard was therefore only available via the Melbourne end points. A supervisor was to be in attendance for shunting movements which were to be made from the Ararat yard to the main line and vice versa.

ARTC has imposed a 30 kph speed limit through Ararat pending a review of safety concerns at that location.

ARTC and Freight Victoria have also conducted a review of their networks in order to identify other locations where the integrity of main lines may not be assured.

8. ANALYSIS

8.1 Introduction

In common with most transport accidents, the accident at Ararat was triggered by an unsafe act performed by an employee.

The objective of this investigation was not to attribute blame or liability, but rather to learn from this occurrence how future accidents may be prevented. In order to achieve this, it is necessary to consider not only the unsafe act performed by the employee, but also the circumstances which may have prompted this person to act as they did, and the nature of the system which permitted their action to have such a serious and immediate effect.

The investigation team analysed this accident using the Reason model. Hence, this analysis section begins with a consideration of the unsafe act and then moves on to examine the local factors which were present at the time and place of the accident.

Following this, systemic weaknesses which contributed to this accident are considered. Systemic weaknesses may take the form of failures of defences or organisational factors.

8.2 Unsafe act

The event which precipitated this accident was the unauthorised action of the Train Examiner in moving the points to set the main line for the yard at Ararat.

Unsafe acts can take a variety of forms, including absent-minded slips, memory lapses, mistaken intentions and rule violations. Industrial safety studies have indicated that rule violations are frequent contributors to workplace accidents. In most cases, rule violations take the form of well-intended shortcuts which are motivated by a desire to get the job done in a manner that is perceived to be more efficient than that laid down in the rulebook.

The action of the Train Examiner in moving the points appears to have been a rule violation, that is, a conscious act which was contrary to procedures. The investigation team was unable to interview the Train Examiner. Nevertheless, the available information suggests that his action was not motivated by any malicious intention. Rather his action appears to have arisen from a desire to assist, combined with a lack of knowledge and experience.

8.3 Local factors

Unsafe acts occur in the context of local factors. These are aspects of the local work environment which increase the probability that an error or violation will occur. The following local factors are relevant to this accident.

8.3.1 Knowledge and qualifications of the Train Examiner

Despite his long period of employment in the railways, the Train Examiner possessed limited experience of main-line rail operations and was not Safeworking qualified.

On the night prior to the accident, he had watched a driver move the points at Ararat, and from this had gained a superficial understanding of the physical actions required

to set the points for the siding. However, it is likely that he lacked an understanding of the Safeworking requirements which must be met before the points could be moved.

Upon his arrival at Ararat, the Train Examiner had observed a train heading west towards Pyrenees. It appears that he assumed that because this train occupied the single track, it would not be possible for a second train to travel in the opposite direction for some time. Such a misunderstanding of the Safeworking system is likely to reflect the lack of Safeworking knowledge referred to above.

8.3.2 Possession of Safeworking key

The Train Examiner was in possession of a V5PSW key. This key would have permitted him to gain access to many items of safety-critical equipment within Victoria, including the locked metal box at Ararat containing the Annett key.

Some people interviewed in the course of this investigation considered that it was reasonable for an employee who was not Safeworking qualified to have access to a V5PSW key in order to perform their duties. Others; however, stated that this key would not normally be issued to a person who was not Safeworking qualified.

8.3.3 Storage of safety-critical equipment

The Annett key used to unlock the points was stored in the metal box referred to above. It was therefore possible for anyone with a 5V5PSW key to gain access to this important piece of safety equipment. Until May 1999, the Annett key had been in the custody of Safeworking qualified personnel.

By storing the Train Staff in the same location as the Annett key, it became necessary to compromise the security of the Annett key each time the Train Staff needed to be retrieved from the box.

8.3.4 Self-imposed time pressure

The available evidence suggests that the Train Examiner, being in the 12th hour of his shift, was looking forward to completing his duties and going home. He stated to the OIC at Maryborough that he was trying to get the task done quickly for that reason. It seems likely that the delay of the ballast train en-route from Ararat, and a desire to finish his working day, motivated the Train Examiner to act as he did.

8.3.5 Lack of radio communication

A two-way radio, or other communication link, may have assisted the Train Examiner to perform his duties more effectively. In the absence of such a link, it was difficult for him to remain informed of the operational situation, or to clarify aspects of his assigned task. He had clearly wished for such clarification on the night before the accident when he had telephoned Maryborough to obtain information about the Train Staff. If he had been able to communicate with the crew of 9795 or Train Control on the night of the accident, he would have become aware of the reason for the delay and may have been less likely to have taken it upon himself to act as he did.

8.3.6 Layout of the track

The geography of the area, although not necessarily an unsafe condition, presented an additional complication. The curve in the rail line west of the overhead bridge meant that the Train Examiner had a limited view of the track to the west and was unable to

see that 9784 was approaching from Pyrenees until the train had arrived at the curve. The curve in the track would also prevent the crews of trains stopped in the Ararat yard from sighting trains approaching from the west until shortly before their arrival.

In addition, due to the descending grade which followed the curve, the Driver of a train coming from the west would have little chance of slowing his train should he become aware of a hazard in the area of the Ararat yard.

8.4 Absent or failed defences

Using the terminology of the Reason model, defences are safeguards built into a system to provide protection against foreseeable hazards. Defences can serve a variety of functions, such as preventing an unsafe situation from arising, warning of an unsafe situation, or containing the consequences of a hazard should all other measures fail.

In everyday situations, where hazards are generally low consequence, few defences may be necessary. However, it is generally expected that in complex technological systems, multiple lines of defence will be in place to protect against high-consequence hazards.

This accident highlighted several areas where defences were inadequate or circumvented.

8.4.1 Inadequate prevention of unsafe act

It is well recognised that human errors are the most frequent events leading to accidents. While no unsafe act is acceptable, in reality such acts must be expected to occur from time to time. Many safety features have been introduced into rail systems over the last century and a half which prevent predictable unsafe acts from being performed. For example, interlocking systems on points and signals physically prevent dangerous actions from being carried out.

There was no system in place at Ararat to prevent the points from being moved as a train was approaching. At other locations, defences such as signal or track circuitry interlocking, or time delay mechanisms, would prevent such an act.

8.4.2 Lack of adequate security for Annett key

The Annett key is an important piece of safety equipment, yet in this case it was stored unsupervised in a steel box by the points. This box, in turn, was secured with a padlock that could be opened by a key which, although subject to control on its issuance, was nonetheless commonly possessed by rail personnel.

The location of the steel box at the base of the road bridge was such that members of the public could readily observe rail personnel access the box and its contents. Indeed, on the evening before the accident, three youths had observed a Second Person access the box and use the Annett key to unlock and operate the points at Ararat. Even if the steel box had been secured with a more secure padlock, it would have been possible for a rail employee or a member of the public to gain unauthorised entry to the box by using force.

The investigation team considered that the location of the box and the manner in which the Annett key was stored, reflected an overly-optimistic assessment of the risks involved.

8.4.3 Procedures for location not followed

The procedures to be followed for a train departing the Ararat siding towards the Pyrenees Loop, are detailed in VicTrack Safeworking circular SW1096/99 and Operational Interface Procedure TA57. Those procedures clearly set out the steps to be followed to change the points and move a train onto the main line. The procedures also specify that only Drivers or competent personnel are authorised to move the points.

Procedures are one of the least expensive forms of safety defence in industrial and transport contexts. Unfortunately; however, procedures are also one of the least effective forms of safety assurance. Worldwide research in fields as diverse as oil production, medicine, airline operations, road transport and railways, have indicated that intentional non-compliance with procedures is a significant safety problem[1]. Violations may be involved in up to 70% of accidents in some industries[2].

In the absence of other defences, the integrity of the main-line track at Ararat relied heavily on compliance with procedures. However, in this case, the procedures were circumvented.

8.4.4 No warning to Drivers of position of points

There was no system in place to warn the crew of a train approaching Ararat of the position of the points. In order to detect that the line was set for the yard, the crew needed to sight the blades of the points. This cannot be done at any great distance by day, and is even more difficult at night. While in the present case, such an indication may not have prevented the accident, it may have enabled the crew of 9784 to reduce the speed of their train before impact and thus reduce the consequences of the accident. In other cases, such indications may provide sufficient time to enable crews to stop their train in order to avoid a collision or derailment.

Footnotes:

1) REASON, J., PARKER. D. and LAWTON, R. 1998, Organizational controls and safety: The varieties of rule-related behaviour, *Journal of Occupational and Organizational Psychology, 71, 289-304.*
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ELANDER, J., WEST, R. and FRENCH, D. 1993, Behavioural correlates of individual differences in road-traffic crash risk: An examination of methods and findings, *Psychological Bulletin*, 113, 279-294.
HUMAN FACTORS IN RELIABILITY GROUP VIOLATIONS SUB-GROUP, 1995 I*mproving compliance with safety procedures. Reducing Industrial Violations,* Health and Safety Executive UK
2) MASON, S. 1997, Procedural violations – causes, costs and cures, In F. Redmill and J. Rajan (eds), *Human factors in safety-critical systems*, (Butterworth Heinemann, London).

8.4.5 No warning to Train Control of position of points

There was no warning to Train Control of the position of the points. In the present case, it is unlikely that Train Control would have had sufficient time to warn the crew of train 9784 of the position of the points, even had such information been available.

Nevertheless, there are other situations in which it would be important for Train Control to be able to monitor the position of the points. Although Drivers are required to inform Train Control when they have reset the points and returned the Annett key to its storage area, this procedure does not necessarily provide a fail-safe method of ensuring that Train Control is aware of the position of the points.

In the absence of Train Control monitoring of the points, there are several possible circumstances in which the points could be placed in the reverse position without the awareness of Train Control. For example, it would be possible for a train to leave the Ararat yard in the direction of Adelaide and for the points to be inadvertently left in the reverse position. Such a circumstance could arise from a combination of Driver and Train Controller errors. It is also conceivable that the points could be moved by vandals, or others with malicious intent.

In the absence of an indication to Train Control that the points were not set for the main line, it would be possible for a Train Controller to authorise a subsequent train to pass through the Ararat yard at the maximum permissible speed for that location.

8.4.6 Construction of locomotive–an effective defence

The anti-ride bars on the locomotives successfully prevented one locomotive riding up and over the top of the other. While the locomotive of train 9784 sustained extensive damage, the cab retained sufficient integrity to permit the survival of the crew. By mitigating the consequences of the accident, the design and construction of this locomotive appears to have been a final, successful defence in the overall system.

The broken mounting on the Second Person's seat in the cab of 9784 was considered to have contributed to the seriousness of his injuries. Further consideration may need to be given to the design and construction of those seats in order to reduce the severity of injuries sustained as a result of such accidents.

8.5 Organisational factors

The investigation team considered that most of the local factors and ineffective or absent defences referred to above, reflected wider organisational issues. These issues are dealt with below.

8.5.1 Hazard identification and risk assessment

The specific sequence of events which occurred on the day of the accident would have been difficult to foresee. Nevertheless, many of the system deficiencies which lay behind those events were present for some time and had not been addressed by previous organisations. Some, if not most of those hazards, could have been identified had more extensive and formal risk identification procedures been followed.

Risk management is an accepted responsibility of management, and guidance on methods to identify and treat risks is widely available. Two key documents are the Australian standard on risk management, AS4360 and the Australian standard on railway safety management, AS4292 Part 1. The PTSD uses those standards as the

basis for accreditation of rail organisations within Victoria and as the standard against which those organisations are audited following accreditation.

However, those requirements were not met in several key respects as outlined below.

8.5.1.1 No documented formal hazard analysis of whole operation

Section 3.1 (b) of AS4292 Part 1 requires organisations to analyse a variety of sources of information about their operations in order to detect potential causes of accidents and incidents. Such an analysis would normally take the form of a documented and formal qualitative analysis of failure modes of safety systems and processes.

A thorough failure mode analysis of the rail system would have required consideration of not only the hazards associated with the physical infrastructure, but also potential failures associated with unauthorised or erroneous human actions.

While Freight Victoria and ARTC did consider the risks associated with various aspects of their operations, particularly those associated with many proposed changes, there was no evidence to indicate that they had conducted formal failure mode analyses of their operations as a whole.

AS4292 Part 5, Section 1.7 acknowledges that the safety of some railway practices has been established though usage. In such cases, compliance with the Australian standard on railway safety management can be achieved by adopting existing practices.

Both the ARTC and Freight Victoria considered that the railway systems they had 'inherited' had demonstrated an acceptable history of safety, as referred to in AS4292 Part 5.

However, the Victorian rail system had been undergoing rapid and significant changes during the 1990s, similar to changes which were taking place throughout the Australian rail industry. Hence, the history of safety counted for less than if the system had been stable.

8.5.1.2 Likelihood appears to have been underestimated

Appendix 2 illustrates a qualitative risk analysis matrix, similar to that contained in the Australian risk management standard AS4360. As can be seen from this table, in order to respond appropriately to potential hazards, an organisation must consider both the *likelihood* of an event and the *consequences* which would ensue, should that event occur.

Both ARTC and Freight Victoria based much of their hazard identification program on the analysis of incident trends. A weakness of this approach; however, is that incidents tend to be likely events, whereas serious accidents may arise from rare but hazardous events. By basing much of their accident prevention activities on incident databases, these organisations may have been less likely to identify hazards associated with low-likelihood events.

On the basis of the information available to them, ARTC and Freight Victoria each apparently considered that the likelihood of a train being diverted inadvertently from the main line onto the siding at Ararat was low. However, an accident on the interstate corridor at Zanthus WA shortly before the Ararat accident suggests that the likelihood of such an error may be greater than had been estimated.

8.5.1.3 Consequences may not have been given appropriate 'weight'

Even if the likelihood of a train being diverted from the main line at Ararat was estimated to be unlikely or rare, the consequences of such an event were potentially very grave, particularly given that passenger trains operate on this section of track.

According to accepted standards of risk management such as AS4360, the serious nature of the risk should have warranted significant attention at the senior management levels.

Procedures were in place to reduce the probability of an error occurring in the first instance. It does not appear; however, that sufficient attention and resources were devoted to establishing an error-tolerant system and to mitigating against the possible consequences of such an error.

8.5.1.4 No formal change case for the changes at Ararat

A condition of an organisation's accreditation is that before a proposed material change to activities is introduced, there should be a thorough and documented assessment of the risks associated with that change.

ARTC commissioned a risk assessment of the proposal to dispense with the Signallers at the Pyrenees Loop in May 1999. However, neither ARTC nor Freight Victoria documented the risks associated with the changes which were introduced at Ararat at that time.

It appears that the major reason for the lack of such a risk assessment was that the changes at Ararat were considered to be minor as they were largely administrative. Nevertheless, as documented in Section 3 of this report, the system in operation at Ararat on the night of the accident was the product of a series of changes, each of which, in isolation, could be viewed as minor.

8.5.1.5 Union role in hazard identification

Given the active role that the Rail, Tram and Bus Union of Victoria has traditionally taken in matters of rail safety, it has the potential to make a significant contribution to the identification of safety hazards, to the mutual benefit of employers and workers. However, the potential benefits of union involvement in safety matters can be lost if safety concerns become entangled with industrial issues. The union believe that some of their concerns are perceived as industrial, rather than safety-related. Whether this perception is accurate or not falls outside the scope of this investigation; however, there is clearly room for better communication between unions and rail organisations on safety issues.

8.5.2 Training

The Train Examiner was not Safeworking qualified despite attempts by his supervisor to have him placed on a training course.

The Train Examiner was involved in a task for which he was not adequately prepared. His lack of knowledge became apparent on the night before the accident, when he had removed the Annett key from its box and taken it with him while he telephoned Maryborough for assistance. This demonstrated lack of knowledge should have triggered the need for a comprehensive briefing before he was required to retrieve the Train Staff a second time.

A person who has an involvement in rail operations, but who does not possess Safeworking qualifications, is in a somewhat ambiguous position between operational

involvement and clerical duties. The Train Examiner involved in this accident was not the only person in that position in Victoria at the time of the accident, as other Train Examiners were also awaiting training in Safeworking at that time.

A person with few qualifications is probably most in need of an awareness of the operational functions which they are permitted to perform, and the activities which they are *not* permitted to perform. Fundamental safety training for non-Safeworking qualified rail personnel may be necessary, to emphasise the limits of their duties and capabilities.

Had such formal training been available, the Train Examiner may have been less likely to have assumed that it was safe for train 9795 to enter the main line, and may have been less likely to have exceeded his authority by moving the points.

8.5.3 Interface management

Although ARTC operates the main-line track passing through Ararat, Freight Victoria has responsibility for the line from Ararat to Maryborough and beyond. The division of responsibility for safety equipment at the point of interface between those two networks, was complex and was not clearly defined.

An idea of the complexity of the interface can be gained from the fact that the points at Ararat, the Annett lock which secured them, the key which opened the Annett lock, the storage box in which this key was kept, and the lock which in turn secured this, were owned and/or managed by a variety of organisations.

The investigation team considered that the security of those pieces of safety-critical equipment, and hence the security of the main line itself, was diminished by the number of organisations who had a stake in owning or managing that equipment. Ultimately, the diffusion of responsibility for this equipment helped to create the situation in which the Annett key could be accessed by unqualified personnel.

The investigation team also considered that it was unacceptable for high-speed interstate trains to operate through points for which uncertain control and security was in place. The responsibilities for the control and access to main lines need to be more clearly defined in order to mitigate against risks inherent in any ambiguities.

8.5.4 System design

Human error is an unavoidable feature in all complex technical systems. Systems such as main interstate rail lines must be designed in a conservative manner to ensure that system integrity does not rely solely on perfect performance by operational personnel.

It has emerged that the system which was in operation at Ararat was fragile in the face of human error.

Locating the Annett key in an unsupervised box locked with a widely available key increased the convenience of operations at Ararat. However, it also increased the likelihood that that the points would eventually be moved in an unauthorised manner.

Such an unauthorised action could have been performed either by a rail employee or a member of the public.

Ideally, it should be difficult to breach the integrity of a main interstate rail line. Indeed, early design proposals for the track and signalling arrangements at Ararat included features which would have made it more difficult for unsafe acts to create a hazardous situation.

One possible explanation for the deficiencies in the arrangements at Ararat was that they had evolved during a period of great change in which there was little continuity in the management of the infrastructure. Over a period of several years the arrangements at Ararat had changed gradually from an inefficient but relatively robust system, into a more efficient but fragile system.

Ararat is not the only location on the Victorian rail system characterised by a lack of robustness or error tolerance. The investigation team learned that some other systems associated with the changing of points at main-line locations are also characterised by a lack of error tolerance.

The investigation team considered that the existence of fragile systems, particularly at the interfaces between organisations on the interstate line, is indicative of a diffusion of responsibility for system design and management.

8.5.5 Standardisation of procedures and safety systems

A lack of standardisation is a common theme throughout the rail systems of Australia.

For example, the House of Representatives report *Tracking Australia* (July 1998) reported that there are 22 different Safeworking systems and eighteen different radio frequencies in use on the interstate network throughout Australia. The lack of standard practices and procedures applies within states, as well as between them. Within Victoria, there are several systems for moving points located on the Adelaide–Melbourne line.

While diverse equipment and operating systems may permit systems to be tailored to particular situations or locations, non-standardisation can produce hazardous situations. Most importantly, if each problem facing system designers is solved with a uniquely tailored approach, rather than with an established method, it becomes more likely that some of those approaches will introduce uncontrolled risks.

In addition, non-standardisation makes it more difficult to monitor the operation of a system and increases the complexity of the work of operational personnel.

The development by ARTC of a single code of practice for its operations on interstate main lines, and the development and adoption of the proposed National Code of Practice, is likely to make a significant contribution toward addressing a number of the current standardisation issues.

8.5.6 Control, distribution and logging of safety-critical equipment

The distribution and management of V5PSW keys was considered to be inadequate. It was unclear who was allowed to have access to V5PSW keys and the investigation team could not locate any document containing the policy for their distribution. It is doubtful; however, that the Train Examiner should have had a V5PSW key on permanent issue.

The manner in which V5PSW keys are logged makes it very difficult to keep track of many individual keys. It is likely that some such keys are currently in the possession of individuals who should not have possession of them.

The control of safety-critical equipment such as V5PSW keys, is an important management responsibility. Adequate management systems are not currently in place to monitor such equipment. The management of this equipment has been a long-term problem and is not a direct result of the re-structure of the Victorian rail industry.

However, the management of this equipment has been made more complicated by this restructure.

8.5.7 Safety oversight

In the past, the designers of safety-critical elements of the Victorian rail safety system were guided by well-established but largely unwritten practices and precedents. In a period of stability, a system based on verbal tradition and accepted practice may work relatively well. As the Victorian rail network moved from public to private ownership; however, the network not only moved from self-regulation to co-regulation, but also did so in the absence of comprehensive documented guidelines on some specific operational policies.

When the most recent changes at Ararat were made, PTSD was not satisfied with the processes which were followed by ARTC, but permitted the changes to occur nonetheless. While ARTC had met the requirements to become an accredited rail organisation within Victoria, there had been insufficient time for ARTC to establish a reputation as being reliable and thorough in matters related to safety issues. Until an organisation establishes a sound safety management record, it is incumbent on the accreditation authorities to work closely with that organisation in order to ensure that safety matters are dealt with thoroughly. A greater independent monitoring of the system is particularly called for with regard to the interfaces between rail operators to ensure that the risks associated with those interfaces are properly analysed and that ambiguities are resolved.

8.5.8 Safety promotion and publicity

Safety promotion through in-house magazines, posters, published accident reports and other activities aimed at promoting safe behaviour, can be an effective element of a company's overall safety strategy. For example, by increasing the awareness of risk among operational personnel, safety promotion material can promote adherence to safety rules and procedures.

Throughout the rail industry in Australia, there is a general lack of such safety promotion material. The limited material which is available, tends to be predominantly related to issues of occupational health and safety rather than operational safety.

No industry-wide publication is available in which accidents and their causes are described for the education of rail personnel.

This accident may still have occurred, even if safety promotion material had been available. Nevertheless, a heightened awareness of operational safety issues and the risks involved in operations, may have made it less likely for a person such as the Train Examiner to act as they did.

8.6 Protection against criminal or civil proceedings

The Train Examiner declined to be interviewed by the independent investigation team. Whilst the investigation team was satisfied that it had identified the key safety issues arising from this accident, it also considered that current Victorian legislation could provide an opportunity for the prevention of critical safety-related information being made available during the course of future rail accident or incident investigations. That legislation should be reviewed with consideration given to amending the

legislation in line with other States. In most other States, a person may not be excused from answering questions or providing other information during the course of a rail accident or incident investigation on the grounds that answering those questions or providing that information might incriminate them. However, any answer given or other information provided during the course of an investigation, is not admissible in evidence against that person in criminal or civil proceedings.

9. CONCLUSIONS

9.1 Findings

1. There was a requirement to transfer a Train Staff by road from Ararat to Maryborough on Thursday 25 and Friday 26 November 1999.
2. A Train Examiner from Maryborough was dispatched to collect the Train Staff on both those occasions.
3. On Friday 26 November, a delay in the arrival of ballast train 9795 into the Ararat yard resulted in the Train Examiner waiting at Ararat for an hour longer than planned.
4. The Train Examiner was in the 12th hour of his shift at the time of the accident.
5. The Train Examiner had no direct method of communicating with the crew of 9795, with other company personnel, nor with Train Control.
6. The Train Examiner operated the points at the time ballast train 9795 arrived in the Ararat yard and stopped at the derailer on the No. 2 Road.
7. The Train Examiner was neither qualified nor authorised to operate the points at Ararat.
8. At the same time the Train Examiner operated the points, freight train 9784 was travelling east toward Ararat and had rounded the curve about 200 m to the west of the stationary ballast train.
9. The crew of 9795 saw that a collision was imminent and escaped from the cab of the locomotive.
10. The crew of 9784 applied emergency braking and braced behind their seats when they observed that the points at Ararat were not set for the main line.
11. 9784 was travelling at 74 kph when it collided with 9795.
12. The crew of 9784 sustained serious injuries while the crew of 9795 escaped without injury.
13. The Train Examiner later indicated that he operated the points because he was trying to be helpful.
14. Operations at Ararat relied heavily on strict adherence to procedures.
15. The points at Ararat were operated with the use of an Annett key.
16. The Annett key was kept in an unsupervised locked box at the base of a road bridge immediately to the west of the main-line points.
17. The locked box could be accessed with a V5PSW key.
18. The Train Examiner had been issued with a V5PSW key.
19. The Train Staff was sometimes stored in the locked box when crews departed from Ararat onto the main line.
20. The points at Ararat were not interlocked with signals or the Safeworking system on the main line.

21. There was no method of warning Drivers on the main line of the position of the points.
22. There was no method of warning Train Control of the position of the points.
23. The potential problem at Ararat arising from the fact that there was no interlocking with the Safeworking system on the main line, was recognised by VicTrack in 1997 during planning for the extension of ASW from Maroona to the Pyrenees Loop.
24. Several alternative solutions were proposed by VicTrack to address the potential problems at Ararat but those proposals were not implemented.
25. A formal risk assessment of the impact of the procedural changes which occurred at Ararat at the same time that the Signallers at the Pyrenees Loop were withdrawn, was not completed.
26. Inadequate measures were in place to mitigate against the consequences of unauthorised or erroneous operation of the points at Ararat.
27. Other locations on the Victorian non-urban network have since been identified following this accident where concerns are held about the integrity of main lines.

9.2 Significant factors

1. The Train Examiner operated the points at Ararat without authorisation and in contravention of the documented procedures.
2. The system in place for the operation of the points at Ararat was fragile in the face of human error.
3. The points were not interlocked with signals or the Safeworking system on the main line.
4. Security of the Safeworking equipment at Ararat was inadequate.
5. Management and control of Safeworking equipment in general, particularly Safeworking keys, was inadequate.
6. The Train Examiner had not received sufficient training to enable him to participate in operational activities which may have involved access to Safeworking equipment.
7. Responsibility for the control and security of the interface at Ararat was complex. This made it more difficult for the organisations involved to identify and control the hazards associated with operations at that location.
8. Freight Victoria and ARTC had not conducted formal failure mode analyses of their operations as a whole.
9. Neither Freight Victoria nor ARTC had conducted a change case for operations at Ararat prior to the removal of Signallers from the Pyrenees Loop.
10. The PTSD did not act assertively when it became concerned that ARTC was not complying with accreditation requirements in relation to risk assessments prior to the proposed changes at the Pyrenees Loop and Ararat.

10. SAFETY ACTIONS

10.1 Local safety action

10.1.1 ARTC

ARTC has completed its review of the Victorian interstate rail corridor. Four locations have now been identified by ARTC as high priority for modification to enhance safety systems. Three other locations have also been identified for further consideration but are considered to be a lower priority. Risk assessments have been undertaken for those locations and a range of technical and procedural solutions are being costed and tested for the degree of amelioration of identified risks. Two of the locations identified as high priority are programmed for modifications as part of current main-line upgrade projects. The identified risks at the other locations will, subject to ARTC Safety Committee approval, be addressed within a month of the the completion of this report.

10.1.2 Freight Victoria

Freight Victoria have completed a preliminary review of their intrastate network and have identified five locations where they consider that further risk assessment needs to be carried out in order to identify whether additional measures are required to reduce the probability and/or consequences of an occurrence.

Although more than one procedural defence would need to be breached at those locations in order for a hazardous situation to develop, the points at those locations are not interlocked with the signals or the Safeworking system on the main line. It would therefore be possible for a train to diverge from the main line without warning. In conducting further risk assessments, consideration is being given to the frequency and type of usage at those locations. For example, passenger services operate on the main lines at two of those locations. Although Freight Victoria consider that a head-on collision at the above five locations would be more remote than at Ararat, an engineering assessment will be conducted to determine the consequences of a train diverging onto the secondary line at main-line speed.

10.2 Final safety action

The following safety deficiencies were identified during the course of the investigation. It is recommended that the PTSD, as the rail safety accreditation authority, ensure that these safety deficiencies are reviewed in conjunction with relevant organisations, with a view to determining what action, if any, needs to be taken.

1. The Victorian rail system has been undergoing rapid change and hence it is not appropriate to assume that the safety of the system has been demonstrated through usage. A ‘whole of system’ hazard analysis is needed to identify the safety risks confronting Victorian rail operations.
2. The integrity of main lines in Victoria is highly susceptible to human error at several locations. This is of particular concern given that passenger services operate through some of those locations. There is a need to examine the potential for human error at those locations and re-design systems to achieve greater error tolerance where appropriate.

3. Training for non-Safeworking personnel who may require access to Safeworking equipment needs to clearly define the limits of their duties and the dangers inherent in exceeding those limits.
4. The responsibilities for control of and access to main lines need to be clearly defined in order to ensure that the integrity of the main line is maintained.
5. The non-standardisation of procedures and safety systems within the rail network is a safety hazard as it increases the potential for human error.
6. Poor control, distribution and logging of Safeworking equipment issued to individuals, particularly Safeworking keys, has increased the potential for non-authorised or erroneous use of that equipment.
7. Inadequate security of the Safeworking equipment at Ararat has increased the potential for non-authorised or erroneous use of that equipment.
8. At present, very little operational rail safety education material is made available to rail employees. Such material can be effective in promoting safe behaviour.
9. There is a need to ensure, either through legislation or other means, that all operational personnel involved in rail accidents are subject to appropriate tests for the presence of alcohol or other drugs following an accident.
10. Current legislation in the Victorian Transport Act is silent on the powers of authorised investigators to obtain information and does not afford protection against criminal or civil proceedings to individuals who have provided information to an authorised investigator during the course of a rail accident or incident investigation. The lack of such legislation has the potential to prevent critical safety information being made available.

APPENDIXES

Appendix 1 – Glossary of terms and abbreviations

The following terms and abbreviations used in this report have been obtained from the sources listed below:

AS4292-*Railway safety management Part1-General and interstate requirements;*

AS4292- *Railway safety management Part 4-Signalling and telecommunications systems and equipment;*

AS4292- *Railway safety management Part 5-Operational systems;*

AS3931-*Risk analysis of technological systems – application guide;*

AS4360-*Risk management;*

National code of practice for railways – Glossary (Draft); and

PTC- *Book of rules and operating procedures (1994.)*

Above and below rail	The organisation of a rail system in which there are separate infrastructure managers, also known as track access providers (below rail), and managers or operators of rolling stock(above rail).
Annett lock	An elementary system of locking whereby a point or signal lever is unlocked by a large key known as an Annett key.
ARTC	Australian Rail Track Corporation.
ASW	Alternative Safe Working (Refer to Section Authority System).
Ballast	Material used to support the sleepers and tracks and which usually consists of crushed rocks.
Baulk	A sleeper bolted onto the track in order to prevent a rail vehicle from inadvertently rolling beyond that point.
Competent employee	Any employee who has demonstrated by maturity and knowledge and has passed the necessary examination or instruction to be competent to perform the allotted duty as required by those instructions.
CTC	Centralised Traffic Control. A length of railway governed by signal indication where such signals and points within the territory are operated by the Train Controller.
Crossing loop	A line at a station or siding, secondary to the main line and provided primarily for the crossing or passing of trains.
Driver	A qualified worker in charge of a train or engine.

Derailer	Apparatus located on a track which is usually interlocked with points and which prevents rail vehicles from inadvertently running onto main lines by derailing them.
Dynamic brake	The dynamic brake is a regenerative brake on the locomotive. Operation of the brake causes the traction motor on the locomotive to operate as a generator.
Electronic authority	Associated with the Section Authority System. An authority which is transmitted electronically and is displayed in the Locomotive Safeworking Display Unit.
ESuT	Eastern standard summer time.
ETAS	End of Train Air System. Apparatus attached to the rear of a train and which indicates to the Driver that his train is complete.
FOE	Freight Operations Employee. An employment classification encompassing multiple roles including, but not limited to, train examination, shunting and safeworking.
Interlocked	Interconnected components of signalling and signal systems, with or without points or crossings, designed so as no conflicting movement can be signalled.
Interlocking	An arrangement of interlocked signals and points.
Intermediate siding	A siding in a section (refer to Section) for purposes other than the crossing or passing of trains.
Interstate system	Any railway system or part of a railway system, designated by its owner as a route to be used for the movement of interstate traffic.
Locomotive safeworking display unit	The display unit in the locomotive cab consisting of two screens, which displays all Authorities and other information transmitted by the Train Controller within the context of Section Authority Working.
Main line	The line normally used for running trains through and between stations.
No. 2 road	The track within a siding which is nearest to the main line (referred to as the No. 1 road) and which is usually connected to the main line at both ends of the siding.
Operator	The person or body responsible by reason of ownership, control or management, for the provision, maintenance or operation of trains, or a combination of these, or a person acting on its behalf.
Points and crossings	In-track structures which provide for one track to join or cross another.
Proceed authority	An authority for a train to proceed in the forward direction under normal operating conditions where exclusive occupancy of the track section to which it applies is guaranteed.

PTSD	Public Transport Safety Directorate. Forms part of the Victorian Department of Infrastructure.
Qualified worker	A worker qualified for the duties required to be performed.
Risk assessment	The overall process of risk analysis and risk evaluation.
Risk identification	The process of determining what can happen, why and how.
Risk management	The systemic application of management policies, procedures and practices to the tasks of identifying, evaluating, treating and monitoring risk.
Safety-related work	Safety activity in one or more of the following: a) Driving and operation of trains b) Control of the movement of trains (including shunting) c) The design, construction, repair, maintenance, upgrading, inspection or testing of rolling stock, civil and electrical traction infrastructure, and signalling and telecommunications equipment.
Safeworking system	An integrated system of operating procedures and technology for the safe operation of trains and the protection of people and property on or in the vicinity of the railway.
Second person	A qualified person used to assist a Driver to perform his duties.
Section authority system	A system of train control whereby Section Authorities are issued and received electronically. Commonly referred to as ASW (Alternative Safeworking)
Section	That portion of the main line between adjoining crossing stations, emergency crossing stations or control points which is outside the station yard limit boards.
Section authority	See electronic authority.
Shall	The word 'shall' is to be understood as mandatory.
Shunt	The movement of trains or rail vehicles for the purpose of marshalling or altering the consist.
Siding	A portion of line connected by points to a main line or loop where rail vehicles can be placed or stored.
Signaller (Signalman)	A qualified worker responsible for the working of points or signals or of an interlocking apparatus or signal control panel.
Staff and ticket	A system of Safeworking whereby a metal token, a Train Staff, is carried by the Driver of a train as a symbol that the train has an authority to proceed on a specified section of track. Only one Train Staff is provided for a section. In cases where trains are scheduled to follow in

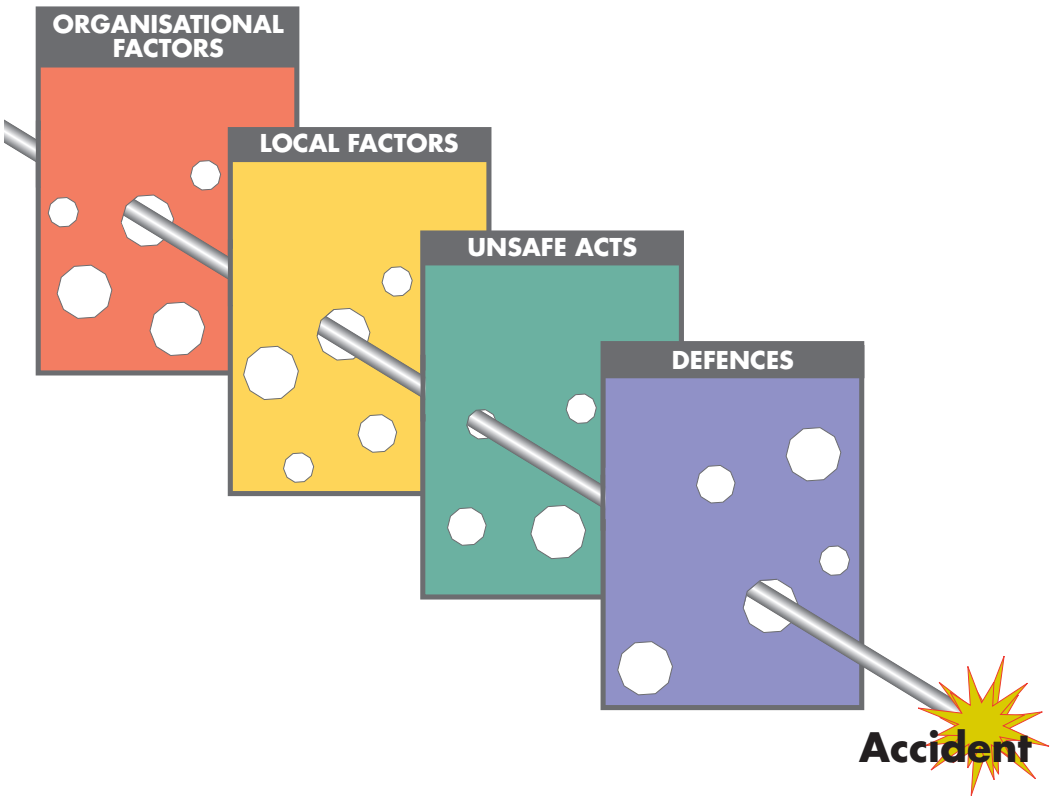
	the same direction as preceding trains, a paper Staff Ticket becomes the authority for the trains to proceed. The crew must also sight the Train Staff when the Staff Ticket is issued. The last train scheduled in the sequence then carries the Train Staff.
Standard gauge	The distance between rails of 1435 mm.
Station yard	A system of track within defined limits.
Track authority	The track owner or track access provider.
Train controller	The worker responsible for the management and control of traffic movements and occupancy authorities.
Train crew	Qualified workers in charge of the operation of a train.
Train examiner	A qualified worker appointed or deputed to examine all types of rolling stock except engines.
Train notice	Operational information issued by or on behalf of the Track Authority.
Train order	An instruction on the prescribed form issued by a Train Controller in connection with the movement of a train.
Train order working	A method of train control which involves the manual issue and receipt of train orders, using a book of manual authority forms, to the Driver of a train as a symbol that the train has the authority to proceed on a specified section of track.
Train staff	A metal token carried by the crew of a train which represents an authority to occupy a specified section of track.
Unattended station	A station at which a qualified worker is not on duty for the working of trains.
VicTrack	Victorian Rail Track Corporation
V5PSW key	A Victorian safeworking key which is issued to authorised personnel to enable them to access safeworking equipment.
Workstation	The electronic train control panel associated with the Section Authority System and in which the Train Controller reserves sections of track for specified trains, track vehicles or maintenance requirements.

Appendix 2 – Risk analysis matrix – level of risk

	CONSEQUENCES				
LIKELIHOOD	***Insignificant***	***Minor***	***Moderate***	***Major***	***Catastrophic***
Almost certain	Significant	Significant	High	High	High
Likely	Moderate	Significant	Significant	High	High
Moderate	Low	Moderate	Significant	High	High
Unlikely	Low	Low	Moderate	Significant	High
Rare	Low	Low	Moderate	Significant	Significant

Table adapted from AS4360 page 25

Appendix 3 – The Reason model of accident causation



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