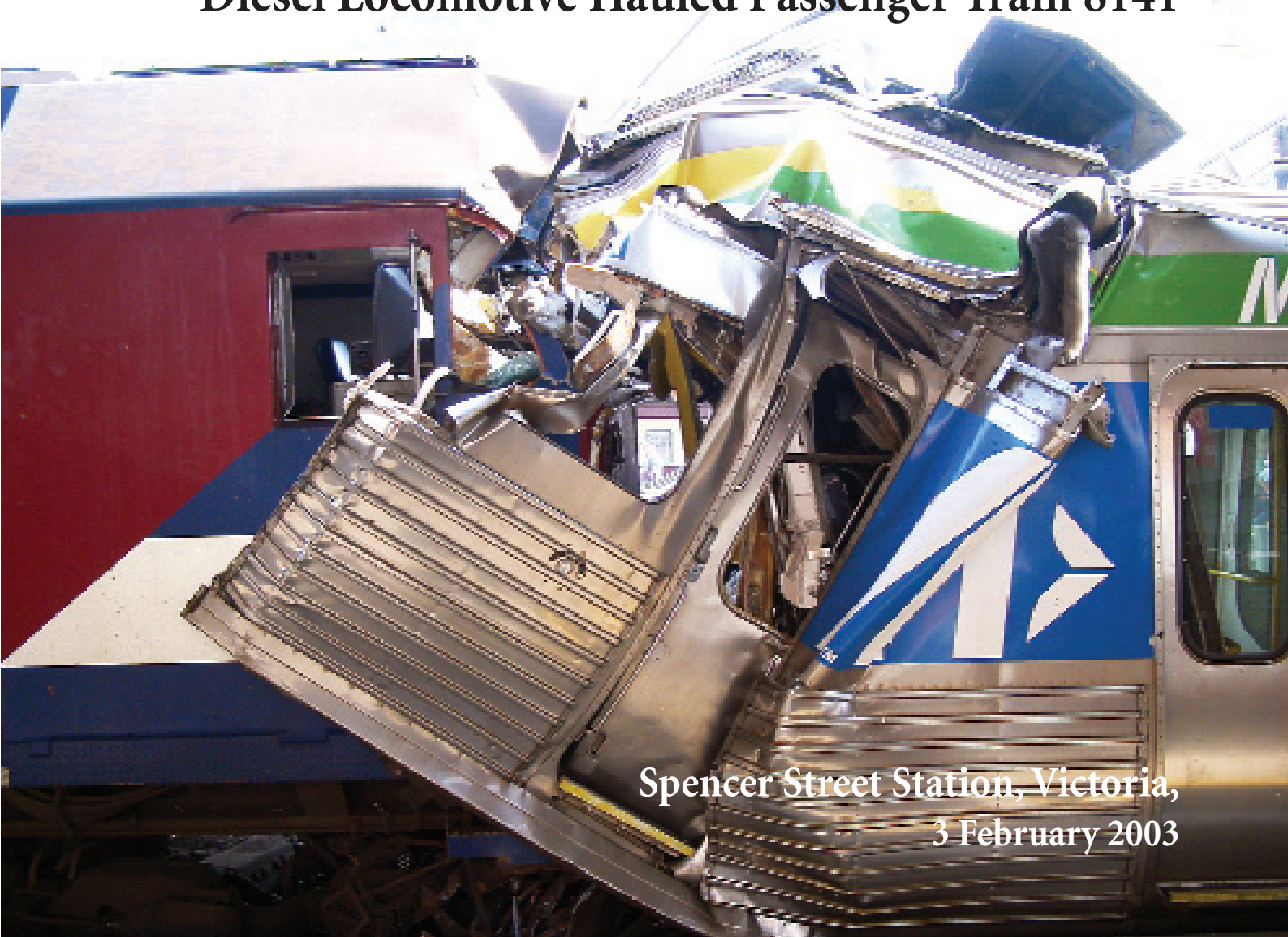


Runaway of Suburban Electric Passenger Train 5264 and collision with Diesel Locomotive Hauled Passenger Train 8141



Spencer Street Station, Victoria,
3 February 2003



Department of Transport and Regional Services

Australian Transport Safety Bureau

RAIL INVESTIGATION REPORT

No. 2003/0001

**Runaway of Suburban Electric Passenger Train 5264
and collision with
Diesel Locomotive Hauled Passenger Train 8141
Spencer Street Station, Victoria,**

3 February 2003

ISBN 1 877071 44 7

October 2003

This report was produced by the Australian Transport Safety Bureau (ATSB), PO Box 967, Civic Square ACT 2608. Readers are advised that the ATSB investigates for the sole purpose of enhancing safety. Consequently, reports are confined to matters of safety significance and may be misleading if used for any other purpose.

CONTENTS

EXECUTIVE SUMMARY	vii
1 INTRODUCTION	1
1.1 Terms of reference	1
2 INVESTIGATION METHODOLOGY	3
3 FACTUAL INFORMATION	5
3.1 Background	5
3.2 Overview of route, Broadmeadows to Spencer Street	5
3.3 Topography of route	6
3.4 Overview of Broadmeadows Station and yard	7
3.5 Spencer Street Station and yard	8
3.5.1 Overview Spencer Street station and yard	8
3.5.2 Access, control and train occupancy, Spencer Street Station and yard	8
3.6 Overview of events, Broadmeadows Station to Spencer Street Station	9
3.7 Sequence of events, Broadmeadows Station to Spencer Street Station	10
3.8 Injuries	18
3.9 Damage to trains 5264 and 8141	18
3.10 Crashworthiness of Comeng suburban electric trains	20
3.11 Damage to infrastructure	20
3.12 Employee issues	20
3.12.1 Train crew details	20
3.12.2 Train 5264 driver medical examinations	20
3.12.3 Train controller / signaller medical examinations	21
3.12.4 Train 5264 driver audit requirements	21
3.12.5 Toxicology	21
3.12.6 Shift and fatigue management, driver 5264	21
3.12.7 Shift and fatigue management, controllers and signallers	21
3.13 Driver's actions	22
3.13.1 Sequence of events, driver's actions, Broadmeadows Station	22
3.13.2 Driver duties – changing driving cabins	22
3.13.3 Driver's procedures, changing driving cabins	23
3.13.4 Cab Unattended Procedure	24
3.13.5 Entering information into the Passenger Information Display System	24
3.14 Train information	24
3.14.1 Comeng suburban electric trains	24
3.14.2 Examination and testing of braking equipment, train 5264	25
3.14.3 Description of parking brake system, Comeng suburban electric trains	26
3.14.4 Passenger Information Display System	26

3.14.5	Position of train system and verification of data	27
3.14.6	Description of train 8141	28
3.15	Track and other infrastructure	28
3.15.1	Track design and permissible speeds	28
3.15.2	Electrical infrastructure	29
3.15.3	Signalling infrastructure	30
3.16	Signal and train control	31
3.17	Communications	32
3.18	Environmental factors	33
3.19	Previous instances of runaway suburban electric trains	33
3.20	Organisational context	34
3.20.1	Background	34
3.20.2	Single person operated trains	34
3.20.3	Accreditation and audit	35
3.20.4	Emergency Response Plan Trains Division	35
3.20.5	Emergency response	36
3.20.6	Post accident measures, Broadmeadows to Spencer Street Station	36
4	ANALYSIS	37
4.1	Overview	37
4.2	Previous runaways	37
4.3	Driver procedures and actions	37
4.3.1	Driver procedures and instructions, changing driving cabins	37
4.3.2	Custom and practice, changing ends	38
4.3.3	Driver actions: train 5264 Broadmeadows Station	39
4.4	Train brakes	40
4.4.1	Inoperative braking system, train 5264	40
4.5	Analysis of Position of Train System data	41
4.6	Possible contingency measures, Metrol officers	42
4.6.1	Possible contingency measures, train 5264	42
4.6.2	Possible contingency measures, train 5262	43
4.7	Possible contingency measures at Spencer Street	44
4.8	Monitoring and communications	45
4.8.1	Overview of monitoring and communications	45
4.8.2	Radio protocol	47
4.9	Consequences of impact on train 8141	47
4.10	Field personnel actions	48

4.11	Shift and fatigue management, controllers and signallers	48
4.12	Post incident measures	48
4.13	Emergency services response	48
4.14	Security accident site	49
5	CONCLUSIONS	51
5.1	Findings	51
5.2	Contributing factors	53
6	SAFETY ACTION INITIATED AND RECOMMENDED SAFETY ACTIONS	55
6.1	Safety actions already initiated	55
6.2	Recommended safety actions	55
6.2.1	Victorian Department of Infrastructure	56
6.2.2	Bayside Trains Pty Ltd, Receiver Manager Appointed (R.M.A.)	56
7	SUBMISSIONS	59
7.1	The Department of Infrastructure	59
8	APPENDICES	61
8.1	Description of damage, Trains 5264 AND 8141	61
8.1.1	Damage to motor car 394 (train 5264)	61
8.1.2	Damage to trailer car 1048 (train 5264)	63
8.1.3	Damage to motor car 393 (train 5264)	63
8.1.4	Damage to Locomotive N 463 (train 8141)	63
8.1.5	Damage to coaches BTH 167, BH 147, BIH 187 & BCH 127 (train 8141)	66
8.2	Extract M>Train Fleet Asset Management Plan	65
8.3	Description of braking system Comeng surburban and electric trains	67
8.4	Instances of previous runaway surburban electric trains	71
8.5	Signals	73
8.6	Track and signal diagram Spencer Sreet Station to North Melbourne	75

EXECUTIVE SUMMARY

Shortly before 2118:17¹ on 3 February 2003 a driverless empty suburban train, numbered as 5264, rolled away from Broadmeadows Station under the influence of gravity and subsequently ran largely downhill for 16.848 kilometres to Spencer Street Station. At about 2133 train 5264 collided with the stationary Bacchus Marsh train 8141 at platform two on Spencer Street Station. The estimated speed at impact with the Bacchus Marsh train was 75kph. The leading car of train 5264 was extensively damaged, as was the locomotive of the Bacchus Marsh train. Both trains were derailed as a result of the impact, the Bacchus Marsh train being forced back some 22 metres in the process. The driver of the Bacchus Marsh train and a V/Line employee jumped clear seconds before impact.

Emergency services, including the police, fire and ambulance services attended the scene. There was no fire, no fuel spill or trapped persons. Eight passengers in the two occupied carriages of the Bacchus Marsh service were injured. Four of the injured persons were treated on site and four were conveyed to local hospitals. None of the injuries were serious.

Train 5264 rolled away from Broadmeadows Station due to a release of brakes as the driver was using the station amenities in the process of changing ends in preparation for the return journey to Melbourne. All passenger doors were open, all carriage saloon lights were illuminated and the passenger indicator display on Broadmeadows platform was displaying the correct information for the intended journey of train 5264. The gradient between Broadmeadows Station and Spencer Street Station is predominantly falling, there being an overall height difference of 116 metres between these two stations. The runaway train reached speeds in excess of 100kph and passed through level crossings and pedestrian crossings well in excess of design speed.

The investigation team has determined that the release of brakes was due to the manner in which the driver's controls were isolated and that the unplanned movement was due to the park brake not being applied.

The investigation team determined that it was not possible for Metrol officers² to control or stop the runaway movement. Metrol officers did not know whether or not there were passengers on the train and this constrained their assessment of options such as seeking to derail the train or route it into a siding. Metrol officers were forced to formulate contingency measures 'on the run'. The efforts of Metrol officers in this regard were severely hampered by the lack of visual indication of the train position and a system of voice communications that is not optimised for contingency broadcasts. For the majority of the journey, Metrol officers were relying on third party information being relayed from station and signalling personnel in the field.

In addition, the speed of the runaway train was significantly in excess of normal scheduled services. Consequently, many of the people involved experienced difficulty in adjusting their mental model of where they expected the train to be between Broadmeadows and its final destination at Spencer Street Station, compared with third party reported sightings.

¹ This is the time recorded by the POTS transponder located at the Up end of Broadmeadows platform. The POTS system tracks train position and records data via interaction between train and track transponders. For a description of the POTS system see section 3.14.5 of this report.

² Metrol officers – network control officers, train controllers, signallers and so on who staff the metropolitan train control centre.

Train 5264 came within a second of being placed on a collision course with the previous Broadmeadows to Flinders Street Station train, number 5262, in the vicinity of North Melbourne. Train 5262 had between 30 and 40 passengers on board.

The investigation team determined that Metrol officers made a conscious decision to route train 5264 into the unwired precinct of Spencer Street Station. If they had not done so, the train would most likely have continued into the 'heart' of the Melbourne suburban network towards Flinders Street Station.

No advance warning of the impending high-speed arrival of train 5264 was conveyed to railway personnel or members of the public at Spencer Street Station. The investigation team found that a number of factors played an important role in this failure.

The investigation established that neither train maintenance nor track maintenance was a factor in the accident. Safety systems designed to stop trains in the event of unauthorised movement are foot and hand pilot valves (often referred to as dead man's handle and pedal), trackside signals and train stops. These devices are effective only when the driver's controls are activated and a driver is in attendance. In this instance the driver's controls were isolated and no driver was in attendance.

Fatigue and the medical condition of the driver of train 5264 and relevant Metrol and field employees were not factors in the accident.

A number of remedial and positive safety actions have been taken or are under way through the Victorian Department of Infrastructure.

The report's recommendations in section 6.2 relate to:

- engineering an automatic application of the park brake when the driver's controls are isolated;
- reviewing and consolidating procedures for changing ends;
- mandating the application of the park brake when the driver's cab is vacated in all instances;
- auditing of driver's actions, isolating driver's controls;
- voice communications across the Melbourne network to be critically examined;
- visual indications in the form of 'real time' display of train movements at the Metrol control centre;
- general training for Metrol staff on train characteristics;
- maintenance on suburban electric trains;
- updating the 'Emergency Response Plan Trains Division';
- training in relation to the 'Emergency Response Plan Trains Division'; and
- minimising the potential for roster induced fatigue.

1 INTRODUCTION

1.1 Terms of Reference

The Terms of Reference for the investigation were as follows;

Runaway of Comeng three car unit from Broadmeadows Station and its Collision with NX V/line Passenger Train at Spencer Street Platform 2 – 21:15H Monday 3 February 2003

In accordance with Section 129U of the Transport Act 1983, the Minister for Transport requires the Australian Transport Safety Bureau (ATSB), to establish an Independent Investigation to investigate the circumstances of the un-scheduled departure of a three car Comeng suburban train at 21.15H from Broadmeadows Station platform without a driver, the management of this uncontrolled train and its collision with the 21.35 Down Bacchus Marsh V/line Passenger train standing at Platform 2 Spencer Street Station at 2133H on Monday 3 February 2003.

The Terms of Reference for the Investigation are as follows:

The Investigation will examine all relevant matters including:

- The events leading to the threecar set being able to depart unattended from the Broadmeadows Station platform, including determination of the relative contribution of rolling stock, infrastructure and operating procedures.
- The events that occurred en route and their management including determination of the relative contribution of rolling stock, infrastructure and operating procedures.
- The events leading to the collision, including determination of the relative contribution of rolling stock, infrastructure and operating procedures.
- Train maintenance systems.
- Signal and track maintenance systems.
- Training and re-training procedures for relevant staff.
- Operating procedures and the effectiveness of such procedures.
- Medical condition of the rail safety workers involved in the collision.
- Post collision emergency management arrangements and procedures, especially focussing on communication issues.
- Relevance (if any) to the recommendations from previous occurrences of train runaways

Final Report format to follow the model Guidelines for railway safety investigation as detailed in AS 5022.

The purpose of this investigation is to enhance rail safety in the Melbourne metropolitan network, by determining the sequence of events which led to the accident and the factors which may have influenced those events. Of particular importance is the need to understand what the accident revealed about the environment in which this event transpired, and to identify deficiencies with the potential to adversely affect future safety.

The analysis of this accident is based on the Reason³ model of accident causation in modern technological systems. The report was written using the format contained in the Australian Standard 5022-2001 'Guidelines for rail safety investigation'.

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

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

In addition technical analysis and reports were provided from relevant experts on aspects of brake systems, signalling and infrastructure.

The investigation team acknowledges the full cooperation received from all parties to the investigation, in particular the assistance rendered by Ms Serena Middleton, of Bayside Trains Pty Ltd, in regard to the collation and distribution of data.

³ REASON, J. 1990, Human Error, (Cambridge University Press: Cambridge); REASON, J. 1997, Managing the Risks of Organisational Accidents, (Ashgate Publishing Limited: Aldershot)

3 FACTUAL INFORMATION

3.1 Background

At about 2133⁴ on Monday 3 February 2003 a driverless empty suburban electric train (5264) collided with train number 8141 at number two platform, Spencer Street Station, Melbourne. The driverless empty train was a Comeng manufactured suburban electric train and consisted of motorised car 394, trailer car 1048 and motorised car 393. This train had runaway from Broadmeadows station shortly before 2118:17 and had no passengers aboard. Train 5264, under the influence of gravity, covered the 16.848 kilometres between Broadmeadows and Spencer Street Station in about 16 minutes. Due to the driver's controls being isolated at both ends and the train trips⁵ being in the raised position, both the train stop system and the driver's pilot valves⁶ ('dead man's pedal') were inactive. Therefore, this train passed signals at stop with no interaction occurring between the train stop system and the raised trip arm at red signals. Also, with the pilot valve inactive there was no application of the emergency braking system due to a lack of pressure on the driver's pilot valve.

Train 8141 was the Bacchus Marsh train and consisted of N class diesel electric locomotive number 463 and four passenger carriages classified and numbered as BTH 167, BH 147, BIH 187 & BCH 127. Train 8141 was stationary at the time of the collision and was due to depart number two platform Spencer Street Station at 2135. This train had a driver and V/Line employee in the locomotive cabin and 16 passengers in the first two carriages, the rear two carriages being locked and empty.

The estimated speed of impact was 75 km/h⁷. The force of the collision derailed both trains, pushing train 8141 back about 22 metres in the process. Extensive damage occurred to both trains and eight passengers sustained relatively minor injuries as a result. The driver of train 8141 and a V/Line employee in the locomotive of the Bacchus Marsh train jumped clear seconds prior to impact.

3.2 Overview of route, Broadmeadows to Spencer Street

The route from Broadmeadows to Spencer Street Station via Essendon was opened in 1872, duplicated prior to 1886 and electrified in 1921. It is 16.848 kilometres in length and forms part of the present day Melbourne electric suburban train system. It is part of the Broad Gauge⁸ network that links Melbourne, Albury, Shepparton and several branch lines in the mid to northern regions of Victoria. This route is double tracked in its entirety and trains that operate from Broadmeadows to Spencer Street are designated as 'Up' trains and those from Spencer Street to Broadmeadows as 'Down' trains.

⁴ All times in this report, except where otherwise indicated, are Eastern Summer Time.

⁵ Train trips are a mechanical device (a trip arm) under the driver's cabin that interact with a trackside lever that will be raised should the applicable signal be at red/danger. Brake pipe air will then be exhausted to atmosphere and the brakes will apply.

⁶ Driver's pilot valve, a foot pedal / hand grip on which the driver must maintain pressure to keep the brakes from applying. It is sometimes referred to as the 'dead man's pedal'.

⁷ Kilometres per hour

⁸ 1600 mm width

The Broad Gauge freight line via Albion opened in 1929 and the Standard Gauge⁹ Melbourne to Sydney line in 1962. Since then traffic between Broadmeadows and the Melbourne precinct has been predominantly suburban electric or diesel locomotive hauled regional passenger trains. However, there are occasions when freight or ballast maintenance trains traverse this route. The predominant operator on this route was the National Express Group, trading as either M>Train or V/Line. In February 2003 there were normally 316 suburban services and 64 inter-urban services between Broadmeadows and Spencer Street per week, typically carrying 207,000 passengers weekly. There are 14 suburban stations inclusive of Broadmeadows and Spencer Street Station all of which, with the exception of the Spencer Street suburban platforms, are managed by M>Train. Of these, Spencer Street, North Melbourne, Essendon, Glenroy and Broadmeadows are designated as premium stations¹⁰.

3.3 Topography of route

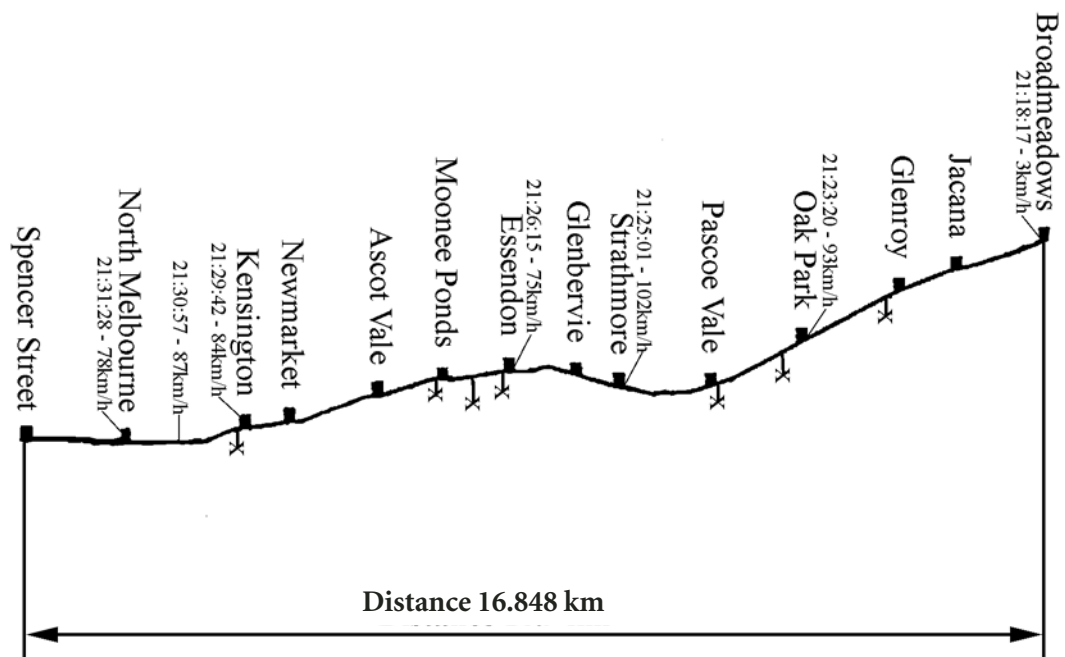
Broadmeadows Station is 124 metres above the low water mark; Spencer Street Station is 8 metres above the low water mark. This is an overall difference of 116 metres in height over a distance of 16.848 kilometres. Broadmeadows Station at number two platform is almost level at a gradient of 1:5000 (0.02%) but in a matter of 200 metres the grade increases to 1:87 and then 1:88 as far as Glenroy Station. Apart from a slight easing to 1:123 at Glenroy Station itself, the downgrade then increases to a 1:50 gradient for 2.4 kilometres to a point just north of Pascoe Vale Station. This particular section is the steepest downgrade on the Broadmeadows to Spencer Street Station route. From this point the downgrade gradually decreases, levels and then rises at a rate of 1:113 through Strathmore and Glenbervie Stations until about 500 metres on the northern side of Essendon Station. The length of this rising grade is about 1.8 kilometres and is the only portion of the Broadmeadows to Spencer Street Station route that has a rising grade of any significance.

There is then a very short slight downgrade before becoming almost level on the approach to and at Essendon Station itself. A very slight downgrade is then evident until Moonee Ponds Station where the grade again levels out. Immediately beyond Moonee Ponds Station though, the grade increases again through to Moonee Ponds Creek at a rate that varies between 1:89 and 1:84. This is a distance of about 4.8 kilometres. Moonee Ponds Creek is about two kilometres from Spencer Street Station, the final portion of the route to Spencer Street being basically level except for two very short undulations of a rising 1:125 grade. A diagram of this route showing gradient details is contained at figure 1 of this report.

⁹ 1435 mm width

¹⁰ Premium stations are staffed first to last train seven days a week, full booking office facilities, bright lighting, closed circuit TV monitoring, public telephones, enclosed waiting areas and toilets open first to last train.

FIGURE 1:
Diagram of route



3.4 Overview of Broadmeadows Station and yard

Broadmeadows Station is designated as a premium station and is an intermediate location for V/Line passenger trains and freight trains to and from Seymour. It is also the limit of the electric suburban service from Melbourne, the 1500 volt direct current overhead system ending on the main line immediately to the north of Broadmeadows Station. Broadmeadows Yard consists of the Up and Down main lines and four dead end sidings. These sidings are used to stable electric suburban trains. In addition, there are three crossovers that link the up and down main lines to each other and, in some instances, the dead end sidings. A number of M>Train's suburban electric train drivers are stationed at Broadmeadows.

Broadmeadows Yard is mechanically interlocked and signalled, being controlled locally by a signaller at Broadmeadows. The signalling system on the Up (southern) side is automatic block¹¹ and the signalling on the Down (northern) side of Broadmeadows Station is double line block signalling¹². These are two different systems of signalling and safeworking. Broadmeadows Signalbox must be attended for the passage of all trains because of the transition between these two safeworking systems.

The broad gauge goods line from Melbourne via Albion diverges about 214 metres on the (Up) side of Broadmeadows Station platform. The standard gauge line to Melbourne via Albion is on a route that passes to the east of Broadmeadows Station. This line then crosses over the Broadmeadows to Spencer Street broad gauge suburban line via a rail over rail bridge about 650 metres on the Up side of the Broadmeadows Station platform. The standard gauge line is remotely controlled from Adelaide by the Australian Rail Track Corporation and is separated from the broad gauge at Broadmeadows. That is, there is no dual gauge track configuration.

¹¹ Automatic block signalling allows trains to follow one another at signal headway intervals.

¹² Double line block working allows one train only at a time between designated blocks / stations.

3.5 Spencer Street Station and yard

3.5.1 Overview Spencer Street Station and yard

Spencer Street Station is the major interchange point for suburban and country services in Melbourne and consists of 14 platforms in total. Country diesel and sprinter¹³ services operate from platforms one to eight and suburban electric services operate from platforms nine to 12. A combination of suburban electric, country diesel and sprinter services operate from platforms 13 and 14. Platforms one to eight are of a dead end configuration with crossovers that allow for run around movements of locomotives via adjacent roads. Platform eight has access via a crossover to road number eight 'A' which is a through road and platforms one and two are dual gauged, having both Broad and Standard gauge access.

The main users of platforms one to eight are V/Line, West Coast Rail, Countrylink, Hoys, and Great Southern Rail. West Coast Rail and Great Northern are intermittent users. The main users of platforms nine to 14 are M>Train, Connex and V/Line. V/Line staff manage platforms one to eight and Connex staff manage platforms nine to 14.

Spencer Street number one signal box controls signalling and points to platforms one to six. Metrol controls signalling and points to platforms eight to 14. Metrol and Spencer Street number one signal box jointly control signalling and points to platform seven.

In addition, there are seven dead end sidings into the carriage maintenance facility and 17 sidings of varying layout that are known as the 'bank sidings'. These sidings are to the north and east of the Spencer Street Station passenger platform facilities.

3.5.2 Access, control and train occupancy, Spencer Street Station and yard

The territory controlled by the Spencer Street number one signal box can be accessed by a broad gauge train travelling on the east suburban line in the Up direction via four separate routes. As encountered by a train travelling in the Up direction they are the:

- Country line;
- East country line;
- Main country line; and
- Through country line.

If no conflicting routes have been set, all four entry routes can access Spencer Street Station platforms one, two, three, four, five, six and seven. Also, access is available to the broad gauge run around road at platform one, the 'centre yard' between platforms two and three, road '4A' between platforms four and five and road '6A' between platforms six and seven. Standard gauge access is shared with the broad gauge at the gauntlet track and the dual gauge track at platforms one and two. In the case of the 'through country line' access is also available to the carriage sidings.

In regard to the arrival of trains, the Metrol complex controls the signals and points that can route an Up train into this precinct as far as the home signals¹⁴ on any of the four entry roads or the entry point into the carriage sidings. The Spencer Street

¹³ Sprinter – a self propelled diesel powered railcar.

¹⁴ Home signals designate station boundaries and control entry into a station yard.

number one signal box then controls all remaining signals and points to platforms one to seven, the carriage maintenance facility, the bank sidings and carriage sidings. Metrol and Spencer Street number one signal box jointly control access to platform seven.

In regard to departure of trains, basically the reverse occurs except there are only three exit routes. These routes are the:

- Country line;
- East country line; and
- Through country line.

Specifically, the Spencer Street number one signal box sets the points and signals as far as the starting signals under their control. The advanced starting signals are controlled by the Metrol complex and allow trains to access the east suburban, main suburban and through suburban lines.

Trains 5264 and 8141 collided at about 2133 on 3 February 2003. At this time the platforms at Spencer Street Station were occupied as set out below.

<i>Platform</i>	<i>Train</i>	<i>Scheduled departure time</i>
One	Standard gauge Overland Adelaide express.	2140
Two	Bacchus Marsh diesel and carriages.	2135
Three	Kyneton diesel and carriages (empty, stabled)	A.M. 04/02/03
Four	Geelong sprinter	2135
Five	Locomotive and carriages (empty, stabled)	N/A
Six	Kyneton sprinter	2140
Seven	Empty carriages for the Warrnambool train	A.M. 04/02/03

Due to their imminent departures, the Spencer Street signaller had set the routes for the Bacchus Marsh, Geelong sprinter, Overland express and the Kyneton sprinter trains. Train 8141 to Bacchus Marsh was set to depart via the east country line, the 2135 Geelong sprinter via the through country line, the 2140 Kyneton sprinter to follow on the through country line and the 2140 overland train via the standard gauge line.

3.6 Overview of events, Broadmeadows Station to Spencer Street Station

On 3 February 2003 train 5264 ran away from Broadmeadows Station to Spencer Street Station without any passengers or crew on board. The time span from initial movement to collision with train 8141 at Spencer Street Station was about 16 minutes. A timetabled express or empty electric suburban train is given 21 minutes to complete this journey.

Runaway train 5264 was recorded by the Position of Train System (POTS) travelling at speeds well in excess of those allowed for the Broadmeadows to Spencer Street route. The highest speed recorded was 102 km/h at Strathmore Station. Calculations indicate that this speed would have been exceeded, possibly reaching up to 121 km/h, between Oak Park and Strathmore stations. The maximum speed allowed for suburban electric trains over this route is 80 km/h. The highest speed exceedance was an estimated

75 km/h on the immediate approach to Spencer Street Station where the speed limit is 25 km/h.

Runaway train 5264 traversed seven level crossings and nine pedestrian crossings. Vehicle boom barriers and pedestrian gates protect all crossings and are activated via track circuitry as the train approaches or by signallers in the field. The approach activation time sequence is based on the speed of the track being adhered to. In this instance train 5264 exceeded track speed and the consequential reduction in time margin resulted in the vehicle boom barriers being only half way down and the pedestrian gates being closed for only one second at Glenroy Road, Glenroy, prior to the passage of train 5264. All other boom barriers were fully horizontal and pedestrian crossing gates closed for the passage of train 5264, albeit with reduced time margins.

Train 5264 passed through 12 stations en route from Broadmeadows Station to Spencer Street Station. Of these Essendon, Kensington and North Melbourne had stationmasters or signallers on duty at the time of the runaway. An examination of CCTV's¹⁵ en route has revealed that passengers were on station platforms and witnessed the train's passing.

During the course of this event, train 5264 passed 41 signals, five of which were in the stop position. Four of the signals passed at stop were fitted with train stop devices.

In an attempt to stop train 5264 'remotely', the overhead power was isolated at the instruction of Metrol control officers. This isolation of power had no effect on slowing or stopping the runaway movement.

Train 5264 came within a second of colliding with the train in advance, number 5262, at North Melbourne. The POTS unit travel report shows train 5264 travelling at 82 km/h at Kensington, 87 km/h at Moonee Ponds Junction and 78 km/h at North Melbourne number one platform.

Train 5262 was a three-car Comeng electric suburban train and was estimated to have in the vicinity of 40 passengers on board. A collision was averted by bringing train 5262 to a stand at signal NME 566 and changing the route. Train 5262 was then driven at speed through points NME 464 towards the main suburban route. Immediately the rear end of train 5262 was clear of NME 464 points and track circuitry, these points were reversed. Within a second later train 5264 passed over the points that were now set for the east suburban route. This was the route originally programmed for train 5262. Metrol officers then intentionally routed train 5264 towards the unwired portion of Spencer Street Station.

3.7 Sequence of events, Broadmeadows Station to Spencer Street Station

Note- Figure 6 at page 17 is a schematic timeline of the sequence of events between Broadmeadows Station and Spencer Street Station. This section is cross-referenced with the timeline by means of numbered events.

The driver of the runaway electric suburban train had driven the train as number 5859 from Flinders Street to Broadmeadows Station. The driver reported that this journey had been routine. The previous driver, whom he had relieved, had informed him that the rheostatic brake on units 393, 1048 and 394 had been cut out some time earlier because it was faulty. As a result, the primary braking mode for train 5859 was electro-

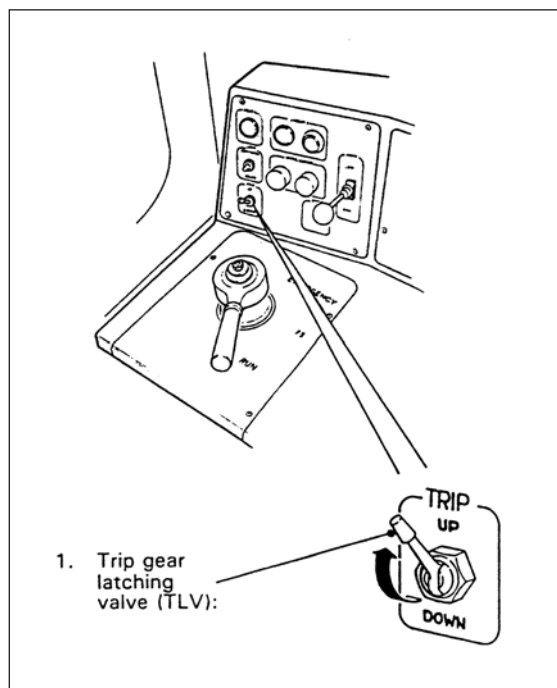
¹⁵ CCTV's – Closed circuit televisions that are provided for security purposes.

pneumatic. This brake was reported as functioning normally by the previous driver and by the driver of 5859 himself.

The POTS unit travel report recorded suburban electric train 5859 arriving at Broadmeadows Station at 2113:17, (figure 6 event 1) travelling at 23 km/h in the Down direction. This train was to become Up train 5264. The track transponder¹⁶ that recorded this arrival is located on the Up end of number two platform at Broadmeadows Station. From viewing the CCTV footage it is estimated the actual time train 5859 stopped at the Broadmeadows Station platform was 25 to 30 seconds later. The Broadmeadows signaller then set the route for train 5264's departure via the Up line.

As train 5859 was arriving at Broadmeadows Station, the driver said he noticed that the passenger information display on the platform was showing the next train as being a Seymour service. This led him to think that he may have to perform a shunting movement to clear the platform after arrival. After coming to a stand he advised that he isolated the driver's controls as per procedures, latching up the train trip in the process.

FIGURE 2:
Raising the trip

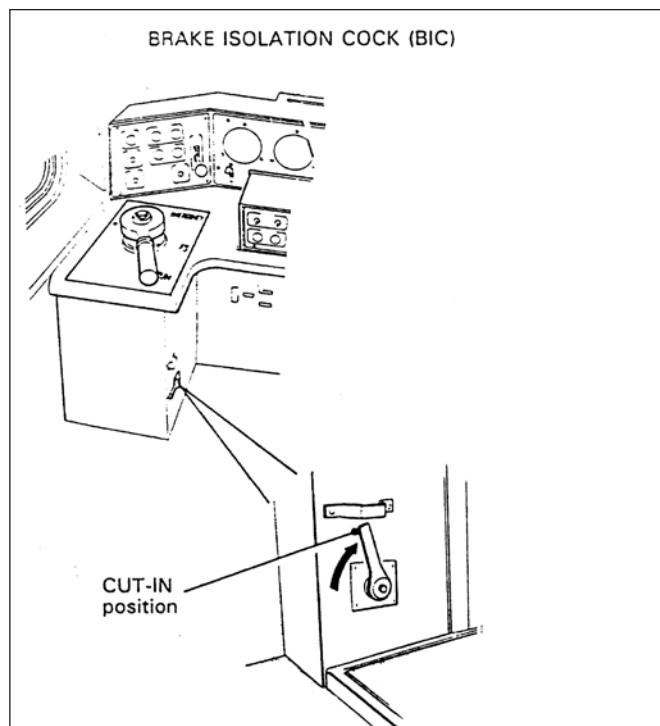


He then said that he waited for a short period of time anticipating that advice regarding the shunting movement would be forthcoming from station staff. When this advice did not materialise, he alighted onto the platform (figure 6 event 2) and looking back along the platform noticed that the passenger information display was now showing the correct return to Melbourne as per his scheduled run for train 5264. He re-entered the driving cabin of car 393, opened the brake valve isolating cock¹⁷ and entered the train description number into the data terminal in the driver's cabin.

¹⁶ Track transponder – a passive 'rail tag' that works in conjunction with the 'on board' POTS controller to identify train location, speed, direction and so on.

¹⁷ The brake valve isolating cock is a device that allows the driver to cut the air brake in or out from the driver's cabin.

FIGURE 3:
Opening brake valve isolating cock



He then said he made a 250kPa¹⁸ brake pipe reduction (by moving the brake handle to the emergency position) and then returned it to the service zone. He then closed the brake valve isolating cock and again alighted from the driver's cabin onto the platform (figure 6, event 3). At this time he checked the destination was correct on the rear of the train before intending to proceed to the opposite end of the train via the staff lavatory on the station platform.

Train 5264 commenced to roll very slowly from Broadmeadows platform as the driver turned and walked towards the station building (figure 6, event 4). By viewing CCTV footage it is concluded that this initial movement took place 190 seconds after coming to a stop as the arriving train 5869. The POTS unit travel report recorded this train traversing the track transponder located on the Up side of the Broadmeadows Platform at 2118:17 travelling at 3 km/h in the Up direction. From viewing the CCTV footage it is estimated that the train took between 70 and 90 seconds from initial movement to interaction with the track transponder.

The station manager, in response to a complaint from a passenger about the train's early departure, proceeded to the platform and saw the train heading towards Melbourne. Contact was then made with the signaller but neither of them were able to confirm if the driver was on board the train. The station manager then went back inside the station building and encountered the driver emerging from the staff lavatory. He then accompanied the driver to the platform and watched the driver run off in the direction of the train. By examining the CCTV footage it is ascertained that 2 minutes and 50 seconds had elapsed since the initial movement of train 5264.

According to the voice transcript, at 2120:52¹⁹ the driver telephoned the Broadmeadows signaller from a phone on a signal post and advised that he had been

¹⁸ KPa – denotes kilopascal, a unit of pressure equal to 1000 pascals.

¹⁹ The voice transcript times are indicative and as such vary slightly from times recorded by the POTS system and signal logging. Additionally, the times recorded reflect the beginning of a conversation, not necessarily the time that the pertinent information was conveyed. They do however represent an accurate sequence of events. All voice transcript times in this report are shown in italics.

unable to board and stop the train (figure 6, event 5). At 2121:30 a Metrol officer answered an emergency call²⁰ from the Broadmeadows signaller and was told that train 5264 had run away from Broadmeadows Station and was heading towards Melbourne (figure 6, event 6). Allowing for the time taken to slowly roll from Broadmeadows Station to the point where interaction with the POTS transponder occurred, it was in the order of four minutes and 50 seconds since initial movement. It was unknown at this time whether or not there were passengers on board the train.

At 2122:46 Metrol requested the Broadmeadows station manager to watch for progress of train 5264 on the CCTVs at remote stations under Broadmeadows surveillance (figure 6 event 7). At 2124:11 the Broadmeadows station manager told Metrol that he had seen train 5264 pass through Glenroy Station (figure 6, event 9). At 2125:03 Metrol officers contacted the station manager at Essendon and asked him to switch the local signal panel in and to keep the runaway movement heading in the Up direction. At 2125:50 the Essendon station manager advised Metrol that he had observed the runaway train go through Glenbervie Station on the CCTV surveillance monitor (figure 6, event 11). Glenbervie is the station on the Down (Broadmeadows) side of Essendon Station and is 7.6 kilometres from Broadmeadows Station.

At 2126:08 Metrol officers spoke to Electrol²¹ about a proposal to isolate the overhead power in an attempt to stop the runaway train. Some discussion then took place regarding the approximate location of the runaway train, the position of the Down Flinders Street Station to Broadmeadows suburban train and what sections of overhead power could be isolated (figure 6, event 12). At 2127 the overhead power was isolated on the Up line between Glenroy and Newmarket (figure 6, event 15).

At 2126:27 Metrol officers told the signaller at Spencer Street number one signal box that there was a runaway electric suburban train and that there was a suggestion that it could be routed towards the area under his control. The signaller advised that he would have a clear road only after the Melbourne to Adelaide Overland Express departed from platform number one. This conversation was not definitive, lasting only 71 seconds and ended inconclusively (figure 6, event 14).

Spencer Street Signal Box – *Yeah?*

Metrol – *Who is this, ****? (persons name)*

Spencer Street Signal Box – *Yeah*

Metrol – *Yeah mate, we got a situation here, we got the runaway train, the up train from Broady.*

Spencer Street Signal Box – *Yeah?*

Metrol – *It's already at Glenbervie going towards Essendon. Just wondering, they suggesting that we going to bring it towards you.*

Spencer Street Signal Box – *You're going to bring it towards me?*

Metrol – *Yep, number one box*

Spencer Street Signal Box – *Oh really? And where am I going to put it?*

Metrol – *Anywhere. Anywhere that's safe for the train to stop. If that one, if that will come towards Spencer Street.*

²⁰ Emergency call- a call made via the SEPAC phone system that is distinguished from a normal call by the operation of an audible and visual alarm.

²¹ The control centre for the Melbourne metropolitan network overhead power.

Spencer Street Signal Box – *I haven't got, I haven't got a platform to put it in.*

Metrol – *You got no platform to put it in?*

Spencer Street Signal Box– *Nope!*

Metrol – *(INAUDIBLE)*

Spencer Street Signal Box – *The only place I'll have is platform one when the Adelaide goes. And then it'll run down and hit the bottom anyway.*

Metrol – *Yeah.....yeah, that's the thing.*

Spencer Street Signal Box – *And it'll run out of wire and then of course nothing moves.*

Metrol – *Mmm-hmmm.*

Spencer Street Signal Box – *And that's what they want to do?*

Metrol – *Yep, that's right.*

Spencer Street Signal Box – *Righto*

Metrol – *OK?*

Spencer Street Signal Box – *No worries.*

Metrol – *No worries, seeya.*

Spencer Street Signal Box – *Yeah, hey listen.....(cut off)*

At 2127:35 Metrol officers received advice from the station manager at Essendon that runaway train 5264 had already passed through Essendon Station and that he could now see this train at Moonee Ponds Station on the remote CCTV monitors. It was now becoming apparent to Metrol officers that isolating the overhead power was not stopping the runaway train (figure 6 event 16).

At 2128:24 a Metrol officer cancelled the route originally set for train 5262 with the intention of re-routing train 5262 via the main suburban line. This cancellation caused signal NME 566 to return to a red aspect and for the points beyond to time out from 2128:31 to 2130:03 (figure 6 event 17). At 2130:01 another Metrol officer contacted the driver of 5262 and told him of the emergency situation and instructed him not to stop at North Melbourne. At the time of this contact, train 5262 was coming to a stand at signal NME 566 (figure 6 event 20). In the meantime (at 2129:47) Metrol officers had again contacted the Spencer Street signallers with confirmation that train 5264 would be routed towards the area under their control. To this end, agreement was hurriedly reached to route the runaway train off the east suburban line onto the country line after it had passed North Melbourne Station (figure 6 event 19).

That train 5264 was rapidly catching up with the previous all stations Broadmeadows to Melbourne train, 5262 was further reinforced during this sequence when communication was received from the signaller at Kensington that the runaway had gone through Kensington Station at 2130 and was 'going like a tyrant'.

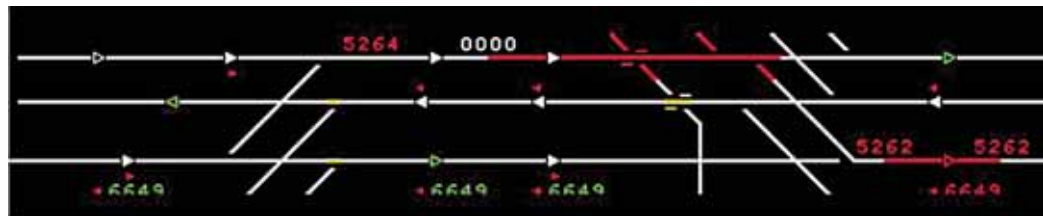
When signal NME 566 cleared at 2130:17²² the driver of 5262 accelerated his train through the points leading to the main suburban route. As he was moving off the driver of 5262 informed Metrol controllers that he could see the runaway train in his rear vision mirrors and that it was travelling at speed (figure 6 event 21). The driver of

²² Signal logging is time stamped and accurate.

train 5262 subsequently told the investigation team that he felt sure the runaway train was going to hit his train. The speed attained by train 5262 through these points was in the order of 62 km/h. The speed limit for a turnout movement at these points is 40 km/h.

The signaller at Metrol then reversed the points immediately beyond signal NME 566 the moment train 5262 cleared the relevant track circuitry. At this time the signaller's VDU screen showed all routes occupied in red and the train radio was crackling, indicating that a collision may have occurred. Metrol staff urgently tried to contact the driver, without immediate success. After a short period they received an answer from the driver of 5262 (at about 2131:20) telling them that the runaway train had passed his train on the east suburban line and was proceeding through platform one North Melbourne at speed (figure 6 event 26).

FIGURE 4:
Signallers VDU screen indicating possible collision



Metrol signal logging revealed that the leading bogie of train 5262 occupied the first track circuit immediately beyond signal NME 566 at 2130:29 and that train 5264 passed signal NME 566 in the stop position, thereby occupying the same track circuit, 33 seconds later at 2131:02 (figure 6 event 24). Points NME 464 are 158 metres beyond signal NME 566 and are the points that set the route for either the Up east or Up main suburban lines. Metrol signal logging revealed that these points reset to the east suburban route and detected normal²³ at 2131:09. If the runaway train was travelling at 80 km/h it would take about seven seconds to traverse the 158 metres from signal NME 566 to points NME 464. The runaway train therefore traversed these points as they were detecting normal (figure 6 event 25). The runaway train then proceeded along the east suburban route. There is therefore no doubt that runaway train 5264 came within a second of being placed on a collision course with train 5262.

During and immediately after the sequence of events surrounding the near miss with train 5262 (at 2130:50) the Spencer Street Signallers telephoned Metrol. The Spencer Street Signallers were told that the runaway train was now very close. Because the Melbourne to Adelaide Overland express was still standing at platform one the Spencer Street signaller told Metrol to route the runaway via the East Country line in lieu of the Country line (figure 6 event 22). At 2131:28 and 2131:32 overlapping conversations took place between Metrol officers and the two signallers at Spencer Street. These conversations in effect advised that the arrival of the runaway train was imminent. The Spencer Street signallers protested that they still did not have a clear road. In response Metrol indicated the train was travelling at speed and that they could not stop it.

²³ Detecting normal- points are regarded as being in the normal position when laying for main route.

As they were speaking to Metrol, the Spencer Street signallers saw the runaway approaching at speed but had few options available as the route had only just been taken off the Bacchus Marsh train and the points run down²⁴ had not expired (figure 6 event 27). This train was due to depart from number two platform at Spencer Street at 2135. The runaway electric then trailed (smashed) through a set of points that were set for the route of train 8141. This event effectively 'stole the route' of train 8141 thereby putting the runaway electric on a collision course with this train.

At 2132:15 a signaller from Metrol telephoned a Connex employee working in the control room on platforms nine and ten at Spencer Street Station advising that there was a runaway train heading into the unwired platforms at Spencer Street Station and for this person to get everyone clear. The Connex employee thought that the runaway train was heading towards the electrically wired suburban platforms. At this time an empty electric suburban train was coming into platform 14 and the Connex employee thought this might have been the train spoken of. A loud bang was then heard and the Connex employee thought a collision had occurred on platform 14. The message seemed contradictory to him so in the short time available (about 45 seconds) he did not effectively act upon it.

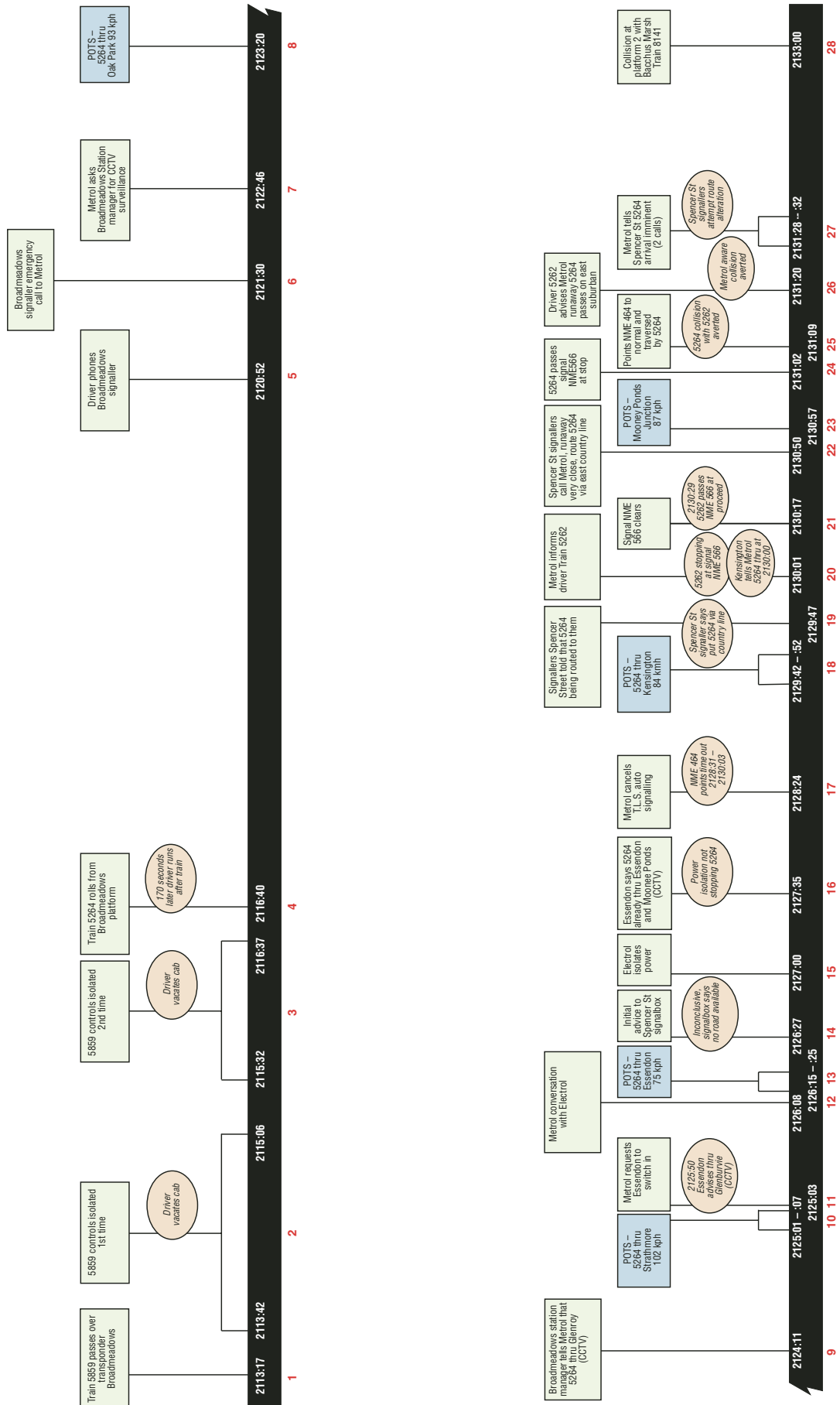
At about 2133 runaway electric suburban train number 5264 collided with the stationary Bacchus Marsh train at platform 2 at an estimated speed of 75 km/h (figure 6 event 28). Emergency services had already been contacted shortly before the collision and were on the scene within minutes. When the collision occurred it was still unknown by all involved whether or not there were passengers on board the runaway electric suburban train.

FIGURE 5:
Collision between trains 5264 and 8141



²⁴ Run down – a time out that prevents points being altered prematurely, thereby mitigating against derailment.

FIGURE 6:
Timeline sequence of events



3.8 Injuries

At the time of completion of this investigation, it had been reported that eight passengers on the Bacchus Marsh train sustained minor injuries as a result of this collision. The worst injury suffered was a dislocated knee. Four were treated on site, two were conveyed to the Footscray Western General Hospital, one to the Royal Melbourne Hospital and one to St Vincent's Hospital.

3.9 Damage to trains 5264 and 8141

Damage sustained to the lead car of train 5264 (car 394) was severe. The driver's compartment and passenger vestibule immediately behind the driver's compartment bore the brunt of this damage. See Appendix 8.1 for more detailed description of the damage to train 5264.

FIGURE 7:
Damage to drivers cabin, car 394



FIGURE 8:
Damage to passenger vestibule car 394



The damage to train 8141 was primarily confined to locomotive N463, the leading driver's cab in particular. A detailed description of the damage sustained to train 8141 is contained at appendix 8.1.

FIGURE 9:
Damage to driver's cabin, N463



3.10 Crashworthiness of Comeng suburban electric trains

The destruction of the driving cab and failure of the collision posts of motor car 393 was as a result of the impact which imposed forces over and above that specified in the Railways of Australia Manual of Engineering Standards and Practices. These standards have been developed over time and in response to previous accidents that have been experienced in this country and overseas. As a result, the cars are designed to provide sufficient strength to resist an impact with vehicles of similar weight, on straight and level track, at speeds of up to 15 kilometres per hour with no resultant body damage. This speed has been determined to be representative of possible mishaps within the system.

Further, the cars have been designed so that in the less likely event of more significant impacts, the car body structure will collapse in a controlled manner in order to minimise injury to those on board.

The speed involved in the collision (75 km/h) was far in excess of the crashworthiness design criteria. While there is no evidence that the vehicles involved in the accident failed to meet the 15 km/h criteria, the lead carriage in particular experienced significant damage.

3.11 Damage to infrastructure

The only damage to infrastructure was at number 77 points at Spencer Street Station. This set of points was slightly damaged as a result of the runaway suburban electric train trailing through them when they were not set for this movement. The blade of the points was slightly bent as was the spreader bar between the two blades. These points were repaired within hours of the accident.

3.12 Employee issues

3.12.1 Train crew details

The driver of train 5264 was a 37 year old male who was fully qualified in all aspects of the position as a suburban electric train driver for M>Train. He commenced his railway career in 1985 as a trainee engineman at V/Line and resigned in 1992, by this time holding the position of locomotive driver. He subsequently joined Hillside Trains (now Connex) in 1998 and attained the position of driver. He transferred to Bayside Trains (now M>Train) in May 2000 as an electric train driver, which was his position of employment at the time of the accident.

On 3 February 2003 he had signed on for duty at 1420 at Flinders Street Station. His first turn of duty was to drive a suburban electric from Flinders Street to Sandringham and return to Flinders Street. He then had a meal break. The next run was to work train 5859 Flinders Street to Broadmeadows returning to Spencer Street on train 5264.

A review of the driver's competency records revealed no non-compliances or disciplinary issues. In addition, he had not been involved in any concerns in relation to occupational health and safety.

3.12.2 Train 5264 driver medical examinations

Medical examinations are periodically undertaken by drivers employed by M>Train, the frequency being dictated by the age of the employee. In this instance, the driver was 37 years of age and was therefore required to undertake a medical examination

every four years. A subsequent medical examination on 14 March 2002 concluded the driver was fit for duty. This was four years and one day after undertaking a pre employment medical prior to commencing employment with Hillside Trains. In addition, a drug-screening test was undertaken in May 2000 prior to being employed by M>Trains. No adverse results were found.

3.12.3 Train controller / signaller medical examinations

The medical referral forms for train controllers and signallers directly involved in this accident have been examined. All have been certified as fit for duty at varying times since the year 2000.

3.12.4 Train 5264 driver audit requirements

Driver's employed by M>Train are to be audited twice every year in accordance with work instruction titled 'Train Driver Safety Audits', Issue Number One, dated 31 December 2002. Prior to this date drivers employed by M>Train were to be audited twice every year in accordance with quality procedure 'Guidelines for Met Train Drivers Safety Audit, New Driver Validation and Re-Accreditation Checklists' dated 2 July 1996.

An examination of records provided by M>Train reveals that the driver of the runaway electric train had been audited a total of three times since he commenced employment with M>Train in May 2000. The dates of these driver safety audits were 3 December 2000, 8 June 2001 and 12 August 2002. No deficiencies were recorded in the three driver safety audits conducted.

3.12.5 Toxicology

The driver of the runaway electric train 5264 was breath tested at 2352 by a principal driver and recorded a negative result. Additionally, a preliminary breath test and impairment assessment record form, number 08551, was compiled. No impairments other than post-traumatic stress were noted.

3.12.6 Shift and fatigue management, driver 5264

The previous shifts that the driver of runaway suburban electric train 5264 had worked up to and including 3 February 2003 have been examined. Although his shift of duty on the day of the accident was additional to the roster (ie overtime), fatigue is not considered a factor in this instance as this was the first shift of duty after four clear days off duty.

3.12.7 Shift and fatigue management, controllers and signallers

The shifts of duty worked by the controllers and signallers who were involved in this accident were examined. This examination revealed instances where night shifts were grouped together as rostered working. Overtime call-outs generally exacerbate fatigue. Of the shift duty patterns examined, there were two notable cases of rosters resulting in high levels of fatigue.

In the first instance a controller at the Metrol centre had worked seven 2145 to 0600 shifts in a row, the seventh shift falling on the evening of the Spencer Street Station collision. This person was heavily involved in the management of this incident, in particular the events en route from Broadmeadows Station. In the second instance, a

signaller at the Spencer Street number one signal box worked a block of three 1400 to 2205 shifts followed by one 2345 to 0605 (overtime) and six 2200 to 0705 shifts between 29 January 2003 and 7 February 2003. On the evening of the accident at Spencer Street he was working the sixth shift of this roster sequence.

3.13 Driver's actions

3.13.1 Sequence of events, driver's actions, Broadmeadows Station

Following the train's arrival the sequence of events as observed on the CCTV tapes after train 5869 came to a stop are:

- The driver extinguishes train headlights 52 seconds later
- The driver extinguishes train ditch lights 3 seconds after this
- The driver then leaves the driving cabin 29 seconds later and checks the rear of train and passenger information displayed on the platform
- The driver re-enters driving cabin 26 seconds later, unlocking the cab door in the process
- The driver leaves the driving cab again 65 seconds later, briefly checks the rear of the train, turns and walks to station building
- The train commences to roll towards Melbourne 3 seconds later
- The driver opens door to the amenities facilities and goes inside 12 seconds later
- A station officer steps onto the platform 118 seconds later and looks in the 'down' direction
- The station officer re-enters the station building 20 seconds later, taking several seconds to unlock the door
- The driver and station officer step onto platform 20 seconds later
- The driver immediately runs after his train 170 seconds after the initial unplanned movement of train 5264
- Station officer re-enters the station building 60 seconds later
- The driver re-appears from the Melbourne end of platform and enters station building 185 seconds after running after his train.

3.13.2 Driver duties – changing driving cabins

When changing ends at a terminal location, the driver of a Comeng electric suburban train has a number of defined duties to perform, some of which are critical to the safety of the train. These defined duties are contained in three separate documents:

- Procedures M.O-13 titled 'Changing Ends' dated 25 November 1997.
- Work Instruction, Refurbished Comeng Trains Function and Operation of Innovonics Equipment dated 1 October 2001.
- A Cab Unattended 'Procedure' that is contained in the Book of Rules, revision three, 1996.

3.13.3 Driver's procedures, changing driving cabins

The driver of Down train 5859 had to configure the consist as the Up (return) service 5264 by changing ends. Procedure M.O-13, titled 'Changing Ends' reads as follows:

Met Train Driver's must adopt the following procedure when changing ends on Suburban Electric Trains.

1. Apply the automatic air brake by placing the brake controller handle into the 'emergency' position. Close the driver's brake valve isolating cock and return the brake controller handle to the 'run' position.
2. Place the trip valve latching switch to the 'up' position and note the brake pipe and brake cylinder pressure on the driver's gauges.
3. Lock the reverser and remove the controller key.
4. Switch the marker lights off, tail lights on and set the destination indicator to 'Blank'. Switch headlights off.
5. Fold in the rear vision mirrors, close all windows, note that the brake pipe and brake cylinder pressure has remained constant, lock the driving compartment door and lock both van doors.
6. Visually inspect the rear of the train.
7. Proceed to the opposite end of the train checking for any obvious train malfunctions and that the pantographs are in good order.
8. Upon arriving at the opposite end of the train, unlock both van doors and the driving compartment door. Fold out the rear vision mirrors.
9. Open the driver's brake valve isolating cock and when brake pipe pressure rises to approximately 300kPa, place the trip-latching switch to the 'lower' position. Place the brake controller handle to the 'emergency' position to reset the trip and then return the brake controller handle to an applied position.
10. Set marker lights, destination indicator and switch the headlights on if required.
11. Visually inspect the front of the train.
12. Place the controller key in the reverser and unlock it.

The following notation is then made (bold type in original):

'(a) At any time that the driver is required to leave the train (to go to the Station Office, toilet etc.) the 'Cab Unattended Procedure' as per page 10-5 of the Book of Rules and Operating Procedures, must be strictly adhered to (apply & isolate the brake, apply the hand / park brake and lock all doors).'

The date of issue of this procedure, M.O-13, Changing Ends, was 19 July 1996. The Quality Assurance Officer, in the first review of this procedure on 25 November 1997, made the following amendments to the 'Front Control Sheet':

1. Review date changed to read 'Review August 1999'.
2. Date of issue and revision amended.
3. Pages amended to read 'Total Pages'.
4. New field attached to the footer.

The proposed review in August 1999 did not take place. Indeed, it would appear that no review of this procedure has taken place since 25 November 1997.

3.13.4 Cab Unattended Procedure

The 'Cab Unattended Procedure' is actually an extract from the Book of Rules, 1994, revision three 1996. The text of this 'procedure' reads as follows-

'When a driver is required to leave the locomotive, the rules and operating procedures must be adhered to, and the driver must comply with the 'cab unattended' procedure.

In the case of an electric suburban train, except when changing ends or giving assistance to customers with special needs, the driver must ensure the park brake is applied, apply and isolate brake, lock all doors, and take the controller key.'

3.13.5 Entering information into the Passenger Information Display System

Driver instructions for entering information into the Passenger Information Display System (PIDS) are contained in a document titled 'Refurbished Comeng Trains Function and Operation of Innovonics Equipment' issue number one dated 1 October 2001. Under a sub heading titled 'To Enter Train Descriptor Number' the following instructions are provided.

- Driver's brake valve isolating cock must be cut in.
- The up and down buttons on the driver's display unit are used to select the required train descriptor numbers.
- The two blank buttons are pressed to move either left or right to enter the next digit of the train descriptor number.
- Then press the accept button.

The headboard at the front and rear of the train and the internal displays will now update to their destination. The destination will also be displayed at the bottom of the driver's display unit. Automatic P.A. announcements will also be available and the running conditions of the train will also be displayed on the internal display in the saloon area.

3.14 Train information

3.14.1 Comeng suburban electric trains

Train 5264 was a three car Comeng suburban electric train. One hundred and ninety of these trains were built by Comeng (Victoria) Pty Limited between 1981 and 1989 of which one hundred and eighteen were utilised by M>Train. These trains are 71.2 metres in length with a tare weight of 135.54 tonnes. The maximum passenger capacity of these trains is 295 persons seated and 696 persons under crush load conditions.

Comeng suburban electric trains are maintained by M>Train Fleet Maintenance which, although being a separate company in its own right, reports directly to the Fleet Engineer, M>Train. These trains are maintained as per the M>Train Fleet Asset Management Plan. This plan is based on a preventative maintenance regime of vehicle examinations and component change outs scheduled to maximise reliability in a cost effective manner. Typically the Comeng suburban electric trains average about 2,300 kilometres per week or about 120,000 kilometres per annum. The servicing requirements as set out in the M>Train Fleet Asset Management Plan can be found at appendix 8.2.

An examination of company records and work plans since January 2001 revealed that these trains had been generally maintained in accordance with the M>Train's Fleet Asset Management Plan.

3.14.2 Examination and testing of braking equipment, train 5264

The ATSB engaged an expert engineering firm with extensive expertise in rail as independent consultants to this investigation. Testing of the brake equipment on Comeng units motor car 393 and trailer 1048 was conducted by these consultants at Newport Workshops on 12 February 2003. These tests were designed to replicate the actions of the driver as stated by him. This testing was carried out in two stages.

The first phase of testing was conducted by coupling motor car 393 and trailer car 1048 to a 'live' Comeng motor car unit, number 329. Air and power could then be admitted to the braking system and the testing of a number of scenarios permitted. The 'live' Comeng motor car was in lieu of motor car 394 that was badly damaged as a result of the collision at Spencer Street. M>Train, Rail Tram and Bus Union and ATSB representatives were in attendance for this stage of testing.

The second phase of testing was conducted by removing brake equipment from motor car 393 and trailer 1048 in order to test this equipment remotely at the Ballarat workshops. This testing was carried out on the Westinghouse test benches at these workshops on 27 February 2003.

Of note is that on 11 May 2002 the brakes on trailer car 1048 were booked as leaking off on all wheels and on 28 December 2002 the brakes on unit 393 were booked as leaking off with the brake valve isolating cock closed. In both instances a faulty triple valve was replaced. Although there have been other brake faults booked since these dates, none relate to an unintended release of brakes.

The key conclusions of this report are:

The testing of the brake equipment has shown that there were no defects in brake system performance that could have contributed to the runaway and subsequent collision at Spencer Street. Tests carried out that were designed to replicate the actions of the driver did not result in a release of braking effort. A similar alternative procedure that caused a release of the brakes in every instance was identified.

An examination of the maintenance records for Comeng train 393M/1048T/394M shows that the brake equipment had generally been maintained in accordance with the M>Train Fleet Asset Management Plan with the exception that 'C' type examinations were not in accordance with the interval laid down. 'C' type examinations contains attention to brake cylinders and rigging.

That a 'fix when failed' methodology appears to be in force. This methodology relies on the inherent redundancy in the design features of the brake system to mitigate against risks associated with brake device failures. This report recommends that an overhaul program be instituted. Also noted was that that maintenance documentation is not consolidated into a single system of documents. Most of the necessary information appears to be available but there seemed to be some gaps at detail level. The report assumed that the maintenance documentation is ongoing in terms of the conversion of earlier documents and their inclusion into the M>Train system as the 'M>Train Fleet Asset Management Plan'.

There does not appear to be any routine maintenance applied to the pilot valve foot pedal nor is its operation checked more often than a 'D' examination (four months). The operation of the pilot valve foot pedal is not routinely checked as part of the driver's preparation of a Comeng train.

A brief description of the braking system fitted to Comeng suburban electric trains and signal train stop mechanisms is contained at appendix 8.3 of this report.

3.14.3 Description of parking brake system, Comeng suburban electric trains

The spring parking brake, as its name implies, is applied by means of a spring. When activated, this spring applied force through a push rod to the brake cylinder and rigging causing the brakes to apply.

The spring park brake is held off by main reservoir air and application is by removal of main reservoir air. This allows the pressure of the spring to become the dominant force thereby applying the park brake in conjunction with a loss of main reservoir air. The spring parking brake is 'train line circuited' meaning that it can be applied or released from any driver's cab by means of on / off buttons. These buttons should be depressed for at least five seconds to ensure the release of all park brakes in the consist. The holding in of this button activates an electric solenoid, which operates a valve manifold that closes off main reservoir air and vents the spring parking brake cylinders to atmosphere.

Each cab is fitted with a spring parking brake gauge indicating whether they are on or off as well as a white dash light which remains on whenever any parking brake is on throughout the train. The spring parking brakes are set up to apply if the main reservoir pressure drops below 350 kPa.

The parking brake is applied and released from the driver's cab by pressing the parking brake 'on' or 'off' button as the case may be. These buttons are mounted together (vertically) on the centre wall opposite the driver's station with the 'on' button being on top and the 'off' button immediately below. The investigation team observed a number of instances where the order of these buttons was reversed. That is, in some instances the parking brake 'off' button was on top and the 'on' button immediately below. This incorrect configuration does not comply with the approved design and therefore has the potential to impact on safety accreditation.

3.14.4 Passenger Information Display System

With the refurbishment of the Comeng fleet of suburban electric trains from March 2001 an integrated communications system was fitted. This communications / information system is commonly known as the passenger information display system (PIDS) and has the following core functions:

- Automatic setting and updates of the train destination board.
- Automatic control of passenger information text signage in passenger saloons.
- Automatic control of public address announcements.
- Passenger emergency intercoms.
- Automatic closed circuit TV.
- LCD flat panel driver's display unit. This unit provides information regarding the status of the passenger information display, closed circuit TV, destination and passenger emergency intercom systems.

The driver enters information via the driver's display unit that is located in the driver's cabin. The driver's display unit is only active when the brake valve isolating cock is open and, as a consequence, all other driver's display units in remote cabins are inactive. If a train description number is entered via the driver's display unit and the brake valve isolating cock is subsequently closed, the displays in the internal passenger saloon and external destination headboard will be retained for three minutes. Once this period had elapsed, the displays will be removed and a default greeting displayed in lieu. The main purpose of this feature is to allow a driver to comply with the procedure for assisting customers with special needs without the signage in the passenger saloon altering. The brake valve isolating cock has to be closed to comply with this procedure.

When entered by the driver, the train description number is used:

- To interact with the position of train system (POTS) by reporting the train number to the POTS server computer. This number is then shown against that train as part of the POTS unit travel report.
- As the primary reference in the PIDS where messages are customised for each train description number.
- In the closed circuit TV recorder, where the train number is incorporated in each image as reference data.

3.14.5 Position of train system and verification of data

A POTS controller is located beneath each trailer car of a Comeng suburban electric train. These controllers interact with track transponders installed at strategic locations throughout the Melbourne suburban network. Track transponders are passive and when interaction occurs with the 'on board' POTS controllers they transmit a unique serial (tag) number that identifies that particular track transponder to the 'on board' POTS controller.

This identification tag number, along with the information contained in the 'on board' POTS controller, is then sent electronically to the POTS server. This server is located in the Transport House Building in Collins Street in Melbourne's CBD. This information is, in effect, a 'package' of information incorporating facets such as train direction, speed, position of the brake valve isolating cock, time and so on.

When the driver opens the brake valve isolating cock and enters the train number into the driver's display unit this information is immediately sent and stored in the 'on board' POTS controller. Unlike the displays in the passenger saloon compartments and external headboards, the 'on board' POTS controller retains and transmits this information to the POTS server even if the brake valve isolating cock is closed. This information exchange continues until a new number is entered, a failure of some sort is encountered or a power outage occurs.

Information sent from the driver's display to the on board POTS controller is protected by low-level communications (CanBUS) checksums to ensure data integrity. All information sent from the on board POTS controller to the POTS server via the radio network is protected by low-level protocol checksums (MASC & ROSI). This is

done to ensure that there is no packet corruption between the POTS controller and radio modem, or the radio modem and the radio network base stations. There are also checksums in the protocols that handle the link from the base stations to the radio network exchange and from the radio network exchange to the POTS server.

Once a packet reaches the POTS server, the server performs checks on the packet length, source and destination addresses before processing the packet as valid data. If the modem addresses are not valid or the tag is not valid, the packet is logged and not processed. Once processed it is entered into the server database which is specifically designed to prevent any form of data corruption through transaction logging. The data base is stored on a NTFS file system on RAID to further protect against data corruption.

In relation to accuracy of time recordings the following occurs:

- The POTS server obtains accurate time from a Telstra civil time receiver. The POTS server sets its system time every five minutes using this time reference as the source.
- Every 20 minutes, the POTS server broadcasts the time to all in-contact on board POTS controllers via the packet radio network.
- Each on board POTS controller contains a battery backed up real-time clock. When a time synchronise broadcast is received, the time is stored in this real-time clock.
- When the on board POTS controller crosses a track transponder (tag), the on board POTS controller uses as a time stamp the current time in the on board real time clock. This time stamp is then sent to the POTS server.

3.14.6 Description of train 8141

Train 8141 consisted of N class diesel electric locomotive number 463 and four passenger carriages classified and numbered as BTH 167, BH 147, BIH 187 & BCH 127. The gross weight of train 8141 was 257.54 tonnes and the length was 91.29 metres.

N Class diesel locomotives weigh 124 tonnes, are 20.034 metres in length and have a power rating of 1840 gross kw / 1680 net kw. The combined trailing consist (four passenger coaches) weighed 133.54 tonnes and was 71.26 metres in length.

3.15 Track and other infrastructure

3.15.1 Track design and permissible speeds

The Up track from Broadmeadows to Spencer Street Station consists of 53 kg/m rail secured onto timber sleepers by either rail clips or dogspikes. There are some very short sections where concrete sleepers are laid, particularly through stations and at level crossings, but timber sleepers predominate. The track bed is made up of crushed rock ballast.

The maximum speed for electric suburban trains on the Up line from Broadmeadows to Newmarket Junction is 80 km/h. A speed restriction of 55 km/h applies at Essendon Station from the Up home arrival home signal. From Newmarket Junction to North Melbourne the maximum speed for suburban electric trains is 65 km/h and from North Melbourne to Spencer Street (via the east suburban line) is also 65 km/h. The maximum speed for trains diverging from the east suburban line to Spencer Street Station platforms one to six is 40 km/h, reducing to 25 km/h for much of the remaining shunt yard and points.

There are no catch points²⁵ on either the Up or Down main lines between Broadmeadows and Spencer Street Station. The use of catch points on main lines varies between rail systems in Australia, the benefits and drawbacks having been the subject of some debate over time. Given the general design of rail vehicles and, in particular, their vulnerability in the advent of a roll-over accident, this debate has broadly centred on whether there is more risk in intentionally derailing a train at main line speed or bearing the consequences of an authority being exceeded. Some systems have made extensive use of catch points in localities that are subject to heavy traffic and (potentially) conflicting movements and others little or none.

The design and condition of track infrastructure is not considered to be a contributing factor in regard to this accident.

3.15.2 Electrical infrastructure

Melbourne suburban electric trains are powered by a 1500 V direct current (DC) overhead system. The overhead wires are supported by structures at intervals of about 70 to 90 metres. The contact wire height is between 4.7 and 5.8 metres above the rail level and the supply of power to the system is monitored and controlled by Electrol.

In an attempt to stop runaway electric train 5264 the power was isolated on the Up line between Newmarket and Glenroy at 2127 on 3 February 2003. This action caused the rear pantograph (on car 393) to drop and the lead pantograph (on car 394) to remain in the raised position. This was due to a feature fitted to all Melbourne suburban electric trains that was designed to alleviate a major power drain on the system in the event of overhead power being restored after an unplanned shut down.

On the approach to Spencer Street Station the east, main and through suburban lines are all wired for the passage of electric suburban trains. The approach to Spencer Street Station platforms one to seven is not. When electric suburban train 5264 was diverted from the east suburban line towards platforms one to seven the overhead wire ran out and the front pantograph fully extended vertically, subsequently becoming 'out of gauge'. As a consequence, the pantograph struck various infrastructure items and sustained damage.

²⁵ Catch points are points that, according to the route set, are deliberately opened in order to halt an unauthorised movement by derailing the train in question.

FIGURE 10:
Damaged fully extended pantograph



3.15.3 Signalling infrastructure

Signalling on the Broadmeadows to Spencer Street route is defined as ‘automatic block signalling’ and comprises a mix of controlled and automatic signals that allows for single direction movements only. Between Broadmeadows Station and Newmarket the signalling system is three aspect colour light signals with the exception of the four aspect colour light signalling at the Broadmeadows and Essendon interlockings²⁶ and between Glenroy and Jacana (Up line only). The signalling system between Newmarket and Spencer Street is four aspect colour light signals. A general description of three and four aspect signal indications is at appendix 8.5.

Runaway electric suburban train 5264 passed 41 signals from Broadmeadows Station to Spencer Street Station. Of this total, 36 were passed in the proceed position and five were passed in the stop position. All signal indications were correct in accordance with track circuit occupancy by trains. The five signals passed at stop were:

- E516 Automatic signal Glenroy, this signal clears to a proceed aspect in conjunction with the boom gates protecting Glenroy Road.
- NME 564 Up home arrival signal North Melbourne. This signal is controlled by Metrol.
- NME 566 Up home arrival signal North Melbourne. This signal is controlled by Metrol.
- SST 512 Controlled automatic signal on the approach to Spencer Street. This signal works in conjunction with signal SST 514.

²⁶ Interlocking- the term used to describe a locally signalled area.

- SST 514 Up home arrival signal Spencer Street. This signal is controlled by Spencer Street number one box.

All signals on the Up line between Broadmeadows and Spencer Street have automatic train stops fitted except for signals SST 512 and SST 514 at Spencer Street. In this instance these train stops did not stop the runaway train because the leading trip valve was not cut in.

Level crossings between Broadmeadows and Spencer Street are equipped with a circuitry design that enables some signals (in the Up direction only) to be set for either stopping or express train modes, thereby reducing dwell times for road traffic at level crossings. This feature can be set manually by the Broadmeadows signaller for the section Broadmeadows to the level crossing at Gaffney Street and automatically by timing circuit at Glenbervie platform for the level crossings at Buckley, Park and Puckle Streets. The express mode allows for an earlier clearance of signals and operation of boom barriers and, as a consequence, reduced dwell time for road traffic. Because train 5264 did not stop at Glenbervie Station, the express mode was automatically selected for the level crossings at Buckley, Park and Puckle Streets.

There was the potential for train 5264 to traverse the Macaulay Road level crossing with the boom gates in the vertical position because these gates are operated in conjunction with routes set by the Kensington signaller. On this occasion though, the signaller at the Kensington Signalbox had the presence of mind to clear the home/starter signal thereby lowering the boom barriers prior to train 5264 traversing this level crossing. The POTS travel unit report records train 5264 travelling at 82 km/h at the Up end of Kensington Station.

At all other level crossings en route the redundancy relative to the maximum permitted speed was sufficient and all boom barriers were horizontal and pedestrian gates were fully closed, albeit with reduced margins.

3.16 Signal and train control

The Metrol train control centre supervises train movements between Broadmeadows and Spencer Street, and other routes in the Melbourne area. Supervisors, controllers, signallers and support personnel staff this complex. National Express Group (Australia) Pty Ltd and Connex personnel, although occupying separate floor space, each supervise their respective train movements from this complex. The complex is basically an open plan environment that allows for an easy exchange of verbal information.

Trains between Broadmeadows Station and signal NME 562, (between Kensington and North Melbourne), are signalled 'from the field' by locally controlled signal boxes. These signal boxes signal and route trains under instruction from the Metrol complex.

Train routing and signalling from signal NME 562 to Spencer Street Station platforms eight to 14 and beyond via the through, main and east suburban lines are controlled by the signallers located in the Metrol complex. These signallers act according to the direction of train controllers and supervisors stationed in the Metrol complex.

Spencer Street signallers set signals and routes for train arrivals and departures within the area of their control as per instructions received from the Metrol complex. Also, they set the routes and signals for shunting movements within the Spencer Street precinct, platforms one to seven and associated sidings, as per instructions from the Spencer Street yard master and shunting staff.

3.17 Communications

There are four distinct systems of voice communications between the Metrol control complex and personnel in the field. They are the train radio system, PABX phone system, SEPAC phone system, and cellular phones.

The principal medium of communications between Metrol officers and drivers of suburban electric trains is via the train radio system. When taking over a train or commencing a journey the driver is required to enter the four-digit train describer number into the train radio system. When this is done, this number then appears on the visual display unit at Metrol. Contact between Metrol officers and the driver concerned can then be made by operating the touch screen on the visual display unit at the signaller's workstation. Likewise, a driver can contact Metrol officers by pushing the applicable call button on the train radio system and a visual indication of the number of the train that was calling appears on the signaller's visual display unit. Issues arise though, if the driver has omitted to enter the four-digit train describer number or some fault in transmission has occurred.

The secondary medium of communication between Metrol officers and drivers is via mobile phone. All drivers are issued with a company phone that have key numbers programmed into them. If Metrol officers desire to contact the driver they have to obtain the number of the phone issued and then connect via the PABX phone system.

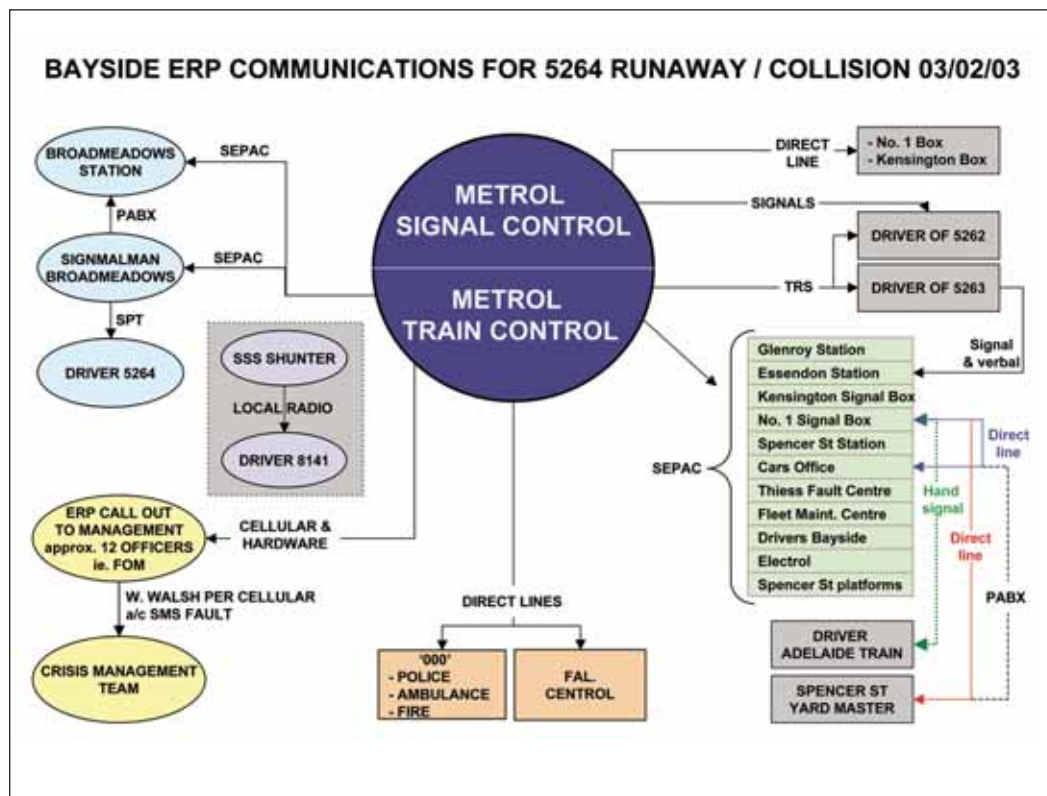
The PABX system is an internal phone network that operates through an internal five-digit telephone exchange. Contact numbers have to be obtained and then manually dialled. The PABX is not a direct phone system.

The SEPAC system is a dedicated system that operates between train control and staff in the field. Station masters, signal boxes, train crew supervisory staff and so on are all connected to the Metrol control centre via the SEPAC phone system. Metrol officers can make a call by pushing a coded button on the phone whereupon they are connected directly to the other party. For example, Metrol officers can call Broadmeadow Station by pressing the button coded as BMSO or the Broadmeadows signaller by pressing the button coded as BMS1. Likewise, Broadmeadows staff could initiate a call to Metrol by pressing a button that would cause the phone at the Metrol control complex to ring. The SEPAC phone system is an open line connection meaning that personnel from several locations could all be on the line at once. This system has been described as being akin to a 'party line' type of phone line.

In addition to these four distinct systems of communication, there is a direct line between Metrol and the Spencer Street number one signal-box. Nearly all communication between these two parties is via this line.

There is no open channel radio system in the Melbourne suburban rail network. Therefore, there was no way in which 'broadcast' messages over the rail network could be made.

FIGURE 11:
Schematic diagram of communications



3.18 Environmental factors

Sunset on 3 February at North Melbourne was at 1932 and Civil Twilight at 2001. The Bureau of Meteorology weather data for the night of 3 February 2003 in the Melbourne Airport locality was as follows.

At 2100 the weather was fine, dark (moonrise was at 2310) and clear with a north / northeasterly wind of 16 km/h, gusting to 21 km/h. The temperature was 27.6 degrees Celsius and the relative humidity 33 per cent.

At 2130 the weather was fine, dark and clear with a northerly wind of 11 km/h gusting to 17 km/h. The temperature was 26.8 Celsius and the relative humidity 36 per cent.

The orientation of Broadmeadows Station is approximately north / northeast. It is remotely possible therefore, that the north / north-easterly wind, although moderate, could have played a part in the initial movement of electric suburban train 5264 from Broadmeadows Station.

3.19 Previous instances of runaway suburban electric trains

Since 1975 there have been three previous incidents of 'runaway' electric trains without a driver on board. Two of the three incidents involved trains that also carried guards.

In 1975 a two carriage electric train ran a distance of about nine km from Camberwell Station and ran to Flinders Street Station. In 1977 a suburban electric train 'ran away' from Gowrie Station over a distance of 12 km, smashing through seven level crossing gates set in favour of road traffic. In 1996 a suburban train rolled 200 m from Spencer Street Station without a driver on board. This train was brought to halt by the train stop at the trailing end tripping at a stop signal.

In all three incidents the driver had not applied the handbrakes/park brakes before leaving the driver's cab. Each case involved a violation of the standard procedures by the driver and, where present, the guard. Punitive action was taken against the train crew in each case.

In none of the incidents was anybody hurt but the potential for fatalities, the destruction of vehicles and infrastructure was very real. These three incidents illustrate that the incident involving train 5264 was not unique or unpredictable. Further information regarding these incidents is at Appendix 8.4.

3.20 Organisational context

3.20.1 Background

In April 1997 the Victorian Government took the decision to privatise the Victorian rail and tram systems. Interested parties were invited to submit expressions of interest in 1998. National Express evaluated the franchise and lodged an expression of interest in January 1999. Between January 1999 and May 1999 National Express, along with other potential tenders, undertook a detailed examination of all facets of the proposed franchise with the assistance of the Public Transport Commission.

National Express was announced as the preferred tenderer for Bayside Trains, V/Line Passenger and Swanson Trams on 26 June 1999. On 29 August 1999 the company operating Bayside Trains was formally taken over by National Express (Bayside Trains) Pty Ltd. In this role, National Express (Bayside Trains) operate about 30,000 train services per month and, in the year 2001/2002, carried 76 million passengers. The fleet of trains consists of 77 six-car suburban electric trains and a sole diesel locomotive powered engine and coaches service between Frankston and Stony Point.

On 22 December 2002 National Express withdrew from its M>Train, M>Tram and V / Line passenger franchises. KPMG Corporate Recovery are continuing to act as receivers and managers for the three rail operating businesses and Bayside Train Maintenance. On 15 January 2003 the Victorian Government announced that it had established a new company, Victorian Rail Services Pty Ltd to acquire the assets of National Express Group (Australia) and to employ existing staff.

3.20.2 Single person operated trains

Historically, the standard train crew configuration in Australia was a driver and assistant (fireman in steam days) in the cab of the locomotive and a guard at the rear of the train. For long-standing electrically operated suburban systems such as the Melbourne network, a driver who operated the train and a guard who assisted with passengers and some safeworking requirements was the traditional standard.

In the mid 1980s freight and some long distance passenger locomotive hauled trains had crew numbers progressively reduced to two person crews with the elimination of the guard from the rear of the train. The principal force behind this rationalisation was the need for efficiency and a substantially reduced need for shunting at wayside locations due to an increase in 'point to point' freight trains.

In the late 1980s and throughout the 1990s driver-only operated trains have evolved in various locations and rail systems throughout Australia. Driver-only operations are generally defined as the driver being the sole occupant of the locomotive cab or the sole crew member of an electric suburban train. This person is responsible for all 'on

board' facets of operations and security. Again, efficiency was the driving force behind this rationalisation.

In the case of suburban electric train operations, Melbourne, Adelaide and Perth have driver-only operations, while Brisbane, Newcastle and Sydney still retain the driver and guard configuration.

Prior to Melbourne suburban electric trains being converted to driver-only operations (known locally as 'single person operated trains') during 1993, substantial analysis and risk assessments were undertaken of all operational aspects. This led to the introduction of altered rules and procedures that complemented this mode of operation. Also, several years ago additional equipment was provided to allow drivers to monitor passenger movements and passenger security.

Additionally Fleet Engineering recommended that the park brake be 'train line circuited', thereby enabling an application and release throughout the train from any driver's cabin. This was initially rejected primarily due to cost. However, the passage of time and experience with driver-only operations led to the train-line park brake proposal being retrospectively introduced.

In the instance of the runaway electric train 5264 from Broadmeadows Station on 3 February 2003 it is subjective to contemplate whether or not an additional crew member, in the form of a train guard, would have been in a position to prevent or halt this runaway movement. Two of the three previous incidents regarding runaway trains that have been examined as a component of this investigation were crewed by a driver and guard.

3.20.3 Accreditation and audit

The Victorian rail system operates on the principle of 'Co-regulation'. The state regulatory authority, the Department of Infrastructure, accredits rail operators based on the regulator's approval of a company's safety management system. The safety management system is contained in the National Express (Bayside) Management Safety Manual. The National Express (Bayside) Management Safety Manual is a general safety management policy document which is supported by other more detailed operational documents covering the various areas of operation which include engineering, maintenance and train operation.

Audits assess compliance with an approved or accredited safety management system or standard. The audit, as a defence against an accident is only as effective as the standard or policy is itself. For example, if there is an inherent fault in a maintenance procedure or standard this may not be identified.

3.20.4 Emergency Response Plan Trains Division

The Emergency Management Act 1986 provides for the establishment of arrangements within the State of Victoria for the prevention of, response to, and recovery from emergencies. Pursuant to this Act and other applicable statutes, M>Train has compiled an emergency response plan titled 'Emergency Response Plan Trains Division'.

Although this manual is, by necessity, generic in nature, it does set out some special instructions for dealing with emergencies such as bomb threats, fire on trains, evacuation of passengers from trains and so on. It does not, however, set out instructions pertaining to a runaway train. In addition, employee interviews

conducted as a result of this incident have indicated that little training in regard to the intent and use of this manual have taken place.

Issue one of this manual was dated 29 April 2001 and was marked for review in October 2002. This review has not taken place.

3.20.5 Emergency response

The fire brigade received notification via a call made from a mobile phone at 2134 and were the first of the emergency services on site, arriving at 2138. They immediately ascertained that there was no fire, no persons trapped or seriously injured and no fuel spill.

It appears that the police were advised by two sources, one was a call at about 2133 on a mobile phone from someone who indicated they were an off duty policeman on Spencer Street Station. The initial call to the fire brigade was passed on to the police via normal channels at 2140. In any case, the police arrived on site at 2145. After conferring with fire brigade personnel the police assumed the role of site controller.

Several ambulances attended simultaneously and treatment and transportation of passengers in need of medical attention to hospitals began.

The emergency response from M>Train and V/Line was also very prompt, especially in relation to V/Line staff who were at Spencer Street Station at the time of the accident and began contingency plans immediately. Personnel from WorkCover Victoria and the Department of Infrastructure also attended in a timely manner.

The site was made secure although the emergency services focus was primarily on the collision impact point and not the remote driver's cab of car 393.

3.20.6 Post accident measures, Broadmeadows to Spencer Street Station

At 2201:07 Metrol officers contacted the police and requested that all level crossings and station platforms be checked for any signs of collisions with road vehicular traffic or injuries to the public. The police responded by visually checking a number of the stations and level crossings and also by flying over the Broadmeadows to Spencer Street route in a helicopter. A heat-seeking device was used in an endeavour to locate any persons that may have been injured as a result of this incident. None were found.

Metrol officers instructed all trains between Broadmeadows and Spencer Street to proceed with caution. It was several hours before track maintenance personnel were deployed to examine the track and associated infrastructure for possible damage.

4 ANALYSIS

4.1 Overview

In the process of changing ends the driver had not applied the park brake, the train stop mechanism had been raised in car 393 and had not been reset in car 394. Once the train started to move under the force of gravity and rolled clear of Broadmeadows Station with no driver on board, the train was out of control. Given the gradient, some form of collision or derailment was inevitable.

Once the train had cleared Broadmeadows Station at about 2118:17 the only strategy that could be employed to control the emergency was to attempt to control the passage of the train. Initially it was hoped that disconnecting the power would stop the train, but other than this the only option was to route the train clear of other trains and to a siding where the movement would be contained as quickly as possible. The complicating factor was that nobody knew whether there were any members of the public on board. Also, the speed of the runaway train was such that many of the people involved had difficulty in adjusting their mental model of where they expected the train to be at any given point in time.

Defences inherent in the infrastructure of the Melbourne suburban rail system that guard against driver or train failure are signal authorities, train stops fitted to signals, boom barriers and pedestrian gates. The primary purpose of these defences is to ensure adequate separation between trains, and between trains and road / pedestrian traffic.

For these defences to be effective:

- there has to be a driver on board, or
- the train stop mechanism has to be set.

4.2 Previous runaways

The three previous train runaway incidents in 1975, 1977 and 1996 on the Melbourne suburban network (section 3.19) demonstrate that such an event is a foreseeable risk. The potential consequences of a runaway train with passengers derailing, colliding with another moving train or with road vehicles at a level crossing are severe. All three of these scenarios were narrowly averted on this occasion. Further information regarding these incidents is at Appendix 8.4.

The 'Emergency Response Plan Trains Division' does not address such an event and, as such, there was no contingency planning available for Metrol staff, signallers or station staff.

4.3 Driver procedures and actions

4.3.1 Driver procedures and instructions, changing driving cabins

Having three separate sources and categories of documentation for such a routine and frequent operation as changing ends is not considered efficient and unnecessarily

complicates the driver's task. It was also found that Procedure M.O-13 titled 'Changing Ends:

- was due for review in August 1999. No evidence has been found that would indicate this review or subsequent reviews have taken place since November 1997.
- instructs the driver to place the brake handle in the emergency position prior to isolating the brake valve isolating cock. It does not instruct the driver to fully exhaust the brake pipe pressure to atmosphere before isolating the brake valve isolating cock.
- requires the driver to close the brake valve isolating cock at step one. At step four this procedure instructs the driver to set the destination indicator to 'blank'. The destination indicator cannot be reset with the brake valve isolating cock closed.
- does not mandate the application of the park brake. Although the intent of this procedure is for the driver to proceed directly to the other end of the train, unforeseen issues could arise once the driver's cab has been vacated. These issues could delay progress to the other end of the train. In addition, by not applying the park brake while changing ends, the final safety defence is removed in the event of brake failure or driver error.

4.3.2 Custom and practice, changing ends

Actual observations and discussions with driving grade personnel during the course of this investigation have revealed that there are variations in how the driver's controls are isolated on Melbourne suburban electric trains. These variations concern the sequence and speed of operation in regard to the operation of the brake valve isolating cock and the driver's brake handle. Also, some drivers apply the park brake when changing ends, even though this was not required by the relevant procedure.

In relation to sequence and speed, some drivers have been seen to close the brake valve isolating cock and then place the driver's brake handle in the emergency position rather than placing the driver's brake handle in the emergency position and then closing the brake valve isolating cock. After the driver's brake handle was placed in the emergency position and the brake valve isolating cock closed, some drivers were seen to return it to the release position, while some left it in the service zone.

In relation to speed, some drivers were seen to close the brake valve isolating cock at almost the same instant that the driver's brake handle was placed in the emergency position.

Also, there appeared to be a widespread practice of drivers isolating the driver's controls, latching up the train trip in the process, and then momentarily opening the brake valve isolating cock. A partial increase in brake pipe pressure results. The intent of this practice is to prove that the train trip has been properly latched up by ensuring that no air blow is evident. This is a preventative measure intended to save time when changing ends by negating the possibility of having to return to the other end to latch up the train trip properly.

The actions described in 4.3.2 above could, given the right circumstances, compromise the amount of brake pipe air being exhausted to atmosphere and therefore the application of, or retention of, the train brakes.

4.3.3 Driver actions: train 5264 Broadmeadows Station

Evidence obtained from closed circuit television (CCTV) security camera footage and the driver's interview indicates that the driver's controls in unit 393 were in effect isolated twice after arrival at Broadmeadows Station. The initial isolation occurred between the arrival time of train 5859 and when the driver exited the driver's cabin for the first time. This time interval is one minute and 24 seconds. Twenty six seconds later, the driver re-entered the driving cab of motor car 393 and remained there for 65 seconds, isolating the driver's controls for the second time in the process.

According to the driver, in isolating the driver's controls in car 393 the second time, he opened the brake valve isolating cock and entered the train description number into the driver's display unit. He then made a partial (250kPa) brake pipe reduction and moved the brake handle to the service zone and closed the brake valve isolating cock. The driver's claim that he closed the brake valve isolating cock on motor car 393 after the second isolation has been confirmed by data retrieved from the POTS server database (see section 4.5).

However, the fact that the train 'ran away' is evidence that the brakes did release at some time when the air pressure in the brake pipe rose and the air pressure in the brake cylinders released to atmosphere.

Opening the brake valve isolating cock with the brake handle in the running / release position allows air to flow into the brake pipe via the charging valve, thereby commencing the charging process of the brake pipe. When the air pressure in the brake pipe becomes greater than that in the auxiliary reservoir the triple valve will move to the release position, exhausting brake cylinder air to atmosphere, thereby releasing the brakes. The brake pipe does not have to be fully charged for this to occur, it only has to be at a greater pressure than that of the auxiliary reservoir. It follows that some scenarios require consideration.

In order to input the train description number into the driver's display unit the brake valve isolating cock has to be opened. This means that the brake pipe would have been in the process of charging and that the train brakes could have been in the process of releasing while this duty was being carried out. In then making a partial reduction of the brake pipe pressure prior to closing the brake valve isolating cock there may have been an insufficient reduction in brake pipe air to reduce the pressure to below that contained in the auxiliary reservoirs. This possibility is heightened as the brake valve isolating cock was opened for a short period only and the fact that air is admitted to the auxiliary reservoir at a slower rate via a choke. There is the potential, therefore, of not achieving a full recharge of the auxiliary reservoir in these circumstances. As a consequence there is a possibility that the brakes, if already in the process of releasing, could continue to do so.

Train 5859 was being operated in electro-pneumatic braking mode. This meant that, at any time the brake valve isolating cock was opened and the brake handle was in the service zone, the train brakes would have been applied regardless of the amount of air in the brake pipe. This is because an electrical signal is derived from the brake controller, according to the position of the brake handle in the service zone, and sent to electro-pneumatic valves mounted on each car. This allows main reservoir air to be admitted into the brake cylinders, effectively by-passing the brake pipe in the process. Also, while in electro-pneumatic braking mode, the only way the stated 250kPa brake pipe reduction could have been made was to move the drivers brake handle to the emergency position.

However, once the brake valve isolating cock is closed, an electrical isolating switch renders the electro-pneumatic brake inoperative. This then means that the retention of any brake application is dependent on the pneumatic (air) brake only. Therefore, there is a risk that the brakes could release should brake pipe air not be properly exhausted to atmosphere prior to closing the brake valve isolating cock. It is absolutely essential that a full emergency application of the air brake is enacted prior to closing the brake valve isolating cock.

A second possibility is that the brake handle was not placed in the emergency position during the second isolation but rather, was left in the service zone prior to the brake valve isolating cock being closed. If this was the case then an electro-pneumatic brake application would occur while the brake valve isolating cock was open but would release when the brake valve isolating cock was again closed.

A further possibility could be that the brake handle might have been left, without movement, in the running / release position during the second isolation of the driver's controls. This scenario was simulated during the testing of the brake functionality by the independent consultant engaged by the ATSB.

- The brakes were applied with an emergency application and the brake valve isolating cock was then closed.
- The brake cylinder pressure was observed to be 275kPa and brake pipe at zero.
- The driver's cab was vacated.
- The driver's cab was then reoccupied.
- The brake valve isolating cock was opened and the train description number entered into the driver's display unit without moving the brake handle from the release position. The brake valve isolating cock was then closed.
- The driver's cab was then again vacated after a brief glance at the pressure gauges.

This sequence was repeated several times. The brake pipe pressure was seen to increase while the train number was entered into the driver's display unit, pause briefly as the brake valve isolating cock was closed, and then continued to climb to 550kpa. On each occasion the consultant had just vacated the driver's cab and was standing at the door when the brakes released.

4.4 Train brakes

4.4.1 Inoperative braking system, train 5264

The hierarchical system of braking that is fitted to Comeng suburban electric trains allows for an automatic change-over to an alternative mode of braking should a failure in a given braking mode occur. In addition, a train trip, hand pilot valve and foot pilot valve are provided should driver failure or error occur. Once the driver's controls of a Comeng suburban electric train are isolated however, all of these safeguards are then by-passed. The only barriers to unplanned movement are then an adequate application of the pneumatic (air) brake and park brake. The only defence against failure at this juncture is adherence to the 'changing ends' procedures.

In the instance of train 5264 at Broadmeadows on 3 February 2003, the driver's controls were isolated prior to the train rolling away and the park brake was not applied. Therefore, once the brake pipe air pressure had increased and the electro-

pneumatic brake was rendered inactive by the final closure of the brake valve isolating cock, all safety defences against unplanned movement were removed.

A description of the braking system fitted to Comeng suburban electric trains is contained as appendix 8.3 of this report.

4.5 Analysis of Position of Train System data

Data from the POTS regarding the passage of Melbourne suburban electric trains comes from two sources, the POTS unit travel report and the POTS server database (see 3.14.4 and 3.14.5).

The POTS unit travel report records the unit number, location, train number, date, time, direction, speed and kilometres from the last track transponder encountered.

The POTS server database records a more detailed 'package' of information, including:

- the pantograph's position,
- if the tag reader is functioning,
- if the distance and direction encoder is functioning and
- whether or not the brake valve isolating cock is open or closed.

The POTS recorded all track transponders and on board equipment pertaining to train 5264 between Broadmeadows Station and the last track transponder encountered at North Melbourne. On 3 February 2003 these were functioning normally. The POTS also recorded whether or not any of the brake isolating cocks were open. A binary system records '0' in the brake valve isolating field of the data base if the cock is closed and '1' if it is open, in any cabin.

In the case of train 5264 on 3 February 2003 between Broadmeadows Station and the last track transponder encountered at North Melbourne, the POTS server database report recorded the status of the brake valve isolating cocks as '0', confirming that the driver had closed the brake valve isolating cock.

The POTS recorded the times that train 5264 passed each track transponder except the Up end of Oak Park Station platform and Newmarket Up and Down.

Broadmeadows number two platform Up end	5264	2118:17	3 km/h
Oak Park platform one Down end	5264	2123:20	93 km/h
Oak Park platform one Up end	-	-	-
Strathmore platform one Down end	5264	2125:01	102 km/h
Strathmore platform one Up end	5264	2125:07	98 km/h
Essendon platform two Down end	5264	2126:15	75 km/h
Essendon platform two Up end	5264	2126:25	73 km/h
Newmarket Down end	-	-	-
Newmarket Up end	-	-	-
Kensington platform one, Down end	0000	2129:42	84 km/h
Kensington platform two, Up end	0000	2129:52	82 km/h
Moonee Ponds Creek Junction- East Suburban Up line	0000	2130:57	87 km/h
North Melbourne platform one Down end	0000	2131:28	78 km/h

Of note is that interaction with the track transponder at the Up end of Oak Park platform and the track transponders at the Up and Down ends of Newmarket platform number two has not been recorded. Also, the train describer number (5264) had defaulted to '0000' through Kensington platform and beyond. Advice from the manufacturers of POTS, Innovonics Pty Ltd, is that the 'on board' POTS controller will revert back to a default train description number of '0000' should power be lost or should the POTS controller reset. In this instance, the overhead power was isolated at 2127 when train 5264 was between Essendon and Kensington stations. This isolation of power should account for the lack of interaction with the track transponders at Newmarket and the train description number defaulting from 5264 to '0000'. It is unknown why interaction with the track transponder at Oak Park platform two Up end did not occur.

4.6 Possible contingency measures, Metrol officers

4.6.1 Possible contingency measures, train 5264

The options of re-routing train 5264 were limited. By the time that either the Broadmeadows signaller or Metrol were told of the runaway, train 5264 had passed the points that give access to the dedicated freight line to Melbourne via Albion. These points are 214 metres from Broadmeadows Station. Once beyond this junction, there is a diversion at Essendon but, it has no catch points and rejoins the Up line about 200 metres past the station platform. Also, train 5264 was travelling at 75 km/h and the speed of this turnout was 40 km/h, making derailment a possibility.

At Kensington, an alternate route via the Broadmeadows suburban line exists but this would have involved diverting the speeding train, travelling at 82 km/h, onto a 30 km/h viaduct. A derailment on this viaduct and rolling stock falling off was a probability (and as noted previously it was not known if passengers were on board). In the event that it did remain on the rails, the runaway train would have found its way into the 'heart' of the suburban electric train network at Flinders Street Station. Also, there are two dead end goods sidings at Kensington but their use was not an option as access cannot be obtained from the Up line.

Another alternate route existed on the Down side of North Melbourne which would have involved using the goods line that connects the Arden Street goods sidings with the main goods line that runs to the east of the suburban lines. This route can be accessed by a turnout immediately beyond signal NME 566 but it is unwired and has a 40 km/h turnout. This route crosses the Down east suburban, Up and Down main suburban and Up and Down through suburban lines and leads to various goods lines and sidings. This route was not an option at this time as train 6649 was travelling on the Down main (see figure 2). Had all conflicting routes been cancelled earlier, this goods line might have been an option. However, given the speed that train 5264 was travelling at, derailment on the 40 km/h turnout was a distinct possibility. In addition, a collision or derailment somewhere else on the main goods line or sidings would have probably eventuated.

Diverting the train onto the underground loop at North Melbourne was not an option as the points that give access are approach locked so that it is not possible to set the route for a conflicting movement. Two trains were in the system at this time, one Sydenham train was exiting the underground city loop and an Upfield train was just entering the underground city loop behind it.

Metrol officers were then faced with the choice of whether to keep train 5264 travelling on the East Suburban lines or to divert it into territory controlled by the Spencer Street number one signal box. Had train 5264 continued along the East Suburban route, it could have been routed into:

- platforms ten and 11 or the road between known as '10A' and beyond; or
- platforms seven or eight at Spencer Street Station; or
- the parcels dock sidings that are immediately beyond platform eight.

To route train 5264 through platforms ten and 11, if clear of other traffic, would result in an unabated progress of this train towards Flinders Street Station, with the possibility of derailment or collision with another suburban train.

Spencer Street platform seven is a dead end road. Platform eight can be utilised as a dead end or through road as there are points prior to the stop blocks that give access to an adjacent through road. At the time of this incident platform seven had the empty coaches that were to form the next day's Warrnambool service and platform eight was empty. The stop blocks at platform eight are platform height only. Therefore there was the possibility that train 5264 could have separated from its bogies and 'speared' into territory beyond the stop blocks had this road been set for the dead end.

The parcels dock sidings consist of a dead end 'van dock' road and two sidings adjacent to the parcels dock loading bank. These sidings were empty at the time of this accident. There are points at the Up (Melbourne) end of these sidings that can route movements into this area but they are operated by Connex employees that are stationed in the Metrol control centre. These points are also subject to a run-down (time out). In order to route train 5264 into these sidings, control of this event would have had to be handed over to these Connex employees. If successful in these endeavours, collision with the stop blocks at either the van dock or the parcels dock would have been the outcome. Again the prospect of train 5264 separating from its bogies and 'spearing' into territory beyond is raised. If unsuccessful in these endeavours, the prospect of train 5264 continuing into the 'heart' of the Melbourne suburban network is yet again raised.

Metrol had been hampered in their management of the incident by:

- the delay in initial notification
- the lack of direct visual monitoring between Broadmeadows and signal NME 562 in the vicinity of North Melbourne
- an expectation that power isolation would stop train 5264
- the priority in avoiding a collision with train 5262
- a delay in confirming that the collision had been averted and
- the quickly developing situation over which they had minimal control.

4.6.2 Possible contingency measures, train 5262

The POTS unit travel report for trains 5262 and 5264 on 3 February 2003 revealed that train 5264 was rapidly running down train 5262.

Location	5262	5264	Difference
Broadmeadows platform Up end	2104:52	2118:17	805 seconds
Oak Park platform Down end	2110:43	2123:20	757 seconds
Strathmore platform Up end	2116:02	2125:07	545 seconds
Essendon platform Up end	2119:21	2126:25	424 seconds
Kensington platform Up end	2127:59	2129:52	113 seconds
Moonee Ponds Creek jct. - East sub line	2129:12	2130:57	105 seconds

The only realistic option open to Metrol Controllers was to divert train 5262 to the main suburban line by switching points NME 464 on the Up side of signal NME 566. The only other option was for train 5262 to attempt to outrun train 5264. This was not a realistic alternative. This train had passengers and would have had to travel at a speed far greater than is compatible with safety.

The driver of preceding train 5262 promptly answered a call on the train radio as he was bringing this train to an unanticipated stand at signal NME 566. After warning the driver of the situation, setting points NME464 and on a proceed signal, the driver of train 5262 was able to negotiate the points safely and clear the runaway. (Had he moved before the proceed signal the automatic train stop would have activated and a rear end collision would have been inevitable.) The fact that the driver of 5262 saw the runaway in his rear view mirrors and felt compelled to negotiate the point at 22 km/h above the track speed illustrates how close the two trains came to collision.

At Metrol the signaller had cancelled the TLS²⁷ mode in the North Melbourne area shortly before 2128:24 so that he could manually operate points NME 464. As train 5264 was traversing points NME 464 he operated the control button for points NME464 so that as soon as train 5262 cleared and the electrical interlock allowed, the points would revert to the east suburban line. Calculations have subsequently revealed that runaway train 5264 traversed points NME 464 at the same time as they reversed back to lay for the East Suburban Line. It appears that it was almost a 'dead heat' in regard to which route the runaway train would take.

The investigation team has been informed by a number of witnesses and personnel involved in this accident that the train radios are often unreliable. The driver of train 5262 told the investigation team that he was surprised his train radio even rang and that had it not he would have detrained and contacted Metrol from the phone on the signal post in order to ascertain the reason for the delay. Had he detrained in this manner, there is no doubt that train 5264 would have collided with train 5262.

4.7 Possible contingency measures at Spencer Street

Communication between Metrol officers and the signallers at Spencer Street had taken place as follows:

- At 2126:27 Metrol officers advised of a runaway train in the system and the possibility of routing it towards Spencer Street. The signallers advised there would be no empty roads until the departure of the Overland express from platform one at 2140. (The initial exchange between Metrol and the signaller in Spencer Street number one signal box did not reflect the reality of the situation facing either Metrol or Spencer Street Station. The initial expectation seems to have been that the train in number one platform would depart before the runaway train arrived).

²⁷ TLS - a signalling mode that automatically sets the route according to the train describer number.

- At 2129:47 Metrol officers confirmed the runaway train would be routed towards Spencer Street. Agreement was hastily reached that Metrol should route it via the country line towards number one platform.
- At 2130:50 one of the Spencer Street signallers contacted Metrol and was told that the runaway train was now very close. Because the Overland express had not yet departed from platform one, the Spencer Street signaller instructed Metrol officers to route the runaway via the east country line.
- At 2131:28 and 2131:32 the two Spencer Street signallers (basically simultaneously) received phone calls from Metrol officers advising of the imminent arrival of runaway train 5264. An examination of the voice transcript reveals that at 2131:46 the Spencer Street signaller tells the Metrol officer, “I’ve got him, I see him, f***ing hell he’s coming up hard.”

Although the departure signals had already been taken off the Bacchus Marsh train the route was still set towards this train because of the run-down before the interlocking is released. The signaller tried to force the signal levers past the locking mechanisms but was unable to do so. The collision between train 5264 and the Bacchus Marsh train (8141) occurred shortly after.

Given the fact that the departure routes had not been taken off the trains awaiting departure from platforms one, two and four, the following scenarios are worthy of consideration. If train 5264 had entered the Spencer Street precinct via the country line, east country line or the through country line, it would have ‘stolen the route’ of one of these trains in the same manner as it did with train 8141. A collision with one of these trains that were awaiting departure would have been a likely occurrence, including the standard gauge Overland train. If train 5264 had been admitted via the main country line though, it would have continued all the way into platform three and collided with the empty Kyneton passenger train that was stabled awaiting departure the next morning. This would occur due to this route being approached locked in order to protect the routes of trains 8141 and the Geelong sprinter.

Had the routes of all trains been cancelled immediately after the first definitive advice was received at 2129:47 there is a chance that train 5264 could have been routed to an empty road or into an unoccupied train. However, the time taken to conclude the conversation commenced at 2129:47, to put all applicable signals back to stop, to wait for the run-downs to expire and to reset the routes would make this a close call. In addition, the Spencer Street signallers were faced with no readily identifiable course of action as all platform roads were occupied. Also, the roads that were empty either led to low level stop blocks or converged with occupied platform roads. Therefore, there was very real potential for the runaway train to separate from its bogies and spear onto busy Collins Street or to collide side on with one of the waiting passenger trains.

4.8. Monitoring and communications

4.8.1 Overview of monitoring and communications

The accident exposed several weaknesses in the monitoring of trains and communications between critical personnel:

- There was a delay in reporting the runaway to Metrol of about four and a half minutes from initial movement.

- Metrol had no means of directly monitoring the run away. Initially, for a period in excess of nine minutes, they had to rely on reports relayed from the field.
- The system limited direct communication between Metrol and Spencer Street Station to a phone on platform 10, which was operated by a different company.
- No warning of the imminent arrival of train 5264 was given to the drivers of the trains awaiting departure at platforms one, two and four by the signallers at Spencer Street.

The communications system, on this occasion, did work well in that the driver of train 5262 was contacted effectively. Also the phone system, on which Metrol relied for third party reports from Broadmeadows and Essendon Station Masters and the signallers at Kensington and Spencer Street, also proved reliable.

Visual monitoring, in the form of displays on the VDU screens at the signal panels at Metrol, is available from about 100 metres on the down side of signal NME 562 to the overhead wired platforms at Spencer Street and beyond. In the case of runaway train 5264, Metrol only had visual indication to the point where this train was diverted from the east suburban line into the unwired platforms at Spencer Street Station. This was a distance of about 1915 metres. If the speed of train 5264 is averaged at 80 km/h for this distance then this train was under visual communication by Metrol officers for only 86.2 seconds. Train 5264 took about 16 minutes to run from Broadmeadows Station to Spencer Street Station. Aside from the 86.2 seconds referred to, this journey was, from the perspective of Metrol officers, in 'dark territory' where no visual indication or control of signals and points was directly available.

In regard to the train radio system, the ATSB investigation team was advised during the course of this investigation that there are 'black spots' in the suburban network where contact between Metrol and drivers (and vice versa) is unable to be made. It appears that there is general knowledge of where these 'black spots' are and that train radio calls in these localities are avoided whenever possible.

In general terms, the communication network is tailored to suit normal operational requirements. While it is acknowledged there is a direct phone line between Metrol and the number one signal box at Spencer Street, the operations within this area are considerable. Moreover, they are controlled and coordinated locally by the signaller at Spencer Street. Metrol officers have no authority and no 'real time' indication in regard to work being performed in this area or indication of what routes are set for what trains. In short, there is no transparency in regard to operations within this locality. In an normal operational sense, Metrol are only concerned with the 'finished product' in the form of a train that exits this precinct onto territory they control or in routing a train into this precinct upon receipt of permission from the Spencer Street number one signal box signaller.

Similarly, within the Spencer Street Station precinct that is under the control of the Spencer Street number one signal box, voice communications are tailored to suit normal operational requirements. That is, the primary communication conduit between the signaller and the yardmaster / shunters and drivers is via radio, channel one. The yardmaster plans and coordinates the work to be done with the shunters, train examiners and station staff. The shunters then direct the shunt locomotive drivers in regard to shunt movements from the ground via radio and hand signals. There is no direct communication other than 'dial up' phone between either the Spencer Street signaller or yardmaster and the Spencer Street Station V / Line platform staff as there is ordinarily little requirement for such communication.

However, contact with the drivers of trains and the Spencer Street signaller is available via channel one. This channel is required to be monitored by signallers, yardmasters, shunters and drivers. As such, this medium of communications could have provided a conduit for advice regarding the imminent arrival of train 5264.

The structure of the voice communications network between Broadmeadows Station, Metrol and Spencer Street number one signal box and the respective areas under their control are adequate for normal operations and the majority of extraordinary events. In regard to the extraordinary circumstances of 3 February 2003 however, this structure hindered the ability of all concerned to deal with an emergency situation in a more timely and effective manner. Indeed, for the majority of the time, Metrol officers could not readily determine where the runaway electric train was or how fast it was travelling. This resulted in Metrol officers engaging in 'crisis management' instead of 'managing the crisis'.

4.8.2 Radio protocol

The main conduit of information throughout this incident was voice communication.

The majority of this communication, given the stressful situation under which all involved were placed was, in the main, acceptable in that it was clear and concise. There were some examples though where the dialogue exchanged did not convey the urgency of the situation in regard to content or the tone of voice used. In addition, recognised protocols for the commencing and ending of conversations were at times lacking.

4.9 Consequences of impact on train 8141

Train 8141 consisted of an 'N' class diesel locomotive and four passenger carriages and was due to depart from number two platform at Spencer Street Station at 2135 on 3 February 2003.

When the collision occurred at about 2133, all passengers were on board and awaiting departure and the train conductor was in the supervisor's office on platform two. That is, there was no one in the process of boarding or alighting from the train at this time. A member of the public was standing in close proximity to the doorway of a carriage but was told to stand back by a V/Line employee in the moments before the collision.

The driver of train 8141 and the V/Line employee who were in the locomotive cabin saw the 'aggressor' train and both jumped clear seconds before impact. At this point the locomotive brakes were fully applied and the train brakes were released.

Despite the estimated impact speed of 75 km/h, it is apparent that the N class locomotive and four carriages absorbed a considerable amount of the force of the collision. This is evidenced by the fact that train 8141 was driven back some 22 metres and that all permanent deformation tubes within the coupler assemblies between the four carriages compressed as designed.

Train 8141 was due to depart for Bacchus Marsh within two minutes of the collision. Indeed, the route and applicable signals had been previously set and were only cancelled shortly before the collision. Had the runaway train been a couple of minutes later in its arrival at Spencer Street Station the probability is that train 8141 would have already commenced its departure.

4.10 Field personnel actions

Actions of personnel in the field were, in general terms, appropriate both during and after the accident. In particular, the actions of the driver of train 5262 are noteworthy in that he used his judgement in regard to what speed his train could be safely driven through points NME 464. This action avoided a collision with runaway train 5264. The signaller at Kensington is also worthy of mention for lowering the boom gates at Macaulay Road in advance of the runaway train.

4.11 Shift and fatigue management, controllers and signallers

Record of the working hours, of the controllers and signallers were assessed for the possible effects of fatigue using the Fatigue Audit InterDyne (FAID) fatigue modelling program. The program was developed by Interdynamics in collaborative partnership with the Centre for Sleep Research at the University of South Australia. The FAID program is a tool for developing a shift work roster to minimise the effects of fatigue. FAID used retrospectively indicates an individual's possible level of fatigue based on the hours of work for the previous seven days by means of a fatigue score index. Research has shown that performance levels at an index score of 100 equates with 0.05 per cent blood alcohol concentration.

Two key operators, the Metrol controller in charge and the Spencer Street signaller both assumed duty early, before their scheduled shift time. Using the FAID score index, their FAID score was calculated for the beginning of their respective shifts as being 63 and 48 respectively. At the conclusion of these shifts the FAID score was calculated as 105.9 and 90 respectively.

Of note is that at the conclusion of the measured roster sequence of the Spencer Street signaller on 8 February 2003 the FAID score was calculated as 118.3.

During the emergency involving train 5264 neither the Metrol controller nor the Spencer Street signaller returned a score that could suggest that their performance was affected by fatigue generated by their work roster.

4.12 Post incident measures

Post incident response was prompt and appropriate and a good rapport was established with emergency services personnel. This was confirmed at an emergency services de-brief that was attended by ATSB rail safety investigators.

After the collision at Spencer Street, train services were allowed to continue between Broadmeadows and Spencer Street Stations. Although drivers were instructed to proceed with caution and no infrastructure damage was subsequently found, runaway train 5264 had exceeded the speed of the route between Broadmeadows and Spencer Street Station to a significant degree. It follows that track or other infrastructure damage could have occurred and moreover, that such damage may not have been detected by the driver of a suburban train.

4.13 Emergency services response

The response by emergency services personnel was excellent. The fire brigade, police and ambulance officers all arrived within minutes of the collision and with appropriate resources. Interaction with all present was conducted in an orderly and professional manner.

4.14 Security of accident site

It appears that personnel first on the scene were focused primarily on the N class locomotive and the leading car of the runaway suburban electric train, car 394. While this is understandable given that this was the impact point, the position of the driver's controls in car 393 was a vital component of determining why train 5264 rolled away from Broadmeadows Station.

Interviews conducted with persons involved in this accident have revealed that personnel from a number of different employment disciplines accessed the cab of car 393 following the collision. These interviews have also revealed that driver's controls were manipulated. However well-meaning these actions may have been, the result is that the position of the driver's controls at the time of impact, with the exception of the driver's brake valve isolating cock, could not be verified beyond doubt.

5.1 Findings

1. Train 5264 ran away from Broadmeadows Station at about 2118:17 on 3 February as the result of an unintended release of the train brakes while the driver was in the process of changing ends. No driver or passengers were on board.
2. The testing of the train brakes revealed no defect that could have contributed to the unintended release of brakes.
3. An inoperative rheostatic brake on train 5264 did not contribute to the unintended release of brakes.
4. The driver was unaware of the movement of this train until informed by station staff upon exiting the staff lavatory in the station's amenities block.
5. It was about four and a half minutes after train 5264 ran away from Broadmeadows Station before Metrol was made aware of the situation.
6. The structure of visual monitoring and voice communication meant that an accurate assessment of arrival times at stations en route or at the Spencer Street precinct were unable to be calculated.
7. Metrol officers were unaware at any stage enroute whether or not there were passengers on board train 5264.
8. There was widespread anticipation that turning off the overhead power supply or placing signals at stop could stop train 5264.
9. No one involved in this incident anticipated that train 5264 would reach the speeds that it did.
10. Train 5264 came within a second of being placed on a collision course with the previous train from Broadmeadows, train 5262. This collision was averted by:
 - The extremely quick action on the part of Metrol officers in changing the routes of trains 5262 and 5264; and
 - The entirely appropriate action of the driver of train 5262, who used his knowledge in regard to what speed his train could be safely driven through the points at this location.
11. No advance warning of the situation was conveyed to Spencer Street Station V/Line staff working on platforms one to seven. Likewise, no advance warning was conveyed to the drivers of trains awaiting departure from platforms one, two and four at Spencer Street.
12. It should have been possible to convey a warning of the imminent arrival of train 5264 to the drivers of trains awaiting departure at platforms one, two and four via radio channel one.
13. At 2132:15, some 45 seconds prior to impact, Metrol officers conveyed a message to a Connex employee on platform ten to clear platforms one to five. The message seemed contradictory to him so in the short time available he did not effectively act upon it.

14. Train 5264 was travelling at about 75 km/h when it collided with train 8141 at the Spencer Street Station number two platform. The 'N' class locomotive of train 8141 and the lead car of train 5264 absorbed the bulk of the impact force.
15. Given the routes that were set for departing trains, had train 5264 been admitted to the Spencer Street precinct via the country line it would have most likely collided side on with the Melbourne to Adelaide Overland Express train at platform one. Of note is that this was the route set until an alternate route (the east country line) was chosen in the immediate seconds after 2130:50.
16. Given the routes that were set for departing trains, had train 5264 been admitted to the Spencer Street precinct via the main country line it would have most likely collided with the stowed (empty) Kyneton passenger train at platform three.
17. Given the routes that were set for departing trains, had train 5264 been admitted to the Spencer Street precinct via the through country line it would have most likely collided with the 2135 Geelong sprinter at platform four.
18. The response of the emergency services was timely.
19. Site control following the collision was focused primarily at the impact point of both trains. Persons of varying employment disciplines were able to access the remote driver's cab of train 5264.
20. The 'Emergency Response Plan Trains Division' does not deal with runaway trains at section 9.0 titled 'Special Instructions'.
21. The 'Emergency Response Plan Trains Division' was not reviewed as scheduled in October 2002.
22. There has been little employee training in the 'Emergency Response Plan Trains Division'.
23. Procedure M.O-13 titled "Changing Ends" had not been reviewed since 25 November 1997.
24. The driver of train 5264 had not been audited as frequently as required in accordance with M>Train work instruction titled 'Train Driver Safety Audits' or previous audit instructions titled 'Guidelines for Met Drivers Safety Audit, New Driver Validation and Re-Accreditation Checklists dated 2 July 1996.
25. Fatigue and the medical condition of the driver of train 5264 were not factors in the accident.
26. Fatigue and the medical condition of Metrol officers and signallers involved were not factors in the accident.
27. The investigation has revealed instances where shift sequences are different from fatigue management practices commonly followed in other sectors of the rail industry.
28. Interviews and informal discussions with M>Train personnel have revealed that the Melbourne train radio system can be unreliable.
29. The design of the track and associated infrastructure is not considered to be a factor in this incident.
30. Given the topography of the Melbourne suburban network, there is a distinct possibility that past incidents of runaway suburban trains will be repeated in the absence of effective mitigation measures.

5.2 Contributing Factors

1. The duties associated with changing ends on a suburban electric train are (potentially) contained in three separate documents. Under certain circumstances these instructions do not mandate the application of the park brake.
2. The release of brakes was the result of the manner in which the driver's controls were isolated. The park brake was then the final defence to unintended movement. The park brake was not applied in this instance.
3. The passage of train 5264 between Broadmeadows Station and Spencer Street Station on 3 February 2003 constituted a movement that was neither controlled nor controllable. Actions that could be taken by Metrol officers were confined to contingency measures such as re-routing trains and warning relevant personnel of the anticipated movement of train 5264.
4. There were no options devoid of risk available to Metrol officers. Every alternative route examined as a component of this investigation presented either a danger of collision with another train, collision with stop blocks or derailment.
5. The flow of communication from Metrol officers to the Spencer Street signallers was hindered by dealing with the near collision between trains 5262 and 5264.
6. In the context of the time available, the structure of available visual monitoring and voice communication contributed significantly to the lack of a more favourable outcome in regard to:
 - the final destination of train 5264; and
 - advance warning to persons on Spencer Street platforms one to eight.

6 SAFETY ACTION INITIATED AND RECOMMENDED SAFETY ACTIONS

6.1 Safety actions already initiated

The safety action issued by the Rail Safety Regulator on 5 February 2003 in the form of a Safety Bulletin is endorsed by this investigation. This safety bulletin reads:

Instruction to All Train Operators and Track Managers

The following actions are to be undertaken immediately:

1. All train operators are to instruct train driver's and other responsible for securing rolling stock that they must ensure that rolling stock is securely braked before leaving the driving cab for any reason.
2. All operational procedures for securing Comeng and Hitachi electric multiple units are to be reviewed to ensure that any work practice(s) do not compromise the effectiveness of the parking brake application.
3. All train operators using Comeng and Hitachi rolling stock are to amend work procedures to instruct train driver's to use the park brake when changing ends of trains for ANY reason.
4. All track managers are to review contingency plans for the management of trains at locations where the activities of train operators require the direction of trains to be reversed. Track managers are to submit updated contingency plans to the Safety Regulator for review and comment by 28 February 2003.

Also, discussions subsequent to the accident between the investigation team and Department of Infrastructure personnel indicate that this accident is being considered in relation to review of a number of safety issues.

6.2 Recommended safety actions

The following recommendations are not designed to be prescriptive or exhaustive and are made in the recognition that some of the issues raised have already been addressed or are being addressed by the organisations involved.

6.2.1 Victorian Department of Infrastructure

RR20030001

The ATSB recommends that the Department of Infrastructure monitor progress of engineering proposals and programs aimed at interconnecting the park brake when the driver's controls are isolated.

RR20030002

The ATSB recommends that the Department of Infrastructure monitor the recommended revision of procedures for changing ends on Comeng suburban electric trains.

RR20030003

The ATSB recommends that the Department of Infrastructure monitor progress aimed at improving voice communication and visual indications across the Melbourne suburban network.

RR20030004

The ATSB recommends that the Department of Infrastructure monitor the review of radio protocols, particularly those related to emergency situations.

RR20030005

The ATSB recommends that the Department of Infrastructure monitor progress in relation to the recommended overhaul of brake and foot pilot valve equipment on Comeng suburban electric trains.

RR20030006

The ATSB recommends that the Department of Infrastructure monitor progress in relation to the recommended amendment of, and training in, the 'Emergency Response Plan Trains Division'.

RR20030007

The ATSB recommends that the Department of Infrastructure evaluate recommendations contained in this report that may be relevant to other operators on the Melbourne suburban network.

6.2.2 Bayside Trains Pty Ltd, Receiver Manager Appointed (R.M.A.)**RR20030008**

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. undertake modification of all Comeng suburban electric trains to ensure that the park brake is automatically applied whenever the driver's controls are isolated.

RR20030009

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. consolidate the duties to be performed by a driver when changing ends on a suburban electric train into one procedure.

RR20030010

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. ensure that these consolidated changing ends duties mandate the application of the park brake on suburban trains whenever the driver vacates the driver's cabin.

RR20030011

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. ensure that instructions are issued that mandate the reduction of the brake pipe to atmospheric air pressure (zero as indicated on the gauge) before cutting the driver's brake valve out. This instruction to be included in the consolidated changing ends procedure.

RR20030012

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. conduct periodical audits of drivers to ensure consistency of drivers' actions when changing ends on suburban electric trains.

RR20030013

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. standardise the position of the 'on' and 'off' park brake buttons in the driver's cabin of Comeng suburban electric trains.

RR20030014

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. undertake a critical examination of voice communication media across its Melbourne suburban network.

RR20030015

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. undertake a review of radio protocols, particularly those related to emergency situations.

RR20030016

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. assess the viability of expanding the visual indications afforded to Metrol control officers from its current boundary in the Kensington precinct to Broadmeadows Station.

RR20030017

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. provide basic training to Metrol officers in the characteristics of suburban electric trains and other forms of rolling stock as deemed necessary.

RR20030018

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. undertake a review of the rosters of operational personnel with the aim of minimising roster induced fatigue. (While the investigation centred on the FAID score at the time of the emergency, this recommendation is based on the projected FAID scores of the controller and signaller and the conclusion of their roster sequences.)

RR20030019

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. consider maintenance scheduling in regard to brake equipment on Comeng suburban electric trains.

RR20030020

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. institute a maintenance and overhaul program for the driver's foot pilot valve on the Comeng suburban electric trains.

RR20030021

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. amend the 'Emergency Response Plan Trains Division' to incorporate generic guidelines for dealing with a runaway train.

RR20030022

The ATSB recommends that Bayside Trains Pty Ltd, R.M.A. institute employee training in regard to the 'Emergency Response Plan Trains Division'.

7 SUBMISSIONS

7.1 The Department of Infrastructure

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

8 APPENDICES

8.1 Description of damage, trains 5264 and 8141

8.1.1 Damage to motor car 394 (train 5264)

Leading car 394 suffered extensive damage in the collision. Upon impact car 394 slid under the anti-climb bar of the N class locomotive, shearing off the collision posts (crash pillars) at floor height in the process. This resulted in the front cabin being crushed almost to the first set of doorways numbers one and six. The fibreglass front, including the windscreens, front upright major structural members, handrails, marker lights, headlights, electrical cabinet, driver's control panel and so on had all been compressed almost perpendicular to ground level. The driver's console, electrical cubicle, brake and master controller were elevated and forced back from their original position on an 80-degree angle to the floor rearwards. The major structural uprights were torn from the headstock and the cabin side window aluminium frames had popped out of the sidewall. One of these aluminium frames landed adjacent to number three platform on the tracks. The toolbox had been propelled through the off side windscreen and had landed on the track at a point past locomotive N class 463.

The headstock, including the main support frame incorporating the Scharfenberg Coupler, was deformed in a direction towards ground level in a manner consistent with a cantilever effect caused by excessive loading and was found to be resting on the cross member of the leading bogie. The Scharfenberg Coupler head was found lodged within the N class locomotive's leading bogie with only the pillow block remaining secured to the headstock. All deformation tubes on the Scharfenberg and intermediate coupler had collapsed.

The number one bogie front cross member and brake rigging was bent and the bolster and anchor bolts were damaged. The main reservoir had moved in the restraining straps by about 40 mm and the wheel slip dump valve number one end and the air compressor mounts were damaged. The line breaker case cover was also damaged and the number one spring park brake cylinder rod was bent. All other spring park brake cylinders had to be manually wound off in order to move the train from the scene of the accident.

The intermediate coupler three phase and control wiring between car 394 and 1048 were torn apart as a result of trailer car 1048 derailing and slowing dramatically while the motor car continued forward.

FIGURE 12:
End of car 1048



All doors were damaged and some were jammed in the open position. This was due to the deformation of the upper brackets secured to the door carrier bar and possible broken chains. Several seat back pads were found dislodged on the floor. The bulk head wall was forced into the saloon area resulting in the flip seats punching the number one and 12 weather shields out of their mountings. The number one weather shield was completely dislodged although the toughened glass in both weather shields remained intact. There appeared to be no damage sustained to the internal ceiling and the floor from the first set of saloon doorways behind the driver's cabin to the number two end. The floor within the saloon showed no signs of buckling and the seat frames appeared to be sound with no visible damage to where they were secured to the floor tapping plates. The number two end wall windows, walkway plates, handrails, external end wall and ducts were damaged.

The 'B' side of the external sidewall stainless steel lower corrugation towards the number two end was deformed, most likely due to scraping number two platform at Spencer Street Station. Number two and nine saloon windows were cracked. The top external stainless steel corners of the windows and the doorframe showed signs of buckling from the middle doorway towards the driver's cabin. The external sidewalls including the driver's cabin sliding doors and roof of the cabin were splayed outwards. These were later cut off with plasma cutting equipment. The headstock was also cut in this manner as it was found to be preventing the bogie from steering. This resulted in a minor derailment while moving the crippled unit to a siding at Spencer Street. The air conditioner had to be removed to bring the height of car 394 within the loading gauge. The pantograph arm had over extended once it left the overhead wire shortly before Spencer Street Station. This resulted in damage to the pantograph head as well as the arm.

FIGURE 13:
Damage to car 394



8.1.2 Damage to trailer car 1048 (train 5264)

Wheel sets number one and two of number one bogie had derailed. There was damage to three phase and control wiring as well as the intermediate coupler, main reservoir and brake pipe hoses. The walkway plates and handrails were damaged and the number one end window smashed. Additionally, the number ten saloon window was smashed. The seat back pads and frames had detached and some of the seat frames were found on the floor. The deformation tubes had collapsed.

8.1.3 Damage to motor car 393 (train 5264)

The number three passenger side door was off its tracks and walkway plates and handrails were damaged. Several seat back pads had dislodged and were found on the floor. The intermediate coupler deformation tubes had collapsed.

8.1.4 Damage to Locomotive N 463 (train 8141)

Number two end was the leading end of the locomotive in the direction of intended travel. There was major damage to the top section of the driver's cabin in the vicinity of the windscreens and this area was compressed back at about a 30 degree angle. The interior of the driver's cabin sustained ceiling damage with some of the fibreglass from electric car 394 strewn about the driver's cab.

The impact from the headstock of electric car 394 resulted in the locomotive's bogie being partly dislodged from under the locomotive. In addition, the diesel engine had been moved off its mounts and the structure behind the radiators had moved by about

25 mm. The antiriders²⁸, main reservoir, brake pipe, jumper cable plugs and receptacles, handrails and so on were all damaged. The rear automatic coupler had fully compressed the attached draft gear²⁹ as evidenced by the marks on the pocket.

FIGURE 14:
Recovery of locomotive N 463



8.1.5 Damage to coaches BTH 167, BH 147, BIH 187 & BCH 127 (train 8141)

The leading carriage, BTH 167 sustained the greatest amount of damage. Within the saloon area of this carriage the floor, at about 800mm from the end wall, was elevated as the draft gear had spread outwards and upwards. There was damage to sliding doors A to D on the first two carriages and doors A and B on BIH 187 were not sliding freely. Hand holds on the anti-collision posts, footplates and airline connections were damaged between carriages BTH 167 and BIH 187.

²⁸ Antiriders – a series of ridges that interlock between vehicles to prevent carriages from lifting up in the event of an accident.

²⁹ Draft gear – the coupling mechanism that attach rail vehicles together.

8.2

Extract M>Train Fleet Asset Management Plan

<i>ACTIVITY</i>	<i>FREQUENCY</i>	<i>LOCATION</i>	<i>CONTENT</i>
Driver's Preparation	Before entering service each day. A reduced version is also performed if the car is to re-enter service that day.	Field	Driver equipment functions checks; brake system function tests, brake equipment and pantograph examination.
A Exam	Weekly between peaks	Field	Examination of under-car equipment, repair & adjustment of brake rigging / cylinders, renewal of brake blocks and pads.
B Exam	4 weeks as part of cycling through stabling locations between peaks	Field	Minor repairs and examination of saloon equipment, seats, lighting, hand grips etc.
C Exam	20,000km between peaks	Depot	Minor examination, primarily doors, pantographs, windscreen & wipers motors wheels, & camshaft powerhead.
D Exam	40,000km	Depot	General examination. 'C' examination plus traction control equipment, more extensive system functional tests.
E Exam	500,000km	Depot	Extensive examination. Bogie overhaul and 'D' examination combined.
F Exam	720,000km	Workshop	Overhaul & upgrade. 'E' examination plus interior upgrade. Main equipment case & coupler overhaul.

ACTIVITY	FREQUENCY	LOCATION	CONTENT
S1 Exam	Every 4th 'D' Examination	Depot	Check and replacement of components at approximately ½ E examination cycle (180,000km).
S2 Exam	Every 'E' examination and after every UFWL operation	Depot / Field	Detail check of wheel protection equipment including spin / slide equipment and brake pressure.

8.3

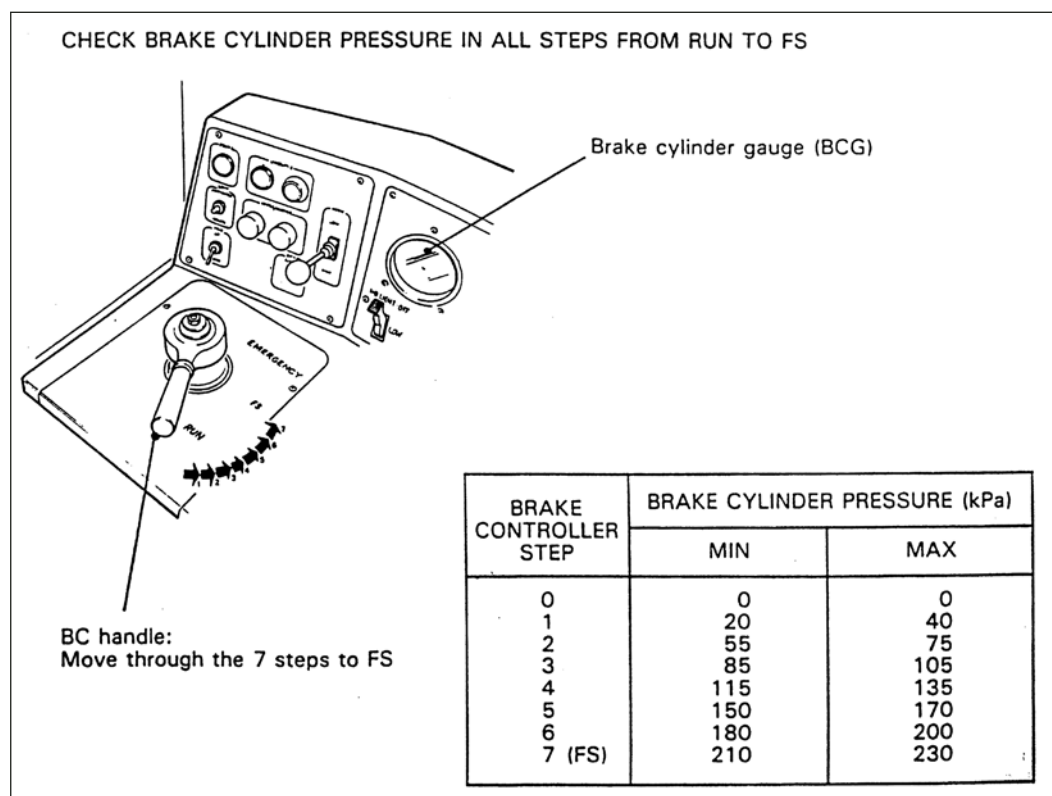
Description of braking system Comeng suburban electric trains

The Comeng train involved in the Broadmeadows to Spencer Street incident was fitted with a Westcode Westinghouse Brake System. This is a hierarchical system, which provides a primary brake mode with additional brake modes as back up.

The primary mode of braking employed is rheostatic braking. This mode of braking employs the traction motors as generators to reduce train speed by directing generated electrical current through resistance grids to turn train kinetic energy into heat. As soon as the driver applies the rheostatic brake, the ammeter on the driver's panel will indicate a braking current up to and around 200 amps or greater, in accordance with passenger load. This will indicate to the driver that they have a full braking effort.

If the rheostatic brake does not work, or is switched off, then the brake system will automatically revert to electro-pneumatic (EP) braking. Under EP braking, an electrical signal is derived from the brake controller which corresponds to the position of the brake handle in the service zone. There are seven different positions in the service zone that can be selected. The EP brake is electrically actuated along the train to the electro-pneumatic application valves mounted on each car. When the electric brake signal is received by these valves, the valves respond in proportion to the signal and admit main reservoir air into the brake cylinders, thus applying the brake-block force to the treads of the wheels.

FIGURE 15:
EP braking mode, tare condition only



If the EP brake fails, or is switched off, then the brake system will automatically revert to automatic-air brake mode. In this mode, a pneumatic signal is applied along the train by a reduction in brake pipe pressure proportional to the movement of the driver's brake handle. The brake pipe reduction causes valves on each car to allow air from the auxiliary reservoirs into the brake cylinders, applying force to the brake blocks on the wheel treads.

If the first brake mode fails each subsequent level cuts in at a similar brake effort to the level demanded by the position of the brake handle. If all fail then the brakes go to “emergency application.” This will stop the train as quickly as possible. Each of these braking systems automatically cut in once the previous braking stage fails or can be manually selected by the driver. If the brake on this train or indeed on any model of train is applied, the gauges on the control panel will tell the driver whether or not the brake is working.

The following systems are set up to operate the emergency brake so that a train under the control of a driver is protected against intrusion into an occupied or unsafe section of track or in case a driver is unexpectedly incapacitated:

- The train trip system (contacts a trackside signal lever and applies brake);
- the hand pilot valve (also known as a ‘deadmans handle’) driver releases hand pressure and brakes apply; or
- a foot pilot valve (foot operated alternative to the hand pilot valve).

On the control panel there is indication of brake operation and failure as follows:

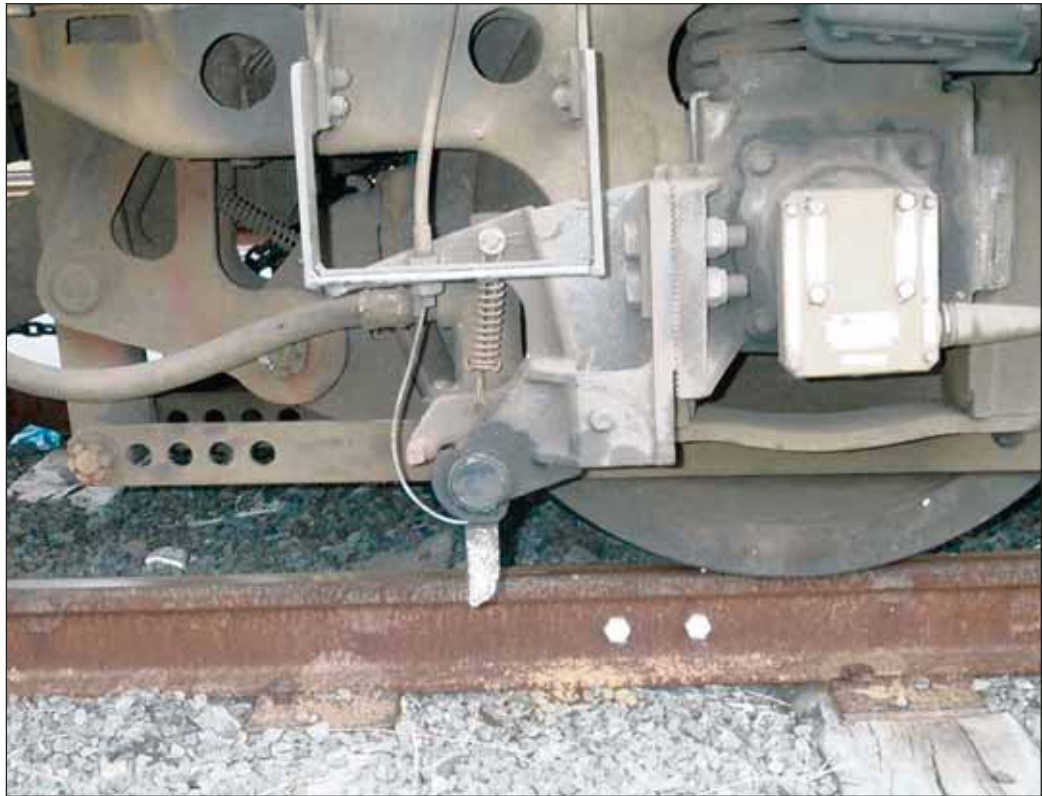
- In rheostatic brake mode, a build-up to around 200 amps on the ammeter and brake cylinder pressure dropping away on the brake cylinder pressure gauge. Failure is indicated by ammeter reading dropping to zero, brake cylinder pressure gauge rise and fault lights on the display panel.
- In EP brake mode the ammeter reading zero and brake cylinder pressure showing a pressure build-up on the gauge. Failure is indicated by the EP circuit breaker tripping, brake pipe pressure drop showing on the duplex gauge, fluctuation of the brake cylinder pressure gauge and a warning device being displayed in front of the driver.
- In automatic-air brake mode, a warning device with a red vertical blade is raised in the driver’s line of sight, a brake pipe pressure reduction shows on the duplex gauge and a brake cylinder pressure build-up shows on the gauge. A drop in brake cylinder pressure indicates a failure.
- Finally, if an emergency application is made or imposed a loud discharge of air from the brake handle area is accompanied by a rapid rise of brake cylinder pressure shown on the brake cylinder pressure gauge and the brake pipe needle on the duplex gauge drops to zero.

Drivers are required to check each mode of brake, including maximum brake cylinder pressure, whenever they take over a train. If the train has not been used that day then the driver is expected to do a full ‘driver’s preparation/examination’ of the train. Drivers are required to test all modes of braking to ensure that nothing is faulty.

If the driver has taken over the train after another driver has already conducted a full preparation that day, the driver is required to do a modified preparation. If the train has been taken over from another driver who has finished their shift, but is still present, then a ‘hand over’ is conducted, where any unusual characteristics are reported to the new driver.

Brakes are applied with the brake handle using the left hand. If the driver has not applied the brakes when they should, and the signals on the tracks are set at ‘stop’ a raised trip arm on the track will contact the downward projecting trip-lever on the train causing an emergency application of the brakes ensuring that the train is stopped.

FIGURE 16:
Trip-lever



Power is controlled by the control-handle, which is operated by the right hand. The handle of the controller incorporates a hand-pilot valve, (sometimes referred to as the 'dead-man's handle'). When the pilot valve is released, an emergency brake application occurs and traction power is cut.

The train brake control is operated using the left hand and the train power control is operated using the right hand along with a hand pilot valve. A foot pilot valve is also provided. The provision of the foot pilot valve allows the driver to use their right hand for passenger announcements and radio communication. For the foot pilot valve to be operative the brake valve isolation cock has to be open.

8.4 Instances of previous runaway suburban electric trains

Details of three previous incidents whereby Melbourne suburban electric trains have runaway without a driver on board have been provided for the purposes of this investigation.

The first instance was on 9 August 1975 and involved a two carriage 'Tait' suburban electric train. This train ran away from Camberwell Station and travelled to Flinders Street Station, a distance of about nine kilometres. A Board of Inquiry found that the principal cause of this incident was a failure by both the driver and guard to apply their respective handbrakes prior to vacating the train in order to change ends.

The applicable rules, regulations and instructions of the day mandated an application of the handbrake by the driver and guard on a stationary unattended train except where the train was to depart or be shunted within five minutes. In addition, the guard had to apply the handbrake in all instances when he left the guard's compartment, regardless of the dwell time. The handbrake on the 'Tait' suburban electric trains was essentially mechanical, and was applied by turning a wheel that was connected to the brake rigging by rods and pulleys. 'Tait' electric suburban trains have been withdrawn from service for many years.

In this particular instance the runaway 'Tait' electric train was stopped when boarded by an employee as it passed through number two road at Flinders Street. There were no passengers on board the runaway train, no injuries incurred and no damage to the train in question.

The findings from this Board of Inquiry directed fault at the electric train driver and train guard and both were fined accordingly.

The second instance occurred on 2 August 1977 when an unmanned 'Harris' type suburban electric train ran away from the main line platform at Gowrie Station. This train then ran away in the Up direction, smashed through seven level crossing gates (that were laying in favour of road traffic) before finally coming to a stand on the approach side of the Dawson Street level crossing. The Dawson Street level crossing is between Brunswick station and Jewell Station and is about 12 kilometres from Gowrie Station.

As a result of the previous runaway of the 'Tait' train from Camberwell Station amended instructions had been issued in relation to leaving electric suburban trains unattended at station platforms or main running lines. These instructions read:

'The electric train driver, when on duty must not leave his compartment unless it is absolutely necessary for him to do so, except as directed in the rules, regulations and instructions without a competent man being left in charge of the train unless it is in a siding.

In every case before leaving the van compartment other than when changing ends the driver must close the brake valve isolating cock, apply the automatic brake, screw the hand brake hard on and remove his controller key.

On returning to his compartment the isolating cock is to be opened to recharge the brake pipe and the hand brake released.

Under no circumstances must the electro pneumatic (EP) brake of a stainless steel or Harris type train be relied upon to secure a train, unless the driver is in his compartment.'

Evidence given before the Board of Inquiry in 1977 revealed that the train was left standing unattended at Gowrie Station platform on the main line with the EP brake applied and that no handbrake was applied at either end. Evidence from the guard and driver revealed that each thought the other was still in attendance on the train. The Board of Inquiry was unable to come to a positive conclusion as to why the runaway electric suburban train had come to a stand on the approach to the Dawson Road level crossing. When the train was boarded at this location the brake handle was found in the applied position and hand brakes released. However, the motor generator had tripped, thereby causing the loss of electrical circuitry and subsequent release of the EP train brakes.

The Board of Inquiry noted the extreme good fortune that this incident occurred at 0440 and the obvious lack of substantial road or pedestrian traffic at this hour. The driver and guard of this train were deemed to be at fault and were fined accordingly. Again, the hand brake on the 'Harris' type electric suburban trains was essentially mechanical and these trains have been withdrawn from regular service for some years.

The third instance was on 17 April 1996 when a 'Hitachi' suburban electric train ran away from platform 14 at Flinders Street Station. This train ran some 200 metres before back tripping³⁰ on a home signal, thereby halting this uncontrolled movement. This incident occurred during a shift change of drivers.

The Hitachi suburban electric train involved in this incident was subsequently examined and tested for any deficiencies in the braking system. This examination was conducted by the Manager, Fleet Engineering and no faults were found with the braking system.

The investigation was unable to conclude whether the incoming driver had applied the train brake when stopping and handing over to the relief driver. The relief driver vacated the driving cabin shortly after and did not ensure the train brake was applied, nor did he apply the park brake. The investigation team concluded that in leaving the train unattended at a station platform in this manner, he was acting in contravention of the rules and procedures of the day. This driver was subsequently removed from driving duties for three months.

In all three incidents the handbrakes / park brakes were not applied, thus removing the final defence that prevents uncontrolled movement. In two of the three instances examined, the potential for a major accident was very high. In one instance the train ran nine kilometres ending up at Flinders Street Station and, in the other, the train travelled 12 kilometres, smashing through seven level crossing gates in the process. The remedial action implemented in all three instances was in the category of procedural amendments and disciplinary action. This category of risk management is towards the lower end of the risk management hierarchy of control. Higher order risk management categories include removal, substitution or engineering.

³⁰ 'Back tripping' refers to a train striking a train stop at a signal applicable to the opposite direction of travel.








8.5 Signals

The signal system adopted by the Victorian rail industry is based on the US Rhea-Rudd speed based system. Signals are separated by distances that allow trains adequate time to stop provided that the speed at which the train is travelling is consistent with speed permitted by the signal indication.

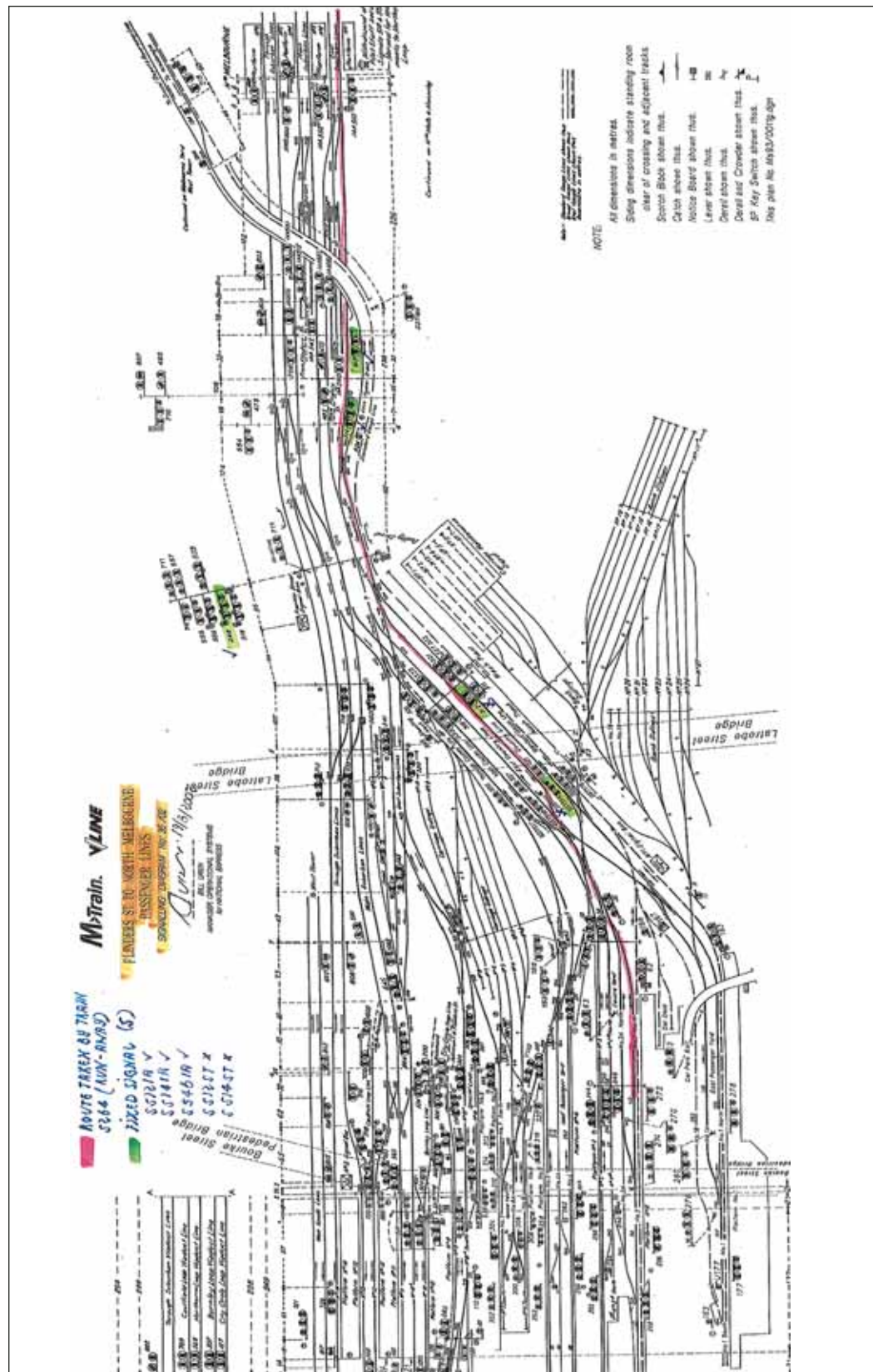
A signal will automatically turn to stop when a train passes. Once the train has cleared the overlap section the preceding signal to this signal will change from a red aspect to a reduced speed aspect, thereby allowing any following movements to proceed to the signal at which the overlap has been cleared. Preceding signals further back along the route will clear to either line or medium speed depending on whether the signals in question are three or four aspect. A diagram of signal indications is at figure 17.

The majority of signals in the Melbourne metropolitan area operate in conjunction with a train-stop mechanism. A lever adjacent to the signals at trackside is positioned parallel to the track and lies horizontally for all signal aspects except for 'stop' (red over red). When the signal is displaying a stop indication, the trip arm is raised so that it strikes the corresponding lever on the train, pushing it back thereby exhausting brake pipe air to atmosphere. The loss of brake pipe air and consequent reduction in air pressure then causes an application of the brakes.

FIGURE 17:
Three and four aspect signal indications

<i>Three Aspect Signalling</i>		<i>Four Aspect Signalling</i>	
Green/red 	Line Speed	Green/red 	Line speed
Yellow/red 	Normal speed & warning next signal at stop	Yellow/green 	Reduce to medium speed by next signal
		Red/yellow 	Medium speed and warning next signal at stop
Red/red 	Stop	Red/red 	Stop

8.6 Track and signal diagram Spencer Street Station to North Melbourne



**Runaway of Suburban Electric Passenger Train 5264
and Collision with Diesel Locomotive Hauled Passenger Train 8141
Spencer Street Station, Victoria**

ISBN 1 877071 44 7