



Office of the Chief Investigator
Transport and Marine Safety Investigations

**Rail Investigation
Report No 2008/11**

**Infrastructure Failure
Connex
Kensington/North Melbourne
6 November 2008**

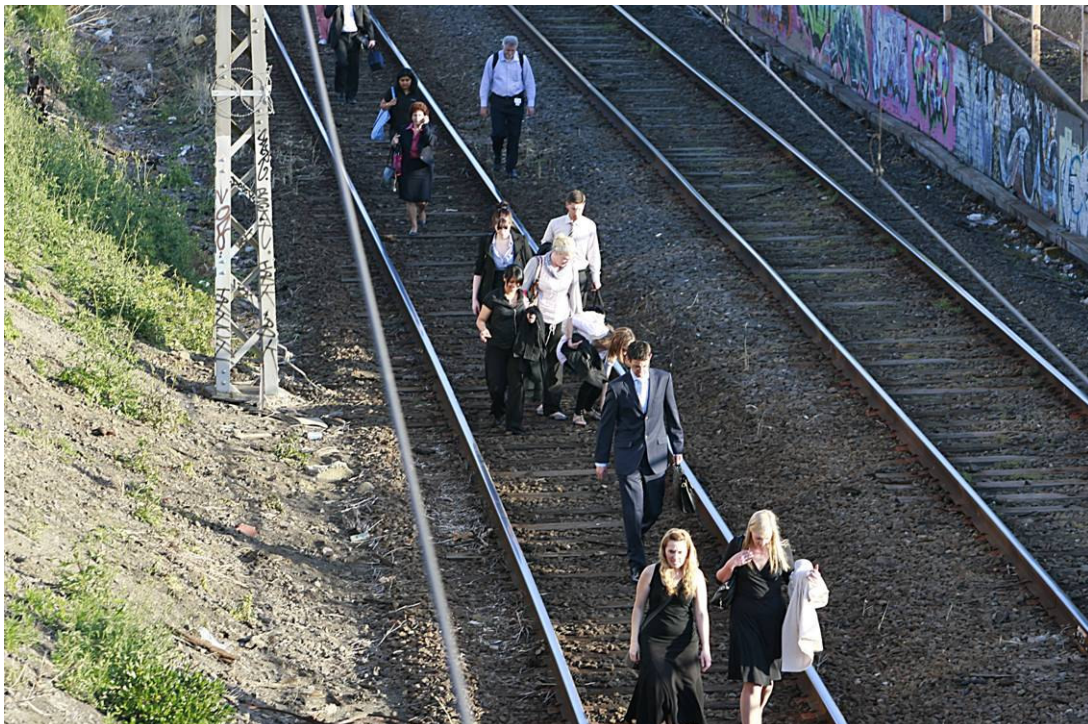


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THE CHIEF INVESTIGATOR

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

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

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

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

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

EXECUTIVE SUMMARY

This investigation has been conducted to examine those aspects of the disruption to Oaks Day 2008 train services that impacted specifically, or had the potential to impact upon public safety. These aspects concern the causes of the train stoppages that resulted in uncontrolled passenger detraining. The investigation does not examine matters of commercial concern for the operator.

On Thursday 6 November 2008, as the exit of race-goer passenger traffic from Flemington Racecourse on Oaks Day was intensifying, several infrastructure failures and critical events occurred in the locations of North Melbourne and Kensington/Newmarket:

1. Two instances of points malfunctioning occurred at Kensington.
2. A track circuit fault caused a Home signal at Newmarket to revert to Stop immediately in front of an approaching train, resulting in the train running past the signal before stopping (SPAD¹) and consequent delays to trains.
3. The original points malfunction at Kensington resulted in an empty Flemington-bound passenger service (the subject train) being detained at a signal near Kensington with the result that its pantograph — which had stopped in a critical position in close proximity to a contact wire ‘air gap’ — arced and burnt through the wire, causing a widespread system power failure.
4. When alternative arrangements had been made to continue train operations a points failure at a separate but critical location interrupted trains through this junction from another direction.
5. When the pantographs on the subject train were lowered, on instructions from Electrol², a further system short-circuit compounded the overhead power-outage.

The result of this series of circumstances was widespread train delays — some with the train stopped in mid-section — that resulted in passengers detraining in the section and walking, in contravention of railway safety requirements, along operating railway tracks in search of an exit from the rail right-of-way.

One passenger was reported to have received a minor injury during detraining. Train drivers reported that other passengers, who had been detained on-board some of the trains that had been stopped-in-section, displayed various degrees and states of distress.

Although Connex have an ERP (Emergency Response Plan) to provide for an operational response to crises, it did not anticipate an emergency situation of this nature. As well as some deficiencies within the ERP as to instructive content, there were deficiencies also in the implementation of control and communications. The report also makes recommendations related to the rail infrastructure.

¹ A SPAD (signal passed at danger) is a rail industry term used to describe an event where a train runs beyond its allocated signal block without authority (as indicated by a lineside signal showing a Stop indication; typically a red light or an aspect incorrectly displayed). Such an event, of itself, is not an accident however the potential exists — under specific circumstances — for it to result in an occurrence such as a collision between trains. The Australian national incident classification scheme includes a category of SPAD that applies to circumstances where the signal reverts to a Stop indication in front of the approaching train due to an equipment failure or signaller error; the train being unable to stop before passing the signal. Such incidents are of reduced significance in terms of safety risk as the route ahead of the signal will have been set for the train.

² *Electric Traction Power Control* centre. The control centre for the Melbourne metropolitan rail network overhead power system.

1. CIRCUMSTANCES

1.1 The Incident

The 'Oaks Day' is one of several major events comprising the annual Victorian Racing Club's Melbourne Cup Spring Carnival. As such, it is included in the Connex franchise agreement *Special Events Regime* as one of the annual pre-determined extra train services that Connex is obliged to provide.

On Thursday 6 November 2008, the total VRC attendance figure for Oaks Day was in excess of 89,000, of which around 40,000 were expected to be train travellers. Connex's operational target was to transport these people away from Flemington in the space of one hour.

At around 1550, as the departure of race-goers off-course was intensifying, a series of infrastructure malfunctions occurred to the Connex network, causing multiple train stoppages. Several heavily-loaded trains were halted in mid-section between Flemington and Newmarket and there was overcrowding on the Flemington Racecourse station № 1 platform. In response to these extended train delays (in some cases, without adequate public announcements), many passengers — some reportedly physically distressed — detrained and walked without guidance or direction along the track in search of an exit to enable them to pursue alternative transport. With the possibility of other train movements through these locations, this ad-hoc interchange of passengers created a serious public safety hazard.

The sequence of reported incidents involved track circuit and points failures and a signal unable to be cleared. This latter problem caused an empty train — running from Flinders Street Station to Flemington Racecourse — to be stopped while approaching Kensington. The stationary train's pantograph burnt through the overhead contact wire causing a traction power outage along the corridor between North Melbourne and Newmarket on the Craigieburn line. This compounded the delays to the trains that had departed Flemington Racecourse.

A set of points on the Upfield lines then failed, causing further congestion and adding to the delays being experienced by trains across the general area.

Connex deployed security personnel at Flemington Racecourse Station for crowd control, and mobilised extra bus and tram capacity. To assist this effort, police implemented their Traffic Diversion Plan.

2. FACTUAL INFORMATION

2.1 Incident Timeline

The chronological development of the sequence of events is set out below. The sequence includes several key contributory occurrences that are designated as 'trigger' events. (Note: refer to Figures 1 and 2 and to Appendixes A, B, C and D for diagrams of the affected infrastructure);

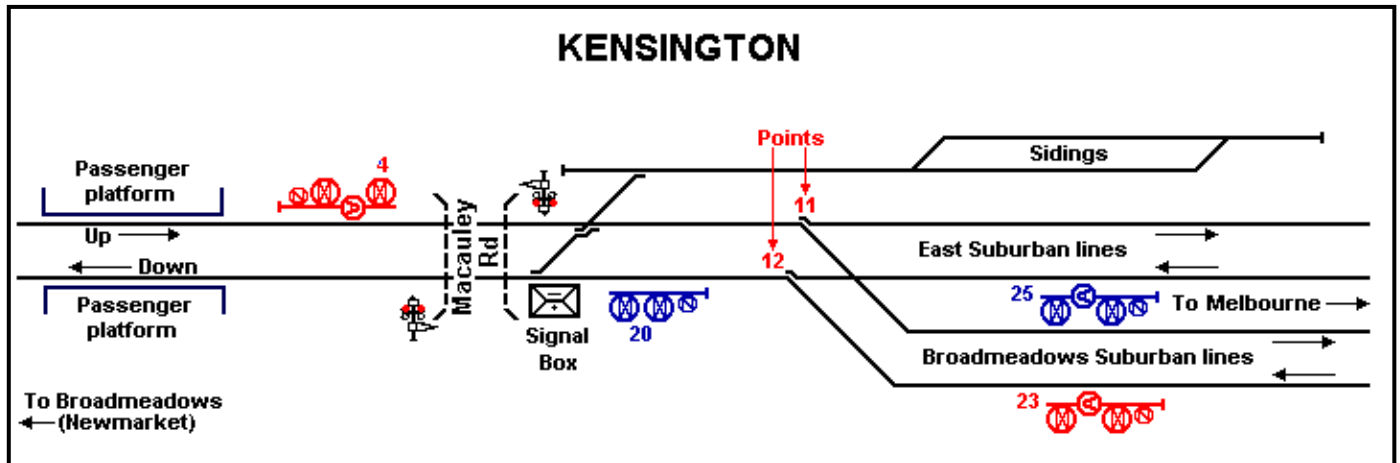


Figure 1 Signalling Diagram – Kensington 'Up' side.

1. Time 1556 (1st trigger event):

The driver of an Up³ train at Kensington platform 1 noticed the № 4 Up Home signal to be alternately indicating Clear and Stop aspects (also referred-to as 'pumping'). The train departed while the signal was Clear and the driver stopped on the Macauley Road level crossing to verbally advise the Kensington signaller of the situation. This train then continued into the city via the Up Broadmeadows Suburban line.

A signal maintenance technician attended, checked all equipment and found all indications were 'OK'. He then went to the platform and observed № 4 Up Home signal to be still alternately indicating Clear and Stop aspects. The technician contacted the signalbox to re-clear the № 4 signal and found that the signaller had been unaware that the signal had reverted to Stop. The signaller reported that indications on his panel showed that 'all track circuits were up'⁴ and that points were showing 'detected'⁵.

As the technician was preparing to depart, the signaller reported trouble with № 12 points (loss of detection in Normal position). The technician checked the points and found them not properly positioned (blade not against stock rail). All other relevant equipment was checked and no fault found. The technician concluded the problem had been a 'soft-pull'⁶ by the signaller on the № 12 points lever and that the signaller had not checked for detection before 'pulling signals'. He stated that this is a recurring issue at the Kensington signalbox.

³ 'Up' refers to trains travelling towards Melbourne (or, on a double-track corridor, the track leading towards Melbourne), while 'Down' refers to travelling away from Melbourne (or, on a double-track corridor, the track leading away from Melbourne).

⁴ A track circuit is referred-to as being 'up' if it is showing *unoccupied*, and 'dropped' if it is presenting as *occupied*.

⁵ The system recognises and returns an indication to the signalbox that the points are correctly positioned and locked.

⁶ Refer to explanation on 4th paragraph, p22.

2. Time 1614:

№ 34 Up Home Signal at Newmarket reverted to Stop in front of an Up train (5222), which ran past the signal before stopping. This incident was unconnected to the problems being experienced at Kensington. Maintenance staff attended this location and could find no fault with the signalling equipment. They concluded that the problem was a 'dropped' track circuit caused by DC current 'saturation' of impedance bonds (refer to Impedance Bonding, p29). The investigation has been advised that this is a recurrent problem experienced within the metro network in locations where older components are in use.

The Kensington signaller stated to the investigation that he had noticed that the above problem would often occur to the track circuit protected by № 34 signal when there were Up and Down trains passing each other in that location.

3. Time 1637 (2nd trigger event):

While the maintenance technician was standing-by at the Kensington Nos 11 and 12 points to carry out a final inspection in both Normal and Reverse positions (maintenance associated with 1st trigger event), the signaller reported that № 12 points were now locked at Normal and that he was unable to move the lever in the frame. The technician re-checked all equipment, found no fault, and reported a possible interlocking fault.

The signaller then informed the technician that № 23 Down Home signal on the Broadmeadows Suburban line could not be set to Proceed.

4. Time 1646 (approx) to 1705 (approx):

Three trains conveying approximately 1200 people each departed Flemington Racecourse. Some of these trains were described in Connex documentation as 'crush-loaded'⁷. These trains were halted, one behind the other, and delayed in the Racecourse-to-Newmarket section for time periods of approximately 45 minutes. The Ascot Vale Road railway level crossing booms remained down for approximately an hour, and road vehicles were reported to be driving around them. Ascot Vale Road is a major thoroughfare for traffic departing Flemington Racecourse. Many passengers detrained and made their way along the rail track in search of an exit and alternative transport. Remaining passengers were able to be detrained when the trains eventually arrived at Newmarket. Some train drivers contacted the Kensington signaller requesting an expedited path to a platform in order to detrain distressed passengers. Two of the trains were further delayed between Newmarket and Kensington for approximately 20 minutes.

A further six trains that departed Flemington Racecourse were delayed to varying degrees. A further 14 trains on the Craigieburn Up and Down lines were halted between North Melbourne and Newmarket, and delayed. Passengers from some of these services detrained and walked along the rail tracks.

5. Time 1654:

Contract security personnel were deployed at Flemington Racecourse Station for crowd control.

⁷ Refers to a rail passenger coach carrying more passengers than the standing load it is designed to carry (not necessarily comfortably) under normal circumstances. This load is usually expressed in numbers of passengers or units of weight. The limiting factors are available space (allocated area per passenger) and the maximum permitted gross weight of the vehicle.

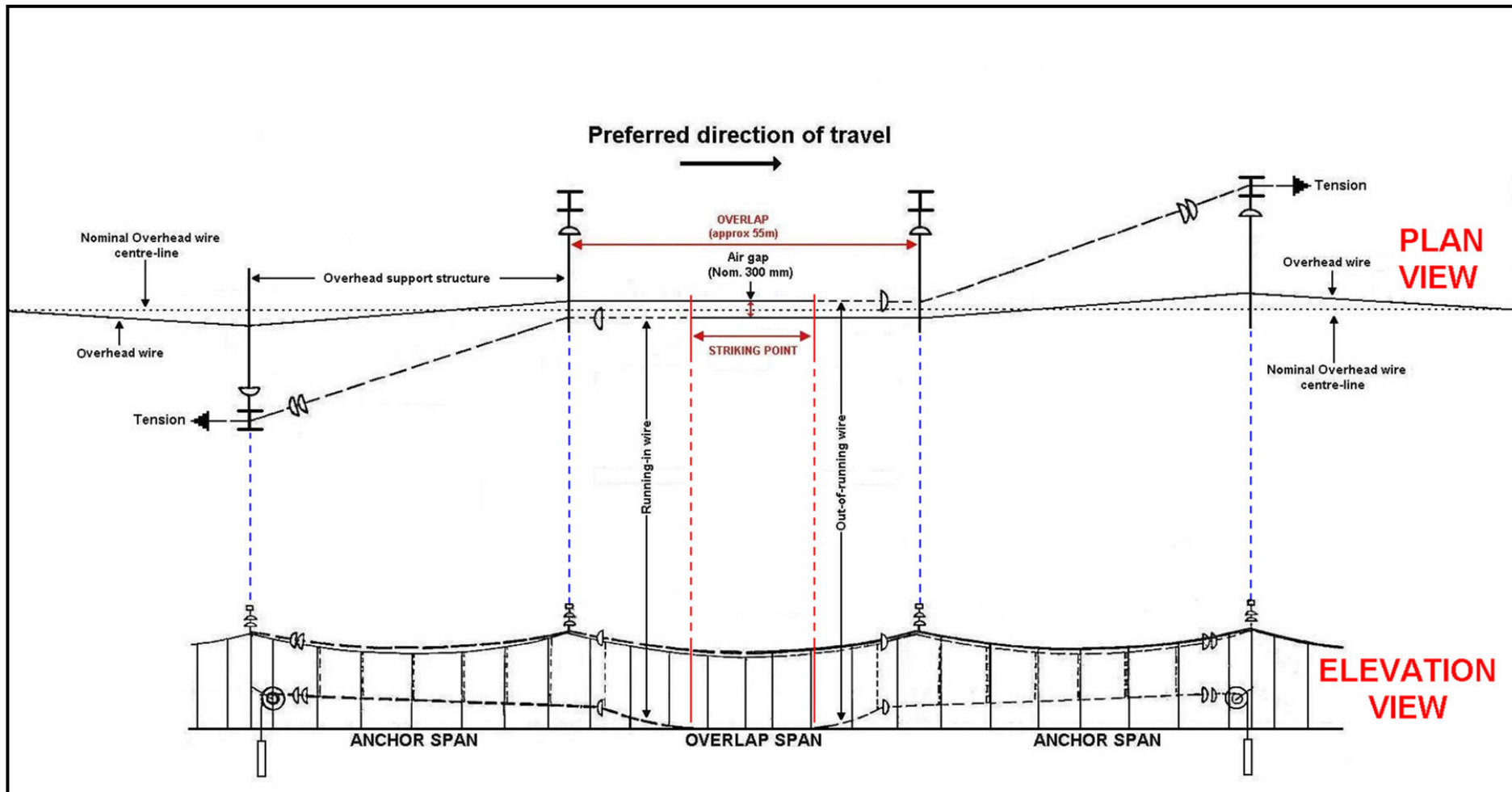


Figure 2 Diagram – Electrical Overhead Section Break (Air Gap) – Plan and side elevation view.

6. Time 1655 (3rd trigger event):

Arising from the problem with the Kensington № 12 points, train R463 — running empty from Flinders St to Flemington Racecourse — was halted at № 23 Down Home signal on the Broadmeadows Suburban (BS) line. By chance, the third of four pantographs⁸ on this stationary train was situated within the *overlap* (but not within the 'striking point': refer to Figure 2). This condition caused the pantograph to be in good contact with one of the wires within the overlap but either just out of, or in superficial contact with the other.

The signal maintenance technician at Kensington found a blown fuse for the 12 track circuit. This caused the № 12 points fault most recently reported by the Kensington signaller. Once replaced, full functionality was restored to all signal apparatus controlled from the Kensington signalbox.

7. Time 1700:

The first replacement bus services were organised.

8. Time 1702:

Due to the position of the third pantograph of train R463, mentioned in point 6, an electrical arc (refer to Section 2.3.3, p30) that formed between one of the overhead wires and the train's pantograph burned through the wire. The wire then fell and contacted the train's roof. This condition caused an automatic substation cut-off that disrupted power to the overhead wires of Sub-section 37/2 ['37-over-Two'] on the Down Through Suburban (TS) line, Branch-section 37/2/1 ['37-over-Two-over-One'] on the Down BS line, and momentarily to Sub-sections 301/1 and 301/2 on the Down East Suburban (ES) lines (refer to Appendix C for diagram). The circuit breaker for this latter disruption was reset remotely from Electrol. At this point, some trains were stranded in mid-section between Newmarket and Kensington and between North Melbourne and Kensington while others were held behind stopped trains or were deliberately halted by Metrol⁹ at suburban platforms where available, otherwise at various signal locations.

9. Time 1705:

Electrol advised Metrol of loss of Overhead power on the Down TS line from Southern Cross Station to North Melbourne, including the Down BS. The Overhead Duty Officer was advised and a repair crew dispatched to open local isolation switch 37/2/1 for this section. This manually-operated switch is located at an Overhead structure on the Down side of North Melbourne Station.

Electrol asked that Metrol request drivers of trains stopped in this location to lower pantographs. This request was procedural and was in anticipation of a subsequent restoration of power.

10. Time 1710:

Metrol advised the Overhead Duty Officer that the wire was 'down' on the Essendon Flyover (BS lines).

⁸ The *pantograph* is mounted atop the train. It maintains contact with the overhead contact wire and collects electric current from it for traction and for use by on-board equipment. A spring-loaded arm holds the pantograph against the contact wire.

⁹ Metropolitan Train Control Centre.

11. Time 1715 (4th trigger event):

№ 427 points (serving the crossover on the Upfield Suburban (US) lines adjacent to dwarf signal NME527; see orange line, Appendix D) were reported 'Out-of-Correspondence/Failed-to-Reverse'. This required Metrol to issue Caution Orders for train movements past various Home signals protecting movements both to-and-from the US lines and North Melbourne Station. The requirements for issuing Caution Orders and the need for trains to operate under these provisions over distances of up to 640 metres caused significant delays to each affected train. These delays impacted upon other train movements to-and-from the ES lines and North Melbourne Station, delaying and in some cases halting trains on the Up ES line between Kensington and North Melbourne and also between Footscray and North Melbourne. Passengers detrained in mid-section from several of the trains halted between Kensington and North Melbourne.

12. Time 1728:

The Overhead wire repair crew arrived at the location of the 37/2/1 isolation switch, and opened it. Section 37 (Broadmeadows Suburban lines) was isolated and made safe. All Up and Down traffic was routed via the nearby East Suburban lines.

Power was restored to the Down Through Suburban line between Southern Cross station and North Melbourne by remote command from Electrol who then advised Metrol.

13. Time 1732:

№ 427 points (see point 11) self-rectified while maintainers were in attendance. No fault was found. Traffic resumed on the Upfield lines.

Technicians requested further isolation of the electrified overhead to ensure safety during repair work.

14. Time 1740:

The Overhead wire repair crew arrived at the fault location mentioned under point 6. They noted the contact wire of Branch-section 37/2/1 being down on the roof of the train. They also noted that the leading 3-car set of this train was still being powered by the adjacent overhead Sub-section 301/2.

15. Time 1745:

Under instructions from Electrol (relayed via Metrol) the driver of train R463 at № 23 Down Home signal lowered all pantographs on that train. At this point, there was a loss of power to the adjacent overhead Sub-section 301/2 on the Down BS line (Note: at this location the overhead wire for Sub-section 301/2 serves the Down ES line as well as a short portion at the Kensington end of the Down BS line). Direct current circuit breakers (DCCBs) for Section 301 at North Melbourne and the Newmarket Tiestation opened automatically. This Overhead section extends along the Down Craigieburn line to beyond Newmarket, and includes part of the Up Racecourse-to-Up Craigieburn track crossover.

Electrol were advised by the Overhead repair crew that they required isolation of the Down ES line to effect wiring repairs.

16. Time 1750:

An Overhead maintenance technician isolated Section 301 (301/2) at the Newmarket Tiestation to make this section safe for repair work.

17. Time 1818:

Electrol opened DCCB 39 at the North Melbourne sub-station by remote command. This was a precautionary measure to de-energise the North Melbourne Stabling Sidings to prevent any train leaving them and entering the earthed Section 37 where the Overhead crew was working.

18. Time 1825:

Overhead Section's 37 and 301 were isolated, tested, and earthed.

19. Time 1925:

The disarranged overhead wire on the Down BS line was repaired temporarily and power restored to all lines. This repair consisted of splicing the two ends of the contact wire together.

2.2 Infrastructure

2.2.1 The Location

Kensington Station is located 4.7 kilometres from Flinders Street Station on the Craigieburn (formerly Broadmeadows) line. The signalbox located there is staffed for around 20 hours per day and controls the junction of the double-tracked and ES Lines with the 'Main Line' to Craigieburn and Donnybrook (see Fig. 1).

Both of the above routes connect Southern Cross Station with Kensington and the Craigieburn/Donnybrook corridor (including the Flemington Racecourse branch-line) via North Melbourne Station. The ES route traverses the locations known as Moonee Ponds Creek Junction and North Melbourne Junction. Due to the convergence of corridors, both of these junctions are potential choke-points. The BS route bypasses these junctions via a flyover (refer to Appendix D).

Moonee Ponds Creek Junction consists of the track crossovers between the ES lines and the TS lines to Newport (Williamstown and Werribee corridors) and MS (Main Suburban) lines to Sunshine (Watergardens corridor) - both via Footscray.

North Melbourne Junction consists of the junction of the MS and ES lines with the Upfield Suburban Lines.

The Flemington Racecourse branch-line is part of the metropolitan rail network. It is a terminating, double-track corridor 2.3 kilometres in length and connects with the Craigieburn/Donnybrook line at Newmarket. The line was originally opened in 1861 and is operated using a Two-position Automatic Block Signalling (ABS) system whereas the Craigieburn line is Three-position ABS territory. The Flemington Racecourse Station and yard at the line's extremity is controlled by the oldest operating mechanical interlocking system in Victoria. The line is used for Flemington Racecourse and Royal Agricultural Society Showgrounds events on around 40 occasions per year and also every weekday and weeknight for the off-peak stabling of electric train-sets.

2.2.2 Track Interlocking

An *Interlocking* is an assembly of track components that are interconnected either physically or electrically. Interlocking is provided at locations such as junctions where 'normal' track ends and more complex trackwork with points and crossings complicates train movements. Mechanical interlocking provides for the protection of multiple train movements within a localised area by being designed to ensure that the point levers cannot be operated so as to create a conflicting train movement. Therefore a signaller is unable to 'Clear' signals for the passage of trains unless the intended route is proven to be 'safe'. This state of security is affirmed by ensuring that points that are capable of presenting a conflicting route are set (and where it is a requirement, locked by a *Facing Point Lock*¹⁰) in a non-conflicting position and 'detected' as such.

Kensington Signalbox and Interlocking



Figure 3 Kensington signalbox – February 2009.

The Kensington signalbox dates to 1887 however the 'cam-and-tappet' interlocking lever-frame was installed in 1918. The lever-frame contains 19 levers for the manual operation of points and the electrical operation (switching) of various signals, plus one set of level crossing active protection equipment (flashing lights, boom barriers and pedestrian gates and bells). Some components of the mechanical interlocking equipment between North Melbourne and Newmarket, which includes Kensington, are in excess of 100 years old.

¹⁰ A Facing Point Lock (FPL) is fitted to facing points to ensure the points are locked in place before a train is able to be signalled over the route. The points cannot be moved until unlocked and cannot be unlocked while a train is on the line.

There are some 48 designated signalboxes within the Melbourne metropolitan rail network, of which 12 operate mechanical lever frames.

Mechanical points associated with colour light signals are electrically detected. 'Detection' of points at the Kensington interlocking requires that the closed points blade be recognised in the *closed* position; the gap between the blade and the stock rail against which the blade must bear not exceeding three millimetres. Interlocking detection at Kensington is accomplished by a track circuit that electrically locks the points lever. The points lever also works the FPL. When the lever is pulled, the early motion withdraws the FPL bolt, then the points move across, and finally — as the lever movement is completed — the bolt is reinserted. Thus, the action of unlocking the points, moving them, and then re-locking them is accomplished in a single lever movement. Via a separate rod connection, the points movement also operates a 'points detection controller' that returns an electrical indication to the signal box of the position of the points.



Figure 4 Kensington signalbox – lever frame.

The interconnection of the levers with the various signals, signal appliances and points is such that their movements must succeed each other in proper sequence, thus correct operation of the levers and connected appliances relies upon this sequence (or these sequences) being followed. The levers stand vertical within the frame when set in the 'Normal' position, presenting to the signaller with reasonably well-designed ergonomics and permitting gravity to assist the signaller when pulling them. From the signalbox, a system of rods runs alongside the track to each individual points assembly (see Fig. 5). Thermal expansion and contraction of the rodding is managed by the provision of a compensating mechanism located within the run-of-rod.



Figure 5 Kensington signalbox – point rodding.

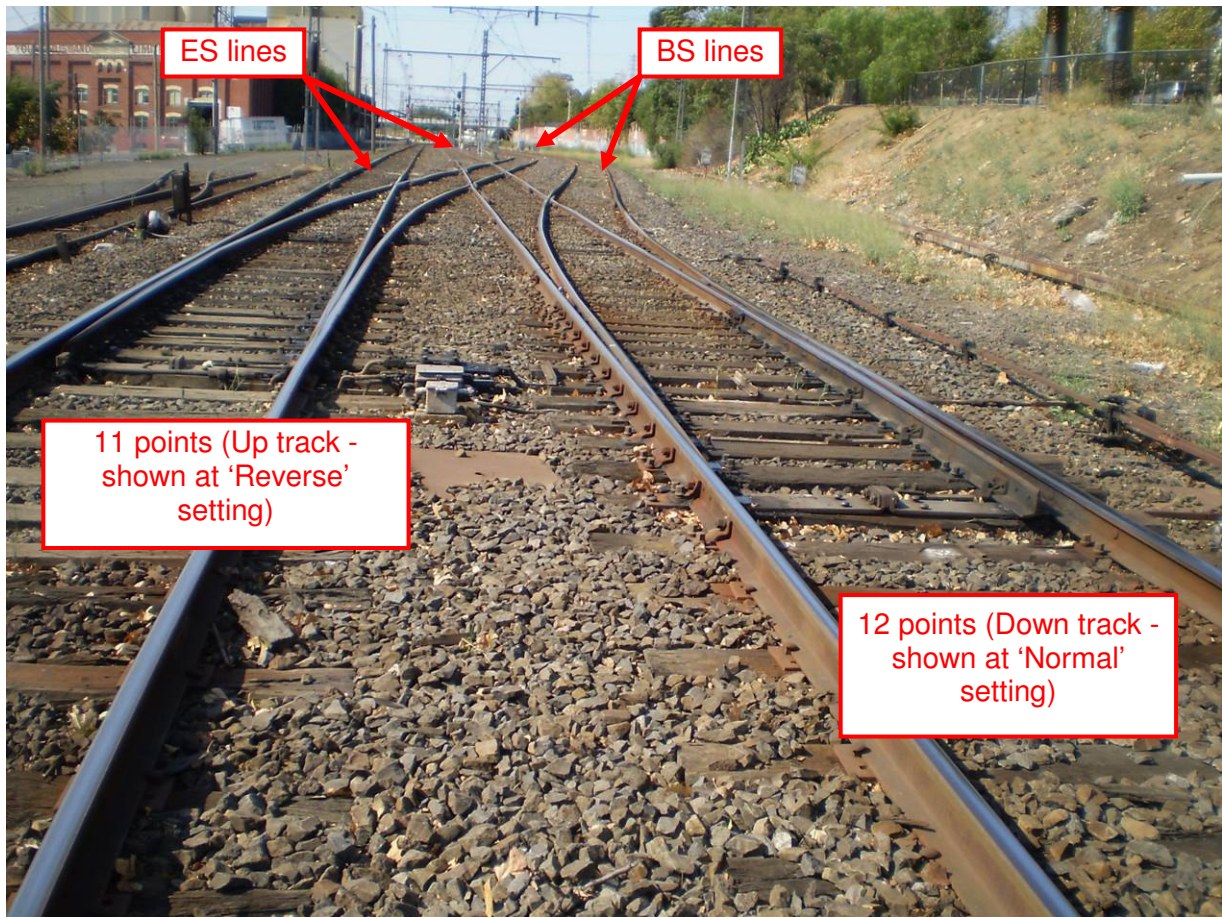


Figure 6 Kensington interlocking showing 11 and 12 points (looking towards Melbourne). See Figure. 7 for signalbox points detection indicators.

The most significant local interlocking actions conducted from the Kensington signal box might be considered to be those for traffic movements through the Kensington junction; that is, to and from both the Kensington-Craigieburn 'Main Line' (ML) and the East Suburban and Broadmeadows Suburban routes via points 11 and 12 (refer to Fig. 6 above and to Fig. 1). Both of these sets of points are at their 'Normal' position when set for the turn-out between the ML and the BS lines, and are at their 'Reverse' position when set straight-ahead for the ES lines. Thus, in the Up direction, movement from Kensington Station onto the BS line requires traverse of No 11 points through the turn-out in the *facing*¹¹ direction while a reciprocal Down movement from the BS line onto the ML and into Kensington Station is made via No 12 points in the *trailing* direction (see footnote below).

2.2.3 Signalbox operations

The Lever Frame

Through manipulation of the signal levers as well as control panel switches, the signaller controls the setting of points and the aspect displayed on signals in the vicinity of the Kensington signalbox, and — when the Newmarket signal panel is 'switched In'¹² — at Newmarket. Lever actions required to effect a particular outcome

¹¹ *Facing* points are the movable switch rails facing an approaching rail vehicle by which that vehicle can be directed via one route or another — usually either straight ahead or onto a diverging path. The term *facing* refers to the situational relationship between moveable switch rails (the points switch) and the approaching vehicle. *Facing* points can divert a rail vehicle from one line to another. The opposite is *trailing* points, by which the points switch is approached from the opposite direction, whereby two lines converge to become one.

¹² When train movements are required on the Flemington Racecourse branch-line, operation of points and signals through that location is controlled remotely via the Newmarket signal panel in the Kensington signalbox. For these activities the Newmarket panel is enabled by 'switching it In'. When the branch-line is not required for train

may consist of a discrete sequence of several lever movements. These are referred to as 'pull sequences' and are listed for the guidance of the signaller; including on the signalling diagram or mimic panel (see Fig. 7). The array of levers in a frame is colour-coded according to individual function. In accordance with convention, levers in the Kensington signal box are painted red for signal operation, black for points operation, and white for ancillary or 'spare'.

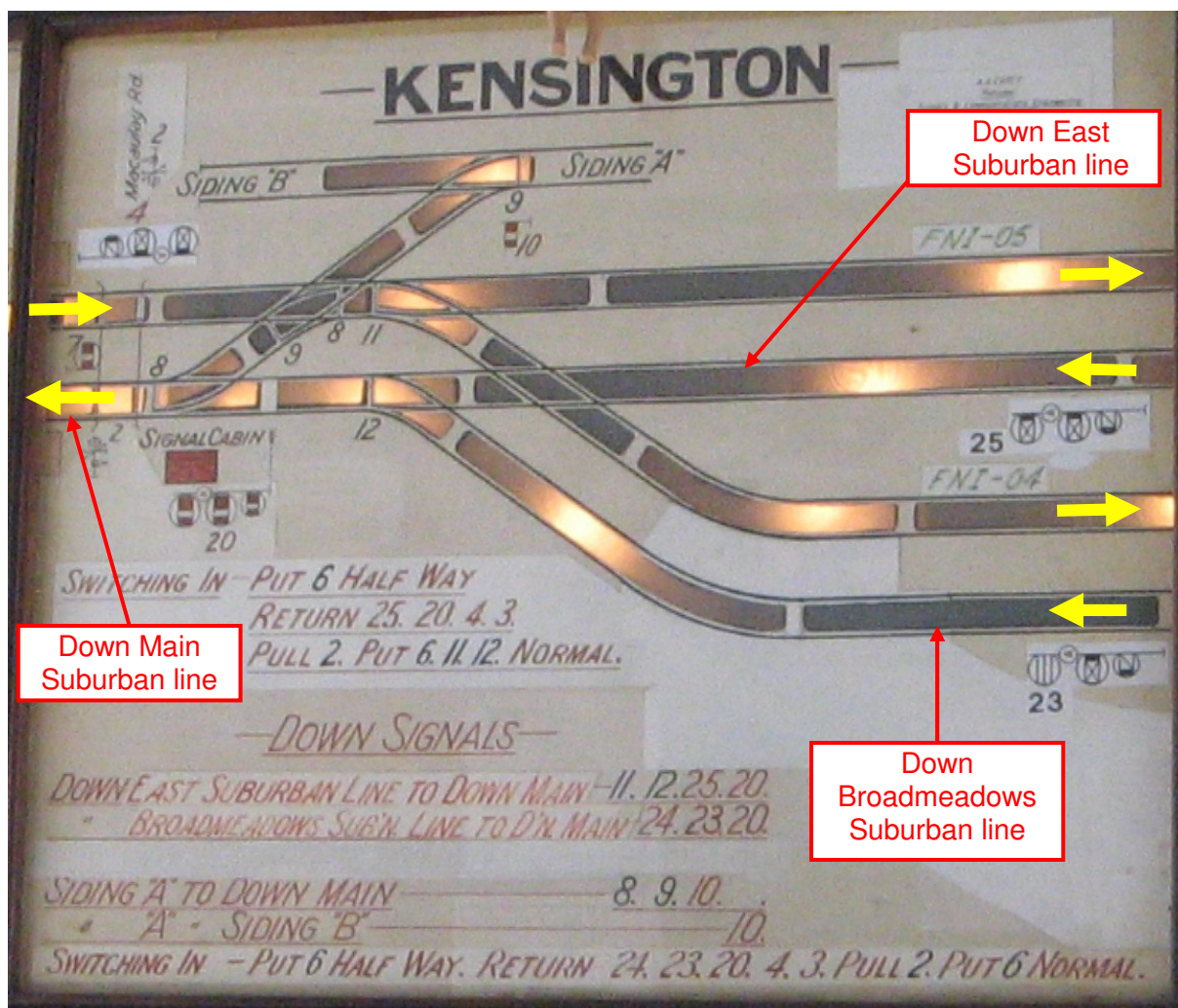


Figure 7 Kensington signalbox illuminated diagram showing various lever 'pull-sequences'.

For the correct operation of the lever frame and intended interlocking outcomes, the signaller is expected to operate the various levers in the correct sequence. In many cases, sequential lever movements cannot be made until points detection from the previous lever movement is received, so — moving through the 'pull sequence' — the signaller is required to constantly refer to the points detection indicators. In addition, to know whether they have achieved the desired outcome, the signaller must also refer, after each movement of a signal lever, to the signal aspect indicator for that particular signal.

Points Detection

'Detection' of points is the process of reporting their correct positioning back to the signaller to provide confirmation that their position has been altered and/or is set as intended. This occurs electro-mechanically via contacts in a 'points detection controller' located beside the points and an electrical circuit to an indicating lamp in the

movements, the Newmarket control panel is 'switched Out', meaning that it is rendered inoperative and signals at Newmarket operate automatically with the passage of trains.

signalbox. Detection is part of the process of validating a signalling circuit that is essential to the safety of interlocking.

As a defence against the potential for derailment should they not be properly set, main line *facing* points such as Kensington № 11 are locked when in both their Normal and Reverse settings (see Section 2.2.2, p17). A correctly-locked condition is part of the process of providing the signaller with the detection indication displayed in the signalbox; the points detection indicators being located immediately above the points levers to which they apply). By comparison, the adjacent № 12 points are part of the Down route and as such, carry traffic in the *trailing* direction and are not deemed to require the integral locking feature.

Unless the interlocking system registers points detection and indicates that the relevant track circuits are '*up*' (that is to say, indicating 'unoccupied'), the applicable signal lever is electrically locked and the signaller cannot move it to place a signal that is protected by those points to Proceed. Note that while there are two essential conditions requiring to be satisfied in order that detection for the № 11 facing points be displayed (that is to say, their *correct position* as well as their *locked state*), only one such condition is needed for detection on the № 12 trailing points; this being their *position*.

There is no evidence that any of the relevant points detectors on the day of the occurrence were non-functional. However although a Safety Practices notice to staff posted in the signalbox refers to a "...*Normal (green) or Reverse (yellow) light...*" being illuminated, detection for points is, in fact, displayed in the Kensington signalbox using green for both Normal and Reverse ('N' and 'R'; see Fig. 8, p23).

Infrastructure maintenance staff remarked to the investigation that it is their view that signallers are sometimes prone to making hasty lever movements within pull sequences. This may result in a less-than-positive response through the interlocking mechanism that is insufficiently robust to provide the required mechanical outcome 'in the field', and is referred-to as a 'soft pull'.

With the cooperation of staff, an investigator conducted tests to replicate a 'soft pull' on the № 11 points lever. Despite repeated attempts utilising different degrees of lever force and methods of action, it was not possible to re-create a 'soft pull'; that is to say, an abnormal interlocking condition of the sort encountered by maintainers in the field.

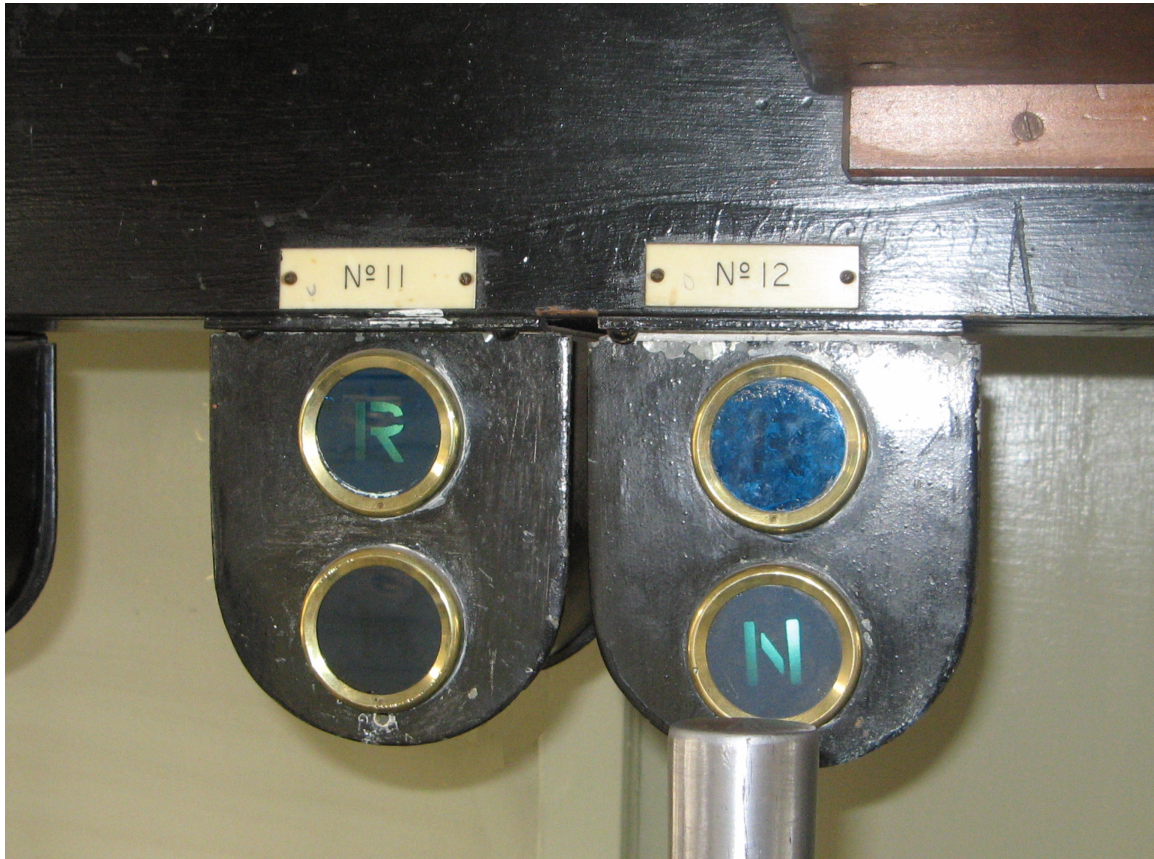


Figure 8 Kensington signalbox 11 and 12 points detection indicators displaying the points settings shown in Figure. 6.

The Newmarket Panel

The Kensington signalbox contains two track indication display panels; an original illuminated track diagram depicting the Kensington mechanical interlocking (operated from the lever frame), and a separate Standard Control Panel providing for the remote control of points and signals at Newmarket — the next station in the Down direction — when required. Installed within the Kensington signalbox in 1969, following closure of the Newmarket signalbox, the Newmarket control panel is located adjacent to the lever frame — and the original Kensington illuminated diagram — at the Melbourne end of the signal box, whereas Newmarket station itself is located — oppositely — along the line in the Craigieburn direction from the signalbox (see Fig. 9).

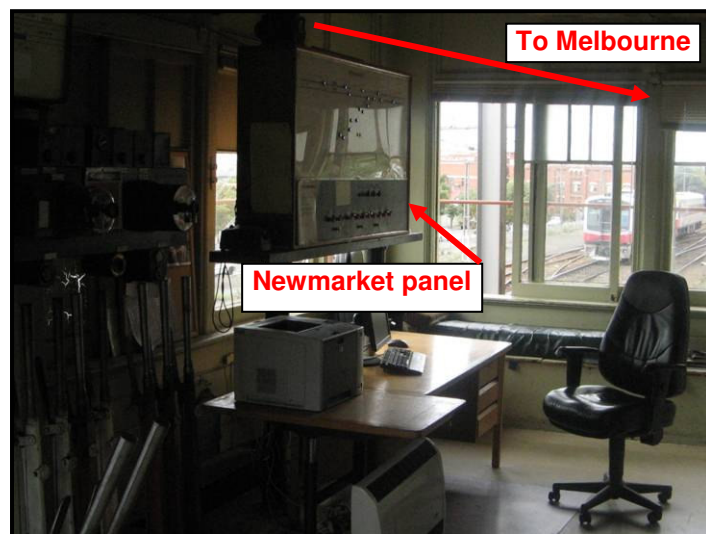
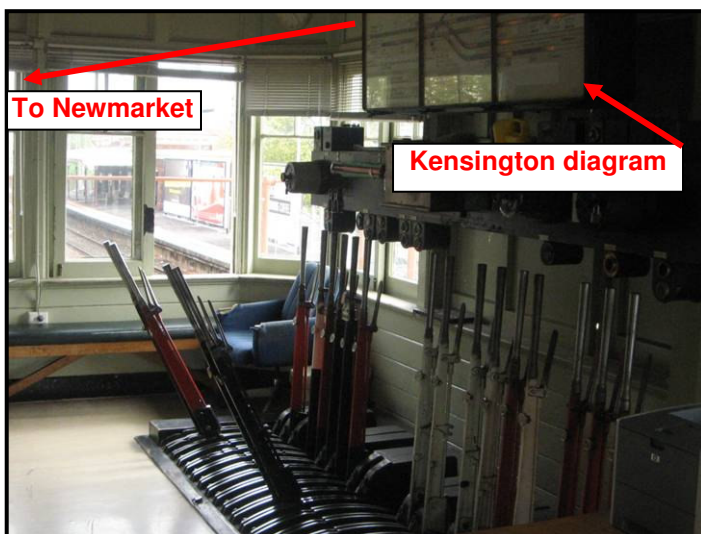


Figure 9 Kensington signalbox; Track indication display panels.

The Kensington illuminated diagram and co-located Newmarket control panel present conflicting display protocols to the signaller. While the older Kensington illuminated diagram graphically displays track circuits that are lit when the track is *not* unoccupied, the opposite is the case for the diagrammatic Newmarket panel which displays track sections via an illuminated lamp when the track *is* occupied (see Fig. 10).

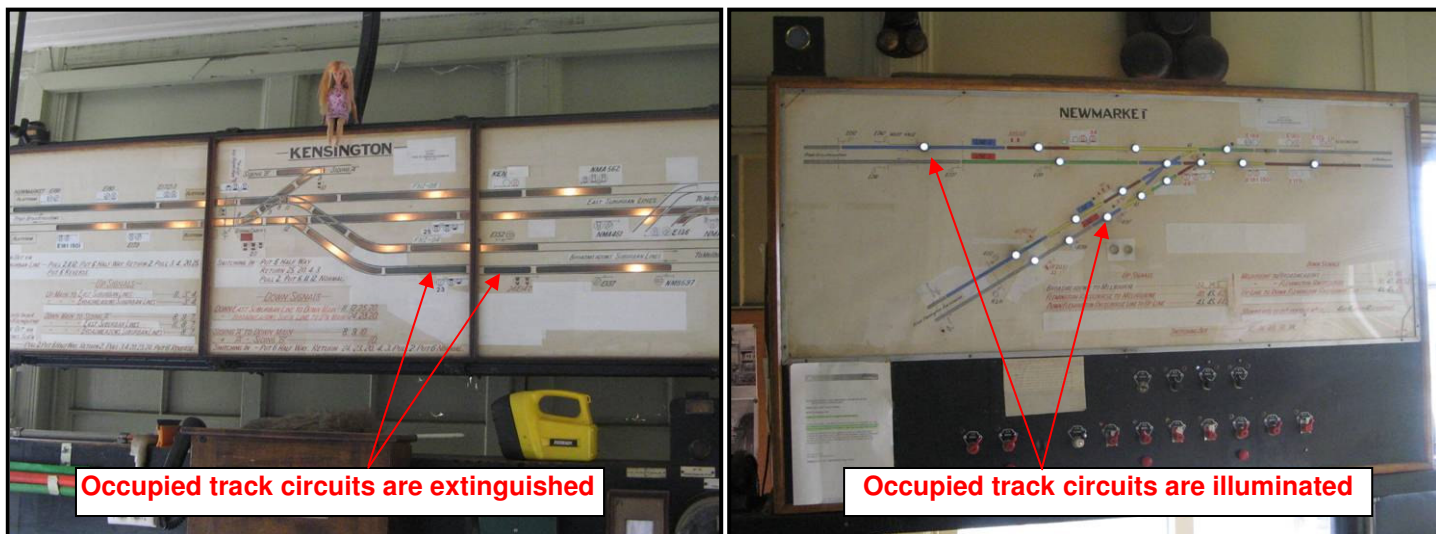


Figure 10 Kensington Signalbox track indication display panels depicting opposite display logic.

Staffing and Communications

During times of heavy traffic movements, such as a weekday commuter rush-hour or an event at Flemington, there are periods when there may be a train movement past the Kensington signalbox every minute or two. There are also brief and sporadic periods when traffic may be even more intense. For Flemington event days there are extra staff members rostered on duty in the signalbox. On the occurrence day there were three signallers on duty; one tasked with operating the lever frame, one the Newmarket panel, and the third with maintaining the Train Register Book and ‘other duties’.

In addition to the above tasks, signallers on duty also share the tasks of communications and recording. Historically, train movements through the station and other events concerning the location controlled by the signalbox are recorded in the Train Register Book. This document has traditionally been an important repository of daily shift events relevant to the signalbox, and its use is prescribed in Rule 4, Section 26 of the 1994 Book of Operating Rules and Procedures. Communications traffic mostly tends to flow between individual signalboxes and between signalboxes and Metrol.

Communication between adjoining signalboxes that is pertinent to the safe advancement of trains along a corridor is performed using the Train Number Transmitter System, (a computer workstation used to transmit and receive a train number to-and-from adjoining signal boxes), Sepac and VT-220 equipment¹³. Signallers and Metrol train controllers utilise the VT-220 terminals to insert train describer numbers that display — on each party’s terminal monitor — the identity and progress of a train. Telephone communication and VT-220 data input are essential

¹³ Sepac is a discrete telephone system with distributed programming capabilities. It provides intra-system ‘selective calling’ (selcall) voice communication between Metrol and signal boxes.

The VT-220 (Digital Equipment Corporation model designation) is a general-purpose workstation terminal that communicates with a host computer. Data entered via the keyboard is sent to the host computer and data received from the host computer is displayed on the monitor.

signalbox activities that consume a significant proportion of the time and attention of signallers. Attending to these latter tasks requires signallers to turn away from their frame or panel duties.

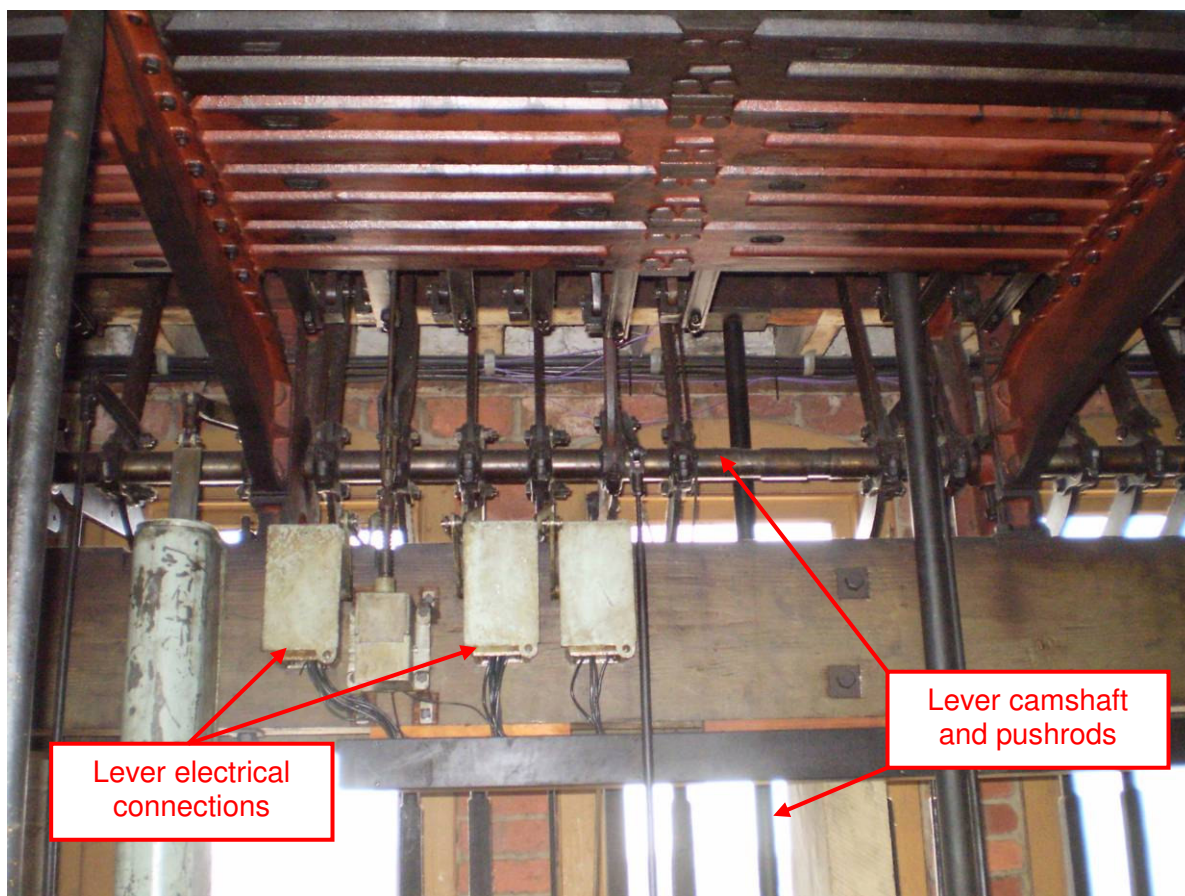


Figure 11 Kensington signalbox – underfloor apparatus.

2.2.3 Infrastructure Maintenance

General

Track, signals and electric overhead maintenance on the Connex network is carried out by MainCo (see section 2.4.3, p35). The MainCo Electrical Networks *Technical Maintenance Plan* (METMP Rev. B) specifies the maintenance policy for the Electrical Networks department and provides an overview of the maintenance regime.

Equipment in the field is maintained either by *preventive* or *corrective* maintenance. Minor repairs and adjustments where faults or unsatisfactory conditions are detected may be undertaken in the field.

Preventive maintenance comprises regular servicing and systematic examination. It is designed to detect and prevent potential failures and is undertaken to keep equipment in a specified operating condition. Scheduled maintenance activities are accorded a time-frame and are expected to be completed within the latitude provided by this. Where this is not achieved, catch-up activity is expected to be planned and managed to ensure the minimisation of net company risk.

Corrective maintenance comprises unscheduled maintenance actions performed to restore the system to a specified condition.

MainCo has a documented maintenance system and a planned reactive process. In addition, at the end of August 2008 and prior to the Spring Carnival, a walking

inspection of the Flemington Racecourse line was carried out and several outstanding corrective work-orders (none of them 'system critical') were completed.

Planned service level

The METMP (Electrical Network Technical Maintenance Plan) provides that, *“Response to faults is governed by business requirements and an agreed level of response performance for attendance to failures. Responses may be then further managed to minimise passenger weighted minutes (PWM) which are generated as a function of consumer time delays and expected passenger loadings arising from train delays caused by infrastructure.”* Passenger-weighted minutes in each month are checked against performance targets set in the partnership agreement and performance against these targets determines whether a bonus or a penalty applies to the operator.

The METMP also specifies that while the management of faults is based around protecting the safety of the public and employees, the minimisation of contract performance penalties (PWM) must also be considered in the allocation of resources to work.

Signalling power supply

Signals and points equipment (and the AC electrical supply frequency installed to operate them) are not standard across the network. There are three short, discrete corridor sections in the metropolitan network — Kensington being one — within which the installed frequency of the 110 volt AC supply is at 25 Hz. These discrete areas are 'isolated' within longer, complete corridors that are supplied at the standard 50 Hz.

For the signalling and interlocking of urban electrified heavy rail networks, 25Hz systems are no longer in general use throughout the world. Because of this, replacement devices and items of apparatus that are designed to operate on 25 Hz are no longer easily obtainable.

Maintenance at Kensington Junction

Data supplied by MainCo indicates that for the period April 2003 to May 2006, Nos 11 and 12 points at Kensington were serviced at approximately 42, 56, or 60-day intervals. For the period July 2007 through 2008 this service interval was reduced to every 28 days.

In the period extending from September 2004 to September 2008, MainCo reacted to 31 signal fault events associated with the Kensington Nos 11 and 12 points. Between February 2005 and September 2008 there were 13 recorded incidents of Nos 11 and 12 points having been reported by the signaller for specific problems with either their mechanical operation or with achieving detection.

2.2.4 Traction Energy Supply and Signalling

The Melbourne metropolitan electrified rail network operates with a 1500 volt DC supply to an overhead wire catenary system with traction return to the substation via one or both running rails and a single rail at points locations. The system provides for the 1500 volt traction supply from substations to be connected to the overhead wiring via 'high-speed' DC circuit breakers (DCCBs). These circuit breakers have an overload setting of between 2500 and 5000 amps depending on the configuration and length of the electrical section involved.

To facilitate electrical fault protection, the control of voltage, and to provide the ability to isolate discrete sections of the overhead (rather than an entire corridor) in the event

of fault or failure, the electrical network is divided into individual supply sections - each being normally fed from neighbouring sub- or tiestations¹⁴. Electrical supply sections are themselves made up of a number of shorter overhead wire sections known as 'tension lengths'. These are a practical solution to regulating the tension of the contact wire — using weights — and are usually about 1000 to 1100 metres long.

Air Gaps

The physical break in the contact wire that is provided to separate adjacent wire sections is variously referred to within Victoria as an *overlap* or *air gap*. There are 846 section break 'air gaps' in the Melbourne electrified network; 244 *open* (or 'non-switched') and 602 *closed*¹⁵ (or 'switched'). This incident occurred at an 'open' air gap.

An *open* air gap provides no electrical connection to the adjacent section - each of the sections being a separate circuit. As a result, different voltage values may exist at the extremities of each section depending upon (1) the distance between the air gap and the point of supply for that section and/or (2) whether the sections are temporarily subject to dissimilar current draw (for example; more trains operating at any given time in one section than in the other).

An air gap is configured such that the incoming (or '*in-running*') contact wire drops down from a tension-and-anchor-point on an overhead support structure, and the outgoing (or '*out-of-running*') wire rises up toward a tension-and-anchor-point. This arrangement allows the moving pantograph to transfer smoothly from the wire of one section to that of the next. The actual 'air gap' referred to is formed by the transitory parallel relationship (lateral distance approximately 300 mm) between the two wires over a span between two successive overhead support structures (the *overlap*; see Figure 2, p13). The two parallel wires never touch, although as the train travels through the overlap the pantograph is briefly in contact with both. This latter brief distance is known as the *striking point*.

Overhead Renewal

By the end of the 1970's, the alteration of train consists (resulting in higher rates of acceleration and decreased pantograph spacing) had led to an accelerated failure rate of some elements of the overhead structure. Between 1984 and 1992 the Suburban Overhead Rehabilitation Project (SORP) was undertaken to renew various key components. The objective of this program was to reduce the incident rate affecting train running to the absolute minimum for the following 20 years without 'real-term' increases in maintenance costs. Following completion of this project, service disruptions due to overhead traction-related faults were almost entirely eliminated¹⁶.

The investigation has been informed that the rolling-stock requirements of the time did not demand extra overhead wire capacity (and therefore extra return current capacity) and for this reason the renewal of 'at rail' or 'below-rail' infrastructure was not scoped as part of the above project.

In 1986 the Newmarket Tiestation was temporarily re-commissioned as a Substation to manage the traffic density expected for the Papal visit. As part of these arrangements, a feeder cable was strung from Newmarket to Flemington Station and remains in use today.

¹⁴ A Tiestation is essentially a Substation not equipped with a rectifier or transformer. In this respect it might be referred-to as a 'DC switching station'.

¹⁵ A closed air gap is a 'section break' with the adjacent sections electrically connected. Closed air gaps permit the use of 'tension lengths' while increasing the total length of the section (i.e. two or more tension lengths joined together) for the purposes of electrical supply.

¹⁶ N. Grady: Institution of Engineer's Australia Conference, 1985.

Impedance bonding

The signal system is comprised of double-rail 110 volt 25 Hz AC electrical track circuits that divide the track into signal blocks which are separated by insulated joints. The rails used for electric traction must provide an unbroken, low-resistance path for the *return traction current*¹⁷ to flow from train to substation, while maintaining the signalling section (or 'block') to provide a means of determining the location of a train. A track circuit is used to detect the presence of a train on rail tracks for the control of relevant signals and the information of signallers and train controllers.

A track circuit typically has power applied between the two rails and a relay wired across them. The basic principle is that the two rails can be connected by the wheels and axles of rolling-stock to 'short' the electrical circuit and de-energise the relay¹⁸. In addition, other environmental phenomena (such as the condition of ballast and sub-grade) can cause a loss of voltage within the circuit such that the relay will not be sufficiently energised and will drop out. Historically, the track relay was physically positioned so that if de-energised it's armature would drop open under the influence of gravity, the circuit would be broken, and the signal indication automatically revert to Stop. This gives rise to the term, 'dropped track'.



Figure 12 New impedance bond installation on original timber mounting at Kensington. The old impedance bond lies, discarded and disconnected, on the right.

¹⁷ The intended current path of a traction substation is from the positive side of the DC circuit, along the catenary wire, down the train's pantograph, through the traction motors of the train and the metal train wheels, along the negative return running rail(s), and back to the negative circuit of the DC-powered substation. The negative portion of the circuit conveys the 'traction return current'.

¹⁸ When the wheels and axles of a train or locomotive 'short' a track circuit (technically referred-to as 'shunting'), the reduction in total resistance within that circuit results in an increase in current flow from the power source. This increases the voltage drop across the feed resistor, in turn reducing the voltage between the two rails. With insufficient voltage across the track relay to keep it energised, its armature drops and the track circuit is open.

Located at the insulated track circuit joints, *impedance bonds* allow the return of traction current to the substation negative side. The impedance bonds offer a low-resistance path to the traction return current but a high-resistance (impedance) to the 110 volt 25 Hz AC signal current. They are designed so that the DC traction return current travels in almost equal amounts in each rail.

The investigation was advised that within the Craigieburn corridor many impedance bonds date to the commencement of suburban railway electric signalling in 1923 and were designed to carry approximately 500A of current. Over the years, internal deterioration due to ageing as well as the increased performance and traction current requirements of newer trains has resulted in significant *current saturation* occurring within some impedance bonds. The potential for current saturation to occur at an impedance bond depends upon the co-occurrence of a degraded impedance bond at a key location, for example close to a substation, and the (usually random) existence of a heavy current draw by a train or trains at or near that location.

One result of return current saturation is that the AC impedance characteristic of the device is diminished, permitting a premature 'short' of the track circuit across the two rails. In such cases the track circuit will 'drop', presenting to the system (and the signaller) as a phantom track occupation which means that the signal(s) protecting the block revert to Stop and no train can be admitted into it. This has severe implications for reliable train running and the investigation received information that the incidence of such impedance bond failure across the network was recurrent. Because of its nature, identifying the exact location of such a fault can be time-consuming. As faulty impedance bonds are identified they are replaced with modern devices of around 2000A capacity.

2.3 Mechanism of Overhead Wire Burn-down

2.3.1 Voltage Supply

Energy to the electrical overhead system is generally supplied at 22,000 volts AC into Substations, then transformed and rectified to 1500 volts DC for output to the overhead catenary system. Since electrical resistance increases with the length of the wire, and since a high resistance value may impair the response of high-speed safety circuit breakers, the length of the wire can be effectively decreased by locating Tiestations at strategic distances (approximately mid-way) along the electrical section. However, a Tiestation is not electrically-supplied from any outside source; its 1500 volt supply coming from adjoining Substations.

The Newmarket Tiestation is situated between the North Melbourne and Essendon Substations and is located such as to also serve the Flemington Racecourse line. Thus, Section 301 was receiving its supply from both North Melbourne and Essendon substations via the Newmarket Tiestation.

By comparison, the Broadmeadows Suburban Line — specifically Branch-section 37/2/1 — is supplied from only 'one end', the North Melbourne Substation. This power supply utilises catenary systems of both Up and Down tracks until a point approximately 975 metres from the burn-down location. From here to the eventual burn-down site (the 'air gap') the supply is via each catenary individually, so that current is only carried on either the Up or Down wires if there is a train under that wire. In this case, due to the presence of train R463, only the Down wire was carrying current, with no prospect of a 'voltage boost' from the adjacent parallel wire. This increased the possibility of a voltage drop at this extremity of Section 37 compared to the adjoining Section 301.

2.3.2 Voltage Difference between Electrical Sections

MainCo engineers advised that when R463 running to Flemington Racecourse was halted at № 23 Down Home signal (refer to diagram at Appendix B), it stopped, by chance, with its third pantograph spanning the parallel wires of an *open* Section Break overlap (refer to Fig. 2) but minimally past the ‘striking point’. In this position, the pantograph would have been in contact — at its normal upward force of around 80 N — with the ‘in-running’ wire of electrical Section 301 (refer to diagram at Appendix C) and either just out of contact with the ‘out-of-running’ Section 37 wire or only lightly touching it, in which case it may have created a resistive connection. Either way, the situation was conducive to the striking of an arc between the pantograph and the contact wire of Section 37.

This scenario would have been promoted had a potential voltage difference existed between Section 301 and Section 37. Section 37 at the time was supplying only one train (via pantographs 3 and 4 of train R463) and this was at the extremity from its power source (North Melbourne substation). In contrast, pantographs 1 and 2 of the train had moved onto Section 301 and were drawing current from that source.

As there is no recording of the voltage values as they exist at section break locations, the presence of such a potential difference cannot be accurately estimated. In this case, MainCo engineering staff consider such a voltage difference may have existed and that it may have been around 50 volts and possibly as much as 100 volts. An electrical potential such as this tends to result in the completion of a circuit where possible, and the resultant arc is this manifestation.

2.3.3 Electric Arc

An *electric arc* is a luminous discharge of electric current formed when a strong current jumps a gap (flows through ionized air) in a circuit or between two conductors. The gap is usually quite small although once struck, an arc may be drawn out some distance. The arc releases energy into the surrounding environment. If a circuit has enough voltage and current to sustain an arc formed outside of a switching device, the arc can melt conductors, destroy insulation, and cause fire.

Figure 13 displays the parted ends of the Section 37 contact wire, and shows the result of tensile pull-apart consequent to annealing. Adhered ‘splatter’ damage to the end depicted at left is consistent with it having been in live contact with and shorting through the train structure after parting.



Figure 13 ‘Necking’ shape of contact wire evidences the tensile failure and consequent pull-apart.

Data supplied by PTSV (the Victorian rail safety regulator) indicates that over the 19 year period between October 1989 and October 2008 there have been 135 instances of 'Overhead Traction Supply (Electrical Infrastructure Irregularity)' events on the Melbourne metro system. Of these, 32 have been identified as events specifically involving train pantographs and consequent disruption to or 'disarrangement' of the overhead wire and support system with consequent power loss.

Records supplied by MainCo indicates at least five similar events since early 2004 a further five prior to August 2002, and yet another five prior to August 1999.

2.4 Organisations

2.4.1 The State

Asset maintenance and renewal

In March 2005 the PTD (Public Transport Division) of the then Department of Infrastructure published a document¹⁹ outlining the history, processes and rationale associated with the franchising of the metropolitan train and tram network. The document recognized that fixed rail assets tend to have extremely long effective lives (typically in excess of 50 years) and that there are few intrinsic incentives for franchisees, as 'short-time custodians', to maintain and renew infrastructure to a high standard. For this reason, the importance of an adequate oversight regime was acknowledged to prevent any tendency for the franchisee to run their network 'safely' for the duration of their contract while spending only minimal amounts on infrastructure maintenance and renewal, thus creating a backlog of maintenance work for the future.

Under the 2004 rail franchise arrangements for the suburban network, infrastructure maintenance and renewal is based on the Connex Asset Management Plan (AMP) covering the whole franchise period. The AMP is developed in consultation with the PTD to ensure achievement of the State's objectives²⁰ – with all risks associated with cost, works quality, effectiveness and operational impact remaining with Connex. An Annual Works Plan is also required to be provided by Connex detailing specific works to be undertaken that year.

The Victorian Government provides the maintenance and renewal funding as part of its Franchise Payment and oversees the manner of its use by Connex. The Government remains responsible for the long-term condition of the asset. In this respect, the government is accountable for:

1. Ensuring long-term planning of the greater public transport network and for major public transport investment.
2. The provision of extensions to the rail network, the improvement of network capacity, and rolling-stock upgrades.

The Victorian Government audit regime on the spending by Connex of maintenance funding is designed to ensure the Government is accurately informed about the state of its assets although asset management is undertaken by the franchisee.

Asset improvement

The Victorian Government has stated its desire to see cost-effective improvements made to infrastructure over time. To achieve this, an 'asset improvement regime' permits the franchisee to propose improvement projects in the range of \$100,000 to \$5

¹⁹ *Public Transport Partnerships: An Overview of Passenger Rail Franchising in Victoria*. DOI (DOT) March 2005

²⁰ Broadly, these have been stated as being; to provide a safe, high-quality, stable public transport system with secure fundamentals, focusing on innovation, modal integration and excellence in customer service.

million aimed at overcoming safety and operational constraints and improving the performance of the existing network. This includes upgrading of the energy supply system and signalling and interlocking improvements and additions. The Victorian Government is under no obligation to fund any proposals received, and may choose which projects it funds, if any, on the basis of an assessment by the PTD of expected net benefits, and the State's broader economic, social and fiscal considerations. The PTD may also propose its own projects.

Asset Improvement Plans are submitted annually by franchisee's in accordance with relevant provisions of the Infrastructure Lease. Connex AIPs include the background statement that the Victorian Government, *"...has a desire to improve the general condition of the railway assets over and above the 'fit-for-purpose' standard delivered under the Asset Maintenance Plan."* The investigation was informed by the PTD that this process had proved to be unworkable in practice and has been revised, resulting in a significant level of total investment beyond the Government's franchise obligation.

The 2008-2009 AIP submitted a list of projects described (in part) as being *"...designed to capture the improvements necessary to be made to an asset now and in the short-medium term, in order to prevent a rapid decline of an asset's condition and thus avoiding major failures (hence delays or service disruptions) ...due to the asset reaching the end of its economical and physical lifespan..."*. The 15 items in this Proposed Project Listing include a study of the replacement of mechanical interlocking at all locations, an upgrade to vital signalling equipment, and an upgrade of 25Hz signal power locations to 50Hz. One of these items — the replacement of mechanical interlocking with computer-based systems — is also listed in the AIP for 2005-2006. The case for this project listed expected benefits of improvements to reliability, safety, asset performance and management, and maintainability.

The AIP for 2007 continues to list the mechanical interlocking replacement submission (now scoped as a 'study') as well as a project to upgrade track circuits while that for 2007-2008 again lists the requested interlocking replacement project and also several signalling upgrade or improvement projects.

2.4.2 Connex

As the franchise vehicle for Connex Group Australia Pty Ltd, Connex Melbourne Pty Ltd operates the Melbourne suburban rail network under a contractual arrangement variously referred-to as the Franchise Agreement or Partnership Agreement with the Victorian Government. Connex began delivering services in 1999 to Melbourne's east and north-eastern suburbs. Since 2004 the company has provided train services to the entire Melbourne metropolitan network.

Among other things, the contractual arrangement specifies the minimum level of passenger services that Connex is required to provide as well as minimum staffing obligations, and contains a mechanism called the 'load standard' for monitoring and managing overcrowding. The load standard represents the desired maximum number of passengers to be carried by each vehicle and is intended to ensure that passenger amenity and comfort are maintained.

The Franchise Agreement also requires Connex to employ a minimum number of Authorised Officers in mobile, customer-facing roles; primarily for revenue-protection and secondarily for customer service and security. These employees are managed by Customer Services, and their deployment and roles are defined within the franchisee's Revenue Protection Plan.

Passenger-Weighted Minutes

As the franchisee of a public transport operation, Connex was subject to an incentive framework, the main component of which is the Operational Performance Regime.²¹ The OPR is used to provide operators with financial incentives to meet specific target levels of performance. Under this regime Connex is accountable financially for its level of performance.

Delays, cancellations and other service failures are measured to the nearest 60 seconds and 'weighted' according to the number of people estimated to be travelling on the particular service. The passenger weightings vary according to the time period, day of week and direction of travel. Delays to a heavily loaded peak train are given a greater value than delays to a lesser loaded off-peak train. This detailed system provides a measure of operational performance expressed in *passenger-weighted minutes* of delay.

Emergency Response Plan

Connex have produced a corporate ERP (Emergency Response Plan) with the stated aim of assisting employees and management in 'making quality decisions' during times of crisis, including major service disruptions. In addition, the Connex ERP provides guidelines for managers and supervisors at all locations to prepare local Emergency Response and Evacuation Plans. Connex railway stations also have site-specific plans that are produced under the guidance of their TERI (Transport Emergency Resources & Information) Manual for use during periods of disruption.

The Plan does provide for the responsibility for 'Incident Control' to be delegated from the Manager Service Performance to the Senior Network Controller. The Manager Service Performance is required to ensure that Metrol has train controllers with suitable qualifications and analytical and decision-making skills to undertake this role.

Customer Service Department Business Plan: VRC Flemington Races Melbourne Cup Carnival 2008

As a major public transport provider with dedicated access to the Flemington Racecourse, Connex plays a vital role in the provision of safe and efficient transport to the venue.

Connex developed the CSDBP (Customer Service Department Business Plan) to assist staff in the professional delivery of the event by focusing on safety and customer satisfaction. The CSDBP incorporates the various Emergency Response Plans of relevant railway stations. Primary stated objectives of the CSDBP include the maximisation of revenue and enhancement of customer satisfaction, the provision of a safe and reliable train service, and the promotion of the efficient exit of patrons from Flemington Racecourse.

A key element of the strategy is the establishment — specifically to coordinate resources and conduct operations relating to emergency management — of the ECC (Emergency Control Centre) operating at the Racing Victoria Headquarters. The ECC accommodates emergency services representatives, VRC and Connex personnel.

²¹ As part of their contract, train and tram operators have the opportunity to obtain incentive payments for exceeding performance targets and can incur penalties for below-target performance. The system by which these payments and penalties are calculated is known as the Operational Performance Regime (OPR).

Other provisions of the CSDBP include:

1. the deployment of certain Customer Service Officers as *Authorised Officers* to provide revenue protection, customer service, and crowd control and to control and report (to the ECC) on passenger flow, and
2. responses to interruptions to the delivery of train services, including the following:
 - Arranging standby buses to run a shuttle service between the racecourse and Ascot Vale station.
 - Arranging for extra tram services (via Newmarket station and North Melbourne).

The need to consider the retrieval of disabled trains — by use of auxiliary motive power — to a point from which passengers might safely disembark would appear to be an obvious requirement in planning for a response to an emergency or major disruption to train movements to-or-from an event such as Oaks Day. The investigation has been advised by Connex that they have considered this requirement for inclusion in their ERP, and rejected the proposal because:

- It introduces new risks and increases cumulative risk.
- It would require the movement of trains with doors unpowered.
- It would require 'wrong-line' movements, making such a rescue operation complex and demanding of time and resources.
- It would require allocation of resources away from such other areas as crowd management and operational control.

Oaks Day Hazard Identification & Performance Review

The quality and substance of the Connex Customer Services response to the Oaks Day disruption was subject to a corporate de-brief review. Processes that were found to be 'positive' included the following:

- The Customer Management Plan was considered to have worked well.
- VRC and Connex PA communications (announcements) were considered to have been effective.
- The provision of extra transport services was as planned.
- Closure of platform 2 and exclusive utilisation of platform 1 proceeded without incident.
- Utilisation and performance of Authorised Officers was effective.
- Deployment of employees was in line with the Business Plan.
- Reaction times throughout the disruption were acceptable.

The following inadequacies were identified:

- Not every person who needed one had been supplied with a 2-way radio.
- The single available radio channel became congested.
- There was no Customer Service staff at Newmarket and Kensington Stations to assist passengers who had experienced extended delays aboard trains.
- Communication difficulties were experienced between Metrol and some signalboxes, between Metrol and various Authorised Officers and between Authorised Officers from different depots.
- Insufficient numbers of Authorised Officers had been rostered and deployed for the Oaks Day event.

2.4.3 MainCo

MainCo is a joint venture between United Group Limited and Connex and is responsible for the asset maintenance and annual works (preventative and reactive maintenance, and renewals) of the Melbourne metropolitan railway network. These responsibilities encompass:

- the track structure;
- the overhead electrical distribution system and substations;
- signalling (including level crossing protection);
- communications, including centralised control facilities such as Metrol (Metropolitan Train Control centre) and Electrol (Electric Traction Power Control centre) as well as associated computer and passenger information display systems;
- rolling-stock (Note: may be sub-contracted to builder-representative organizations);
- structures and facilities (including rail bridges, tunnels, lifts, escalators and train stations).

2.4.4 Yarra Trams

MetroLink Victoria Pty Ltd, trading as Yarra Trams, is a joint venture between Australian asset management company Transfield Services and European public transport operator, Transdev. The company operates the Melbourne suburban tram network under a franchise agreement with the Victorian Government. Yarra Trams began delivering services in 1999 to Melbourne's eastern and northeastern suburbs and in 2004 the company assumed responsibility for operating the entire Melbourne tram network.

Yarra Trams work closely with Connex in coordinating public transport requirements on various Flemington event days, including Oaks Day. On the day of this occurrence, Yarra Trams was called upon to operate extra services to cater for race-day patrons unable to catch trains at Flemington Racecourse station due to the train delays.

Some members of the public were seen to climb aboard tram exterior bumper/anti-climb assemblies and seek to ride while holding onto exterior hand grabs. Yarra Trams stated to investigators that tram drivers cannot see people who are riding the trailing end of their trams in this position, and rely on notification from passengers, passers-by, and other tram drivers. Yarra Trams instructions to drivers include a warning to look for such riders and notify the driver and/or the Fleet Operations Control centre. When detected, the tram is stopped and these riders are asked to remove themselves.

Since this incident, Yarra Trams have distributed an Operations Minimum Requirements reminder poster to drivers alerting them to people riding the exterior of trams and the action to take.

2.5 Environment

The weather was fine and clear. Maximum temperature on the day was 24 °C (22.6 °C at 1500 hrs) with a gentle breeze.

3. ANALYSIS

The transport of a large number of race-day patrons away from the racecourse within the space of one hour (and in parallel with a weekday rush-hour) was a challenging target that required the system to operate with precision and efficiency. Ensuring such an outcome required Connex to be able to provide serviceable trains and efficient infrastructure, and have adequate, suitably qualified staff and well-tested procedures in place to deal appropriately with emergencies and exceptional circumstances.

On Oaks Day there were a number of failures of the rail infrastructure which resulted in trains loaded with passengers stopping between railway stations. Passengers subsequently took it upon themselves to de-train and continue their journey over the rail track while trains continued to operate through the affected sections.

While it could be argued that the degree of rail infrastructure failure was abnormal and thus was not anticipated, the potential for some failure of the infrastructure should always be considered by a transport operator. The prime focus of any transport operator should be the safety of its customers, staff and the general public. On Oaks Day the operator did not adequately ensure the safety of its customers.

3.1 Train onboard environment

The day was not particularly hot; however, the atmosphere in a halted train that was tightly-packed and with limited ventilation when the air-conditioning ceased to operate would have quickly become oppressive. Should their train be stopped en-route, passengers with little or no conclusive information as to the likely extent of the delay can be expected to become anxious and agitated and eventually take action to leave the train.

3.2 Loss of electric power to trains

The request for electric trains in an area that has become de-energised to lower their pantographs is an operational protocol that ensures that when the overhead is re-energised 'start-up' power usage ('in-rush' current) in the section can be managed.

At 1702 hours train R463 stopped at signal No 23 and one of its pantographs burnt through the overhead wire. A few minutes later Electrol requested — through Metrol — for drivers of all trains in the Newmarket area to lower their pantographs. This action resulted in those trains — all Comeng sets — losing electrical power and as a result air-conditioning and the ability to keep doors electrically closed.

The investigation has been advised that because of the consequences (such as door controls being de-energised) of removing the 1500 volt power supply while trains are stationary, the Comeng fleet has been modified to provide — under such circumstances — for the automatic retraction of all except the leading pantograph. This modification provides for effective management of in-rush current draw when the overhead is re-energised. The existence of the modification does not appear to have been recognised or understood by either Electrol or Metrol in their request to have drivers 'manually' lower pantographs.

Given this lack of comprehension of the Comeng modification, an explicit instruction was made to drivers to lower pantographs. In this case it was only necessary to request trains on the Through Suburban lines in the Southern Cross-to-North Melbourne area (including the 'Broadmeadows Suburban fly-over') to lower pantographs and not all those in the Newmarket area. As a result of the broadcast

request there was a possibility of more passenger disruption (with potentially unsafe outcomes) than was necessary.

(Note that due to different technical configurations, other types of Electric Multiple Unit rollingstock do not require the modification described above)

3.3 Safety of passengers

- The Emergency Response Plan:

The ERP focuses on the definition of 'Emergency' as defined in the Emergency Management Act 1986 and although it mentions other, broader categories of occurrence — such as “...an event which may endanger or threaten the safety or health of any person...” — it gives the reader the impression that an emergency is a spectacular or sensational event such as an earthquake, flood, fire, explosion, plague/epidemic war, siege, riot or hazardous substance spill. The document does not define who is responsible for declaring an emergency. Further, it does not prescribe any regime for training staff in its use or testing its effectiveness, apart from the general guideline statements that staff members are to be familiar with the Plan and that an annual training exercise is to be conducted.

The ERP states that a 'Disruption' is a minor (less than 60 minutes) or major (more than 60 minutes) delay. However, it does not give guidance as to how a more prosaic set of circumstances that might develop incrementally from a service disruption should be recognized by staff as having the potential to constitute either a disruptive event or an emergency. As the total event developed it took some time for Connex to appreciate that they had a situation of potential danger to public safety on their hands.

No Disruption or Emergency was declared and therefore the ERP was not invoked or an Incident Controller formally designated.

Section 6 of the ERP addresses guidelines for preparation of an ERP and states (in part), that where possible, normal (Connex) transport services outside the emergency area should be maintained. It is possible that this guideline was interpreted as meaning that it was desirable to keep trains on adjacent tracks running past the affected area.

Section 6 also addresses the subject of planning for anticipated scenarios. In common with other passages of this ERP, this clause is ambiguous because it begins by referring to a 'major emergency' and ends with a reference to a “...type of emergency...” that can be dealt with by “...adapting or expanding the plan...”, suggesting that there is recognition that an 'emergency' event may be of greater or lesser magnitude. Elsewhere in the ERP, the possibility of a significant event of lesser magnitude than an Emergency is acknowledged and is referred to as a 'Disruption'. The ERP appears to recognise that there may be significant events of different magnitude, and attempts to categorise these as Disruptions or Emergencies however not all sections of the ERP maintain this distinction. This lack of consistency has the potential to cause confusion among those charged with implementing the ERP and such confusion has implications for the maintenance of public safety.

This section also encourages the organisation to conceive event situations that might reasonably be expected. The circumstances that constituted this event (that is, a localised loss of overhead power applying to trains conveying departing Racecourse patrons, and the consequences) were able to be anticipated and should have been provided for in Emergency planning.

- Passengers detraining:

Section 7 of the ERP addresses (in part) the matter of disseminating information to passengers.

Due to the nature of communications between Connex/Metrol and train drivers as well as the unserviceability of some on-board PA systems, many passengers were ill-informed or uninformed. This caused them to seek to take some degree of control of their perceived situation.

Sections 2 and 3 address the matter of evacuating passengers from disabled trains and escorting them to safety. There is also an instruction regarding having trains proceed with caution or, if need be, stopped.

Had a Disruption or an Emergency been formally declared it could be expected that the foregoing provisions of the ERP (and where relevant, of Connex's separate train evacuation procedures) might have been followed. As it was, train 'evacuation' of passengers did not occur. Arbitrary 'detraining' by passengers, however, did occur and only limited official assistance for these passengers was forthcoming.

Instructions were issued for train drivers in the affected locations to proceed with caution, however, had it been fully appreciated that passengers had detrained arbitrarily and were walking unsupervised along the tracks, it would undoubtedly have been prudent to stop all train movements in the vicinity. A Connex report from a Communications Officer states that 'senior signalling staff' were sent at 1815 hours and, police at 1900 hours to the stopped trains to 'ensure passenger safety' as passengers walked along tracks. It would seem irregular for signalling staff — who undoubtedly had other, vital tasks to perform — to be utilised to escort detrained passengers. The fact that this was deemed necessary suggests that someone in either Connex or Metrol did indeed appreciate the danger to public safety. It also suggests that Connex Customer Service staff (Authorised Officers) were either unavailable or were unable to be moved to these trackside locations as their level of Track Safety Awareness training did not permit them to supervise the evacuation of passengers on active running lines. Competent employees who might be formally instructed to proceed to the location of disabled trains in-section are — if they hold current Track Safety Awareness to Level 1 or 3 — able to assist small groups of evacuated passengers off the rail reserve so long as the route to safety does not involve increasing the risk.

It would seem from the above-mentioned report that the arbitrary detraining of passengers had been recognised at some time prior to 1700 hours and that drivers of other trains had been warned. And yet it took a further hour — and perhaps as long as 90 minutes — for staff (the signalling personnel mentioned above) to be directed to assist these passengers.

- Incident management:

Section 4 of the ERP (in part) provides instruction on the need for consistent and effective management to be in place and applicable to all types of emergencies.

The role of Incident Director resides with the Manager Service Performance but may be delegated to the Senior Network Controller or the Train Controller in charge of the operating floor at Metrol. The Manager Service Performance is responsible for ensuring *"...that Metrol has suitably qualified personnel who are able to analyse and make appropriate decisions, or take the necessary course of action when an incident/emergency occurs..."*

The Incident Director is required to provide direction and information to all parties throughout the duration of the incident/emergency as well as maintain appropriate records of the event. Resulting from daily experience and the regular occurrence on the network of disruptive events of one kind or another, train controllers with a reasonable length of service could be expected to perform adequately in the role of Incident Director. However, on Oaks Day 2008 there does not appear to have been timely recognition within Metrol that the individual incidents that were occurring in the Nth Melbourne/Kensington/Newmarket area were developing into a significant event with a potential risk to passenger safety.

- Retrieval of disabled trains:

Connex have advised that provision for the emergency removal of disabled trains to a safe passenger disembarkation point has previously been considered and rejected on grounds of risk, operational complexity, and resource availability.

Many passengers aboard race-day trains would be wearing footwear unsuitable for walking on the track/ballast surface, and walking barefoot under these conditions would likewise be out of the question. Under these circumstances it would seem to be desirable for the franchisee to have a contingency for moving such disabled trains to a location permitting safe passenger disembarkation. Existing safeworking instructions regarding the absolute occupation of a running line and the removal of disabled trains are certainly prescriptive in their totality, however it should not be inconsistent with the intent of the rules, nor beyond the capacity of the system to be able to plan for their conditional application to such a contingency.

3.4 Infrastructure performance

As mentioned earlier, it would not be normal for the number of infrastructure failures to occur in the same area and in such a short space of time. It is therefore important to assess the performance of the infrastructure in the area of this occurrence.

3.4.1 Signals and interlocking

The Kensington interlocking is old. The age of critical parts means that a sustained effort is required to maintain the physical plant. This maintenance requirement is signified by the regular attention concentrated on Nos 11 and 12 points. It should be acknowledged that there are subtle aspects of 'wear and tear' and 'lost motion' that are often characteristic of the ageing of mechanical equipment that cannot always be rectified by the continual replacement of individual parts. MainCo data indicates the infrastructure at this key location is susceptible to faults, the causes of which apparently have not been determined and addressed, and therefore to being able to produce significant service disruption with the potential for a negative safety outcome as occurred on Oaks Day.

3.4.2 Fault at No 4 signal and points No 11 and 12

The maintenance personnel attending to the faults in this equipment were unable to find the cause of the equipment malfunctions and stated that they suspected 'soft' lever pulls in the Kensington signal box were a 'recurring fault' and that in their view signallers were not always checking for points detection before 'pulling signals'. However, the signaller who had been operating the lever frame at the time held a different view. He stated that he believed that the age and general condition of the mechanical interlocking infrastructure was mostly to blame for track circuit and signal faults and failures. For example, No 4 signal is interlocked with Nos 11 and 12 points. If 4 signal is 'pumping' it could be because the track circuit(s) that apply to this signal's indication are unstable or that detection for Nos 11 and/or 12 points is intermittent.

Such irregularities could result from the age and/or maintenance of the total interlocking system (mechanism and apparatus as well as applicable wiring and even permanent way subgrade condition).

The distinction is also made that while there are two vital conditions requiring to be satisfied in order to obtain detection for the № 11 points, only one condition is needed for detection on the № 12 points. This subtle fact may result in the № 11 points being more susceptible to a failure to achieve detection.

Because of the problem with No 12 points, signal No 23 was at stop and as a result train R463 was delayed at the signal with the resultant 'burn-down' of the overhead in the area that further compounded service disruptions.

Despite the views of the maintainers and the signaller it is apparent that an on-going fault was not adequately investigated to determine the cause.

3.4.3 Signal № 34 Passed At Danger

A 'signal passed at danger' (SPAD; refer to footnote, p7) is a precursor safety occurrence; an event which could, under specific circumstances, lead to an accident such as a collision between trains. In this instance the route was cleared for the train and the signal reverted — due to the existence of a track circuit fault — from Proceed to a Stop indication as the train approached. The train was unable to stop before it ran past the signal.

Because it protects against conflicting movements at the Flemington Racecourse junction, № 34 Up Home signal at Newmarket is critical. The Kensington signaller interviewed has stated that the track circuit controlling this signal — a circuit monitored from the Kensington signalbox — is prone to 'dropping' when Up and Down trains are passing each other in the vicinity.

A report from a Connex Train Services Officer on the day of this occurrence indicates that the timing of this SPAD event is consistent with "*...an Up and Down train movement through Newmarket Station.*" This would tend to support the Kensington signaller's contention.

The signaller informed the investigation that this fault had occurred on a number of occasions while he was on duty and that he was aware of it having occurred to other signallers. He stated that the normal process for such an occurrence would be for the signaller to advise MainCo by phone (or personally if there were technicians in the signalbox at the time) and to record details in the Train Register Book. He could not, however, be certain that he had always recorded the details in the Train Register Book.

Again, this was a systemic technical fault that MainCo would have been aware of and that appears to have been accepted without adequate investigation to determine its cause.

The above aspects of the developing Oaks Day incident speak to the general state of the 'at-ground' infrastructure specific to the corridor.

3.4.4 Fault at № 427 points

This points failure occurred in a location un-connected to the infrastructure problems that were already creating the train delays around Kensington and nearby locations. The № 427 points — at a crossover on the Upfield Line providing access to and from the Macauley Train Stabling Sidings — were originally reported 'Failed to Reverse: no detection' by a Metrol train controller. When a maintainer attended, the points were

found lying in the Normal position and in an operational condition. While the maintainer was in the relay room checking the wiring diagram the fault rectified itself. According to MainCo personnel, this is an intermittent and unexplained fault that last occurred in September 2008 and has occurred previously. These points and this recurring fault are familiar to track maintenance staff responsible for this area.

3.5 Traction energy supply

3.5.1 History of overhead burn-downs

The circumstance of trains stopping at signals with the result that a pantograph is spanning an 'air gap' such as to create an arc is a problem that has happened before. It could be eliminated with relatively little effort and cost. The MainCo report of a similar incident at North Melbourne in February 2008 recommended several rectification options; among them:

1. *Re-profile the geometry of the catenary and contact wires to 'steepen' the gradient of the running-in and out-of-running wires. This creates a more positive arrival of the in-running contact wire to and departure of the out-of-running wire from the pantograph.* This option was not adopted as it effectively reduces the length of the 'striking point' (see diagram, p13) but not the probability of a burn-down.
2. *Re-locate the existing 'air gap' away from the natural stopping point of train pantographs.* Not adopted due to the expense.
3. *Survey the network to determine the number of locations where signal and co-existing 'air gaps' presented a potential problem when trains are stopped.* Adopted.
4. *Investigate whether the polarity of the out-of-running wire might influence the establishment of an arc in the circumstances of a pantograph stopped while spanning an 'air gap'. Characteristics of arc welding (electrode being 'positive' or 'negative', and arc stability in conditions of low DC voltage) are discussed.* This option not adopted as it was considered to be more of an exercise to satisfy curiosity than a potential solution.

The investigation has been advised that none of these actions were taken prior to the 2008 Oaks Day occurrence. Since the occurrence, a review of the location of open 'air gaps' with reference to Home signals has been undertaken.

3.5.2 Traction 'return current' saturation

With completion of the Suburban Overhead Rehabilitation Project in 1992 the network saw a dramatic reduction in the number of service disruptions due to overhead traction-related faults.

It is noteworthy that the 'overhead' is but one half of the energy supply system; the other critical element being the 'at-rail' negative portion of the traction circuit. There has been no similar project undertaken for 'at-or-below-rail' infrastructure, as at the time there was no expectation that future traction capacity requirements would require it.

The investigation received credible industry advice that a modern railway would, generally-speaking, avoid the use of impedance bonds by the use of jointless track circuits or alternate means of train detection.

3.6 Signalbox activities

3.6.1 Monitoring of indicators by signallers

Observations by an investigator and information provided suggests that reference by signallers to the *points detection* and *signal aspect* indicators in the signalbox is sometimes not as constant as it might be. In a busy period of train movements it was obvious to the investigation that the tempo of lever activity can become quite intense. In these conditions signallers might move through a pull sequence with only sporadic reference to these indicators; there apparently being an expectation that detection will inevitably result from each movement. For example, early in the sequence of this occurrence, the signaller was not aware that the No. 4 signal which had been 'pumping' reverted to Stop at the Kensington Up platform when the maintainer went to check it.

The investigation noted that there is a difference in the system requirements for obtaining detection between correctly moving the No 11 points and that applying to the correct setting of No 12 points (refer to p22). This arises because No 11 points are facing points (requiring that two vital conditions be satisfied in the provision of detection) while No 12 points are trailing points (requiring that only one condition be satisfied). From this it might be assumed that No 11 points have an increased latent potential for detection failure than the corresponding No 12 set.

The points detection indicators in the Kensington signalbox convey both Normal and Reverse indications with a green illuminated display. A Safety Practices notice exhibited in the signalbox states (with regard to the operation of points during a signal failure) that, *"...each point lever... must be operated... as required and sleeved, ensuring that the 'Normal' (green) or 'Reverse' (yellow) light is illuminated."* From this it appears that it is intended that points detection indicators display an illuminated yellow 'R' when indicating that points have correctly Reversed. The display in the Kensington signalbox is at odds with this specification and it can be expected that were the points detection indicators to display dissimilar colours for 'N' and 'R' — as the Safety Practices notice suggests — they may more effectively capture the attention of the signaller.

The investigation was unable to elicit information from Connex confirming the specification for the lens colours of signalbox points detection indicators.

3.6.2 Staff distractions

It was apparent to the investigation that signallers might on some occasions be subject to distraction. In busy periods such as a Spring Carnival raceday, there are three signalling staff rostered to the Kensington signalbox; one to operate the lever frame, one to operate the Newmarket panel, and another ostensibly to handle communications and attend to the Train Register Book.

Under these circumstances the signaller operating the interlocking lever frame is required to maintain visual reference from the signalbox in the direction of North Melbourne (the Up direction) as well as toward Newmarket (the Down direction). Likewise, the person tasked with operating the Newmarket panel also needs a view in both directions from the signalbox. Because the frame and panel are both located at the opposite ends of the signalbox to the direction of the infrastructure to which they apply, both of the signallers operating them are required to peer around the other — and possibly the third person — in the performance of their duty.

An additional potential distractor is the conflicting panel display logic between the Kensington illuminated diagram and the display on the co-located Newmarket control panel. During periods of intense activity there is potential for this inconsistency to

impact adversely on the intuitive perception by signallers of the diagram and panel indications and thus on the precision, ease and efficiency of operations within the signalbox.

The use of signalboxes with mechanical lever frames to control signals and interlocking at various locations along a rail corridor is, in a national context, nowadays the exception rather than the rule. Although greatly rationalised over recent decades, the Melbourne metropolitan rail system continues to make use of signalboxes with mechanical lever frames in various locations. In this environment, signallers utilise inter-box telephone communication, a PC-based display system, and operational oversight by Metrol for information about train running and expected train movements.

These communication tasks are essential signalbox activities that consume a significant proportion of the time and attention of signallers. However, attending to communications tasks has the potential for distracting signallers from the situational awareness provided by their attention to the lever frame or control panel and their vision through the cabin windows. Therefore, the suitability of the operational environment at the Kensington signalbox is in need to review.

3.6.3 Use of the Train Register Book

Current operational rules mandate the use of the Train Register Book to record a diverse amount of activity associated with the signalbox on a shift-by-shift basis. Despite these regulations and instructions, though, investigators are left to conclude that use of the Train Register Book by signallers has become discretionary. Despite existing procedures and the attendance of a dedicated staff member, the relevant page for the day of the occurrence, a day in which so much unusual activity occurred — contains only 24 lines of written entry, including just six train movements, and was of little use as a source of information for the investigation. It can have been of limited use, also, as a record of the daily signalbox activity, its principal reason for existence.

The investigation has been informed by Connex that information regarding the passage of trains past the Kensington signalbox (as well as some other locations) is recorded on a Daily Running Sheet and that where this latter instrument is used the Train Register Book need not be. The fact remains that explicit instructions pertaining to maintaining the record of signalbox activity reside as the applicable rule in the 1994 Book Of Rules and Operating Procedures, as well as a Safety Practices notice (posted in the signalbox and quoting the applicable rule) stating, *“Signallers are hereby reminded of Section 26-4, Rule 4, of the 1994 Book Of Rules and Operating Procedures. Signallers must use the Train Register Book to record all aspects of working of traffic and signals covering all matters that take place in the section. In addition, a report must be forwarded of any failure or irregularity.”*

Any corporate view within Connex that the Daily Running Sheet can be used for train data recording instead of the Train Register Book would appear to be an informal one. Such an expectation is also inconsistent with existing regulations requiring use of the Train Register Book.

3.7 Operational Performance Regime

As a Victorian public transport franchisee, Connex is subject to an Operational Performance Regime that is designed to provide it with the financial incentive to achieve a specified level of performance. Service deficiencies and degraded performance are calculated and expressed in terms of ‘passenger-weighted minutes’ of delay (PWM) therefore the franchisee will endeavour to minimise delays to reduce penalties imposed under the franchise agreement.

It follows, therefore, that the franchisee's performance would be improved by upgraded infrastructure. This could be expected to reduce faults and the maintenance effort required, and therefore delays to services. However, the franchisee is largely reliant for capital improvement on securing government funding.

- Electrol:

The problem of outdated infrastructure also manifests with regard to the network Electric Traction Power Control room. 'Electrol' is the central facility which contains the supervisory and control equipment used to manage the electrical supply to the metropolitan train network. In this facility a variety of technologies are in existence – some being subject to obsolescence and system support issues. Modern system life of a SCADA²² installation such as exists at Electrol is estimated at 10–15 years, however some parts of the electrical control system in this facility are now over 25 years old.

There is no indication that equipment or processes within Electrol contributed to the creation or development of this incident. However, in any assessment of the reliability of the current network the age of some components of the control system might rate consideration.

²² A Supervisory Control and Data Acquisition system is a remote control scheme for monitoring and controlling a utility from a central control point.

4. CONCLUSIONS

4.1 Findings

1. Several critical infrastructure failures occurred that compounded each other, causing the stoppage and delay of trains.
2. The stopping of a train at a signal resulted in the 'burn-through' of the overhead wire and loss of power to portions of the Craigieburn corridor.
3. Some elements of the fixed infrastructure on this corridor are very old.
4. Several of the infrastructure faults that occurred on Oaks Day were known to have occurred previously.
5. A number of passengers detrained without supervision and walked on active rail lines.
6. There was one minor injury to a passenger reported.
7. Connex staff did not declare an emergency.
8. Some train control processes, including communications, were inadequate.
9. The introduction of new rolling-stock has placed excessive demands on elements of the traction energy supply system.

4.2 Contributing Factors

1. The contact wire 'air gap' across which train R463 stopped was located in such a position relative to Home signal № 23 that a pantograph of the train arced against the wire causing the wire to burn through and separate.
2. The failure of some on-train Public Announcement systems and a lack of staff at some key locations left the passengers of some trains uninformed and/or misinformed and created anxiety.
3. The 'group call' from Metrol to trains to lower pantographs was not specific enough as to whom it was directed. This effectively deprived some trains of power to control and operate doors and air conditioning systems as well as the potential to move should the opportunity have presented.
4. The degraded condition of some impedance bonds has rendered them incapable of coping with present-day traction return current requirements.
5. The content and execution of Connex contingency planning for a disruptive event or emergency was inadequate.
6. Some signalbox activity and processes at Kensington were deficient.
7. Authorised Officers were unable to be effectively mobilised and deployed to assist passengers as the event developed.

5. SAFETY ACTIONS

5.1 Safety Actions taken since the Event

1. MainCo have undertaken a review of open 'air gap' locations across the network. At eight locations identified as having a high probability of a burn-down occurrence a 'section insulator' has been installed away from the pantograph stopping zone and the air gap 'jumpered'.
2. Connex have undertaken to review the number of portable radios required to be issued to staff during large crowd events, and update their Customer Service Department Business Plan accordingly.
3. Connex have undertaken to review their Customer Service Department Business Plan to identify where resources and personnel deployment strategies can be improved.
4. Connex have undertaken to investigate radio resources and channel availability.

5.2 Recommended Safety Actions

Safety issue 1

Although definitions are provided, the Connex Emergency Response Plan does not adequately describe how an Emergency and a significant event of lesser magnitude (a Disruption) might be differentiated and recognised. The ERP does not prescribe a detailed process for escalating a rail operational incident from a Disruption to an Emergency.

RSA 2008058

That the franchisee review and amend or otherwise ensure that the ERP includes details specifying how a 'significant event' emerging incrementally might be recognised, dealt with, and escalated if necessary, and who would be responsible for the escalation.

Safety issue 2

The overall performance of Metrol was lacking insofar as recognition of the nature of the emerging Oaks Day event was concerned. In the context of the ERP, Incident Direction involves commanding Connex resources to control an emergency and to ensure appropriate resultant actions. Before an Incident Director can be assigned, the organisation must recognise and acknowledge the existence of a state of Disruption or Emergency. Because there was no formal recognition of the emergence of a state of Disruption or Emergency during this occurrence the ERP was not invoked and thus an Incident Director not appointed.

Authorised Officers may have been available to attend the locations of disabled trains and provide assistance to passengers, however any decision to mobilise them would most likely have been the responsibility of an Incident Director. In this case, management of Authorised Officers would need to formally pass (and such a transition would need to be embraced by the ERP) from Customer Services to the Incident Director.

RSA 2008059

That the franchisee;

- (1) review processes within the organisation generally and Metrol specifically by which the appearance of an Emergency or Disruption can be recognised.
- (2) review the allocation of responsibilities for Emergency/Disruption Incident Direction to ensure that personnel accorded this responsibility are adequately informed of their responsibilities and trained to conduct them.
- (3) consider formalising a mechanism by which management of Authorised Officers can pass seamlessly from Customer Services to the Incident Director, as decided by the Incident Director under circumstances where their role in the interests of passenger safety and security might override those of customer assistance (in the normal sense of the word) and revenue protection.

Safety issue 3

The 'group call' from Metrol to trains to lower pantographs was not correctly addressed and effectively deprived some trains of power to control and operate doors and air conditioning systems as well as the potential to move the trains should the opportunity have presented. This action contributed to the emerging disruption by adding to the danger posed by passengers wanting to detrain.

RSA 2008060

That the franchisee reviews the process for instructing train drivers to lower pantographs in circumstances of loss of overhead power. This review should focus on ensuring that trains that do not need to be included in the instruction are not included and thus deprived of power.

Safety issue 4

Some of the trains involved in this occurrence had faulty Public Announcement systems and the drivers were unable to communicate adequately with passengers. In other cases train drivers were unable to gain sufficient information from Metrol about the likely extent of the delays to pass on to passengers. Without knowing when Connex would be able to continue to transport them, and not knowing the likely timeframe for the delays, many passengers alighted and made their way along the track. This placed them in danger from other trains, especially since no instructions had been issued to specifically halt train operations in these locations.

RSA 2008061

That the franchisee ensures they have an effective process for informing and, when necessary, evacuating passengers from trains that are stopped-in-section.

Safety issue 5

Impedance bonds play a crucial role in both ensuring the integrity of the energy circuit for powering trains and the vitality of signal circuitry. The investigation was advised that many impedance bonds around the Melbourne metropolitan rail system are old, are in a degraded condition, and are no longer able to perform reliably in the current train operating environment. When a track circuit fault occurs that can be traced to the failure of an individual impedance bond it is usually replaced with a component of

greater capacity, although the process of identifying the subject impedance bond in each instance can be problematic and time-consuming.

RSA 2008062

That the franchisee reviews impedance bonds throughout the network to determine the extent of the problem and then undertakes appropriate remedial action.

Safety issue 6

The mechanical interlocking existing at locations on the Craigieburn corridor and at other locations throughout the metropolitan network is old and, despite intensive maintenance, cannot be relied upon to operate dependably at all times. When a fault or failure within, or a misuse by an operator of this equipment coincides with a period of heavy passenger traffic there is the potential for train stoppages leading to a situation of danger to public safety from uncontrolled passenger detraining. .

RSA 2008063

That the proposed Asset Improvement study to replace all mechanical interlockings on the Melbourne metro rail system with contemporary computer-based equipment be advanced by the Public Transport Division and the franchisee as a matter of priority.

Safety issue 7

Because Platform 2 at Flemington Station does not have the fences and gates to safely contain and control a large, waiting throng of people, the crowd that developed at the station as a result of the delays to train departures was required to be directed to Platform 1. This intensified the crush of people on the platform which, in turn, increased the chance of a dangerous incident occurring to a member of the public or a staff member.

RSA 2008064

That the franchisee considers altering the crowd management features of Flemington Station Platform 2 to replicate those on Platform 1.

Safety issue 8

Some of the operating procedures in the Kensington signalbox lacked compliance with requirements. On the day of the occurrence, the Train Register Book was not properly utilised as an essential record of signal box activity, despite the provision of a staff member assigned to the task. Connex have advised the investigation that where a Daily Running Sheet is used in signalboxes (for example, Kensington) to record train movements, use of the Train Register Book for that purpose is not required. Other daily activity pertinent to the operation of the Kensington signalbox on Oaks Day 2008 was also not recorded in the Train Register Book. It appears that use of the Train Register Book is becoming (or has become) optional. Since explicit instructions relating to mandatory use of the Train Register Book continue to exist, these procedural expectations are confusing, even contradictory. A dangerous precedent is set by any transport organisation that permits or implicitly requests safety workers to routinely ignore a current operating rule or regulation.

Additionally, in some cases, signallers are not taking the time to observe signal and/or points detection indicators when working through a signal lever 'pull-sequence'. This

latter issue may have contributed to the faulty operation of the mechanical interlocking and if it did not on this occasion, it has the potential to do so.

RSA 2008065

That the franchisee:

(1) reassess the manner in which the use of the Daily Running Sheet is authorised or directed, and whether or not use of the Train Register Book should continue as a central requirement.

(2) review their audit process for monitoring the actions of signallers in their manipulation of signal levers and of their observance of status indicators, and provide any required remedial training.

Safety issue 9

The Kensington signalbox lever frame and accompanying illuminated panel and the control panel for Newmarket Junction are co-located in such a way that the two panels are at opposite ends of the signalbox to the direction in which their functions apply. As well, the illuminated feature of the track circuit display operates oppositely, one from the other. On the illuminated Kensington lever frame panel the depiction of *occupied track circuits* is unlit while in the Newmarket Control Panel the same indication is lit.

It is acknowledged that the relative position of the two panel assemblies in the signalbox cannot easily be rectified. However, the matter of contradictory display logic for the presentation of occupied track circuits on the panels deserves attention. In this case, identical information is displayed to the operator in two different ways. This creates the potential for the operator to misinterpret either display.

RSA 2008066

That the franchisee investigate the matter of the contradictory panel displays, with a view to establishing a standard for how such displays are presented and make appropriate alterations to current installations and instructions.

Safety issue 10

The investigation found that signallers can sometimes miss or do not provide due regard to points detection indicators. The points detection indicators in the Kensington signalbox convey both Normal and Reverse indications with a green illuminated display while a Safety Practices notice suggests that it is intended that the Reverse display should be presented with an illuminated yellow 'R'. The use of different colours would render the indicators more noticeable.

RSA 2008067

That the franchisee review the specification regarding the intended colour of points detection indicator 'R' displays in signalboxes, and that such displays in all signalboxes be rendered correctly and consistently.

Safety issue 11

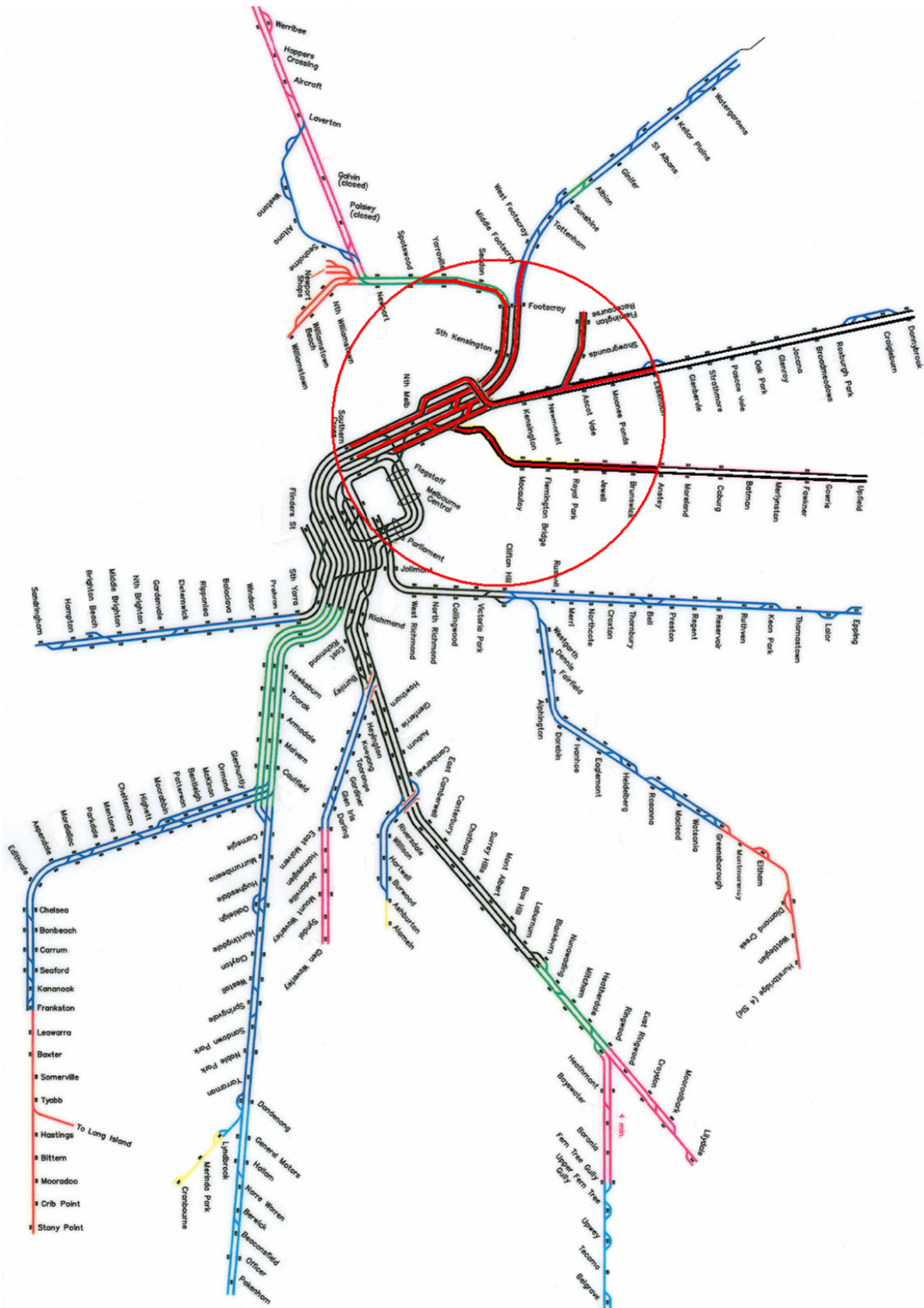
The Comeng fleet has been modified to provide — under circumstances of traction power loss to a stationary train — for the automatic retraction of all except the leading pantograph. This configures each train, should there be several disabled in the section, to reduce the inrush current draw at re-energisation to a manageable level, thus the original requirement to instruct drivers to ‘manually’ retract pantographs no longer applies to Comeng rolling-stock. The resultant amendment to the original requirement in circumstances of loss of the 1500 volt supply does not appear to have been comprehended by either Electrol or Metrol, hence their request to drivers and the subsequent creation of a dangerous situation for passenger safety.

RSA 2008068

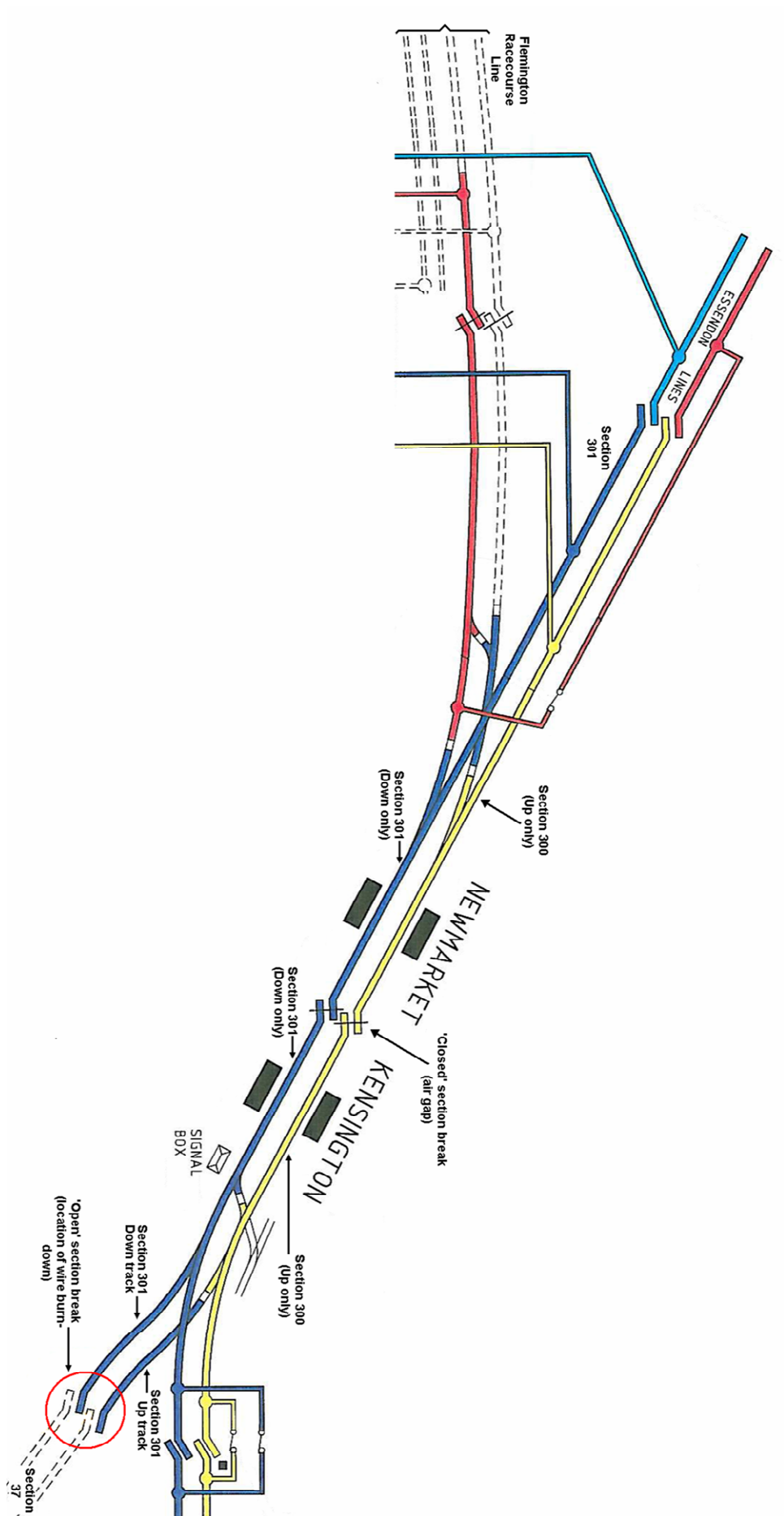
That the franchisee take action to ensure that notification regarding this modification to Comeng trains is circulated to all concerned and that the amended requirements for stationary Comeng trains consequent to a loss of the 1500 volt traction power supply are understood.

APPENDIXES

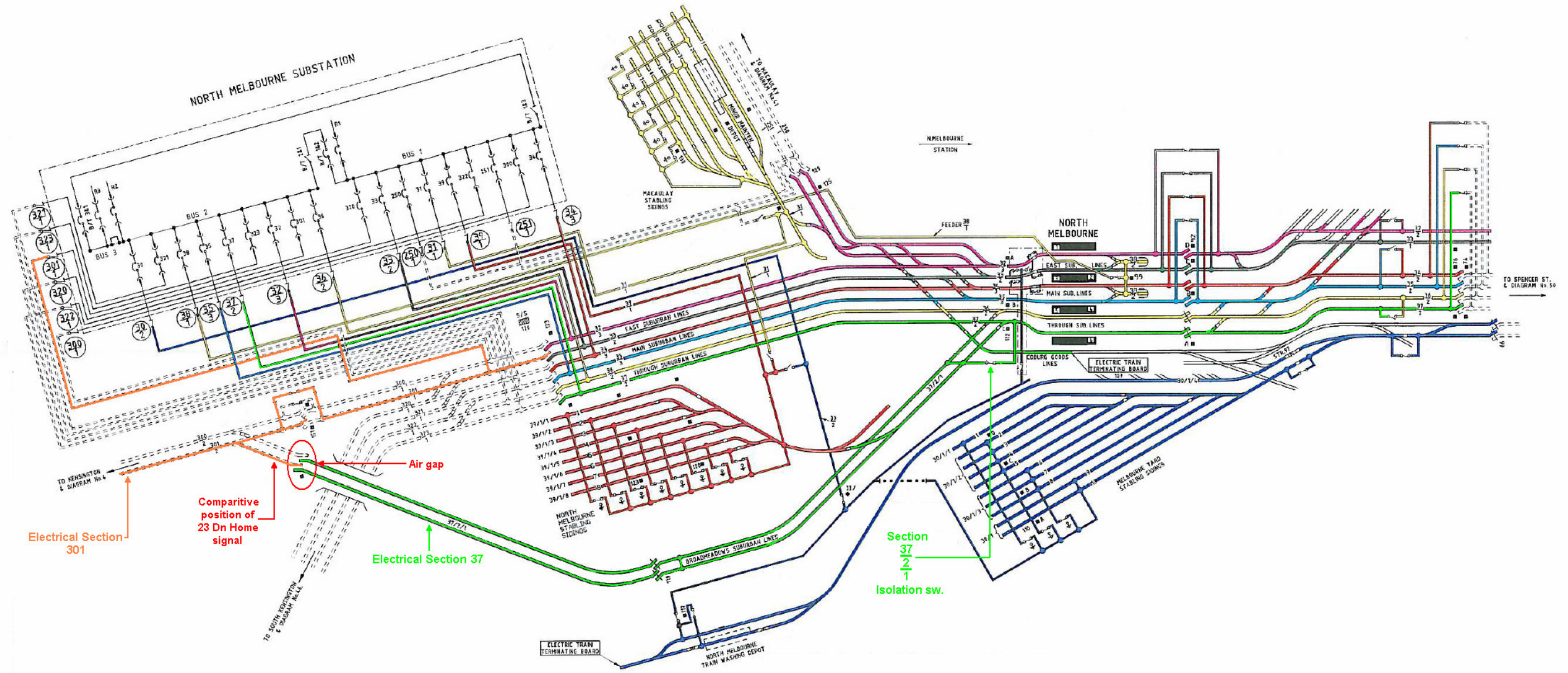
Appendix A: Connex Melbourne rail network, showing (in red) the area and lines directly affected by the Oaks Day incident.



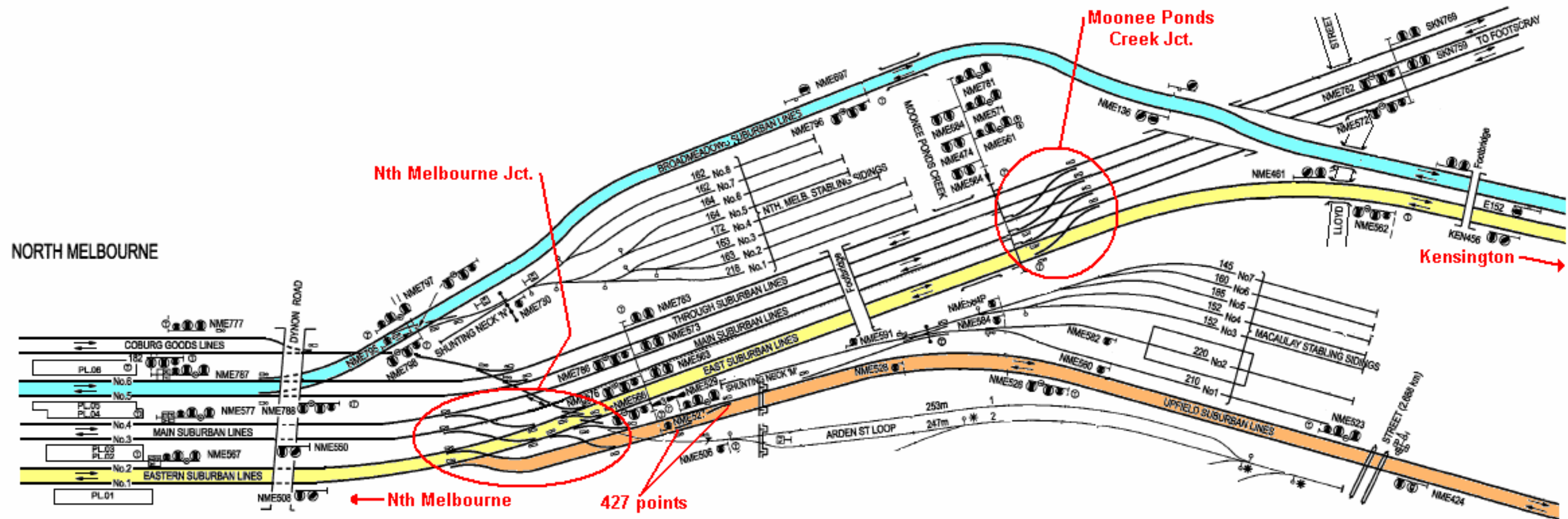
Appendix B: Detail of Electrical Overhead Power Distribution – Kensington to Newmarket.



Appendix C: Electrical Overhead Power Distribution – Nth Melbourne-Kensington



Appendix D: Signalling diagram and track chart – Nth Melbourne and Macaulay



Appendix E: Overhead wire burn-down sequence

