



OTSI Office of Transport Safety Investigations

RAIL SAFETY INVESTIGATION REPORT

**DERAILMENT OF CITYRAIL PASSENGER SERVICE
K496**

UNANDERRA

24 JANUARY 2009



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ACKNOWLEDGEMENTS

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The diagram of the Unanderra track and signal configuration on page 9 was provided by *RailCorp*.

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GLOSSARY OF TERMS

Area Controller	A qualified worker who remotely monitors and controls train movements from a signal box.
Block	A portion of the line with defined limits between which only one train is allowed at any one time.
Catch-points	A set of points usually comprising a single switch or run-off lead, the normal position of which provides an open trap to a movement in the facing direction resulting in an enforced derailment thus avoiding a potential collision between movements.
Foul	In a position to obstruct rail traffic on an adjacent line.
Points	A set of points is located at the position where one track separates into two tracks (or vice-versa) and generally includes moving rail components each called a point (alternatively called a switch).
Rail Commander	RailCorp's Rail Commander is a suitably qualified person appointed by the Rail Management Centre Shift Manager to liaise with emergency services and OTSI at an incident site and to manage RailCorp's on site response.
Rail Vehicle Detection System	Described in RailCorp's Network Rule NSY 500 as a system of safeworking which uses continuous track circuiting, or axle counters, to detect the presence of rail traffic in a block and prevent following rail traffic entries into occupied blocks.
Signal Passed at Danger (SPAD)	Unauthorised passing of a signal displaying a stop (red) indication.
Train Stop	A trackside mechanical device normally linked to a signal. When the signal is not clear to pass, the trip is raised which activates a passing train's brakes through contact with the air valve at the front of the train.
Unanderra to Kiama/Nowra 'Branch' line	A railway line that is usually designated for rail services travelling in either direction between Unanderra and Kiama/Nowra. In this case train K496 was travelling in the 'Up' direction.
'Up and Down' lines	Trains that travel away from Sydney are Down trains. The lines that carry them are Down lines. Trains that travel towards Sydney are Up trains. The lines that carry them are Up lines, e.g., 'Up and Down Illawarra' Lines.

EXECUTIVE SUMMARY

At approximately 2:35am on 24 January 2009, CityRail four-car Tangara passenger service K496 departed from Unanderra Station towards Signal WG1010 which was at stop. A loud noise from a passenger disturbance in the vestibule behind the Driver momentarily distracted him and, as a result, he allowed the train to pass Signal WG1010 at stop without authority (SPAD).

The train then encountered the two safety defences associated with Signal WG 1010. The first, a train stop, automatically triggered the application of the train's emergency brakes as it passed the signal thus reducing its speed and so mitigating the consequences of the SPAD. The second defence, catch-points, derailed the train into a safe area away from the adjacent line and so a potential collision with an opposing freight service, which was approaching on the 'Down Illawarra' line, was prevented. The leading two cars of K496 derailed all wheels and the leading bogie of the third car also derailed, while the remaining car remained on the track.

No injuries were sustained by the crew or passengers. The damage caused by the derailment was limited to the bogies and bodywork of the two front passenger cars and to the infrastructure associated with the catch-points.

The investigation found that the SPAD and subsequent derailment was a consequence of the Driver's inattentiveness resulting in his not responding to the stop signal which applied to his line. The Driver's error can be attributed to one or, most likely, a combination of the following:

- the distraction of the passenger disturbance behind him,
- a loss of situational awareness due to fatigue brought on by insufficient quality rest and sleep, and
- the Guard not working from his assigned position.

The shift had been an eventful one due to unruly passenger behaviour which had caused the Driver and Guard to be concerned about their own safety. Immediately before encountering the train stop, both the Driver and Guard heard a noisy passenger disturbance followed by a loud bang on the crew compartment door which resulted in the Driver turning around.

The Driver was not sufficiently rested to enable him to effectively perform his duties and, over the preceding three days, had suffered lingering effects of the flu and a sub-optimal sleep environment because of hot weather. Despite this he chose not to declare himself unfit for duty on the day though it would have been appropriate to do so under RailCorp's Fatigue Management Policy.

Contrary to RailCorp procedures, the Guard was riding in the front car with the driver's approval and this meant that he took his cue to depart Unanderra platform from Signal WG1016 instead of the Guard's indicator which was linked to Signal WG1010. A subsequent internal RailCorp audit at Unanderra Station found guards riding with drivers on five out of 29 occasions.

This was the fifth recorded SPAD at Unanderra since 2003. A SPAD in 2003 was investigated by OTSI resulting in a recommendation that a human factors review be undertaken in relation to signals and the predictive information they convey. The recommendation was subsequently not implemented.

RailCorp used a "*Human Factors SPAD Hazard Checklist*" in conducting a sighting test for Signal WG1010 in February 2009 in response to the SPAD which is the subject of this investigation. It revealed five infrastructure issues that could have an impact on driver performance.

The key recommendations made as a result of the investigation are concerned with RailCorp:

- a. ensuring that drivers understand how to make adequate provision for quality rest and sleep to militate against the onset and effects of workplace fatigue;
- b. revising the content of induction and continuation training programs for drivers, guards and other transport safety workers to ensure the curriculum comprehensively addresses:

- the effects of sleep deprivation on operational performance,
 - sleep hygiene (optimising sleep and the sleeping environment),
 - objective methods of identification of fatigue;
- c. ensuring guards ride in their assigned positions;
- d. improving the signalling infrastructure and SPAD defences at Unanderra;
and
- e. revising strategies for addressing the problem of SPADs in general, based on an evaluation of the effectiveness of those that have been implemented over the last five years.

PART 1 FACTUAL INFORMATION

Incident Synopsis

- 1.1 At approximately 2:35am¹ on 24 January 2009, a CityRail four-car Tangara passenger service designated K496, crewed by a Driver and Guard and en route from Kiama to Wollongong, was proceeding via Unanderra Station and Signal WG1010 which was at stop. The Driver heard a loud noise from a passenger disturbance which momentarily distracted him and, as a result, the train passed Signal WG1010 at stop without authority (SPAD). After passing the signal, the train derailed on the catch-points designated 1106 (see *Photo 1*).

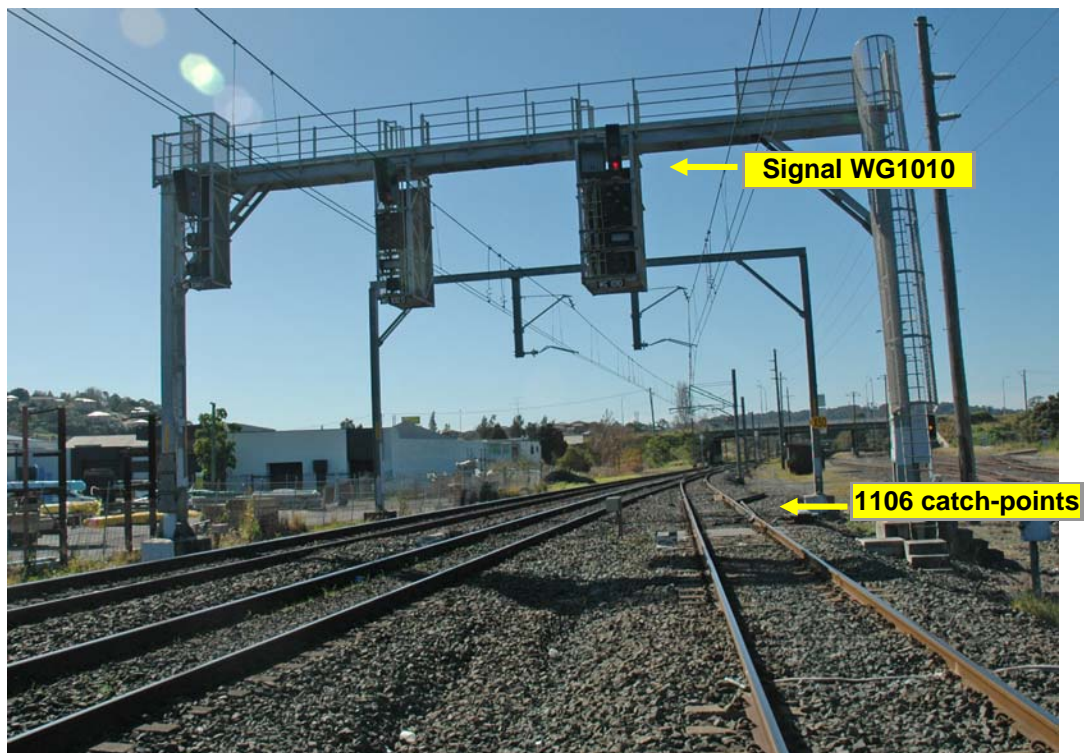


Photo 1: Signal WG1010 and 1106 catch-points

¹ Times referenced to RailCorp's Rail Management Centre (RMC) times: Australian Eastern Summer Time.



Photo 2: K496 showing front two cars derailed

- 1.2 The leading car of K496 came to rest at 87.880km² approximately 50 metres past the catch-points (see *Photo 2*). Consequently, the first two cars of the train derailed all wheels and the leading bogie of the third car also derailed, while the rear car remained on the track. As a result of the catch-points performing their intended function, a potential collision with an opposing freight service 8938, which was approaching on the 'Down Illawarra' line, was prevented.
- 1.3 There were no injuries to the crew or the four passengers on board, and only minor damage to the train and track.

Incident Narrative

Before the Derailment

- 1.4 Both the Guard and Driver worked the train as passenger service C495 from Sydney Terminal to Kiama. After encountering several trespassers in the rail corridor, unruly passengers and disruptions to the train's timetable en route, C495 arrived at Kiama 15 minutes late,

² This rail distance as measured from Sydney's Central Station.

and then formed passenger service K496. As the Driver changed ends, the Guard indicated to the Driver that he was feeling stressed and unwell and asked if he could ride in the crew compartment of the leading car, sitting alongside the Driver for the journey to Wollongong. The Driver agreed to this request.

- 1.5 The train commenced out of Kiama four minutes later than tabled and was scheduled to stop at all stations to Wollongong where it would terminate. There were no passengers on board when the train departed from Kiama. En route to Wollongong, one male passenger joined the train at Oak Flats and four unruly male youths joined at Dapto.
- 1.6 On arrival at Unanderra Platform, the Guard opened the doors of the train and the passenger who had boarded at Oak Flats alighted, leaving only the four male youths on the service. The Guard then closed the doors and gave the Driver a bell signal to depart the platform.

The Derailment

- 1.7 The Driver stated that he did not recall seeing Signal WG1010³ which was at stop. However, on approach to that signal, he was startled by a loud bang on the crew compartment door behind him. He turned around momentarily to look at the compartment door and then heard a loss of brake pipe air from the train.⁴ Upon hearing the release of air he then made an emergency brake application. However, the train had already passed Signal WG1010 at stop and proceeded through the catch-points and derailed. It continued in the derailed state for approximately 50 metres before coming to a stand (see *Photos 3 to 5*).

³ Signal WG1010 gives authority for trains that are continuing towards Wollongong to cross from the Kiama 'Branch' line onto the adjacent 'Down Illawarra' line.

⁴ The train's brake pipe is an air pipe connecting the braking system through each car along the length of the train and is used for proving 'continuity' of the air supply and for controlling the actual brake. The release of brake pipe air occurred when the train's trip gear was activated by the train stop on signal WG1010 (refer to *Photo 6*). Also referred to as a train stop arm, this is fixed next to the line at a signal and has a moveable arm which is raised when the signal is indicating stop and lowered when the signal is giving a proceed indication. The train stop associated with Signal WG1010, located approximately 5.5m before the catch points, tripped the device at the front of the train and caused the brakes to apply automatically. In conjunction with the normal braking initiated by the driver, this action by the train stop had the desired effect of slowing the train thus reducing the effects of the train derailing.



Photo 3: Final position of the derailed train



Photo 4: Final position of train relative to 'Up and Down Illawarra' lines



Photo 5: Side view of train

After the Derailment

- 1.8 Just prior to an emergency call from the Driver, the Signaller at Wollongong Signal Box heard a SPAD alarm activate and observed on his signal panel that the train had occupied the track ahead of Signal WG1010, contrary to the route and signal settings. The Signaller contacted the driver of freight service 8938, which was approaching the area on the adjacent 'Down Illawarra' line, and instructed him to bring his train to a stand immediately.
- 1.9 After checking that the Guard was uninjured, the Driver of K496 initiated an emergency call via the train's MetroNet radio. This emergency call was first answered by the Signaller, then shortly after by the South Coast Train Controller⁵. The Driver confirmed that the train had derailed and that he could observe freight service 8938 had come to a stand on the 'Down Illawarra' line. He was unable to advise if his train was foul of the 'Down Illawarra' line, but was instructed to check by the Train Controller. Further, the Train Controller instructed the Signaller to place blocking facilities on all signals in the Unanderra area to prevent any train movements towards, or past, the incident site.
- 1.10 Subsequently, the Driver confirmed that his train had not fouled any adjacent lines and arrangements were then made for freight service 8938 to be worked past the derailment site at restricted speed.

⁵ The South Coast Train Controller is based at the RMC which is located at Sydney Central Station.

Incident Response

- 1.11 NSW Police were advised of the incident at 2:46am and officers from Lake Illawarra Local Area Command arrived at the site at 2:52am. They took brief statements from the Driver and Guard before breath testing the Driver. The Police and the Guard then evacuated the four passengers from the rear car of the train and escorted them back to Unanderra Station.
- 1.12 The first RailCorp incident response personnel, from their overhead wiring discipline, arrived on site at approximately 3:30am, followed shortly by the Station Operations Superintendent (SOS). The overhead wiring representative satisfied himself that the overhead wiring had not been affected by the derailment. The SOS assumed control of the site and closed the line pending the arrival of RailCorp's Rail Commander, investigators from the Office of Transport Safety Investigations (OTSI) and the Independent Transport Safety and Reliability Regulator (ITSRR), and RailCorp's rolling stock recovery team. OTSI's investigator arrived on site at 5:20am and the ITSRR investigator at 7:20am.

Derailment Location

- 1.13 The derailment occurred 200m North of Unanderra on the 'Branch' line connecting Nowra, via Kiama, to the Illawarra line at Wollongong. Unanderra is located in the Illawarra region of NSW, approximately 73km South of Sydney and approximately 5km South of the Wollongong CBD (see *Figure 1*).

Train Information

- 1.14 K496 consisted of a four-car Tangara set; two power cars and two trailer cars (Set G4).⁶ The train had a total length of approximately 81m and a total weight of approximately 199 tonnes.

⁶ The set consisted of cars OD 6826 (lead car and driving position), OLN 5863 (2nd car which was also fitted with a passenger toilet), ON 5813 (3rd car) and OD 6825 (rear car and the Guard's formal riding position).

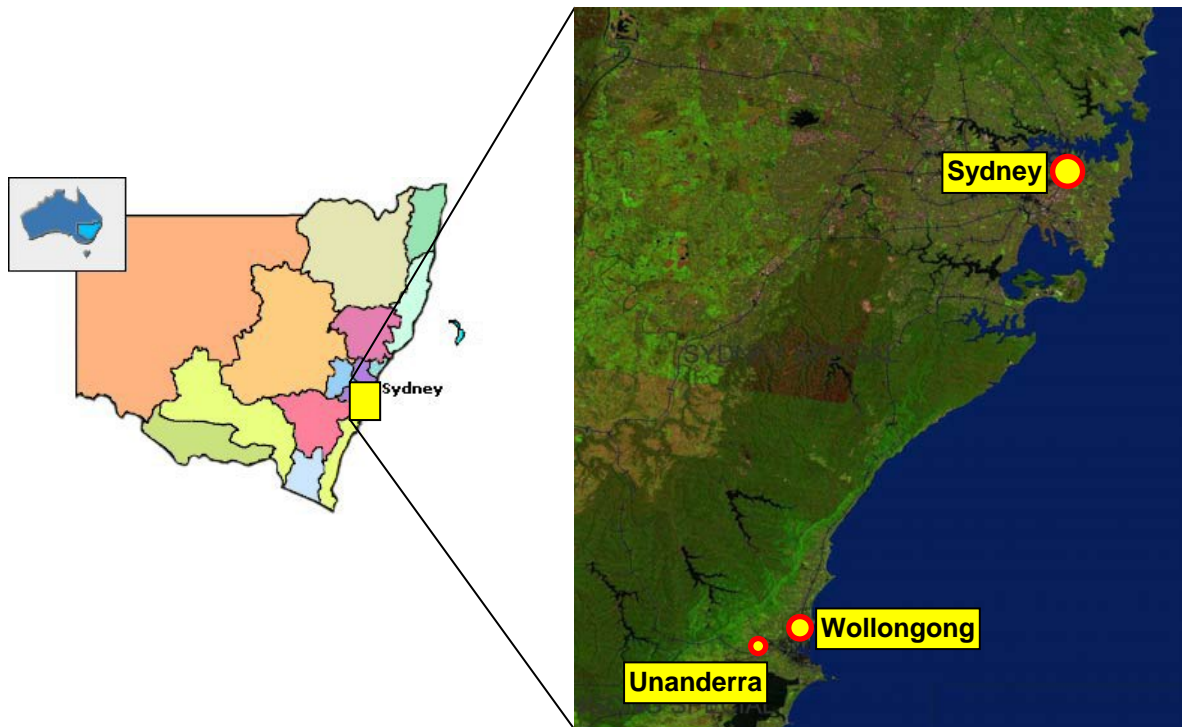


Figure 1: Incident location

Injuries and Damage

- 1.15 No injuries were sustained by the crew or passengers.
- 1.16 The train received minor damage to the wheels and undercarriage of the leading two cars (OD 6826 and OLN 5863).
- 1.17 Damage to the track infrastructure was confined to the mechanism of the 1106 catch-points. Overhead power was restored at 9:00pm and re-railing of K496 was completed by 9:16pm on 24 January 2009. All repairs to infrastructure were completed by 11:19am on 26 January 2009.

Employee Information

- 1.18 The Driver, based out of Sydney Central Station, had been employed by RailCorp since August 1976 and obtained his driving qualification in October 2004. The Guard, based out of Wollongong, had been employed by RailCorp since April 2000 and obtained his guard qualification in August 2001.

Track Information

- 1.19 Unanderra is a junction within the RailCorp intercity rail network where the South Coast Branch line (from Nowra) and the Moss Vale to Unanderra Main lines join the Up and Down Illawarra lines (see *Figure 2*). The main tracks around Unanderra have overhead wiring and the related signalling functions are normally controlled remotely from Wollongong Signalling Complex⁷.
- 1.20 The immediate area surrounding the site of the derailment is relatively flat and the line is relatively straight with a slight falling grade as the train approaches Signal WG1010. The track speed on approach to Unanderra Station is 80km/h, with a turnout speed of 50km/h through 1106 crossover, situated just beyond Signal WG1010 and 1106 catch-points.

Operations Information

- 1.21 The safeworking system for the line between Kiama and Unanderra is rail vehicle detection system, controlled under RailCorp's Network Rule NSY 500 *Rail Vehicle Detection System*. Signals are operated by signallers or track circuits and control the movement of trains in the sections.

Communication Equipment

- 1.22 The train crew had access to a WB 450.050 MHz portable radio handset, a mobile telephone and MetroNet radio with which to contact Train Control and signallers. K496's crew members did not utilise the train's internal communications system during the journey.

⁷ Unanderra Station has a local control panel which controls points and/or signals that may be switched to and from local control. When switched to remote control, the points and signals are controlled from the Wollongong Signalling Complex.

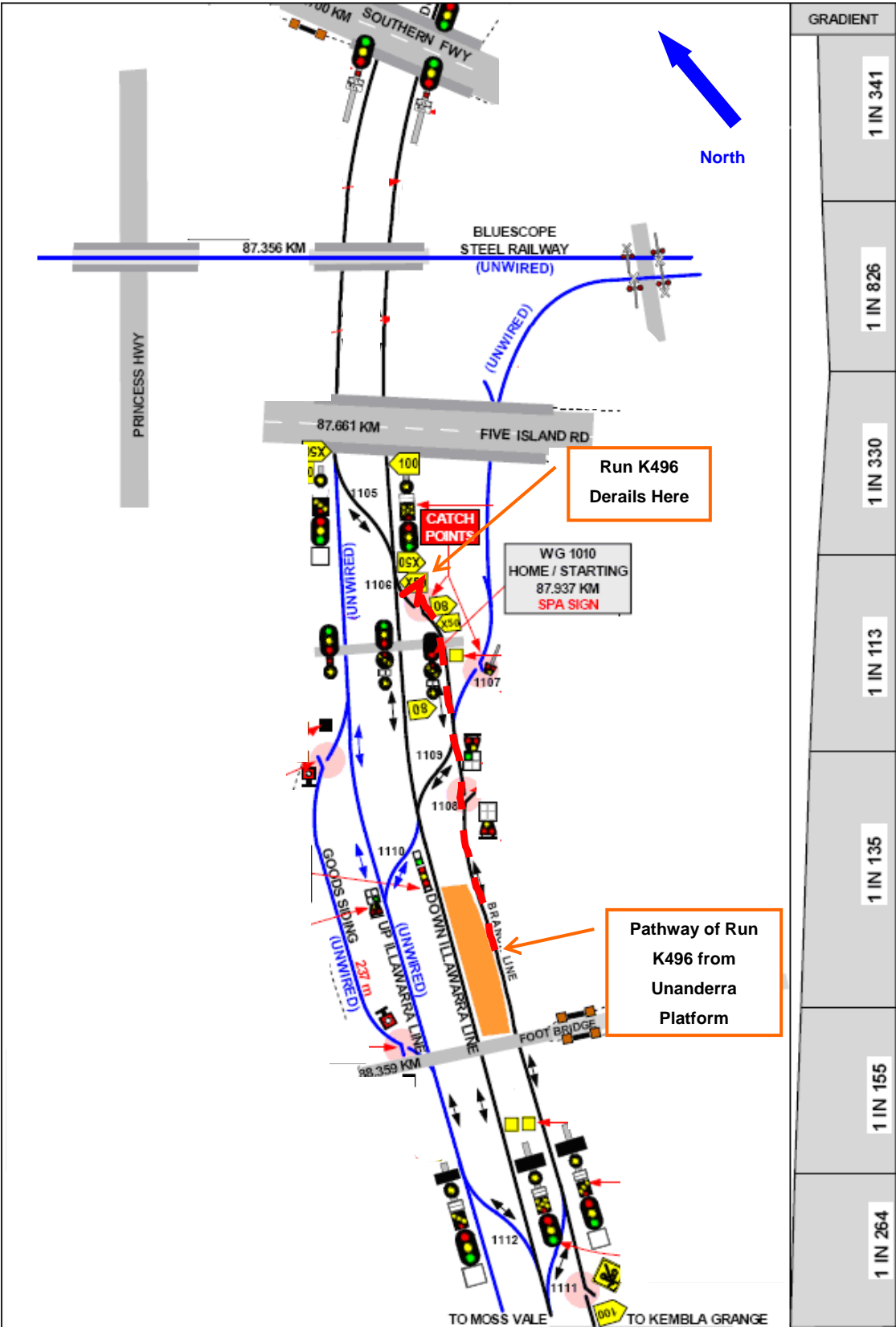


Figure 2: RailCorp Diagram of Track and Signal Layout at Unanderra

Medical and Toxicological Information

- 1.23 Both crew members of K496 and the Signaller at Wollongong Signalling Complex returned negative results when tested for the presence of drugs and alcohol.⁸
- 1.24 Both of the crew members were within their respective medical assessment periods.

Meteorological Information

- 1.25 The train crew described the weather conditions at the time of the derailment as warm, dry and humid. The Bureau of Meteorology recorded a maximum overnight temperature of 21.5°C at Bellambi, approximately 7km North of Wollongong. The maximum temperature recorded on 24 January 2009 was 40.1°C, which was the highest temperature recorded for that area in January 2009.

⁸ The Police who responded to the incident interviewed both crew members and it was their initial determination that, as there was no obvious 'fault' by the Guard, only the Driver was required to submit to an initial breath analysis by them for the presence of alcohol. The Guard and Signaller were subsequently breath tested by a RailCorp authorised officer, whilst both crew members and the Signaller at Wollongong subsequently underwent comprehensive drug testing by a RailCorp contractor.

PART 2 ANALYSIS

Introduction

- 2.1 The performance of the train's brakes and the signals at the site were eliminated as possible causes or contributory factors as a result of testing by RailCorp engineers. The train's brakes were examined by a brake systems engineer and no faults were found. A signals system engineer confirmed there were no abnormalities experienced with the points and signals at the site prior to the derailment. After the infrastructure was repaired, a simulation of the signalling at the time of the derailment was conducted which further confirmed the signals were operating as designed.
- 2.2 At interview, the Driver of K496 acknowledged that he did not observe that Signal WG1010 was at stop as he approached it. He stated that, when he departed the platform, he initially focussed on the ground Signal WG1016⁹ which was displaying a yellow proceed at caution indication. As he continued along the track towards Signal WG1010, he was distracted by a passenger disturbance behind him in the vestibule area and, as this was occurring, he passed Signal WG1010 at danger and derailed on the catch-points. Accordingly, the investigation focussed on matters that may have affected the Driver's decision-making and actions, and inherent factors with the signalling system.

Event Recorder Information from K496

- 2.3 K496 was fitted with an event recorder ('data logger').¹⁰ The records for the leading car OD 6826 revealed the following sequence of events:
- a. the train ran seven minutes later than timetabled out of Unanderra Station;

⁹ Signal WG1016 is an intermediate shunting signal facing Up direction trains on the Branch line and is the first signal located beyond the exit-end of Unanderra Platform.

¹⁰ The data captured by the recorder included speed, brake pipe pressure, wheel slip and operation of the doors, deadman, headlights, horn and spring park brake.

- b. upon receiving the bell signal from the Guard to depart Unanderra Platform, the Driver released the brakes¹¹ and applied power in Notch 3;¹²
- c. power was applied for a period of 16 seconds at the end of which the train reached a speed of 40km/h;
- d. the Driver shut off power and allowed the train to coast for a period of 18 seconds during which the train maintained the speed of 40km/h;
- e. at approximately 30m prior to the signal, the brake handle was placed into Notch 5;
- f. the brake pipe air pressure then began to reduce, which indicated that the train's trip gear had been activated by Signal WG1010's trip arm as the train passed the signal; and
- g. the train continued past the signal at a speed of approximately 39km/h and proceeded through 1106 catch-points at a speed of approximately 34km/h.

Train Handling

2.4 In his statement to the OTSI investigator, the Driver indicated he didn't remember seeing Signal WG1010. The train handling, as evidenced by the event recorder, shows a brake application commencing 30m prior to this signal. The driver has not been able to explain the reason for his making this brake application. However, the brake application is not considered significant enough to reveal an intention of stopping at the Signal, unlike the later emergency application made when the SPAD defences had begun to take effect.

2.5 RailCorp estimate that, at 40km/h, it would be necessary to commence 'normal' braking between 120m and 163m out from a signal. Further, the stopping distance from 40km/h using emergency braking would

¹¹ The brake has nine positions including 'Running/Release' (off), seven increments of braking (the seventh is a full service application) and an 'Emergency Brake'. The brake handle is pushed forward away from the Driver when braking.

¹² The throttle has five positions including 'Off' and four increments of power (1 to 4), with 4 being the highest throttle 'power'. The throttle handle is pulled back towards the Driver when powering.

have been approximately 84.8m. The initial brake application only 30m prior to Signal WG1010 at Notch 5 was clearly an inadequate braking response to the approach of the signal at stop.

- 2.6 The train handling is consistent with the Driver being distracted and losing situational awareness, which resulted in his not noticing the signal.
- 2.7 The Driver stated that, after departing Unanderra Station and accelerating to approximately 40km/h, but at some point just prior to reaching the signal, he was distracted by a “*large bang*” emanating from the passenger vestibule area immediately outside the door to the Driver’s cab. On hearing this noise, he turned around and looked towards the door and, in doing so, turned his line of vision away from the direction of travel and his view of Signal WG1010.
- 2.8 The Driver was looking towards the cabin door when he heard the brake pipe air releasing which was a sign that the train’s trip gear had been activated by the trip arm on Signal WG1010 (see *Photo 6*). Upon hearing the air release from the brake pipe, he immediately turned back around and made an emergency brake application, i.e., moved the brake handle forward from Notch 5 to the Emergency position. However, by this time, the train had already passed Signal WG1010 and was derailing on the catch-points.
- 2.9 Due to the heavy motion that the train experienced during derailment, the front internal security door of the crew compartment was forced open. The Driver later stated that, in that instant, he was concerned that the Guard may have fallen out through the door. This, together with the shock of the derailment, left the Driver highly agitated which was evident from the voice recordings and was acknowledged by he and the Guard during interview.



Photo 6: Train stop arm at Signal WG1010 showing a fresh strike mark from the trip gear of K496

- 2.10 The Driver's handling of the train was contrary to RailCorp's Train Working Procedure TWP 100 *Responsibilities of Train Crews* which prescribes that drivers must;

"pay strict attention to and obey all fixed signal indications and adjust the speed of the train in accordance with the signal indication displayed."

The intent of this is that drivers remain vigilant, despite whatever distractions may occur around them or the train. Further, RailCorp's Network Rule NSG 606 *Responding to Signals and Signs*, requires that;

"Drivers or track vehicle operators must keep the signal indication clearly in view."

Line of Sight Considerations

- 2.11 Blinds are provided for all windows in the crew cabs of the Tangara and are adjustable according to crew personal preference (see *Photos 7 and 8*). The Driver stated that the blind on the front window of K496 was drawn down to prevent glare from external light sources affecting his night vision such as street lighting, building lighting and motor vehicles. However, this has the potential to obscure a driver's view of signs, structures and gantry signals. Regardless of the intentions of the Driver, it is likely that, for some period on the approach to Signal WG1010, the blind obscured his view of the Signal.



Photo 7: Drivers blind position on the windscreen and the emergency door

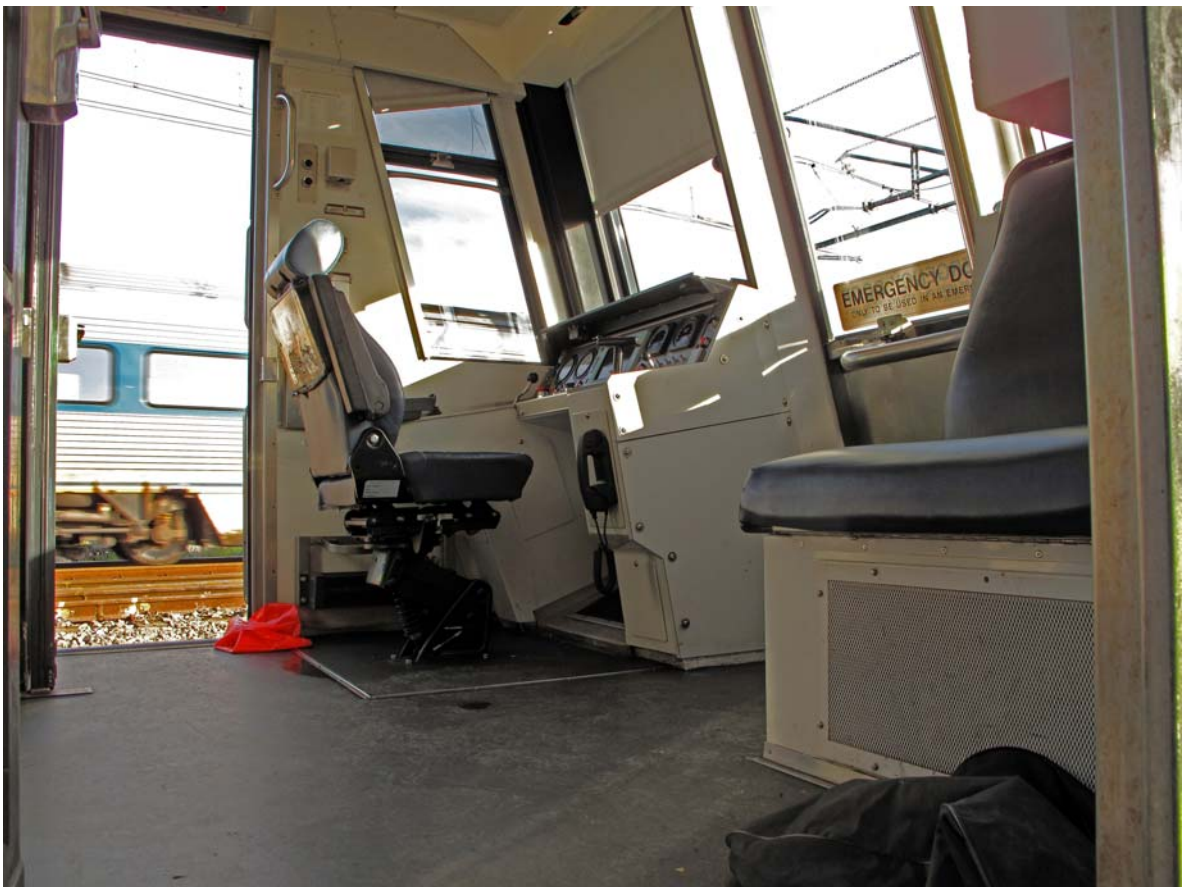


Photo 8: Drivers cab showing seating and blind positions

2.12 In contrast, Signal WG1016 is positioned low to the ground and may have remained longer in the Driver's line of sight from departure. (*Photos 10 to 12* depict relative positions and signal combinations.) The combination of the driver not recalling seeing Signal WG1010 upon departure from Unanderra, Signal WG1016 displaying a proceed indication and the blind obscuring Signal WG1010 may have contributed to the Driver being unprepared for the Signal WG1010 stop indication. This would have been reinforced if, as asserted by the Driver, Signal WG1010 was set at proceed on all his previous journeys along this route and so he had never been required to stop.



Photo 9: View of Guard's indicator (illuminated), stopping marker and signals visible from Unanderra platform



Photo 10: Close up of Signal WG1016 showing stop indication



Photo 11: Signal WG1016 showing proceed indication in relation to signal WG1010 at stop

Driver's Training

- 2.13 The Driver was assessed and deemed competent to undertake suburban train driving duties on 8 October 2004. He successfully completed a further five days training in long distance (InterCity) trains on 28 September 2007. InterCity driver training is supplemented by an additional four days of route knowledge training on each corridor, where trainees drive under supervision on that corridor during different times of the day and night. This covered the Driver for Sydney to Wollongong after which he underwent another two days of route knowledge training for the Branch line working between Wollongong and Kiama.
- 2.14 The importance of route knowledge is acknowledged in the fact that drivers must requalify on a route on which they have not travelled within 12 months. Although based at Central Station, the Driver was rostered to drive over all the InterCity corridors, including through Unanderra, several times within the previous year. However, the Driver explained that these infrequent journeys to the area did not facilitate gaining and retaining as much local knowledge as drivers based at Wollongong.
- 2.15 At the time the Driver undertook his driver training, SPAD awareness was not prominent in the course curriculum. RailCorp advise the course had "... a component called 'Introduction to Professional Driving' which contained some SPAD awareness material".

Fatigue

- 2.16 From discussions with the crew and an examination of their rosters, there was nothing to suggest that the Guard may have been suffering from fatigue. However, there was evidence to suggest that the Driver may have been.
- 2.17 Research has established that basic human biological functions vary according to a 24 hour cycle which has been termed the body's circadian rhythm.¹³ It has also been established that, during the periods 3:00am to 5:00am and 2:00pm to 4:00pm, there is a dip in the

¹³ For further information on the circadian rhythm refer to Flinders University website at <http://som.flinders.edu.au/FUSA/NEUROSCIENCE/sleep.htm>

body's circadian rhythm and that, though one may be awake during these periods, one is less alert and more prone to error. At the time of the derailment, the Driver was operating close to a period of circadian 'low'.

2.18 Though the Driver's roster met industry and RailCorp's scheduling parameters, he was on his third consecutive nightshift and this is a common rostering practice in transport operations. Such a level of exposure to night work is difficult to avoid where train drivers provide services to the public that extend into the night and begin early morning. However, it is noteworthy that the Driver indicated that he:

- a. felt jaded prior to and during his shift on the night of the incident;
- b. suffered a flu like illness three days prior and, although he took time off, was still overcoming the effects and had lower energy levels;
- c. had a disrupted sleep during the day on which he commenced the shift (23 January 2009), experiencing hot summer temperatures and getting only two hours sleep between 9:00am and 11:00am; and
- d. experienced a long period of wakefulness from 11:00am until the start of his shift at 10:45pm. [This period of wakefulness, if extended to the normal end of his shift at 6:08am on 24 January 2009, would have been over 19 hours.]

2.19 Night shifts are often associated with sleep reduction of two hours or more. As the driver was on his third consecutive night shift, it is likely he experienced sleep loss over more than one day¹⁴. The Driver also indicated that it was not unusual to be feeling jaded as he had experienced this many times before. In relation to night work, he added that:

- a. he usually felt tired before a night shift, but felt better after a shower immediately before getting ready for work;

¹⁴ Roach, GD, Reid, KJ & Dawson, D 2003, 'The amount of sleep obtained by locomotive engineers: effects of break duration and time of break onset', *Occupational and Environmental Medicine*, vol.60, e17.

- b. he felt a certain obligation to go to work (to earn a living, not let the side down, not wanting to be 'performance managed' for too many days off with fatigue, etc.); and
- c. once he started work, he again felt better when he focussed on the driving task.

2.20 In combination, the above considerations point to it being very likely the Driver had an accumulated sleep debt that may have contributed to a loss of situational awareness and concentration.

*"Less sleep than required can lead to 'sleep debt' which can adversely affect fatigue and reaction times, concentration and judgement and decision making. Sleep debt is accumulative and over several days the effects can be compounded."*¹⁵.

Humans experience increased pressure to sleep with increasing time awake and this effect is influenced by prior sleep loss and circadian effects¹⁶. The driver would have experienced all these factors due to his sleep loss, the long time awake and the circadian effects on alertness and performance.

2.21 The training that drivers undertake in relation to fatigue management is included as a core module in RailCorp's induction training for new staff. It covers topics such as circadian rhythms, the effects of fatigue on health, fatigue management tools, strategies for shiftwork, lifestyle management and employee responsibilities. If employees believe they are unfit for work due to fatigue then they are instructed to self identify. Employees who do self identify are asked to take sick leave for that shift. If this continues then management discusses the issue with the employee to try to find the cause of the problem. Following initial training there is continuation training for drivers, guards and supervisors as well as ongoing employee awareness sessions. However, RailCorp training records do not indicate if either the Driver or Guard received any formal instruction related to self-assessing fitness for work.

¹⁵ Rail Safety Standards Board June 2008, *Understanding Human Factors – a Guide for the Railway Industry*, p.129.

¹⁶ Philip, P and Akerstedt, T 2006, 'Transport and industrial safety, how are they affected by sleepiness and sleep restriction?', *Sleep Medicine Reviews*, vol.10, pp. 347-356.

- 2.22 The training information and Fatigue Management Policy provided by RailCorp contained little detail on how to optimise the sleep environment, or how to assess one's own fitness for duty. The Policy states:

"If the need to self identify occurs frequently (e.g. two or more times in a month), the employee must discuss their difficulties with their manager/supervisor to identify any potential roster problems, the possible need to seek professional advice on contributory medical problems or on the management of their social life, family responsibilities and relationships ...

Absences due to fatigue will be (sic) addressed in accordance with the Absence Management Policy and Leave Policy."

Guard's Training

- 2.23 The Guard successfully completed all aspects of guard training and was assessed and deemed competent to undertake suburban train duties in 2001. He successfully completed further training in long distance (InterCity) trains on 15 June 2005 and had the necessary route knowledge.

Effect of Passenger Behaviour

- 2.24 There were two large public events in Sydney on the evening prior to the incident; the Big Day Out concert and a one-day international cricket match. These events resulted in a significant increase in evening patronage across all lines and amended service patterns were in place to cope. Both the Guard and Driver of K496 stated that, once the train left Central for Kiama, there were several incidents involving trespassers and unruly passengers which affected the running of their service. At least once they were concerned for their own safety. K496 was also found to be extensively littered and vandalised.
- 2.25 On the journey from Sydney to Kiama, the Driver had encountered several delays and disruptions because of incidents involving trespassers in the rail corridor and unruly passengers on platforms and

the train.¹⁷ These disruptions had left him feeling stressed but he considered himself fit to continue duty. He did not reveal his concerns to the Guard, Train Control, or his supervisors until later when explaining the events leading up to the derailment.

- 2.26 Likewise, previous incidents during the shift¹⁸ had caused the Guard to feel stressed and unwell and it was at Kiama that he sought consent from the Driver to ride up the front for K496's return to Wollongong. In the weeks preceding this incident, both the Guard and Driver had experienced several incidents involving anti-social and risky behaviour (close calls) on the part of members of the public, resulting in both crew members seeking counselling. The Guard indicated that, following his counselling, he had returned to work just four shifts prior to the derailment.
- 2.27 Both crew members recalled that the events on the night of 24 January 2009 brought back memories of their previous adverse experiences and this may have affected their performance, judgement and levels of stress and fatigue.

Guard's Actions

- 2.28 Although the Driver consented to the Guard's request to ride with him, the practice contravenes RailCorps' procedures, in particular TWP 100 *Responsibilities of Train Crews* which directs "*the rear car*" as the guard's "*location of workstation*" in a four car suburban or InterCity train. As a consequence of riding in the front car, the Guard was unable to see the Guard's Indicator¹⁹ which was positioned on the platform awning in line with the middle of the train and facing towards the rear (see *Photos 9 and 12*).

¹⁷ This included four youths at Dapto who, when seeing the approach of the train, pushed a shopping trolley near the edge of the platform as if to push it onto the line. The Driver braked more heavily than usual to pull up short of the youths, who then pulled the trolley back from the edge.

¹⁸ Due to disruptions to services on the Illawarra line, the Guard had been asked to work an extended shift which covered the running of C495 and K496.

¹⁹ RailCorp's Network Rule NSG 604 describes the working of a Guard's indicator as: "*If it is possible for the signal at the exit-end of a platform to be obscured from a Guard's view, a Guard's Indicator is placed over the platform. If the exit-end signal displays a PROCEED indication, a Guard's Indicator shows a lunar white, or a blue light*".

- 2.29 Contrary to the intent of RailCorp's Network Rule NSG 604 *Indicators and Signs* (which assumes a link between a guards indicator and a single exit-end signal), the Guard's Indicator at Unanderra is only illuminated when *both* WG1016 and WG1010 signals are displaying proceed indications. RailCorp have indicated the design intent as being to hold a train on the platform when either signal is displaying a stop indication. If the Guard had been in the correct riding position he would have seen that the Guard's Indicator was not illuminated and would not have been entitled to signal the Driver to proceed.
- 2.30 Without a view of the Guard's Indicator, the Guard instead looked up the line towards the next facing signal - shunting Signal WG1016 - and noticed it had a proceed indication. He assumed the Signal satisfied the need for a signalling authority to depart the platform then closed the doors, gave the Driver the proceed bell indication and went and sat down on the seat opposite the Driver. The Guard also failed to notice Signal WG1010.
- 2.31 The Guard indicated that when he sat down, he did not communicate with the Driver, rather, he looked towards the rear compartment door beyond which he could hear the four youths talking and moving noisily around the vestibule area. The Guard also corroborated the Driver's statement about a "*large bang*" then emanating from the passenger vestibule area.
- 2.32 The Guard indicated he was unaware the train had passed Signal WG1010 until he felt it rock violently. When the train came to a stand, he confirmed to the Driver that he was not injured and then went to check on the condition of the four passengers. He later liaised with the Police to have them assist him in escorting the passengers from the rear car back to Unanderra Station. He stated that he did not consider treating the passengers as vandals as his prime concern was escorting them safely from the scene and assisting the Driver with managing the incident area.
- 2.33 The Guard stated that it had become a common practice for guards to give a bell signal to a driver to depart their train from the platform

without having a proceed indication in the Guard's Indicator. They either check the condition of the next signal in advance or ask the driver to check. This is contrary to the procedural requirement that they wait until the Guard's Indicator illuminates before giving a proceed bell to the driver.

- 2.34 Whilst the guard is only required to provide a bell to the driver when the next signal, or Guard's Indicator, is showing a proceed indication, this does not in any way absolve the driver from maintaining vigilance for the next signal indication.



Photo 12: Close up of unlit Guard's indicator at Unanderra Platform

Signal and Track Infrastructure Issues

SPAD History at Unanderra

- 2.35 Neither RailCorp nor ITSRR had any previous records for SPADs at signals WG1024 (the last mainline signal before WG1010) or WG1016, but they did have differing details on SPADs at Signal WG1010 (see *Table 1*).

Time & Date	Incident Details	Comments
0223hrs 22 July 1991	Locomotive D36 passed signal WG1010 at stop and derailed at 1106b catch-points.	Incident information was taken from OTSI's 2003 report which referenced Rail Infrastructure Corporation's (RIC's) Safety Incident Database (SID).
1102hrs 28 June 2003	Freight service B9162 passed signal WG1010 at stop and derailed at 1106b catch-points.	Incident subject to OTSI investigation, with human error the main factor. There were contributing factors surrounding the signalling configurations. Majority of the recommendations were directed to the freight operator (Pacific National) and the remaining were directed to the track owner (RIC) to address possible anomalies with the local signalling configurations which may heighten the risk of human error.
0709hrs 17 May 2004	Locomotive No. 8226 passed signal WG1010 at stop, but did not derail at 1106b catch-points.	Incident subject to internal investigation by Pacific National. Incident did not show up in RailCorp data for this location, despite referencing an earlier RIC incident database reference number (IIMS 41). RailCorp have advised that their SPAD database has been updated accordingly.
1049hrs 9 May 2006	Passenger service KN16 passed signal WG1010 at stop and stopped just short of derailling at 1106b catch-points.	Incident did not show up in RailCorp data for this location. RailCorp have advised that their SPAD database has been updated accordingly.
0232hrs 27 May 2007	Passenger service K498 passed signal WG1010 at stop and stopped just short of derailling at 1106b catch-points.	Incident subject to an internal RailCorp investigation during which the driver of K498 admitted human error. He indicated that his attention was focused on intermediate signal WG1016 until he looked up late and observed gantry mounted signal WG1010 displaying a stop indication.
0236hrs 24 January 2009	Passenger service K496 passed signal WG1010 at stop and derailed at 1106b catch-points.	Incident subject of this investigation.

Table 1: History of recorded SPAD incidents at signal WG1010

2.36 Of the total of six recorded SPAD incidents at Signal WG1010 since 1991, five have occurred since June 2003. Three occurred close to the circadian low period 3:00am – 6:00am. Two of these three led to derailment at the catch-points. Local signal configurations are raised as possible contributory factors in the 2003 and 2007 incidents. The 2003 incident was investigated by OTSI and is the subject of further comment in later paragraphs.

SPAD History in NSW

2.37 In order to manage the risks associated with SPADs, RailCorp maintains comprehensive data on where they are occurring. A SPAD Review Committee, in conjunction with a Signal Sighting Committee, determines the priorities for upgrading signals and the installation of measures intended to prevent or reduce the consequences of SPADs.

2.38 In July 2006, ITSRR observed that;

“although the annual numbers of SPADs have not yet begun decreasing, it seems some worthy initiatives have been undertaken by RailCorp on SPAD risk management. In summary they have established a 5-point program covering: enhanced performance measurement and evaluation, education and information, train management techniques, multi SPAD signal action plan and multi SPAD driver management.”²⁰

It may be timely to review strategies for addressing SPADs on the basis of an evaluation of the effectiveness of the strategies implemented to date through the 5-point program given they have now been in place for a number of years.

2.39 *Table 2* is a summary of SPAD data for the last five years compiled by ITSRR. Though it can only be taken as indicative²¹, it does tend to suggest that the effectiveness of initiatives undertaken by RailCorp to reduce the likelihood of SPADs due to driver error or technical malfunctions have been comparatively limited. The total distance travelled by trains does not appear to have a significant influence on the situation.

²⁰ Quoted in OTSI Rail Safety Investigation Report “*SPAD and Opposing Movement of CityRail Service 67-R, North Strathfield, 2 September 2006*”.

²¹ ITSRR advised the data has been adjusted to take into account changes in the amount of rail traffic over the period. Whilst the figures show little change in the number of incidents, the data does not take into account any change in the risk profile of the incidents.

Year	Total number of SPADS reported in NSW	Number of the SPADS in RailCorp territory related to RailCorp passenger trains e.g. driver error	Number of the SPADS in RailCorp territory related to the signal returning to stop and not related to driver performance e.g. technical malfunction or signaller error	CityRail Train Km (million)
2004/05	420	122	142	37.23
2005/06	427	119	148	34.95
2006/07	406	120	124	35.73
2007/08	453	120	103	37.33
2008/09	488	120	145	38.98

Table 2: SPAD data for period 2004/05 – 2008/09

Signal Sighting Test for Signal WG1010

2.40 RailCorp carried out a signal sighting test for Signal WG1010 on 19 February 2009, using a “*Human Factors SPAD Hazard Checklist*” developed by Human Engineering Australia. The following observations are of significance:

- a. The signal in the rear of Signal WG1010, Signal WG1024, was always encountered by drivers as a caution aspect.
- b. Signal WG1010 was different to the other two main line signals sharing the gantry in aspect configuration, signal type and horizontal offset from the rail (as can be seen in *Photo 1*).
- c. The height of Signal WG1010 is different to other signals on the route.
- d. Signal WG1010 is obscured temporarily by overhead wiring structures from a number of locations between Signal WG1024 and the departure end of the platform.
- e. Signal WG1016 is located on the ‘wrong’ side of the track, i.e., the right hand side in direction of travel instead of the left. (This Signal was installed over 20 years ago and the reasoning behind its placement is not readily identifiable.)

- 2.41 Whilst the checklist does not provide an analysis of these findings, it does reveal that there are inherent issues with the signalling that may impact on the visibility, reactions and behaviours of drivers.

Earlier OTSI Investigation into a SPAD and Derailment at Signal WG1010

- 2.42 The key infrastructure concerns expressed in the OTSI investigation into the SPAD and derailment at the same location in 2003 related to the local signal configuration. In addition to their primary purpose, signals convey predictive information regarding the next signal in advance. The Investigation Report concluded there was scope to improve this in some signal configurations. Though the focus of this aspect of the Investigation was on the relationship between Signals WG1024 and WG1010, the resultant recommendation contained a general component:

“It is recommended that RIC conduct a human factors review of the potential risks associated with a driver’s response to single head signal configurations that have a limited number of coloured light indications. Such a review is recommended to determine if the existing pulsating yellow Medium signal enhancement is considered an appropriate modification to address the human factor concerns of removing the predictive information associated with standard single head signals. The review is also recommended to assess the suitability of those locations on the NSW network in which the pulsating medium indication is currently implemented.”

- 2.43 The particular recommendations were initially accepted but then rejected by RIC²² signalling engineers based on their view the Report lacked convincing evidence to support the recommendations, particularly on a network wide basis, and were never progressed. Given there have been five recorded SPADs at Signal WG1010 since 2003 and the human factors examination has identified that there are still some signal infrastructure issues at Unanderra, there would appear to be sufficient justification to revisit the 2003 Report’s recommendations, albeit confining the review to the Unanderra area.

²² Rail Infrastructure Corporation. This rail territory, formerly managed by RIC, is now managed by RailCorp.

Anticipation and Management of Risk

SPAD defences

- 2.44 Appropriate SPAD defences are installed at Signal WG1010. The SPAD alarm incorporated into the signalling system was effective as was the responsiveness of the Signaller to it.
- 2.45 The train stop was effective in triggering the train's brakes but the close proximity to the catch-points means very little deceleration can occur before a train derails. The Driver did not see either of the visual clues of a raised trip arm or open catch-points. It was only when he heard the release of air when the train passed the trip arm that he made the emergency brake application. Once derailed, the train came to rest upright, safely away from any major infrastructure and did not foul the adjacent 'Down Illawarra' line.
- 2.46 In 2004, ITSRR issued RailCorp with a Notification of Emerging Safety Concern relating to the provision of train stops at running signals.²³ In this Notice, ITSRR observed that;

".. there appears to be substantial risks associated with the fact that many automatic signals in the electrified area are still not equipped with train stops."

While Signal WG1016 is not an automatic signal, it automatically clears on setting the route through to Signal WG1010 and so the provision of a train stop may mitigate the consequences of a SPAD at either signal. Also, anecdotal evidence suggests that, in the absence of a light in the Guard's Indicator or a proceed for Signal WG1010, drivers and guards rely on a proceed indication from Signal WG1016 to advance a train out of the Unanderra Platform towards Signal WG1010 even when it is at stop. Signal WG1016 is an intermediate signal and not fitted with a train stop and currently does not provide any additional defence against a SPAD. Therefore, there appears to be a justification for an additional (intermediate) train stop associated with Signal WG1010.

- 2.47 More sophisticated technological solutions, such as the Automatic Train Protection system (ATP), are now available to protect against a range of

²³ ITSRR Notification of Emerging Safety Concern, Reference No. 00/001478 dated 18 October 2004.

circumstances which might lead to a SPAD such as driver incapacitation and speed. This system automatically stops the train in the event that it passes a signal at stop. ATP is in limited use throughout Australia at this time and it was trialled by RailCorp between September 2007 and January 2008 on the Blue Mountains line. Based on the results of this trial, RailCorp prepared a business case outlining an implementation strategy and funding requirements for the introduction of ATP on its network. RailCorp's Board has approved funding to progress the design and planning phases of the ATP program in parallel with the consideration of the business case by Government so as to ensure that RailCorp can progress the initiative if it is endorsed by Government.

Adequacy of the Emergency Response

- 2.48 The SPAD alarm at Wollongong Signalling Complex activated as required and the subsequent responses of the Signaller, Train Controller and crew were appropriate. Priority of concern was rightly given to avoiding the potential opposing movement by freight service 8938.
- 2.49 The Driver did not lower and isolate the pantographs on the train following the derailment as he considered there was minimal damage to the overhead wiring.
- 2.50 From voice logs it was identified that the Train Controller did not have an up to date callout list for RailCorp's incident response personnel - Network Operations Superintendents (NOS). The first NOS contacted by the Train Controller advised him that the roster for the on-call NOS had been "*all swapped around*" and he would have to contact another person to attend. It took approx 30 minutes to make contact with the right NOS.

Remedial Actions

- 2.51 The practice of guards riding with drivers came under scrutiny from RailCorp investigators who audited 29 passenger train movements through Unanderra Platform. They found guards riding in the leading crew compartment with the Driver on five occasions. RailCorp also

indicated an intention to undertake an audit of compliance with TWP 100 by observing where guards are riding in the train on the Unanderra, Hornsby and Carlingford lines.

Other Safety Matters

Driver's Console Lenses

2.52 Evidence was found of lenses on the driver's console having been coloured with a dark marker to reduce the illumination and glare for the driver (see *Photos 13 and 14*).



Photo 13: Drivers console on K496 showing lenses coloured in



Photo 14: Drivers console on another Tangara service showing lenses coloured in

2.53 The Driver was unaware of who had darkened the lenses but acknowledged that it is a common occurrence. He stated that he had observed many trains that had similar darkening of the lenses and that he could recall seeing this on other Tangara trains. This practice is contrary to the requirements of TWP 100 which states that train crew must “.. *not intentionally override any of the train safety systems.*” However, it appears the action is being taken to reduce or remove an annoyance or distraction interfering with their driving duties.

PART 3 FINDINGS

Causation

- 3.1 Service K496 passed Signal WG1010 when it was showing a stop indication (SPAD). It then derailed on the catch-points which were set open in accordance with the Signal's stop indication. The SPAD of Signal WG1010 was the consequence of human error on the part of the train Driver.

Contributory Factors

- 3.2 Contrary to procedural requirements, but on the grounds of feeling stressed and unwell, the Guard was riding in the driver's cab with the Driver's approval. This meant that he took his cue to proceed from Signal WG1016, the next signal in advance from the platform, instead of the Guard's Indicator which was linked to Signal WG1010.
- 3.3 Although the Driver of K496 was qualified for the route, it was likely that he was subconsciously expecting the route beyond the Unanderra platform to be set for the train to continue past Signal WG1010 as it had been in his experience on all previous occasions. He departed the platform on the Guard's bell indication, passed Signal WG1016, but then did not respond to Signal WG1010, which was at stop, until the associated train stop had triggered the application of the train's emergency brakes. A brake application made 30m prior to Signal WG1010 was not significant enough to reveal an intention or ability to stop at that Signal.
- 3.4 Signal WG1010 may also have been obscured for part of the time due to the position of the driver's blind and trackside infrastructure.
- 3.5 It is likely that fatigue played a part in the Driver losing concentration and situational awareness. He was not sufficiently rested to enable him to effectively perform his duties due to a lack of quality sleep, lingering effects of the flu and sub-optimal sleep environment because of hot weather. Immediately prior to the derailment he had allowed himself to

be distracted by a noisy passenger disturbance behind his cab. The Guard was likewise distracted.

- 3.6 Neither the Guard nor Driver are recorded as having received formal instruction related to self-assessing fitness for work in their induction training but they would have at least undergone awareness sessions subsequently. However, the current RailCorp training information and Fatigue Management Policy contain little detail on how to optimise the sleep environment or how to objectively assess one's own fitness for duty.
- 3.7 The shift had been an eventful one due to unruly behaviour on the part of members of the public which had caused the Driver and Guard to be concerned about their own safety. This experience is likely to have had a greater effect on their performance than would normally be expected as both had also experienced anti-social and risky passenger behaviour in recent weeks resulting in their seeking counselling.
- 3.8 This is the fifth recorded SPAD at Unanderra since 2003. The 2003 SPAD was investigated by OTSI resulting in a recommendation that a human factors review be undertaken in relation to signals and the predictive information they convey. The recommendation was subsequently not implemented. In February 2009, in response to the incident subject of this investigation, a "*Human Factors SPAD Hazard Checklist*" was used to conduct a sighting test for Signal WG1010 which revealed five infrastructure issues that could have an impact on driver performance.
- 3.9 Testing by RailCorp engineers allowed the performance of the train's brakes and the operation of the signals at the site to be eliminated as possible contributory factors.
- 3.10 Both the Guard and Driver were fully assessed and deemed competent to perform their respective roles. Although the Driver was not based in the local area and therefore not driving the route regularly, his route knowledge for the Unanderra area satisfied RailCorps' requirements.

Anticipation and Management of Risk

- 3.11 The SPAD defences installed at the site worked effectively. However, there is a very short distance between the train stop and the catch-points. If the current signalling is retained at the site, there may be justification to install an intermediate train stop in association with Signal WG1010 to negate or reduce the extent of an induced derailment. Signal WG1016 is not an automatic signal but does automatically clear on setting the route through to Signal WG1010.
- 3.12 Available indicative data for SPADs in RailCorp territory over the last five years shows that SPADs attributable to 'driver error' and 'trackside' related causes have generally remained at the same level despite various initiatives implemented to address the problem.
- 3.13 More technologically sophisticated defences are now available to protect against SPADs. Trials of ATP technology have been completed and RailCorp has progressed to the design and planning phase in parallel with the consideration of the business case by Government.

Effectiveness of the Emergency Response

- 3.14 The response by all parties was appropriate and effective. However, the Train Controller not having an up-to-date callout list for incident response personnel is a matter for concern.

Remedial Action

- 3.15 An audit by RailCorp at the Unanderra Platform found guards riding with drivers on five out of 29 occasions. As a result RailCorp have indicated they will undertake a wider compliance audit.

Other Safety Matters

- 3.16 The darkening of lenses on drivers' consoles in Tangara trains to reduce glare for drivers appears to be a fairly common practice.

PART 4 RECOMMENDATIONS

- 4.1 It is recommended that **RailCorp** undertake the following remedial safety actions:
- a. Ensure that drivers' understand how to make adequate provision for quality rest and sleep to militate against the onset and effects of workplace fatigue.
 - b. Revise the content of induction and continuation training programs for drivers, guards and other transport safety workers to ensure the curriculum comprehensively addresses:
 - the effects of sleep deprivation on operational performance,
 - sleep hygiene (optimising sleep and the sleeping environment),
 - objective methods of identification of fatigue, and
 - RailCorp procedures for fitness for duty.
 - c. Ensure existing staff are trained in the resultant additional and revised subject material.
 - d. Reinforce the requirements of TWP100 with train crew especially in relation to the correct riding position for guards.
 - e. Implement a system of regular auditing of compliance with the requirements of TWP100.
 - f. Reopen and implement the recommendations at paragraph 7.2.2 of OTSI's investigation into the SPAD and derailment at Unanderra on 28 June 2003, but confine the review to the Unanderra area.
 - g. Analyse the findings and implement strategies to address the risks associated with the issues raised in the sighting test of Signal WG 1010 carried out on 19 February 2009.

- h. Evaluate the effectiveness of the initiatives implemented to date through the 5-point program and revise strategies for addressing SPADS accordingly.
- i. Evaluate options for additional SPAD defences in association with Signal WG1010 including the installation of an intermediate train stop.
- j. Ensure emergency callout details for on-call incident response personnel are accurate and up-to-date.
- k. Implement further strategies to address the practice of obscuring light indicators/lenses on drivers' consoles.

PART 5 APPENDICES

Appendix 1 Sources, References and Submissions

Sources of Information

- Bureau of Meteorology
- RailCorp
- Crew members of K496
- Officers of the NSW Police, Warilla Station
- Independent Transport Safety and Reliability Regulator (ITSRR)

References

- OTSI's rail safety investigations into SPAD related derailments at Unanderra 2003, Thirroul (2006) and Homebush (2009).
- *Rail Safety Act 2008 (NSW)*
- *Passenger Transport Act 1990 (NSW)*
- *Transport Administration Act 1988 (NSW)*
- *RailCorp Network Rules and Procedures*
- *RailCorp Train Operating Conditions Manual*

Submissions

The Chief investigator forwarded a copy of the Draft Report to the Directly Involved Parties (DIPs) to provide them with the opportunity to contribute to the compilation of the Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and to submit recommendations for amendments to the Draft Report that they believed would enhance the accuracy, logic, integrity and resilience of the Investigation Report. The following DIPs were invited to make submissions on the Draft Report:

- RailCorp
- Independent Transport Safety and Reliability Regulator (ITSRR) NSW

Submissions were received from both DIPs.

The Chief Investigator considered all representations made by DIPs and responded to the author of each of the submissions advising which of their recommended amendments would be incorporated in the Final Report, and those that would not. Where any recommended amendment was excluded, the reasons for doing so were explained.