RAIL SAFETY INVESTIGATION REPORT

SIGNAL PASSED AT DANGER AND OPPOSING MOVEMENT BETWEEN TWO FREIGHT TRAINS

GUNNEDAH

7 MARCH 2012
THE OFFICE OF TRANSPORT SAFETY INVESTIGATIONS

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OTTI Rail Safety Investigation

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ACRONYMS AND ABBREVIATIONS

ARTC .......... Australian Rail Track Corporation
ATMS .......... Advanced Train Management System
ATP ........... Automatic Train Protection
CTC .......... Centralised Train Control
DIP .......... Directly Involved Party
FAID .......... Fatigue Audit Interdyne
ICE .......... In cab equipment (radio system)
ITSR .......... Independent Transport Safety Regulator
LED .......... Light Emitting Diode
NC .......... Network Controller
NCCN .......... Network Control Centre North (Broadmeadow)
OTSI .......... Office of Transport Safety Investigations
PN .......... Pacific National
SPAD .......... Signal Passed At Danger
TSR .......... Temporary Speed Restriction
TTM .......... Train Transit Manager
# GLOSSARY OF TERMS

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td>Advanced Train Management System (ATMS)</td>
<td>A train management system which includes a transmission based signalling system with authorities to proceed displayed in locomotive cabs rather than on wayside signals. The system provides automatic enforcement (i.e., applies brakes) if an authority is at risk of being exceeded.</td>
</tr>
<tr>
<td>Automatic Train Protection (ATP)</td>
<td>A system which supervises train speed and target speed, alerts the driver of the braking requirement, and enforces braking when necessary. The system may be intermittent, semi-continuous or continuous according to its track-to-train transmission updating characteristics.</td>
</tr>
<tr>
<td>Braking Curves</td>
<td>Plots of speed against distance for the braking performance of particular trains from various speeds over various gradients.</td>
</tr>
<tr>
<td>Braking Distance</td>
<td>For a nominated portion of railway the maximum distance which any train operating on such a portion of railway at its maximum authorised speed, will travel during a full service application of the brakes, between the point where such application is initiated and the point where the train comes to a stop.</td>
</tr>
<tr>
<td>Centralised Traffic Control (CTC)</td>
<td>A system of working whereby signals and points at a number of adjoining signalled sections, including interlockings, are operated remotely from a centralised train control centre.</td>
</tr>
<tr>
<td>Dead end signal</td>
<td>A signal fitted below the main signal head on a bracket and located on the same side as the route which it authorises.</td>
</tr>
<tr>
<td>Distant Signal</td>
<td>A signal that informs a driver of the condition of the next signal in advance but which generally cannot display a ‘Stop’ indication.</td>
</tr>
<tr>
<td>Down and Up Direction</td>
<td>Trains travelling away from Sydney are referred to as Down trains. Trains travelling towards Sydney are referred to as Up trains.</td>
</tr>
<tr>
<td>FAID (Fatigue Audit Interdyne)</td>
<td>A computerised model that calculates a fatigue score which is compared with the fatigue expected to be induced by working a particular pattern of work. The principal use of FAID is to assist in better managing shiftwork, scheduling and fatigue risk.</td>
</tr>
<tr>
<td>Home Signal</td>
<td>A controlled signal which directly protects a permanent risk within an interlocking e.g., a set of points.</td>
</tr>
<tr>
<td>ICE</td>
<td>“In Cab Equipment” train radio system.</td>
</tr>
<tr>
<td>Kilometrage</td>
<td>The distance by rail as measured from Central Station in Sydney.</td>
</tr>
<tr>
<td>Network Controller</td>
<td>A Train Controller for an unattended location, a Signaller for an attended location, or a delegate carrying out some functions of a Train Controller or Signaller.</td>
</tr>
<tr>
<td>Overlap</td>
<td>The length of track beyond a stop signal which must be unoccupied before the stop signal next in rear can display a proceed indication. It is provided to secure a margin of safety by establishing and maintaining a minimum separation distance between a train approaching the signal and any other train authorised to occupy the line ahead of the signal.</td>
</tr>
<tr>
<td>Phoenix System</td>
<td>A Centralised Train Control System that provides the Network Controller with real time monitoring and control of infrastructure such as points and signals.</td>
</tr>
<tr>
<td>SPAD</td>
<td>Signal Passed At Danger and without authority.</td>
</tr>
<tr>
<td>Single Line</td>
<td>A single running line on which trains can travel in either direction.</td>
</tr>
<tr>
<td>WB radio</td>
<td>Open channel VHF radio used primarily by train crews to talk to each other, terminal staff and signallers.</td>
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</tbody>
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EXECUTIVE SUMMARY

At 2227\textsuperscript{1} on 7 March 2012, Pacific National grain train 5424N passed signal GH26 on the outskirts of Gunnedah while it was showing a red Stop indication. The second person alerted the driver to the incident and the driver responded by applying the brakes. The train then trailed through a set of points before coming to a stand. Concurrently, Pacific National coal train WH191 was proceeding in the opposite direction from a passing loop onto the single Main line and so was on a collision course. On becoming aware of 5424N coming towards him, the driver of WH191 immediately brought his train to a stand. The trains stopped 715 m apart with 5424N 870 m beyond signal GH26. The crew of 5424N did not detect the presence of WH191 until after both had stopped.

The network controller attempted to make an emergency broadcast call over the CountryNet radio when he became aware of 5424N passing signal GH26. However, the call failed primarily due to the network controller’s lack of understanding of the radio system’s characteristic delay when placing this type of call. The Australian Rail Track Corporation has since produced an information and instructional document on the subject and distributed it to its network controllers.

The investigation focused on the actions of the train crews before and during the incident and the communications failures immediately after it. Also considered was the design and layout of the signalling infrastructure and crew fitness for duty.

The reason the driver of 5424N did not respond to the signal indication is likely to have been his misreading of two consecutive stop signals as a single signal causing him to misinterpret where he should stop.

Appropriate remedial actions have been taken, or are in train, to minimise the potential for this type of incident to recur. However, it is recommended that the Australian Rail Track Corporation evaluate the effectiveness of action taken to improve its network controllers’ competencies in handling the CountryNet radio system. It is also recommended that Pacific National establish the colour perception status of the second person from the grain train crew, although this was not a contributing factor in the incident.

\textsuperscript{1} The 24-hour clock is used in this report and the times referred to are in Eastern Daylight-saving Time (UTC+11 hours).
PART 1  FACTUAL INFORMATION

Before the Incident

1.1 Pacific National (PN) bulk commodity train 5424N originated at Bellata where it was loaded with grain. A new crew took charge of the train at Narrabri where they obtained a train order from the Australian Rail Track Corporation (ARTC) Network Controller (NC) in the Network Control Centre North (NCCN) at Broadmeadow and departed at about 2100 on 7 March 2012.

1.2 On arrival at Turrawan, 21 km from Narrabri and 72 km from Gunnedah, the crew fulfilled the train order and continued on the authority of line-side signals towards Gunnedah.

1.3 Meanwhile, an empty PN coal train (WH191) was waiting in Gunnedah loop for a loaded coal train (WH166) to depart Whitehaven Colliery outside Gunnedah. Once the rear of WH166 cleared the points of the loop, the NC reset the route and signals GH21 and GH23 then cleared to allow WH191 to depart the loop and proceed towards Whitehaven Colliery (see Figure 1). This meant that signal GH26, the home signal for 55A points in the Up direction, was held at Stop to direct the driver of the grain train to bring his train to a stand clear of the path of the coal train. As GH26 was displaying a red Stop indication, distant signal GH26Dist displayed a yellow Caution indication as an advanced warning for the crew of the grain train.

Figure 1: Incident track and signal layout

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Train Order: A safeworking method whereby the Train Controller issues ‘train orders’ to rail traffic to authorise them to travel through a section or occupy track within Train Order territory areas. On this line Train Order working territory ends at Turrawan.
The Incident

1.4 As the grain train approached the curve leading to the 9 km straight towards Gunnedah, signals GH26Dist, GH26 and GH22 came into sight. GH26Dist was displaying a steady yellow Caution indication while signals GH26 and GH22 were displaying red Stop indications. At this time, the signals were respectively about 5.5, 7 and 9 km distant. Once the train had rounded the curve, both Stop signals could be distinguished with GH22, the furthest away and located on the crest of a rise, being more prominent. However, the yellow Caution signal then blended in with the lights of the coal loader, which crossed over the track between this signal and GH26. The track was straight and on a slightly falling grade past the first two signals before rising gently at first then more steeply (1:89) to GH22. This caused the two Stop signals to appear to be in line one above the other.

1.5 As the train continued towards Gunnedah on the straight portion of track, the first line-side indicator encountered was the Gunnedah location sign at 482.575 km (see Photograph 1). In accordance with Network Rule ANSG 606 Responding to signals and signs, in signalled territory such as at Gunnedah, no response is required by the driver of an approaching train other than “being prepared to respond to the next signal”.

[Photograph 1: Gunnedah location sign]
1.6 At this point signal GH26Dist, which did require the crew’s response, was still hard to distinguish from the coal loader lights. The distant signal, located at 481.855 km, began to become more prominent and therefore distinguishable, appearing to the left of GH26 signal located at 480.575 km and to the left of, and below, GH22 signal located at 478.472 km (see Photographs 2 and 3).

Photograph 2: View from distant signal towards Gunnedah

Photograph 3: View of the three signals from approximately 483.100 km
1.7 The second person, a trainee driver, informed the driver of the “steady yellow” signal indication (caution) and the driver acknowledged this. The driver was reducing speed due to the presence of a temporary speed restriction (TSR) of 40km/h located between 481.520 and 481.400 km beginning 335 m beyond GH26Dist.

1.8 As 5424N slowed, and after it passed GH26Dist, the second person informed the driver of the red signal (GH26) ahead. The driver acknowledged the second person’s warning.

1.9 As 5424N passed through the TSR area, the second person repeated the ‘red signal’ warning which the driver again acknowledged.

1.10 5424N continued at a little over 40km/h (the wagons of the train were still passing through the TSR) but did not slow down further as it approached red signal GH26. At interview, the second person related the following sequence of events: “(I) looked at the driver (and) wondered why we weren’t slowing. He was looking straight ahead and had hands on the brake stand (the controls). I confirmed that the signal was at Stop again and he replied ‘yes, red light’”. The train then passed GH26 at Stop at 2227. The second person stated that he stood up and told the driver that he had passed the signal at Stop and that he must stop the train. In the words of the second person, he was “yelling at the driver to stop the train. We passed signal and I stood up and told him”. The driver responded ‘no we haven’t, it’s further up.’” The second person shouted “stop the train; we have gone past our signal”.

1.11 In the meantime, the coal train (WH191) had departed from Gunnedah loop and the locomotives had proceeded over the rise where signal GH22 was located. The crew observed their next signal, GH23, displaying a dead end signal to authorise their passage into Whitehaven Colliery loop. They also saw the headlights of the grain train to which the driver responded by switching off his locomotive’s headlights.

1.12 The driver of the coal train indicated that the headlights of the grain train remained on making it difficult to see GH23. When the headlights of the grain train were extinguished some seconds later, he observed GH23 now displaying a Stop indication (i.e., the dead end signal had been extinguished).
The coal train driver applied the brakes in response to the signal having returned to Stop and concurrently received an incoming call from the NC on the CountryNet radio. The driver attempted to answer it but the call disconnected. He realised that the grain train may have passed GH26 and could still be moving towards them on the single line so immediately applied the train’s brakes fully to bring his train to a stand.

1.13 Continuing beyond signal GH26, the driver of the grain train (5424N) noticed that 55A points were set for Gunnedah coal loop and realised that he had passed a signal at Stop. He applied the train’s brakes but ran through 55A points, coming to a stand about 280 m beyond the points and 870 m beyond signal GH26. The crew of 5424N had not noticed WH191 before its headlights had been extinguished and so were not immediately aware of its presence. The two trains were 715 m apart when they came to a stand (see Figure 2).

![Figure 2: Final positions of trains](image)

**Incident Response**

1.14 When 5424N passed signal GH26 at Stop, a signal passed at danger (SPAD) alarm sounded at the NC’s workstation in NCCN where the position of the trains could be seen on the NC’s Phoenix VDU screen. Train 5424N then ran through 55A points, causing the Phoenix display of 55A points to flash (see Figure 3). There were no unoccupied track circuits between the two trains.
1.15 The NC initiated a call to WH191 via CountryNet radio but the call was terminated by the NC before it could be answered.

1.16 The NC then initiated a ‘locomotive non-specific’ priority call (an emergency call to all trains in the area) at 2228 over the CountryNet radio system saying “Emergency emergency emergency, all trains bring your trains to a stand please, straight away (pause) north control out”. This was nearly one minute after being alerted to the SPAD at which time both drivers were in the process of bringing their trains to a stand. There is no evidence that this call connected to either of the trains before the NC terminated it so neither driver heard the NC’s message.

1.17 Thirteen seconds later, the driver of WH191 called the NC back in response to the original missed CountryNet call. The NC answered immediately and it was quickly established that WH191 was at a stand with the driver also observing “it doesn’t look like he’s moving” in reference to 5424N.

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4 Two terms are used: ‘locomotive specific’ is a priority call to a selected locomotive while a ‘locomotive non-specific’ is a priority call to all locomotives in a selected area.
1.18 At 2230 the NC tried to contact 5424N over the WB radio. The crew of 5424N responded once to this call but were not heard by the NC (see Paragraph 2.21).

1.19 As no response had been received from 5424N, the NC’s supervisor, the Train Transit Manager (TTM), contacted PN at their offices in Parramatta to obtain a mobile telephone number for the crew of 5424N. Initially an incorrect number was supplied and the TTM had to call PN again before being supplied with the correct one. At 2238, about 11 minutes after the SPAD, the NC spoke to the driver of 5424N by telephone and confirmed details of the incident and that 5424N was and would remain stationary.

1.20 ARTC’s TTM at Broadmeadow contacted an ARTC senior investigator to attend the incident. At 2254 the TTM reported the incident to the OTSI Duty Officer.

1.21 Post-incident testing for the presence of alcohol was undertaken on all train crew members. Subsequently, on 9 March, both crew members of 5424N were tested for the presence of drugs while at the Werris Creek Depot. All tests returned zero or negative readings.

**Damage**

1.22 No.55A points were damaged when 5424N ran through them.

**Location**

1.23 Gunnedah is located on the Liverpool Plains in New South Wales, 476 km by rail from Sydney. Gunnedah has a railway station with one daily passenger service passing through in each direction between Sydney and Moree. Gunnedah Yard also includes infrastructure built to accommodate different requirements over the years. This has included mills, oil sidings and grain sidings. Today, the mill is still serviced by rail and the yard is also used for rolling stock maintenance. Further north-west (towards Narrabri), additional infrastructure was added outside the confines of the original Gunnedah Yard, notably a stock siding, grain silos, Gunnedah Municipal Abattoir sidings and Whitehaven Colliery balloon loop.
1.24 Whitehaven Colliery balloon loop, connected by No. 55 points (see Figure 1) currently has two coal loaders. To help facilitate additional coal train traffic, a 1360 m passing loop was constructed on the north-west side of the Main line.

1.25 On approach from Emerald Hill, the line follows a south-easterly direction before turning about 30 degrees towards the east. From there the line is straight for over 9 km to and through the incident location (see Figure 4).

![Figure 4: Satellite image of Gunnedah and incident location](Image from Google Earth)

**Safeworking / Signalling Equipment**

1.26 For many years rail traffic through Gunnedah Yard was controlled by semaphore signals operated by a signaller, while traffic in the sections on either side (Curlewis to the south and Emerald Hill to the north) was authorised using the electric staff method of safeworking.5

1.27 Access to rail infrastructure outside the confines of Gunnedah Yard, such as the coal loop, was controlled by ground frames operated by train crew. Intermediate staff huts were provided to allow electric staff to be deposited or

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5 Electric Staff: A safeworking method wherein a metal staff, removed from an electric staff instrument, gives authority to enter and travel through a section. The instrument is electrically interlocked with the instrument at the opposite end of the section and within the section and only one staff can be absent from the instruments at one time.
obtained as trains entered or left the loops or siding. This safeworking method authorised one train at a time to occupy a particular main line section.

1.28 In November 2010 the line from Werris Creek (70 km south-east of Gunnedah) to Turrawan was converted from electric staff to Centralised Train Control (CTC) with colour light signals installed to control rail traffic.

1.29 These signals are controlled by a combination of the actions of the NC and track circuits. The route has to be proved safe with the track clear of other traffic, and points in the correct position, before signals will clear. In general, colour light signals can show four aspects:

- red for ‘stop’ or ‘danger’
- yellow for proceed at caution (with the next signal likely to be at stop)
- pulsating yellow for medium caution (indicating that the next signal is not at stop)
- green for proceed with the next signal in advance showing at least a caution indication.

Additionally, distant signals are provided where required. These signals can generally display ‘proceed’ or ‘caution’ only, as dictated by the aspect of the next signal in advance. They cannot usually display a stop indication.

**Train Information**

1.30 The incident train was a loaded grain train travelling from Bellata towards Werris Creek and was designated 5424N. Tractive power was provided by an 81 class locomotive (leading) and two 48 class locomotives. The train load consisted of 40 grain hoppers, all but three being loaded. The train mass was 3,242 t with a total length of 656.3 m.

1.31 PN provided an analysis of the Hasler (data logger) tape from the lead locomotive (8179). This analysis showed that, prior to the incident, the train was operated at speeds of up to 92 km/h, which exceeded the maximum permitted speed for this class of train by 12 km/h. The analysis also identified that a running brake test had not been conducted by the crew of 5424N after departure from Narrabri as required by PN’s procedures. The management of the train during the incident is analysed further in Part 2 of this report.
1.32 The opposing coal train consisted of three WH class locomotives and 82 empty coal hoppers with a total length of 1325.5 m and a total mass of 2,170 t. A post-incident data logger download confirmed that the train had been managed in an appropriate manner in the lead-up to the incident.

1.33 No faults were recorded with regard to the condition of either train.

**Employee Information**

1.34 The incident train was crewed by PN employees. The driver had been employed as a driver by PN for seven years with previous rail industry experience as a terminal operator. Whilst employed by PN, the driver had had no previous safeworking incidents recorded. He had a current certificate of competency and had passed the required medical assessment on 1 December 2011. The medical assessment category is determined according to the *National Standard for Health Assessment of Rail Safety Workers*.

1.35 The second person had been employed by PN since November 2010 as a trainee driver with no previous rail industry experience. The second person was scheduled to complete his training by the end of 2012. He had a current certificate of competency and had completed the required medical assessment on 5 November 2010. However, the medical certificate stated “*Fit for Duty Subject to Job Modification- Does not meet all the medical criteria, but could perform current rail safety work if suitable modifications were made*”. The following modification was recommended: “*Fit to drive only on the Pacific National system as per Practical Colour Vision test on 2/11/10*”. The test referred to may be carried out subsequent to a rail safety worker making a defined number of errors during a 12 plate Ishihara\(^6\) (colour vision) test sequence. The test was carried out while travelling in a locomotive cab from Narrabri to Werris Creek where a manager asked the second person to read signals (i.e., identify the colour aspect displayed) en route. The second person was reported to have correctly identified signal indications during the journey.

1.36 The fatigue scores for the driver and second person, as calculated using the FAID model, were well within the recommended limits. Both employees stated that they did not feel fatigued.

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\(^6\) The Ishihara Colour Test is a colour perception test for red-green colour deficiencies. It uses coloured dot patterns wherein a person with normal colour vision can discern a number but those with non-normal colour vision may not.
1.37 The empty coal train had three crew members present in the cab of the lead locomotive: a driver, a second person and a trainee, all correctly certificated.

1.38 The NC located at the NCCN had six years experience as an ARTC network controller and had previously been employed by the NSW State Rail Authority as a signaller of various grades for 15 years.

Network Rules and Procedures

1.39 There is a location sign on approach to Gunnedah (see Photograph 1). Network rule ANSG 606 Responding to signals and signs directs that, in signalled territory, “Drivers and track vehicle operators must be ready to respond to the first signal … at the location” after passing a location sign. However, the rule does not require rail traffic to reduce speed, only to be “ready to respond” to a signal. During the hours of darkness the signals in advance are visible before the location sign, rendering it largely irrelevant.

1.40 Network Rule ANSG 612 Overrun of limit of authority prescribes the rules for dealing with an overrun of authority, such as passing a signal at Stop. The rule states that drivers “who find they have overrun a limit of authority must immediately (stop their train and tell the network control officer)”. The network control officer must “stop rail traffic that has overrun its limit of authority and not stopped (and) stop and prevent other movements that are at risk …”.

1.41 ARTC’s Network Rule ANTR 406 Using Train Lights (version “Revision 1”, as in force at the time of the incident) directed that headlights must be “switched off during approach to another train”. Also, “If necessary, a Driver may flash a locomotive’s headlight to give warning”. This rule has been updated since the incident (see Paragraph 2.35).

Pacific National Procedure

1.42 In addition to the ARTC Network Rules and Procedures, PN has its own requirements designed to mitigate the risk of SPADs. PN (Bulk Rail Division) has a document entitled “Defensive Train Handling Techniques and Strategies” DSN No: BR-0901. A diagram displayed on the door of the train crew office at Narrabri shows a diagrammatic representation taken from this document (see Photograph 4). This requires that a train’s speed be reduced to 15 km/h before the head of the train approaches within 200 m of a signal or
other required stopping location, and to bring it to a stand 50 m short of that signal or location.

![Image of diagram explaining stopping distance requirements](image)

**Photograph 4: PN “Stopping Distance Requirements”**  
(Diagram courtesy of PN)

**Communications Systems**

1.43 The train crew had immediate access to three communication modes during this incident: CountryNet radio, WB radio (open channel) and PN supplied mobile telephones.

1.44 A CountryNet radio was installed in each locomotive cab and facilitated direct communication between train crews and the NCCN.

1.45 WB radio (open channel) was available in the Gunnedah area. WB provided communication between different train crews and between train crew and network control.

1.46 Although there is mobile telephone coverage at Gunnedah, Network Control did not have the number for either crew.

**Environmental Conditions**

1.47 The incident occurred on a clear night with a near full moon. The moon was not in a position such as to obstruct the field of view of the incident train crew.
Safety Actions

1.48 Subsequent to the incident, the following safety actions were undertaken:

- PN separately recertified the second person and driver and they returned to duty on 21 March 2012 and 30 March 2012 respectively. Further, the driver’s qualification was reduced such that he was no longer in a position to mentor trainees.

- ARTC technicians checked the operation of the CountryNet and WB radio systems and identified that NCs were unaware of a system delay when making ‘priority’ calls on the CountryNet system. Information was then provided to control centres for reference by network control staff.

- ARTC recognised the deficiency in its training that led to its network control staff being unaware of this delay and has requested their training provider to include this information in their training material.

1.49 In June 2012 PN released a training document titled “Bulk Rail SPAD Strategy”, briefing Number: SB0115. This document incorporated DSN No: BR-0901 (see Paragraph 1.42) and was introduced as a training document for drivers and second persons. It identified that the Bulk Rail Division of PN had had 38 “at fault” SPADs in the period between August 2009 and December 2011 and gave examples to illustrate the potential consequences of a SPAD. The document specifically directs a second person to take action if a train is not being appropriately managed on approach to a signal at stop. If the driver does not respond appropriately to verbal advice then the second person is directed as follows:

“you must take action to apply the train brake by

- Physically applying the train brake by placing the automatic air brake handle into the emergency position or

- Physically applying the train brake by placing the emergency brake pipe isolating cock into the open position

- Pressing and holding down the vigilance control button to achieve a penalty brake application...”
PART 2 ANALYSIS

Crew of WH191

2.1 Leading up to the incident, the driver of WH191 operated the train in a manner commensurate with the prevailing conditions. When authorised by GH21 displaying a Caution aspect, the train was advanced towards Whitehaven Colliery, accelerating from zero to maintain a constant speed of about 20 km/h. On seeing the opposing train 5424N on the same line, the crew immediately turned off their headlights in accordance with ANTR 406. Once it became evident that 5424N had not stopped as expected, the driver of WH191 brought his train to a stand and attempted to contact the other train via WB radio, but did not flash the locomotive’s headlights to give warning as allowed under ANTR 406.

Crew of 5424N

2.2 PN (Bulk Rail Division) has a document entitled “Defensive Train Handling Techniques and Strategies” as part of their driver training material. This document includes specific guidance on the speed at which a signal at Stop should be approached, as discussed in paragraph 1.42. This was reinforced in notice DSN No. BR-0901 dated 15 February 2009 which highlighted the fact that the division had recorded seven SPADs attributable to driver error in a 12-month period. The document reinforced the requirements on approaching a signal at Stop.

2.3 The Hasler tape analysis indicates that, while the driver of 5424N did allow his train to over-speed by up to 12 km/h (15%) during its journey from Narrabri, he did control the train’s speed in response to the conditions on approach to Gunnedah. Notably, he reduced the speed of the train using the locomotive’s dynamic brakes to 44 km/h and then to 42 km/h in response to the 40 km/h TSR between the distant signal and GH26. However, there was no further speed reduction on approach to GH26. The braking curve applicable to this type of train does not extend to a speed as low as 42 km/h. However, an extrapolation of the curve implies a stopping distance of under 350 m. This supports evidence that the brakes were applied just before the train ran through 55A points as it came to a stand 280 m beyond them. The train’s
headlights were not turned off in response to the approach of WH191 and both crew members stated that they were unaware of its presence until after they came to a stand.

2.4 The second person stated at interview that he was aware of the various signal indications and called them to the driver as required. As the train continued towards the signal at Stop, the second person wondered why they were not slowing; he ‘called’ the Stop signal to the driver for a third time. As the driver correctly acknowledged every time the second person called the signal indication and appeared to be alert at the controls, he assumed that the driver was in control of the situation. It was only when the signal was passed, still displaying a Stop indication, that the second person was prompted to intervene more forcefully by rising to his feet and telling the driver what had occurred. The second person, a trainee driver with limited rail experience, felt reluctant to intervene before this due to both his inexperience of the route and the existence of an authority gradient between an experienced driver and the trainee.

2.5 The driver of 5424N stated that he could not recall having been required to stop at signal GH26 before. However, he had “often stopped” at the next signal, GH22. Signals GH26 and GH22 appeared at a distance as two single points of light one above the other. Even though one signal was 2.1 km beyond the other, the LED light intensity was such that they appeared to be quite similar in size and brightness. The view presented to the driver in a similar configuration to that of a single LED signal, displaying Stop, i.e., one red light above another similar red light. It is quite possible that the driver of 5424N ‘read’ the two red lights presented to him on approach to Gunnedah as belonging to the same signal (GH22). He could then have developed a mental model, a conditioned response based on prior experience, of where he was to stop (signal GH22). At interview, the driver could not explain why he passed GH26 signal at Stop but did state that, immediately before the SPAD, he was “focused on (the) second signal (GH22)”. He acknowledged the second person’s repeated warning (thrice given) of a red signal ahead but these warnings failed in their purpose as the driver accepted them as relating to the second signal, at which he was intending to stop. He was not receptive to the visual cue of the first red signal. This is a recognised phenomenon, referred
to as “inattentional blindness” or “change blindness” where a person unconsciously disregards subsequent visual changes or cues after developing a particular mental model or focus of attention.7

2.6 The non-awareness of the headlights of WH191 is attributable to the fact that the second person was focussed on the driver and the closely approaching GH26 signal while the driver’s attention was focussed on the more distant GH22 signal. Similar to his non-responsiveness to GH26, the driver may not have been consciously aware of the headlights, which in any case were extinguished quickly by the driver of WH191.

2.7 The possibility that the crew were in a state of low arousal and therefore failed to respond to the signal indication can be discounted as the Hasler tape analysis indicates that the train speed was managed in response to the 40km/h TSR located between the Distant signal and GH26. The visual cue of an unlit yellow TSR sign is considerably less prominent than that of colour light signals. It would appear unlikely that the crew, and notably the driver, could have responded to the TSR but not shortly afterwards to the signal.

**History and Design of Signalling Infrastructure**

2.8 Signalling is designed and constructed to give the drivers of rail traffic sufficient warning of the need to slow down or stop, with reference to a combination of the maximum allowable speed and the braking performance of that rail traffic, track gradient and signal sighting.

2.9 ARTC’s Engineering (Signalling) Standard ESD-32-01, *Signalling Rollingstock Interface* states “Train braking poses the problem of matching signalling infrastructure design to train braking potential, so that the signalling system can provide sufficient warning for all trains approaching a ‘stop’ signal to stop safely before the obstruction that it protects”. The same section goes on to say; “Finally, there is a risk that the driver may not adequately perceive or respond to signalling indication.” However, this risk is not addressed by ARTC signalling standards; it is identified as a risk belonging to the operator.

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7 ‘Change blindness and inattentional blindness studies show that we perceive little outside the immediate focus of our attention’ and ‘much of what we perceive comes not from sensory input from the world but rather from our use of expectations and knowledge to construct scenes on the basis of a rather limited amount of attended sensory input’. Jackie Andrade and Jon May, *Cognitive Psychology*, Garland Science/BIOS Scientific Publishers, Abingdon, Oxfordshire 2004, page 36.
2.10 To assist with the design and verification of signalling layouts, braking distance tables have been developed. “Stopping distances are measured from the point of application, when the driver moves the brake handle/pedal to the position at which the train/vehicle comes to a stand.” The only protection against a SPAD and conflicting move at the incident location was the vigilance of the train crew and their ability to bring their train to a stand before the protecting signal or, in the extreme, before the point of conflict. Additional mitigation against a SPAD at this location is the provision of an overlap of over 550 m between the home signal GH26 and the conflict point. This distance exceeds the 300 m minimum overlap currently specified. The minimum overlap would generally only be effective in the case of a low speed SPAD where the train brakes had already been applied. In this incident 550 m proved ineffective in preventing a conflicting move from occurring after the SPAD event.

2.11 In much of the Sydney Metropolitan Rail Area, train stops are used to mitigate the consequence of SPADs. They work by means of a steel actuator striking a valve on the front of a train so releasing brake pipe air and applying the train’s brakes. This system works for all RailCorp passenger trains but the necessary equipment is not fitted to signals outside the Sydney Metropolitan Rail Area, or on freight locomotives.

2.12 The use of a form of Automatic Train Protection (ATP) as widely used overseas would have either prevented the incident or at least reduced the impact of the SPAD by reducing the distance that the train travelled beyond the signal. The Waterfall Inquiry into the fatal accident in 2003 recommended that RailCorp introduce ATP, and RailCorp is currently in the process of trialling a suitable system.

2.13 ARTC is introducing an Advanced Train Management System (ATMS). ATMS does not require line-side signals and therefore the possibility of ‘SPADs’ will no longer exist. However, the analogous risk of a ‘limit of authority overrun’ would be present; ATMS includes ‘automatic protection’ against this risk. ATMS is being introduced for a range of operational reasons but will also achieve significant safety outcomes. While the Hunter Region with its high traffic volumes is likely to be an early recipient of ATMS, it is not clear when it might reach outlying locations such as Gunnedah.
Previously, the standard for a Location such as GH26 at Gunnedah stipulated an overlap of at least 500 m. An internal ARTC review of SPAD events over the five years to 2009 found that the majority of SPAD events resulted in an overrun of less than 300 m. The majority of those that exceeded 300 m also exceeded 500 m because the train crew had ‘missed’ the signal and was not trying to stop. This informed a risk assessment process which led to a case for the minimum overlap to be reduced to 300 m. This process was monitored by the Independent Transport Safety Regulator (ITSR) and the standard was eventually changed to the lower the overlap distance to 300 m.

The signalling infrastructure at Gunnedah was commissioned in 2010 and was built to the applicable ARTC signalling design standards. The standards do not require the fitment of train stops or ATP.

Characteristics of LED Signalling Equipment

The LED signals, GH26 and GH22, display a red Stop signal by means of strings of LED lights arrayed to form a matrix. The LEDs generate red light which is focussed by lenses integral to each individual LED. The light then passes through a clear cover towards approaching rail traffic. They are Westinghouse RM4-RCFB25-B-AU units which have a 'medium spread' with a nominal range of 600 m (in daylight). Also available are ‘intermediate’ and ‘long’ units with less 'spread' focussing the light more narrowly and achieving nominal ranges of 1.5 km and 2.5 km respectively. The longer range units are used less often and, in the case of the longest range units, at locations where the signal may be silhouetted against a bright sky such as the setting sun. Even so, at night, these ‘medium spread’ lamps were clearly visible several kilometres away. The LED units deliver a higher intensity of light than the traditional incandescent units previously available.

A smaller red marker light is provided to maintain a Stop signal in the event of a failure of the main head. Although these are of a smaller diameter and therefore contain fewer LEDs, they have similar characteristics to the main signal head and appear similar at night.

Incandescent signals are gradually being replaced by LED signals across NSW. The left hand image shown in Photograph 5 (page 19) is a night time view of an incandescent signal, while the image on the right is of an LED
signal. Both signal’s lenses are of similar physical sizes to each other with a larger main ‘head’ and a smaller marker light below. However, LEDs provide a bright point source of light and, while the main signal head is larger and emits more lumens than the marker light, both emit light at high intensity. The nature and intensity of the LED light is such that, seen against a dark background (e.g., during night-time), irradiation causes both lights to appear to the observer (and the camera) to be of similar size and intensity. The light sources therefore appear to be of similar brightness and size even though, clearly, they are not.

Photograph 5: Incandescent (left) and LED (right) lights displaying Stop indications

Communications

2.19 After the NC became aware of the SPAD and continuing movement of 5424N, he first made a CountryNet call to WH191, but this was terminated by him before it could be answered. He then made a non-locomotive specific (broadcast) call over the CountryNet radio with the intention of warning the drivers of both trains. The NC had never used this function before and did not wait for the calls to connect; making his broadcast in the first nine seconds before the system connected the call to either train.
2.20 The driver of WH191, responding to the first CountryNet call, called the NC back. The NC answered immediately and a constructive conversation ensued during which it was established that WH191 was at a stand and also that 5424N appeared to have stopped as well.

2.21 The NC tried to contact 5424N over the WB radio. 5424N responded to it but the NC did not hear it, possibly because another driver transmitted concurrently via WB radio. That is an inherent disadvantage of open channel communications.

2.22 At no time did the NC attempt to make a direct call to 5424N via the CountryNet radio system.

2.23 The TTM had to contact PN at Parramatta to obtain a mobile telephone number for 5424N. PN initially provided the wrong number but the NC was able to speak to the driver of 5424N at 2237, nearly 10 minutes after the SPAD. A delay would not have been incurred if the NC had had the correct number immediately at hand.

**Operation of CountryNet Priority Call Function**

2.24 The CountryNet Radio System has an “emergency call” function which allows drivers to communicate with the NC. If an emergency call is activated, a red icon on the screen alerts the NC. Conversely, the NC may initiate a “priority call” (emergency call) to train(s) in their area of control. The NC can elect to make a priority call, that is a call that is ‘locomotive specific’ or ‘locomotive non-specific’ and intended for broadcast to all locomotives in an area.

2.25 A locomotive specific call, as the name suggests, is made to a specific identified locomotive. The NC presses the ‘priority’ icon followed by the locomotive icon of the train that he wants to call. To the train driver, the call is a ‘normal’ CountryNet call. However, in a priority locomotive specific call sequence, other locomotives within a 50 km radius are also called via a “conference bridge”. As per the ‘specified’ locomotive, the drivers hear a ‘normal’ CountryNet call but when they answer they will not be able to transmit but can hear the conversation between the specified locomotive driver and the NC. It can take up to a minute for the conference bridge to connect to the other locomotives in the section, but the NC has no indication of when, or if, the other locomotive drivers have been connected.
2.26 In a non-specific locomotive (broadcast) call, as made during this incident, the NC presses the ‘priority’ icon twice followed by the line or section where he wants to broadcast. In this case all locomotives in the area are connected via a “conference bridge” and when they answer the call they can hear the NC but cannot reply. The functionality is identical to that in a locomotive specific call with the NC having no indication as to when or if the drivers have answered the call or whether his message has been received by all or any of the drivers.

ICE Radio System

2.27 ARTC has been developing a National Train Communication System (NTCS) since 2000. The system selected is known as ICE which stands for ‘In Cab Equipment’. ICE is designed to replace the legacy regional communications systems currently used by ARTC across Australia.

2.28 ICE uses mobile telephone technology while using satellite communication in areas with no mobile telephone coverage and as back up in the event of a terrestrial system failure. The system interacts with the NC’s communications system display in the same manner as CountryNet, and as locomotives are fitted with the ICE system they can use them in place of CountryNet. They appear on the NC’s screen with an “i” after their designation to signify “ICE”.

2.29 The ICE system has a number of advantages over CountryNet. Generally, the lag currently experienced when making priority calls will no longer be incurred, except in locations where the terrestrial service is not available, a delay of up to 40 seconds could occur. In the event of a terrestrial system failure, a delay of up to 60 seconds could still be incurred. Priority calls will be identified as such to drivers with the system ‘self answering’, allowing the NC to broadcast the message over speakers in the cab. The message is also rebroadcast from the locomotive over the local VHF channel (‘WB’ in NSW).

2.30 It is proposed to have all locomotives accessing the ARTC system fitted with ICE by the end of 2013 after which CountryNet will be decommissioned.

Training of Network Controllers

2.31 Network controllers were given training in the use of CountryNet radios both off and on the job during initial training and also during scheduled ‘refresher’ training. However, the time delays (lags) inherent in the CountryNet radio’s “Priority Call” functions were not covered. Usage of the “Priority Call” function
is very low, with a straw poll of NCs carried out by ARTC management identifying only three out of 75 at NCCN who had ever made one. Since it is a rarely practiced activity, the provision of information and training is vital to maintaining current competency.

2.32 Since the incident, a seven page document entitled “Network Controller VCS Train Radio Emergency & Priority Call Operation” has been produced and distributed to NCs. Five scenarios are canvassed, each with a step-by-step description. One passage in each scenario reads “CountryNet Locos that are conferenced into the Emergency (or priority) call do so via a conference bridge unit which can take from approx 30 secs up to 1 minute to connect the call”. There was no formal presentation of this material, nor was there a ‘sign-off’ to confirm that the material had been received or understood.

Application of Rules and Procedures

2.33 When 5424N passed signal GH26 at stop and without authority (itself a breach of ANSG 606), rule ANSG 612 “Overrun of Limit of Authority” became relevant. A driver who becomes aware that the limit of authority has been overrun, such as the driver of 5424N, was required immediately to “stop their trains…and tell the Network Control Officer”. While he did stop his train, the driver did not contact the NC. The NC was aware of the SPAD and continuing movement of 5424N due to the sounding of a SPAD alarm and the Phoenix VDU indications. The NC’s responsibilities under ANSG 612 include “stop rail traffic that has overrun its limit of authority and not stopped” (5424N) and “stop and prevent other movements that are at risk” (WH191). The NC chose to make a non-specific locomotive priority call to stop the two trains involved. However, this call was ineffective for the reasons set out in paragraph 2.19.

2.34 The use of train headlights was governed by ARTC’s rule ANTR 406 Using train lights: “Trains must have a working headlight fitted to the leading locomotive, and travel with the headlight switched on, when the train is traveling (sic) in ARTC territory”. The rule prescribed situations where the headlights were to be switched off, such as “during approach to another train”. The driver of WH191 promptly complied with the requirement by turning his lights off as soon as he observed 5424N ahead. However, the crew of 5424N did not observe WH191 before its headlights were extinguished and WH191
did not flash its headlights to give a warning. The crew of 5424N remained unaware of the train’s presence until after the incident.

2.35 ANTR 406 has been changed to require headlights to be dimmed under prescribed circumstances, for instance when approaching another train. This change was in response to a recommendation made by OTSI as the result of an investigation into a double fatality at Singleton, NSW, on 16 July 2007.8

2.36 Although RailCorp and ARTC networks are connected and run parallel to one another in some locations,9 RailCorp has not adopted the new rule. Therefore, the situation will arise where headlights are required to be used, full or dimmed, on the ARTC tracks while being required to be turned off on RailCorp tracks. This situation exemplifies the consequences of inconsistency in the development and implementation of network rules by rail infrastructure owners. This may be contrary to Part 5, Section 31 of the *Rail Safety (General) Regulation 2008* and is an issue that has been raised in several recent OTSI rail safety investigation reports.

**Previous Incidents**

2.37 On 23 October 1997 there was a collision between two coal trains in the Hunter Valley of NSW. In this incident a loaded coal train collided with the rear of another, stationary, loaded coal train resulting in four people being injured, three seriously, and significant damage to rolling stock and railway infrastructure. The incident occurred when the train crew did not respond to a Caution then a Stop signal, only applying the train’s brakes when the rear of the stationary train was noticed ahead. The collision occurred 678 m beyond the signal at Stop and beyond the 445 m overlap provided. Section 3.2 of the report10 identified five “significant factors”, three of which have parallels with the Gunnedah incident:

- “The task of operating (the train)...was routine and relatively undemanding, conducive to also reducing the alertness of both driver and observer.

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9 For example, the ARTC controlled Sydney Metropolitan Freight Line runs parallel with RailCorp’s Bankstown line for some kilometres and the South Sydney Freight Line runs alongside the Main South Line.

• The safe progress of the train relied on a system intolerant of human error, depending entirely on the crew observing and responding to track signal indications.

• Defences to protect the train from human error had not been established or were inadequate.”

2.38 On 3 February 2012 at Bletchley in the UK, a locomotive derailed after the driver did not respond correctly to a turnout signal indication. An investigation\textsuperscript{11} conducted by the Rail Accident Investigation Branch (RAIB) concluded “that the driver’s belief that he was continuing on the up slow line overcame the fact that the ‘F’ indication (the turnout indication) was clearly visible to him”. This incident has parallels with the Gunnedah incident in that both incidents involved the driver failing to be cognisant of a recognisable signal indication that was displayed in clear view.

Health Standards

2.39 The second person’s recommended job modification of driving “only on the Pacific National system” is effectively meaningless given that PN operates throughout the country and does not have its own rail ‘system’.

2.40 Updated health standards came into effect on 20 January 2013. They are the National Standard for Health Assessment of Rail Safety Workers October 2012. Section 19.2.2 Colour vision risk assessment for Safety Critical Workers reads:

“Train drivers must be able to recognise colour signals. Position cues are not always available because red/green lights often operate from a single lens signal; lights from a signal may have no background or illumination at night to help their identification; there may be dazzle from a low sun behind the signal; and red lights may be shone from a lantern in emergency situations, requiring rapid reaction. Combinations of red/yellow/green signals are used to inform the train driver of a safe speed and routing.”

2.41 Workers, such as train crew, who fail a colour vision screening:

“may be further tested with a lantern test, preferably the Railway LED Lantern Test” (Section 19.2.3 General assessment and management guidelines) “The RailCorp Lantern is a simulation of modern LED railway signals that permits people with a colour vision deficiency to be tested in a consistent manner on a simulation of the actual lights they are required to identify in the workplace”.

This provision removes the option, contained in the previous Standard, for a ‘field test’ as taken by the second person of 5424N.

**Running Brake Test**

2.42 PN has a requirement for a Running Brake Test: “It is Pacific National Policy to carry out a running brake test as soon as possible after departing the originating location or at a crew changeover to test and get a feel of the braking condition of the train.” A running brake test was not carried out during the passage of 5424N from Narrabri to Gunnedah.
PART 3 FINDINGS

Causation

3.1 The SPAD and opposing movement resulted from train 5424N being driven through signal GH26 at Stop without authority then proceeding to trail through 55A points. This brought the train into a conflicting movement with train WH191 approaching with authority from the opposite direction on the single line.

Contributing Factors

3.2 When viewed from a distance, signal GH22 appears directly above signal GH26. The main head and marker lights of each signal merge to appear to be one light. This produces the effect that signals GH26 and GH22 look like one signal (main head and marker) as two red lights can be observed one almost above the other, even though they are two separate signals 2.1 km apart. The driver is likely to have observed the two signals as being one and formed the opinion that the signal was GH22 where, from past experience, he might expect to have to stop.

3.3 It is likely that the visual distortion was caused by the design of the signal lights that now use LED technology which, in low ambient light, make the smaller marker light appear to be of similar size and intensity to the larger main head. The two separate signals appeared to the driver to be one and, despite the calls from the second person, influenced the driver’s mental model of where he was authorised to proceed. Notably, this is the first reported incident of its type since the installation of the LED lights at these signal locations in late 2010.

3.4 The second person was under training and was relatively inexperienced; an authority gradient existed between him and the driver. This contributed to the second person not taking more positive action when the driver of 5424N did not comply with PN’s procedure requiring him to reduce speed to 15 km/h 200 m from the signal and stop 50 m before it.

3.5 On becoming aware of the SPAD, the NC did not attempt to contact 5424N directly via CountryNet, instead first trying to contact WH191 then making a ‘broadcast call’, neither of which was successful.
3.6 Defence against human error at the site relied entirely on the crew of 5424N observing and obeying the indication of colour light signals. Installation of an automatic train management system on the network will provide additional defences in the future.

Other Safety Matters

3.7 The NC did not know how to make an effective CountryNet ‘priority’ call. ARTC responded to this general lack of knowledge by producing a reference document for Network Control staff. However, its distribution was not accompanied by any formal presentation or assurance activity to determine if the safety message had been understood by staff. [Recommendation 4.1]

3.8 The CountryNet system has connection lags which delay connection to locomotives. This characteristic will be eliminated in most cases when CountryNet is replaced by the In Cab Equipment radio system.

3.9 Updated health standards which came into effect on 20 January 2013 provide for a more rigorous colour vision test than the one used to assess the second person and which resulted in a meaningless job modification recommendation. [Recommendation 4.2]
PART 4 RECOMMENDATIONS

No recommendations are made in relation to the key safety issues identified during the investigation as appropriate remedial actions have been taken, or are in train, to minimise the potential for this type of incident to recur. These actions are:

- the recertification of the drivers of 5424N
- the issue of CountryNet reference material to network controllers
- the upgrading of CountryNet training material
- the replacement of the CountryNet radio system
- the installation of an automatic train management system.

However, it is recommended that the following actions be undertaken by:

**Australian Rail Track Corporation**

4.1 Undertake an evaluation of the effectiveness of action taken to improve network controllers’ knowledge, understanding and practical handling of the operational characteristics of the CountryNet radio system in an emergency situation.

**Pacific National**

4.2 Establish the second person’s colour perception status by having him undergo the RailCorp Lantern test in accordance with the National Standard for Health Assessment of Rail Safety Workers October 2012.
PART 5  APPENDICES

Appendix 1: Sources and Submissions

Sources of Information

- ARTC
- Asciano (Pacific National)

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:

- Asciano
- ARTC
- Drivers of train 5424N
- Independent Transport Safety Regulator

Submissions were received from:

- Asciano
- ARTC
- A member of the crew of train 5424N
- Independent Transport Safety Regulator

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.