Australian Government
Australian Transport Safety Bureau

Collision between train BC151 and an excavator

near Maitland, NSW | 20 December 2011

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2011-018
Final – 27 March 2013

Australian Government

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ATSB TRANSPORT SAFETY REPORT

Rail Occurrence Investigation

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Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

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SAFETY SUMMARY

What happened

At 0743 on 20 December 2011, an empty coal train collided with an excavator that was being used for scheduled maintenance of rail lines near the High Street Station at Maitland, NSW.

The excavator suffered extensive damage while the lead locomotive suffered minor damage and was able to continue on its journey after a crew change. Neither the train drivers nor the track workers were injured in the collision.

What the ATSB found

The ATSB found that the collision occurred despite the fact that the maintenance work being undertaken had been authorised and that safety measures designed to exclude rail traffic from the worksite had been put in place.

The ATSB further found that the network control officer did not confirm the location of the worksite before authorising access to the track for maintenance purposes, there were communication protocol omissions between network control and the worksite protection officer and a lack of coordination between interfacing network control officers.

What has been done as a result

The track manager has advised that it is reviewing the safe working rules and will include the issues identified by the ATSB in that review.

Safety message

The incident highlights the importance of ensuring the exact location of a given worksite is clearly understood by all concerned in providing protection and that communications between network control officers and worksite staff is effective.

CONTENTS

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THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: the ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

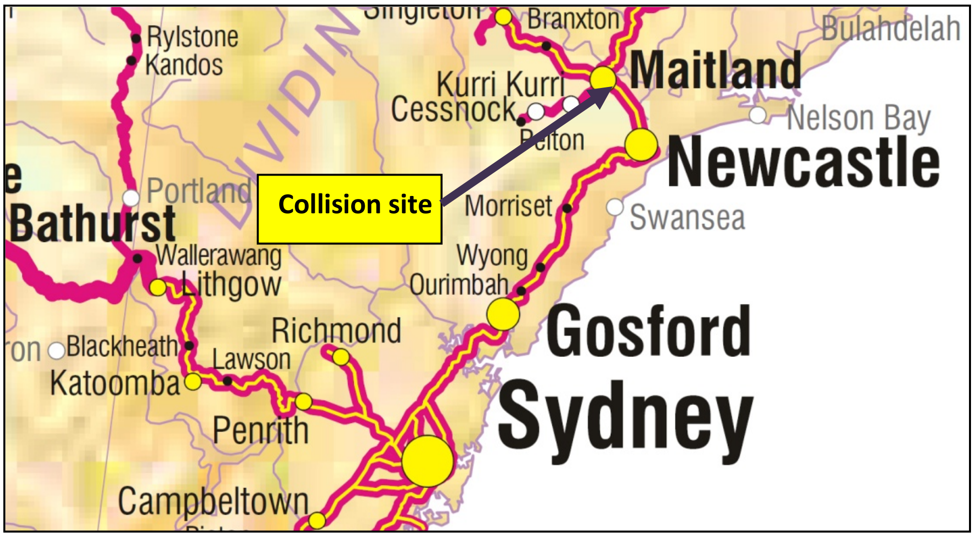
Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

1 FACTUAL INFORMATION

1.1 Location

At 0743[1] on 20 December 2011, empty coal train BC151 collided with a road/rail excavator near Maitland, NSW, at the 191.200 km point[2] on the rail corridor between Islington Junction and Maitland (Figure 1). The weather at the time was fine, dry and clear.

Figure 1: Location of Maitland



Source: NatMap, Railways of Australia, Geoscience Australia

The worksite was located on the Up Coal Road beneath the High Street overbridge (Figure 2) between the 191.100 and 191.200 km marks on a curve that had a radius of about 970 m. The rail corridor at this location consisted of four tracks; the Up and Down[3] Main Lines and the Up and Down Coal Roads. The traffic on the two main lines generally consisted of passenger and freight trains while traffic on the coal roads generally consisted of loaded and empty coal trains. All four lines were uni-directional[4]. The up lines carried 'southbound' traffic and down lines carried 'northbound' rail traffic.

The maximum speed of trains on the Up and Down Coal Roads was 100 km/h. However, at the time of the collision, there was a temporary 60 km/h speed restriction on the Down Coal Road just beyond the worksite. This meant that the speed of trains travelling on the Down Coal Road should have been in the vicinity of 60 km/h in anticipation of this speed restriction

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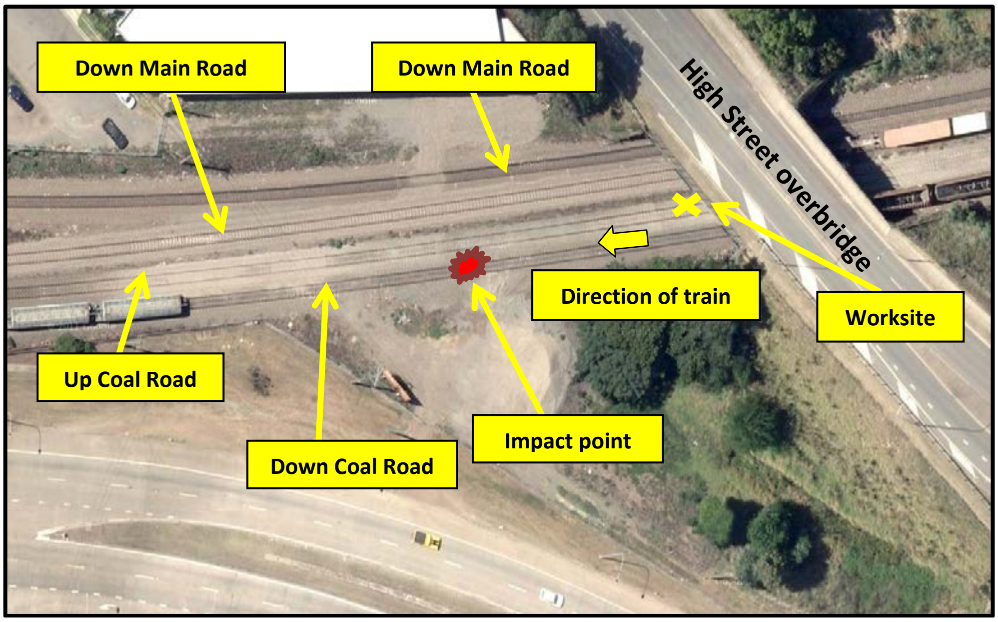
1 All time references in this report are in Eastern Daylight-saving time (EDT).

2 Distance in kilometres from a track reference point at Sydney Central Station.

3 'Up' refers to trains running to Islington Junction; 'Down' refers to trains running from Islington Junction.

4 Allowing for normal travel in one direction according to the infrastructure and system of safeworking in use.

Figure 2: Worksite location overview



Source: Google Maps annotated by ATSB

1.2 Rail corridor management

1.2.1 Track and train control overview

The rail corridor between Islington Junction and Maitland was owned by the NSW State Government statutory corporation Country Rail Infrastructure Authority[5] and managed and maintained by the Australian Rail Track Corporation (ARTC) under a lease agreement with the NSW State Government.

Responsibility for the day to day operational management of the rail corridor in the greater Newcastle, Maitland and Hunter Valley area is vested in the ARTC Network Control Centre at Broadmeadow. Network control officers at this facility are stationed at control boards which are allocated on a geographical basis taking into account distances and traffic density.

The primary responsibility of a network control officer is to manage the allotted rail corridor to facilitate the safe and efficient transit of rail traffic. In fulfilling this role a network control officer must set, plan and prepare routes while prioritising and managing trains. This also includes the issuing of track authorities for contingency measures in times of incidents or out of course train running. These tasks often involve regular and direct communication with operators, maintenance personnel and external services.

The ARTC network control officers perform the role of train controller and signaller, as outlined in the ARTC network rules and procedures.

Train movements on the rail corridor between Islington Junction and Maitland are controlled by a fixed signalling system which detects the presence of rail vehicles.

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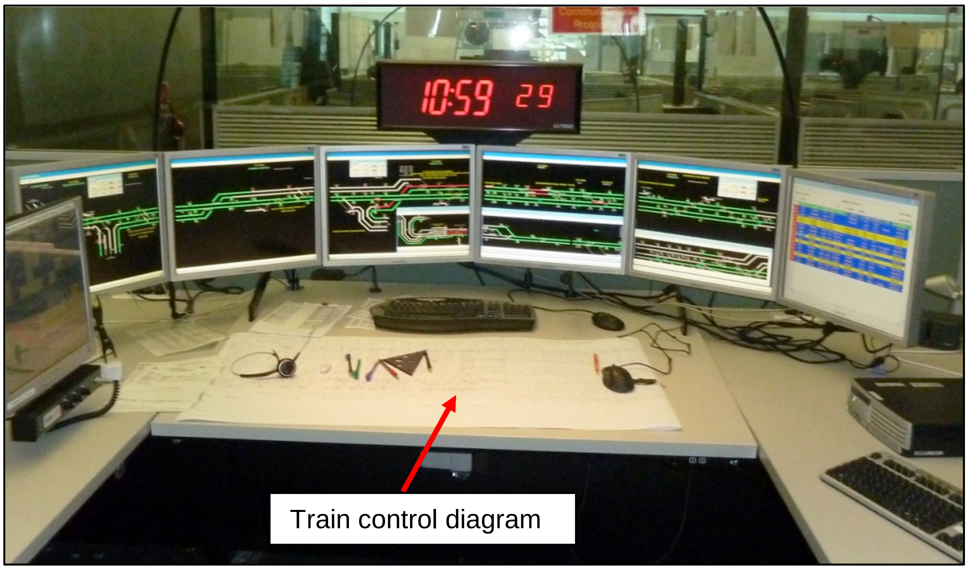
5 From 1 July 2012 the Country Rail Infrastructure Authority was absorbed into Transport for NSW.

The signalling system is known as Rail Vehicle Detection (RVD) and uses the Phoenix control system. This system allows the network control officers to monitor and control the field hardware, such as signals and route setting. The Phoenix control system is a non-vital[6] Centralised Traffic Control (CTC)[7] system that provides real time monitoring and control of field hardware including signals, points, track circuits and the associated management of train movements.

There are two key components at a network control officer's workstation in RVD territory (Figure 3) that enable them to perform their role: electronic displays and hard copy train control diagram.

Figure 3: Network Control board, VDU screens and train control diagram



Source: ATSB

The electronic displays mimic the status of track circuits, signals and turnouts in the field. This allows the network control officer to monitor events in real time and to make decisions, such as changing a route, to facilitate train running.

The train control diagram is a key component of a train controller's task in terms of planning train running and track maintenance tasks. A train control diagram is a distance and time graph which depicts train running. Distance and locations are located on the y-axis and time is located on the x-axis. The scheduled paths of trains are recorded in permanent form and the actual running of the train is recorded in unbroken pencil line by the network control officer. Pencil is used because frequent variations to train running, both forecast and actual, often make it necessary for the train controller to erase and re-draw train running.

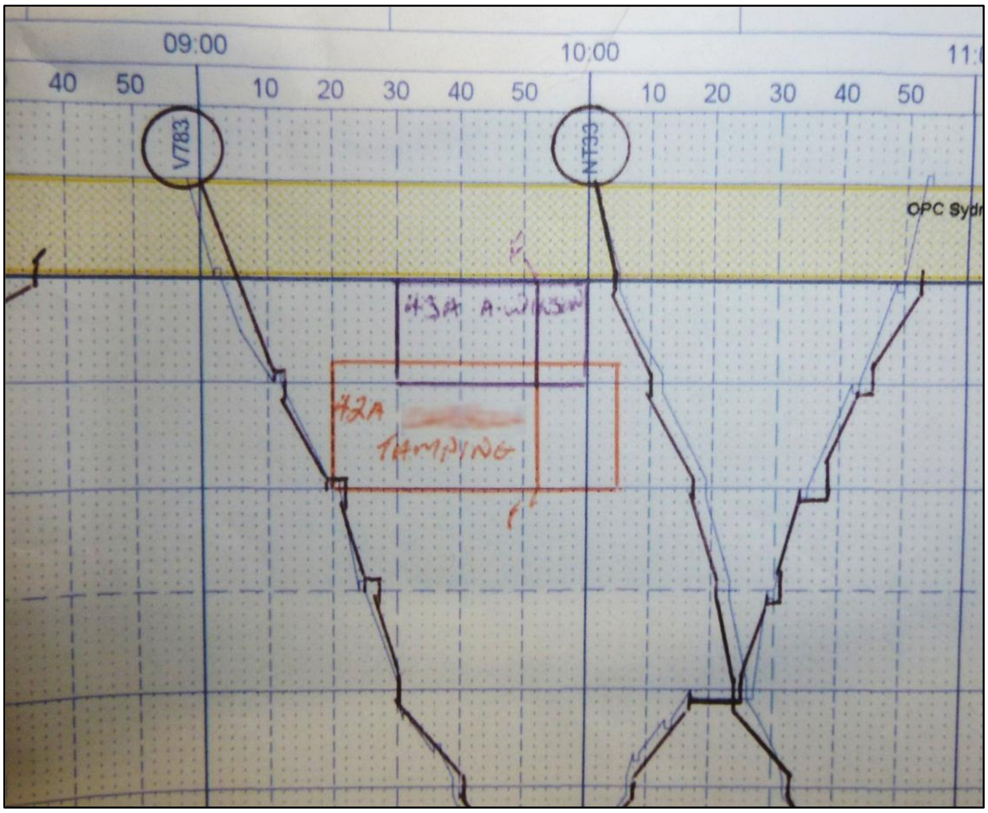
If a network control officer authorises access to the track, the section of track involved would be delineated against the 'y' axis and the start and finish time on the

6 Signalling equipment and circuits are considered non-vital where failure to function correctly would not cause an unsafe outcome of the signalling system. Non-vital equipment and circuits do not affect the safe operation of the signalling system.

7 A safe working system of remotely controlling points and signals at a number of locations from a centralised control room.

‘x’ axis. When providing a track authority the network control officer draws a box on the graph at the intersection of the location and allotted time point. This box is delineated using red pen to clearly display that any line indicating a train path which crosses the borders of the box is in conflict with the issued authority (Figure 4).

Figure 4: Example of a track work authority ‘boxed’ on a train control diagram



Source: ATSB

1.2.2 Train control board interface

The rail corridor between Islington Junction and Maitland is controlled by two network control officers. The Lower Hunter Network Control Officer controls rail traffic from Islington Junction to the southern boundaries of Thornton. The Middle Hunter Network Control Officer controls rail traffic at Thornton Junction.

1.2.3 Network Control Officers

The Middle Hunter Network Control Officer had worked in the rail industry for about 35 years. Prior to starting work at the Broadmeadow Train Control Centre in 2000, he had been a signaller at various signal boxes in the Sydney and North Coast area. In 2006, he was appointed as a network control officer with the ARTC at the Broadmeadow Train Control Centre and was qualified on six of the train control boards.

The Lower Hunter Network Control Officer had worked in the rail industry for over 30 years. During this time he had been a station assistant, signaller and terminal coordinator. Since 2007, he had worked as a network control officer within the ARTC Broadmeadow Train Control Centre. He qualified on the Lower Hunter train control board in July 2007 and was qualified to operate on seven train control boards at the centre.

1.2.4 Track gang

The track gang consisted of eight persons: a Site Supervisor, a Protection Officer, five track workers and a contracted excavator operator. Apart from the excavator operator, all were employees of the ARTC and were based at the ARTC Maitland maintenance depot where they had signed on at 0600.

The Protection Officer had about 15 years of experience in rail maintenance work and for the last 5 years had been based at the ARTC Maitland infrastructure depot. He had experience in the operation of heavy plant and machinery and qualified as a protection officer about 3 ½ years before the incident. His qualifications were current and he was fit for duty at the time of the incident.

The Site Supervisor had been based at the ARTC Maitland infrastructure depot for 10 years performing rail maintenance. He qualified as a work group leader (site supervisor) about 4 years before the incident and his qualifications were current.

1.2.5 Train and crew details

Train BC151 was owned by Xstrata Coal[8] and operated by Freightliner Australia. The train was being hauled by three C44aci 3,370 kW locomotives. It was 1,478 m long, weighed just under 2,000 t and was travelling empty from the port of Newcastle in a generally north-westerly direction to the coal mine siding at Bulga.

The train was equipped with Electronically Controlled Pneumatic (ECP) brakes. Brake application and release on trains equipped with ECP brakes is controlled by broadcast data signals sent from the control unit on board the lead locomotive to a receiver unit on each wagon, allowing all wagons to receive the ECP signal simultaneously. This system provides uniform braking in terms of application and release regardless of train length.

The train was crewed by a driver and a trainee driver. The driver had worked in rail operations since 1977 and had driven trains since 1986. The trainee was nearing the end of the practical train handling component of driver training and, at the time of the collision, was driving under the supervision of the driver.

The qualifications of the driver and trainee were current at the time of the occurrence.

1.3 The occurrence

On 20 December 2011, scheduled maintenance work was to be undertaken to tamp a short section of track on the Up Coal Road in the immediate vicinity of the High

8 Xstrata are the operators of the Bulga Coal Mine. Xstrata manage the mine on behalf of the Bulga Coal shareholders.

Street overbridge. The equipment needed to complete this task included hand operated tools such as jacks, shovels and bars and an excavator that was fitted with a tamping head and capable of being mounted on rail. The excavator was a Yanmar model V1055-5 that weighed over 5 t.

In order to perform this work, it was planned to have the excavator access the rail corridor via the nearby track access road, cross over the Down Coal Road, 'on-rail' on the Up Coal Road and then drive the short distance along the rail to the area of track in need of repair. The excavator would then be used to lift and line the track while the track workers assisted with hand tools.

Before accessing the site, the Protection Officer compiled a worksite protection plan in accordance with ARTC procedures. In compiling the protection plan, he concluded that the appropriate worksite safety protection method for the planned work would be a Track Occupancy Authority (TOA) applicable to the Up Coal Road and, in order for the excavator to cross the Down Coal Road, a Controlled Signal Block (CSB) was required on the last controlled signal TN17 at Thornton Junction.

The Protection Officer then conducted a pre-work briefing with the track workers and excavator operator in which emphasis was placed on the hazards associated with the excavator's boom swing zone, the fact that adjacent lines would still be 'live', uneven ground and the use of mobile phones. The briefing was recorded as being conducted at 0715 and all eight members of the work gang signed the pre-work brief form.

At about 0700, the Protection Officer contacted the Middle Hunter Network Control Officer to advise of the intended work and to ascertain when access to the track might be granted. The Middle Hunter Network Control Officer advised the Protection Officer that there were two trains in the section between Maitland and Thornton on the Up Coal Road and both were clear of the intended worksite.

The second of these trains (BO150) was stationary in the section and past the area of the intended worksite. To facilitate access for the track gang under these circumstances, the Middle Hunter Network Control Officer issued a TOA for joint occupancy following a train [9] on the Up Coal Road and, as such, the Middle Hunter Network Control Officer requested that the Protection Officer provide him with the lead locomotive number of train BO150.

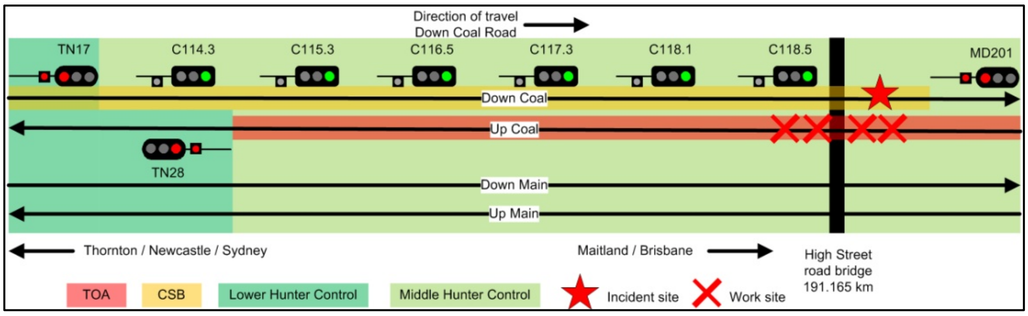
The Middle Hunter Network Control Officer and Protection Officer agreed that the worksite supervisor would drive his vehicle to the leading end of the stationary train and advise the Protection Officer of the locomotive number. When this was done, the Protection Officer contacted the Middle Hunter Network Control Officer and advised that locomotive 8217 was the leading locomotive of train BO150.

The Middle Hunter Network Control Officer confirmed that this was correct and then issued a TOA which excluded rail traffic from the worksite on the Up Coal

[9] When a TOA is issued as a joint occupancy after/following a train, the Network Control Officer has to ensure that the train has passed beyond the proposed worksite. In such a situation, the PO has to watch the train pass the worksite and tell the Network Control Officer the identification number of the lead locomotive.

Road for the period 0727 until 0800 by placing a block[10] on controlled signal[11] MD220[12] located at Maitland and TN28 at Thornton Junction.

Figure 5: Diagram of network control responsibility versus authorities



Not to scale and some details omitted

The Middle Hunter Network Control Officer advised the Protection Officer that a train was about to go past the worksite on the Down Coal Road. The Protection Officer informed the Middle Hunter Network Control Officer that he would obtain the lead locomotive number of that train to give it to the Lower Hunter Network Control Officer as he required a CSB on signal TN17 (Figure 5) on the Down Coal Road in order to get an excavator across the Down Coal Road to access the worksite on the Up Coal Road.

Although the worksite location was in the Middle Hunter's controlled area, the signal (TN17) controlling entry into the section was operated by the Lower Hunter and as such he would need to speak to the Lower Hunter to get a CSB.

Just before 0739, the Protection Officer contacted the Lower Hunter Network Control Officer and said 'I need to get a CSB on TN17 at Thornton please'. The Lower Hunter Network Control Officer then asked why the CSB was needed. The Protection Officer replied 'we need to get an excavator from the down side over to the up side here at the 191.100 km mark to do some tamping and we need a CSB on the down to get him across'. The Lower Hunter Network Control Officer then asked about protection on the Up Coal Road. The Protection Officer advised that there was a block on the Up Coal Road. The Protection Officer then advised the Lower Hunter Network Control Officer that the number of the lead locomotive of train LD149 was 9024 and that it had passed their worksite on the Down Coal Road. The CSB was issued at 0740 for an indefinite period as the Lower Hunter Network Control Officer believed that there were no other approaching trains at that time. The Protection Officer confirmed the details of the CSB with the Network Control Officer by reading back the details of the CSB.

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10 A means to prevent clearance of a signal when it is desired to inhibit entry of a train movement into the section governed by the signal.

11 As the name implies, controlled signals can be operated by the Network Control Officer or signaller. Automatic signals operate automatically according to the status of the track section occupancy detection.

12 The Middle Hunter Network Control Officer placed a block on a signal MD220 to ensure it displayed a Stop (red) aspect. MD220 was the last controlled signal before the worksite.

The track gang then entered the rail corridor and the Site Supervisor walked ahead to the area of work below the High Street overbridge. At the same time, the excavator operator drove the machine to the Down Coal Road and started to cross over that track.

A number of the track workers then saw a down (northbound) train coming towards them. Initially they thought that it was on the Down Main Line as their expectation was that there would be no trains on the Down Coal Road due to the CSB. However, they soon realised the train was coming towards them on the Down Coal Road. They quickly alerted each other and the excavator operator to the clear track.

The excavator operator, who now had the excavator straddled across the Down Coal Road, swung the boom around and started to manoeuvre the excavator off the track. However, he realised he would not be able to get the machine clear before the train arrived, so he vacated the cabin exiting towards the outer perimeter of the rail corridor.

Due to the curvature of the track, the High Street overbridge and the works being located in the vicinity of the bridge, the ability of the train crew on BC151 to clearly see the worksite on the approach was somewhat limited (Figure 6).

Figure 6: Visibility from the worksite, beneath High Street Bridge

Source: Australian Rail Track Corporation

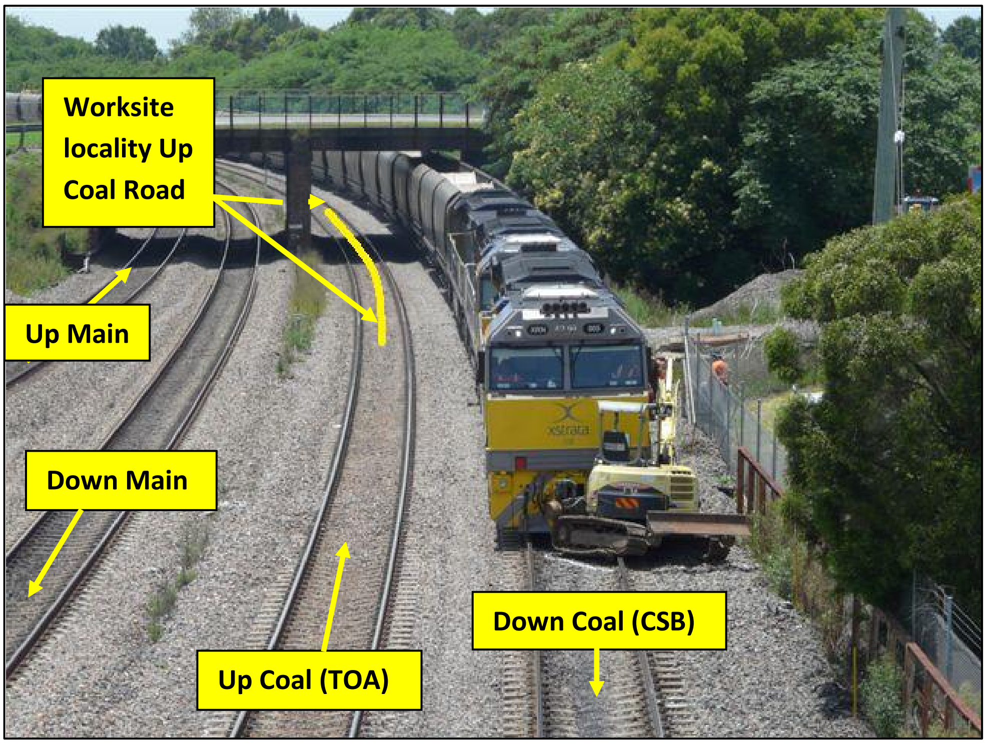
As the train approached the High Street overbridge, the drivers saw someone in an orange vest that appeared to be facing the other way. The locomotive horn was sounded for a short duration (a routine action when someone is observed on or near the track) and the drivers waited for a ‘clearance’ signal (a raised arm) to indicate all was well. The drivers then recognised that the person in the orange vest was waving people to get off the track, so they made a ‘minimum’ application to the train brakes. Moments after this brake application, the drivers sighted the excavator on the track beyond the bridge and increased the train brake application to an ‘emergency application’. The two drivers then vacated their seats and sought refuge in the vestibule behind the driver’s cabin. Moments later, the train collided with the excavator pushing it down the track a short distance (Figure 7).

The excavator was extensively damaged in the collision and there was minor damage to the lead locomotive. However, the train was able to resume its journey after a routine change of the crew had been carried out.

The train drivers were not injured and the track workers and the excavator operator were able to vacate the area of impact without injury.

The train driver radioed the Middle Hunter Network Control Officer to advise of the collision. In the meantime, the Protection Officer called the Lower Hunter Network Control Officer with the details of what had occurred.

Figure 7: Collision aftermath



Source: Australian Rail Track Corporation

2 ANALYSIS

2.1 Evidence

Investigators from the Australian Transport Safety Bureau (ATSB) sourced a variety of evidence from the Australian Rail Track Corporation (ARTC) and interviewed a number of persons directly involved in the collision.

The lead locomotive was fitted with a fixed forward facing camera. The footage from this camera was also acquired and analysed as part of the investigation.

The following analysis examines whether the methods aimed at excluding rail traffic from the worksite was appropriate, regarding the interface arrangements when more than one network control board is involved in excluding rail traffic from a worksite and the actions of the network control officer.

2.2 Sequence of events analysis

2.2.1 Locomotive data

A review of the locomotive data and footage from the camera showed that, after passing signal TN17 at proceed (green), the driver vigilance acknowledgement was operated at regular intervals, the maximum speed attained by the train was 67 km/h and throttle movements were uniform in maintaining a consistent speed in this range. Given that signal TN17 and the following six automatic signals were displaying a proceed (green) aspect, this data is consistent with good train handling practices.

Figure 8: View from the locomotive, as the emergency brake was applied

Source: Freightliner

The first recorded indication of diversion from routine train handling was when the horn of the lead locomotive was sounded for 1.5 seconds. The data shows that this took place 377 m and 24 seconds prior to impact. About 6 seconds later, and 270 m prior to impact, a minimum reduction brake application was made followed 8 seconds later by an emergency brake application. At the time of the emergency brake application, the train's speed was 61 km/h and the leading locomotive was 130 m from impact (Figure 8).

Figure 9: View from the locomotive just before impact

Source: Freightliner

At the time of impact, the train's speed was 42 km/h. The train stopped 59 m beyond the point where it collided with the excavator.

Allowing for the visual obstruction of the High Street overbridge and the lack of a clear stop signal from persons at the worksite, the drivers' response was consistent with the expected response to an emergency situation.

Train braking performance

Train BC151, which was equipped with ECP brakes, was running empty, weighed about 2,000 t and was 1,478.2 m long.

When the emergency brake application was made, train BC151 was travelling at a speed of 61km/h on a slightly falling grade of between 1:1040 and 1:273. The train then stopped in 189 m and 20 seconds. The deceleration rate of 0.8 m/s^2, due to the application of the brakes uniformly throughout the consist, was significantly better than that of a similar train fitted with conventional pneumatic braking.

2.3 Rules and procedures

2.3.1 Work on track

The safeworking rules for the ARTC rail network in NSW are distributed over a number of documents. In this case, the relevant rules and procedures are those relating to 'work on track'.

The ARTC document ANWT-300 *Planning work in the rail corridor* prescribes the rules for planning work within the rail corridor and assessing the work for safety. The rules state that a worksite must have a protection officer and work in the danger zone[13] must not begin until the protection officer has put the required safety measures in place. The rule specifies that there are five methods that may be used when conducting work in the danger zone. The following is an overview of those methods:

- Local Possession Authority (LPA), where a defined portion of track is closed to all rail traffic for a specified period.
- Track Occupancy Authority (TOA), where a specified portion of track may be occupied for an agreed period. A TOA gives exclusive occupancy, but may permit joint occupancy under some conditions.
- Track Work Authority (TWA), where a defined portion of track may be occupied between train movements. A TWA does not give exclusive occupancy.
- Controlled Signal Blocking (CSB), where signals are used to exclude rail traffic from a portion of track, usually for minor work that requires only hand tools or for the purpose of crossing the track.
- Lookout Working, where only light, non-powered hand tools are used and workers are able to remove themselves from the track to a safe place immediately if rail traffic approaches. Lookout Working is used in daylight hours only.

ANWT-300 *Planning work in the rail corridor* also notes that each method of work has mandatory minimum safety measures and states that work in the danger zone must not begin before the required safety measures are in place.

2.3.2 Exclusion of rail traffic

A protection officer's primary duty is to keep the worksite and workers safe. Before the danger zone is accessed, the protection officer must conduct a safety assessment, develop a worksite protection plan and conduct a pre-work briefing with all workers, emphasising the hazards identified in the safety assessment.

In this instance, the safety assessment conducted by the Protection Officer identified that a TOA would be used to protect the worksite by excluding all rail traffic on the Up Coal Road for the duration of the work and a CSB would be used

[13] The danger zone is everywhere within 3 m horizontally from the nearest rail and any distance above or below this 3 m, unless a safe place exists or has been created.

to exclude all rail traffic on the Down Coal Road for the time needed for the excavator to cross the Down Coal Road.

Given that the worksite was fixed and that the last controlled signal was more than 500 m away, the rules and procedures required protection in the form of red flags and detonators on the Up Coal Road at least 500 m from the boundary of the worksite. In this instance, the worksite protection plan included the placement of detonators and red flags 928 m on the southern side and 740 m on the northern side of the worksite. Because the adjacent Up and Down Main Lines and the Down Coal Road would still be carrying rail traffic (the latter, after the CSB had been fulfilled), the Protection Officer assigned two members of the track gang the role of lookout, one each side of the worksite. This was a safety measure identified during the safety assessment process and was aimed at reducing the risk to track workers from rail traffic on these lines.[14]

The TOA applicable to the Up Coal Road, and the CSB applicable to the Down Coal Road, were the correct measures in accordance with the rules and procedures to exclude trains from, and protect, the worksite. In addition, the safety assessment, pre-work briefing and implementation processes conducted by the Protection Officer were in accordance with the rules and procedures for protection of worksites.

2.4 Issue of work on track authorities

2.4.1 Issue of the TOA by Middle Hunter Control

The Middle Hunter train control board Phoenix media file replay indicates that during the TOA authorisation process, a block was placed on signal MD220 at 0728:20, thereby excluding rail traffic on the Up Coal Road beyond that signal. Signal MD220 was at the 192.464 km mark, 1.364 km from the worksite.

A review of the verbal communication logs between the Middle Hunter Network Control Officer and the Protection Officer indicates that the authorisation and issue of the TOA at 0727 was without incident and in accordance with the pertinent rules and procedures.

2.4.2 Issue of the CSB by Lower Hunter Control

The Lower Hunter train control board Phoenix media file replay indicates that during the CSB authorisation process, a block was placed on signal TN17 at 0740:10, preventing rail traffic on the Down Coal Road from proceeding beyond this signal. Signal TN17 was at the 183.239 km mark, 7.861 km from the worksite. However, empty coal train BC151 had already passed the signal at proceed (green) at 0736:38, 3 minutes and 32 seconds before the block was put in place.

An ATSB review of the verbal communication logs between the Lower Hunter Network Control Officer and the Protection Officer, and interviews with both the

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[14] A flagman is also mandated by rule ANWT308 when only one controlled signal can be set at Stop for the purpose of protecting work undertaken with CSB, as in this situation.

Lower and Middle Hunter Network Control Officers identified a number of factors which may have contributed to this situation.

The telephone conversation between the Lower Hunter Network Control Officer and the Protection Officer was not consistent with the requirements outlined in rule ANGE 240 *Network Communications* or procedure ANPR 721 *Spoken and Written Communication.* It was characterised by open-ended responses from the Lower Hunter Network Control Officer and periods of silence, one of which was 28 seconds duration. Safety critical information given by the Protection Officer such as worksite location (by actual kilometre mark), locomotive identification number and his phone number was not confirmed or read-back by the Lower Hunter Network Control Officer. Additionally, the Lower Hunter Network Control Officer was about to terminate the conversation without confirming the details of the CSB until the Protection Officer interposed and repeated the details of the CSB.

In May 2010, the Independent Transport Safety and Reliability Regulator issued a Rail Industry Safety Notice 30 (RISN 30) as a result of the fatality of a track worker at Kogarah to remind all railway operators '…that the Signaller and the Protection Officer must share communication to confirm that the correct signal(s) have been placed to stop with blocking facilities applied *and* that there is no rail traffic between the protecting signal(s) and the worksite.'

The procedure for issuing a CSB, ANPR 703 *Working using controlled signal blocking*, specifies the actions to be taken. The procedure stipulates that the Protection Officer must contact the signaller controlling the signal used to exclude rail traffic, to request the CSB. The signaller then checks that the line is clear between the signal and proposed worksite location, speaks to the train controller about the request for CSB, then sets the protecting signals to stop and applies blocking facilities.

In this instance, the Protection Officer did not explicitly ask the Network Control Officer whether the signals were at stop with blocking facilities applied or whether there was any rail traffic in the area between the controlled signals and workers as required under ANPR 703[15]. Although the Protection Officer did not strictly comply with the procedure, once the CSB was issued, he probably had no reason to believe that the section between the protecting signal and the workers was not clear.

The Lower Hunter Network Control Officer received the request for the CSB in his role as signaller controlling signal TN17. However, he was not the train controller responsible for the area in which the worksite was located and he did not contact the Middle Hunter Network Control Officer, the train controller responsible for that area. Although the Network Control Officer position combines the roles of signaller and train controller, the procedure for issuing a CSB explicitly separates these two roles.

At interview, the Lower Hunter Network Control Officer stated that he did not cross reference the worksite location kilometre mark provided by the Protection Officer with the train control diagram. As a result, he erroneously perceived the worksite to be in the vicinity of Thornton, near signal TN17. Further, the Protection Officer had

[15] ANPR703 states before any work begins the protection officer must confirm with the signaller that there is no rail traffic in the area between the controlled signals being used for the protection and the workers.

advised of the lead locomotive number of train LD149 while the Lower Hunter Network Control Officer was watching train BC151 progress through the automatic signals on the Middle Hunter overview screen at his workstation. The Lower Hunter Network Control Officer said that he did not cross reference the locomotive number, and assumed that the Protection Officer was referring to the train he was watching (BC151). This further error confirmed the Lower Hunter Network Control Officer's misperception that the worksite was in the vicinity of Thornton rather than near Maitland.

2.4.3 Potential influences on the actions of the Lower Hunter Network Control Officer

Fatigue

The Lower Hunter Network Control Officer had worked between the hours of 0700 and 1500 the previous day and was rostered on the same hours on the day of the incident. He was into his first hour of his shift when the incident occurred.

When interviewed, he advised that he was not taking any medication at the time of, or in the period leading up to, the incident and that his quality of sleep whilst on day shifts was less than optimal. However, there was no compelling evidence to indicate that his performance on the day of the collision was impaired by fatigue.

Workload

The role of a network control officer consists of a number of complex and dynamic planning tasks combined with a very high volume of interpersonal communications with train operators and track maintenance staff. Interviews with network control officers indicated that during a normal eight hour day shift, a network control officer would expect to take some 300 to 400 telephone calls, of between 30 seconds and 10 minutes duration.

Managing large volumes of information (much of it safety critical) requires considerable attention resources from the network control officer, such that quality of communications becomes of paramount importance in preventing error from resulting in an accident. One way of increasing the quality of communication is to use standardised communication protocols, whereby standard words are used and critical information is confirmed via read-back. This method assists in ensuring that each party to the communication has the same understanding of the situation. The requirement on Spoken and Written Communications in the ARTC network is provided for in the ANGE 204 *Network Communications* rules.

Whilst the ARTC rules and procedures governing the issue of CSB require the protection officer to provide the key information to the network control officer, there is currently no requirement for standardised confirmation by read-back on the part of the network control officer, as there is for a higher levels of track authority.

2.5 Train control board interfaces

2.5.1 Overview

The boundary between the Middle and Lower Hunter train control boards on the Down Coal Road is just beyond signal TN17 at Thornton. The signal is controlled by the Lower Hunter Network Control Officer. The next controlled signal on the Down Coal Road is signal MD201 at High Street (just before Maitland) which is controlled by the Middle Hunter Network Control Officer.

The distance between these two controlled signals, TN17 and MD201 is about 8 km and the passage of trains on this section of the Down Coal Road is controlled by six automatic signals which operate according to the status of the Rail Vehicle Detection (RVD) equipment. A network control officer does not have any control of these automatic signals. The first signal he is able to control after these six automatic signals is MD201 (Figure 5).

Although rail traffic at the worksite location was controlled by the Middle Hunter Network Control Officer, he was unable to issue the CSB on the Down Coal Road, due to signal TN17 being located within the Lower Hunter Network Control Officer's area of responsibility. As such, the Protection Officer had to liaise with the Lower Hunter Network Control Officer to have a CSB placed on signal TN17.

Therefore, three safety critical workers were involved independently of each other in order to obtain the necessary authorities for work on track at the 191.100 km mark. Notably, the Middle Hunter and Lower Hunter Network Control Officer sat side by side at the Broadmeadow Network Control Centre, albeit with a dividing workstation wall.

2.5.2 Interface arrangements, work on track authorities

Local Possession Authority (LPA)

Rule ANWT-302 and procedure ANPR-700 set out the roles and responsibilities of rail safety workers when authorising, issuing and working under a LPA. Although this method of work on track authority was not used at the Maitland worksite on 20 December 2011, the interface arrangements between train control boards when more than one board is affected are examined for comparative purposes.

The relevant portion of rule ANWT-302 reads as follows:

> If the proposed limits of the LPA affect more than one train controller (network control officer), the train controllers must confer and nominate a coordinating train controller. The coordinating train controller must authorise the LPA.

The intent of this instruction is repeated in procedure ANPR-700.

An LPA is used for major works and, hierarchically, is the highest of the work on track authorities. As such, there are a number of formal steps involving written and verbal communication and worksite(s) protection by methods including clipping and locking points, booking infrastructure out of service, use of personnel for piloting track vehicles. An LPA must be advertised at least 7 days in advance.

Track Occupancy Authority (TOA)

Rule ANWT-304 and procedure ANPR-700 set out the roles and responsibilities of rail safety workers when authorising, issuing and working under a TOA. The rule states that train controllers (network control officers) may authorise a TOA only for track that is under their control.[16] Rule ANWT-304, which states:

> If the proposed limits of a TOA affect more than one train controller:
>
> > The train controllers must agree about the train control area most affected, and
> >
> > The train controller responsible for the area most affected must authorise the TOA.

The intent of this instruction is repeated in procedure ANWT-700.

Compilation of the TOA form is a key component of a TOA authorisation process. A TOA form is jointly compiled by the network control officer and the protection officer. The TOA is not authorised until the TOA form has been read back by the protection officer and confirmed as correct by the network control officer. In order to ensure that the network control officer and protection officer come to a clear understanding of the worksite location, ARTC recently amended the TOA form. Explicit in the amended TOA form is the location of the fixed worksite or track vehicle journey start and finish localities[17].

Controlled Signal Blocking (CSB)

Rule ANWT-308 and procedure ANPR-703 set out the roles and responsibilities of rail safety workers when authorising and issuing a CSB. Unlike the rules and procedures for LPA and TOA, the issuing of a CSB which affects more than one network control officer's area of responsibility does not require discussion and coordination between controllers. Rule ANWT-308 specifically states:

> A signaller may authorise controlled signal blocking only for signals in their area of control.

This can result in a situation, such as that which occurred at Maitland on 20 December 2011, where the responsibility for placing the CSB is with a network control officer who is not responsible for the area of track where the worksite is located. In such instances, and considering the high workload of each controller, it would be expected that:

- for the most part, the network control officer's primary focus of attention would be on the territory for which they are directly responsible; and
- use of the train control diagrams as a planning tool would be similarly focussed on the territory for which the controller is directly responsible.

The protection officer is required to deal with the network control officer who has control of the signal to which the CSB is to be applied. However, this network controller may not always be responsible for the area where the worksite is located.

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16 A signaller may issue a TOA on the authority of the Network Control Officer.

17 ATSB Report RO-2010-004 Collision between an XPT passenger train and a track mounted excavator safety action recommendation.

In this instance, protection of the worksite required that the Protection Officer deal with two separate network control officers to achieve both the TOA and the CSB. Interviews with network control officers indicated that working on track authorities which affect another controller are usually communicated to that controller so that they may use that information for planning purposes. This was normally communicated either verbally or via telephone between workstations, and was done opportunistically when there was a break in the work. However, on this occasion the details of the CSB were not discussed.

In addition, the rules and procedures provide for verbal authorisation of a CSB which is notated on the train controller's diagram. The level of attention paid to defining the specific circumstances of the authorisation, including the worksite location, was not undertaken in the same robust manner as it was with a LPA or TOA.

2.5.3 Conclusion

The collision between train BC151 and the excavator occurred in territory that was the responsibility of the Middle Hunter Network Control Officer. However, the Middle Hunter Network Control Officer did not have control over the signal that allowed train BC151 to access the worksite on the Down Coal Road, nor was he advised by the Lower Hunter Network Control Officer about the request for the CSB.

The rules and procedures for authorising a LPA or TOA that affects more than one network control officer specify that the network control officer responsible for the most affected area must coordinate/authorise the work on track authority. This acknowledges the risk posed by the requirement placed on a network control officer to authorise a work on track authority at a location for which they do not control.

On this occasion, errors were made by the Lower Hunter Network Control Officer when issuing the CSB. However, had there been a coordinated approach to issuing the CSB that included both network control officers, it is likely that these errors would have been identified and the collision would have been averted.

2.6 Other types of protection

While there are administrative controls such as CSBs and TOAs to provide protection for work sites there are, in some circumstances, engineering controls, like short circuiting clips, that could also be used. However, their use can be problematic in areas where there are certain types of RVD, such as axle counters.

This example is a demonstration of why there is no single engineering solution for all occasions where worksite protection is required.

However, in addition to the administrative controls, placing lookouts with clear line of sight and with reliable communications with the worksite protection officer can be used to great effect.

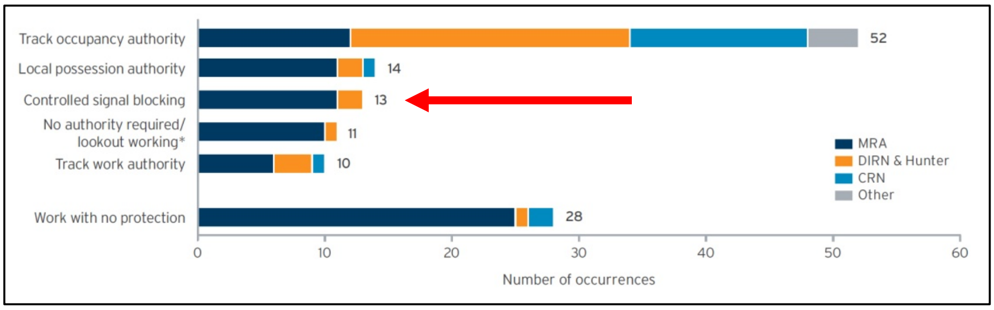
2.7 Worksite protection irregularities

The ATSB has investigated a number of worksite protection irregularities that have contributed to an occurrence[18]. In most cases it was evident that the protection officer and network control officer did not clearly communicate the location, type of work, and position of trains in relation to the site during a joint occupancy authority.

The Independent Transport Safety Regulator of NSW (ITSR) publishes a report titled *Rail Industry Safety Report* for each financial year. The 2010-11 report summarises safety performance on the NSW rail network and considers the trends over time. The report considers three aspects of rail safety performance; fatality and injury, rail accidents and accident precursors. The report describes a precursor rail safety occurrence as:

> Incidents that could, in combination with other events, progress to accidents and actual harm. Accident precursors serve as warning signs of failures in safety risk controls employed by rail transport operators. They are particularly important in providing insight to the underlying risks of infrequent, but serious, accidents that are still relevant to a railway under its current level of risk control but have not occurred in the period of available accident data.

Figure 10: Extract from ITSR 2010-11 report, worksite protection



Of interest is the high number of serious failures in the systems to manage the safety of on-track workers (worksite protection) which are classified as a precursor rail safety occurrence. The report breaks down the data into the five methods of worksite protection (Figure 10).

Based on the ITSR data for 2010-11, CSB irregularities contributed to 10.2 per cent of the total worksite protection irregularities. The most prominent failure of CSB working was at Kogarah[19], NSW, which occurred on 13 April 2010, resulting in a rail worker being struck and fatally injured by a train.

The NSW Office of Transport Safety Investigations conducted an investigation of the Kogarah incident and concluded that, amongst other issues, the signaller (area controller) did not identify the train between the blocking signal and the worksite.

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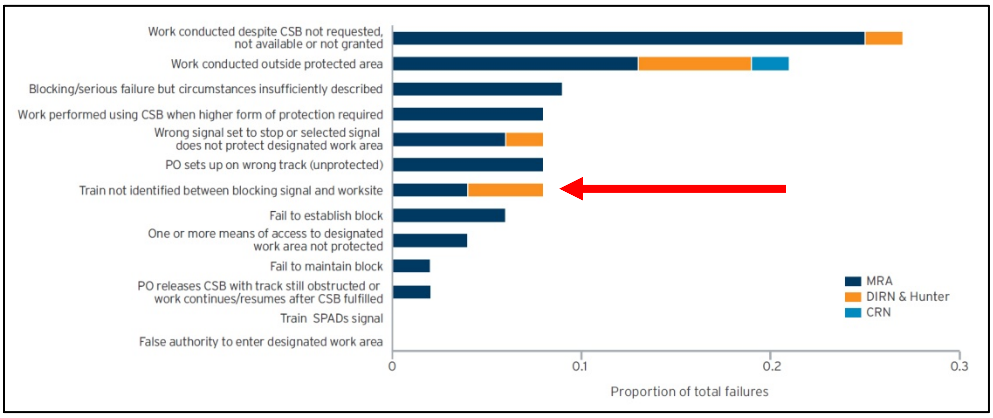
18 RO-2011-011 Collision between freight train 3SP7 and road-rail vehicle near Menindee, NSW on 13 July 2011. RO-2011-006 Collision between freight train 7SP3 and a track mounted excavator near Jaurdi, WA, 28 March 2011. RO-2010-007 Safeworking incident - Junee, NSW on 4 August 2010. RO-2010-004 Collision between XPT passenger train WT27 and a track-mounted excavator near Newbridge, New South Wales on 5 May 2010.

19 Kogarah is not on the ARTC network.

Comparing this finding with the ITSR report data (Figure 11), this type of failure within CSB working represents a less significant proportion of total failure types (about 8 per cent of total CSB irregularities). However, when considering the imminent approach of a train towards an unprotected worksite, the consequences of this type of failure are far more serious. Similarly with TOA working, a 'train incorrectly believed or not confirmed to be beyond a work location' represents a less significant proportion of total failure types. However, as with a CSB this type of failure is far more serious, as highlighted in the ATSB report RO-2010-004 into a collision between a track mounted excavator and the XPT WT27 near Newbridge, NSW, on 5 May 2010 where a track worker was also fatally injured.

Figure 11: Extract from ITSR report, CSB failure types



In recognition of the high number of worksite protection failures, ITSR has implemented an ongoing focused regulatory campaign with 65 inspections of worksites and 18 investigations already undertaken.

In this occurrence, the train not being identified correctly between the blocking signal TN17 at Thornton and the worksite near East Maitland lead to the Lower Hunter Train Controller believing that the section was clear for him to issue a CSB.

2.8 Rail Resource Management training

The impact of human performance limitations on accidents is common across all transport modes. In order to reduce human performance induced accidents in the rail industry, the Rail Safety Regulators Panel (RSRP) has progressed a Rail Resource Management (RRM) project. In February 2011, the RRM project released a facilitator training course for wider promulgation throughout the rail industry on a voluntary basis.

In the rail industry, RRM training aims to develop understanding of human performance strengths and limitations, and thereby reduce the impact of those elements through recognition and early intervention during an event sequence. It focuses on developing the non-technical skills essential for operating as a team in a dynamic safety-critical environment. Elements of effective RRM include; leadership, task management, teamwork, communication, risk management, situational awareness, decision making, emergency management and self-management.

Ineffective RRM has been identified as a contributing factor in a number of rail incidents, including the Waterfall accident in 2003. The Waterfall Special

Commission of Inquiry Report included the recommendation that ‘train driver and guard training should encourage teamwork and discourage authority gradients’. A review by ITSR of 14 incidents between 28 July 2009 and 4 August 2010 concluded that elements of RRM were ineffective in the vast majority (13 out of 14 examples) and contributed to the event. [20]

In this instance, elements of RRM were ineffective. Communication protocols utilised for the issue of the CSB were not sufficiently robust to assure protection of the worksite.

RRM training for network control officers and protection officers would provide these key personnel with an understanding of sound error management techniques, particularly with regard to effective communication protocols and coordination, and thus enhance the defences in place against human error.

[20] Incidents include Safe Working Irregularities, SPAD’s, Rolling Stock Irregularities, Near Misses, Collisions with track mounted equipment, Derailments and Fatalities

3 FINDINGS

3.1 Context

From the evidence available, the following findings are made with respect to the collision between empty coal train BC151 and an excavator near Maitland, NSW on Tuesday 20 December 2011 and should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing safety factors

- The network control officer responsible for issuing the Controlled Signal Block to protect the movement of the excavator while it was accessing the worksite misunderstood the location of the worksite and the information provided by the protection officer in relation to the identification of the locomotive that had just passed the site.
- Details of safety critical information such as worksite location, locomotive identification and protection officer's contact details were not read back by the network control officer during the conversation associated with the issuing of the Controlled Signal Block.
- The rules and procedures governing the issue of a Controlled Signal Block did not require or provide for coordination between network control officers when the Controlled Signal Block affects more than one controller's area of responsibility. *[Minor Safety Issue]*

3.3 Other key findings

- A Track Occupancy Authority (TOA) and Controlled Signal Blocking (CSB) were appropriate methods of excluding rail traffic from the worksite.
- Train BC151 was being driven in accordance with the rules and procedures before the track workers and obstruction were sighted. The subsequent reaction by the train drivers was timely.
- Rail Resource Management (RRM) training for network control officers and protection officers would provide these key personnel with an understanding of sound error management techniques, particularly with regard to effective communication protocols and coordination, and thus enhance the defences in place against human error.

4 SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a copy of the draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

4.1 Australian Rail Track Corporation

Minor safety issue

The rules and procedures governing the issue of a Controlled Signal Block did not require or provide for coordination between network control officers when the Controlled Signal Block affects more than one controller's area of responsibility.

Response from Australian Rail Track Corporation

The Australian Rail Track Corporation has advised that it is currently reviewing the entire content of Rule ANWT 308 – *Controlled Signal Blocking* and will include the issue identified by the ATSB in that review.

APPENDIX A : SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- Australian Rail Track Corporation
- Freightliner Australia Pty Ltd
- Network Control Officers from the Broadmeadow Network Control Centre
- Personnel from the worksite
- The NSW Independent Transport Safety Regulator
- Train crew of BC151

References

RISSB National Guideline Glossary of Railway Terminology

ARTC Rules and Procedures

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the Australian Rail Track Corporation, Freightliner Pty Ltd, the NSW Independent Transport Safety Regulator, the train crew of train BC151 and a number of individuals.

Submissions were received from the Australian Rail Track Corporation, the NSW Independent Transport Safety Regulator, the train crew of train BC151 and a number of individuals. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

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Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
Collision between an empty coal train and a track mounted excavator near Maitland NSW on 20 December 2011
RO-2011-018
Final – 27 March 2013