

Australian Government Australian Transport Safety Bureau

# Collision between an XPT passenger train and a track-mounted excavator

near Newbridge NSW | 5 May 2010



Investigation

ATSB Transport Safety Report Rail Occurrence Investigation RO-2010-004 Final



**Australian Government** 

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### ATSB TRANSPORT SAFETY REPORT

Rail Occurrence Investigation RO-2010-004 Final

# Collision between an XPT passenger train and a track-mounted excavator near Newbridge, New South Wales 5 May 2010

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# SAFETY SUMMARY

# What happened

At about 1116 on 5 May 2010 a collision occurred between an XPT passenger train and a track-mounted excavator near Newbridge, New South Wales. The operator of the track-mounted excavator was fatally injured. During the course of the investigation a similar incident occurred near Wards River, New South Wales (17 March 2011), where two work groups had to hurriedly vacate their on-track worksite due to an approaching train (there were no injuries). Both incidents occurred despite the fact that the work groups had been authorised, under a Track Occupancy Authority (TOA), to occupy and work on the track.

# What the ATSB found

The ATSB established that, for the accident at Newbridge, a TOA was an appropriate method of authorising the work to be performed. However, a combination of individual actions and systemic issues contributed to the collision. When requesting the TOA, neither the Protection Officer (PO) nor the Network Control Officer (NCO) positively identified the location and type of worksite. Their actions were influenced by a deficiency in the TOA form, in that no provision was provided to record this critical information. Consequently, both the PO and NCO incorrectly concluded that the train had already passed beyond the limits of the worksite. In addition, the workers accessed the danger zone before additional site protection measures (detonators and flags) had been put in place. The ATSB also found that the workers were relatively inexperienced and that their training had not specifically discussed the hazards and protections that were relevant when working under a TOA.

The scenario for the Wards River incident was similar in that the track access point for the work was about 16 km into the section defined by the limits of the proposed TOA. In this case, the location of the work (Wards River) was communicated at about 0735 when the TOA was first requested. Due to operational reasons the TOA was not issued until 0840. Similar to the Newbridge event the PO did not clearly identify the location of the worksite and the NCO did not ensure the train had passed beyond the worksite or track access point.

# What has been done as a result

As a result of the incident at Newbridge on 5 May 2010, the Australian Rail Track Corporation (ARTC) took action to reinforce the rules and procedures associated with the issuing of TOAs. The ARTC also implemented the use of a revised TOA form that provides for the recording of critical information regarding the location and type of worksite. It is likely that implementation of the new form should reduce the risk of similar incidents.

# Safety message

It is essential that information critical to the safe implementation of a TOA be clearly communicated between the Protection Officer and the Network Control Officer.

It is also essential that workers do not access the track until all levels of worksite protection have been fully implemented.

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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 it appropriate. 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.

# **EXECUTIVE SUMMARY**

At about 1116<sup>1</sup> on 5 May 2010 a collision occurred between an XPT passenger train and a track-mounted excavator near Newbridge, New South Wales. The operator of the track-mounted excavator was fatally injured. During the course of the investigation a similar incident occurred near Wards River, New South Wales (17 March 2011), where two work groups had to hurriedly vacate their on-track worksite due to an approaching train (there were no injuries). Both incidents occurred despite the fact that the work groups had been authorised, under a Track Occupancy Authority (TOA), to occupy and work on the track. Due to the similarities between the two occurrences, the Australian Transport Safety Bureau (ATSB) decided to examine the issues associated with the incident at Wards River in conjunction with the investigation into the fatal collision that occurred near Newbridge.

The work planned at Newbridge on 5 May 2010 was to cut reclaimed rail into manageable lengths and transfer the sections from the north side to the south side of the track ready for collection and removal by truck. The work group consisted of a Protection Officer (PO), a 'hot-work' labourer (using oxyacetylene cutting equipment) and an excavator operator.

At about 1050, XPT passenger train WT27 departed Bathurst and travelled as normal towards Newbridge. About 4 minutes later, the PO contacted the Network Control Officer (NCO) to request a TOA for conducting track work within the danger zone between Bathurst and Newbridge, a track distance of about 31 km. The intended worksite was about 29 km from Bathurst, so at the time the TOA was requested, train WT27 was still about 22 km away, but travelling towards the worksite.

At about 1058, having received authorisation to access the track, the PO advised the hot-work labourer and excavator operator that the TOA had been obtained and that they could prepare for work while he went to put the additional site protection measures in place (warning flags and detonators<sup>2</sup>). However, both workers entered the danger zone before the additional protection was in place; the hot-work labourer placed oxyacetylene hoses across the track and the excavator operator drove the excavator up onto the track.

Meanwhile, train WT27 continued to travel towards the worksite. At about 1116, train WT27 approached the worksite (at about 69 km/h) through a left-hand curve and cutting just before the worksite. The driver was unable to see the track mounted excavator until the train was about 95 m away, at which point he immediately placed the brake handle into the emergency brake position. However, there was insufficient time for the XPT to stop and a collision was inevitable.

When the train collided with the excavator, the excavator was propelled along the track for about 20 m before the extended boom struck a utility vehicle parked on the southern side of the track. The excavator and utility vehicle were then pushed off the track and came to rest about 38 m from the point of initial impact. During the

<sup>&</sup>lt;sup>1</sup> Eastern Standard Time (EST) was Coordinated Universal Time (UTC) +10 hours. All time references for the Newbridge incident are EST.

<sup>&</sup>lt;sup>2</sup> A detonator is a device that explodes on impact used to warn drivers and track vehicle operators of the condition of the track ahead.

collision sequence, the excavator operator was ejected from the excavator and sustained fatal injuries. The leading end of train WT27 stopped about 196 m beyond the initial point of impact.

The ATSB established that a TOA was an appropriate method of authorising the work to be performed. However, a combination of individual actions and systemic issues contributed to the collision.

When requesting the TOA, the PO did not positively identify the location of the worksite as required by the Australian Rail Track Corporation (ARTC) procedures. Similarly, the NCO did not positively determine the location of the worksite, so could not ensure the train had passed beyond the worksite or track access point as required by the procedures. The actions of the PO and the NCO were influenced by a deficiency in the TOA form, in that no provision was provided to record critical information regarding the location and type of worksite. Consequently, both the PO and NCO incorrectly concluded that the train had passed beyond the limits of the worksite.

In addition, the hot-work labourer and excavator operator accessed the danger zone before the additional site protection measures (detonators and flags) had been put in place. The hot-work labourer and excavator operator were relatively inexperienced and may have assumed that having received a TOA they were safe to enter the danger zone as no trains would be approaching the worksite. The ATSB found that the minimum level of training provided to the track workers did not specifically cover the hazards and protections that were relevant when working under a TOA. While the PO told the track workers that a TOA had been received, he did not explicitly communicate that they should not occupy the danger zone until all site protection measures were put in place. The workers were aware of this requirement, but without having attained the experience or training to become fully aware of the risk associated with working under a TOA, the track workers were less likely to protect themselves by not entering the danger zone until the appropriate measures were in place.

While not contributing to the collision at Newbridge, the ATSB investigation into both the Newbridge and Wards River incidents identified a number of other safety factors that may increase the ARTC's safety risk. These safety factors related to:

- inconsistencies between actual work practices, the ARTC procedure ANPR-701 (Using a Track Occupancy Authority) and rule ANWT-304 (Track Occupancy Authority)
- the use of non-authorised reproductions of the ARTC's Track Occupancy Authority form
- possible fatigue related issues.

As a direct result of the incident at Newbridge on 5 May 2010, both the Independent Transport Safety Regulator (ITSR) and the ARTC took action to reinforce the rules and procedures associated with the issuing of TOAs and to ensure trains have passed beyond a proposed worksite or track access point before a TOA is issued. In addition, the ARTC implemented the use of a revised TOA form that clearly provides for the recording of critical information regarding the location and type of worksite, though the changes had not been implemented at the time of the Wards River incident. It is likely that implementation of the proposed form should significantly reduce the risk of incidents, similar to Newbridge on 5 May 2010 and Wards River on 17 March 2011, in the future.

# 1 FACTUAL INFORMATION

### 1.1 Overview

At about 1116<sup>3</sup> on 5 May 2010 a collision between a scheduled XPT passenger train (WT27) and a track-mounted excavator occurred near Newbridge, New South Wales. The operator of the track-mounted excavator was fatally injured.

During the course of the investigation, a similar incident occurred near Wards River, New South Wales. At about 0850<sup>4</sup> on 17 March 2011, two work groups had to hurriedly vacate their on-track worksite due to an approaching train. There were no injuries.

Both incidents occurred despite the fact that the work groups had been authorised to occupy a defined portion of track for a specified period. That is, Track Occupancy Authorities (TOA) had been issued. Due to the similarities between the two occurrences, the Australian Transport Safety Bureau (ATSB) decided to examine the issues associated with the incident at Wards River in conjunction with the investigation into the fatal collision that occurred near Newbridge.

### Location

Newbridge is located about 274 track kilometres<sup>5</sup> west of Sydney on the Defined Interstate Rail Network (DIRN) between Sydney and Broken Hill<sup>6</sup>. Wards River is located about 283 track kilometres north of Sydney on the Defined Interstate Rail Network (DIRN) between Sydney and Brisbane (Figure 1).

The track in both areas was owned by the Country Rail Infrastructure Authority (CRIA), but managed and maintained by the Australian Rail Track Corporation (ARTC) under a lease agreement with the New South Wales Government<sup>7</sup>. Train movements were controlled by a fixed signalling system using Rail Vehicle Detection (RVD)<sup>8</sup> and operated by an ARTC Network Control Officer (NCO) located in the Broadmeadow Network Control Centre using the Phoenix control system. The Phoenix control system was a non-vital<sup>9</sup> system that provides real time monitoring and control of field hardware including signals, points, track circuits and the associated management of train movements. Signal, points, track and train

- <sup>5</sup> Distance in kilometres from a track reference point located at Sydney Central Station.
- <sup>6</sup> The track through Newbridge, although on the DIRN, is part of the New South Wales Country Regional Network (CRN).
- <sup>7</sup> As of January 2012, John Holland was awarded the lease to manage and maintain the CRN.
- <sup>8</sup> The portions of line where the system of Safeworking relies on track-circuiting or axle counters. (Source: ARTC NSW Glossary)
- <sup>9</sup> A non-vital system does not directly affect the safe operation of the system. That is, the failure of the system would not cause an unsafe outcome.

<sup>&</sup>lt;sup>3</sup> Eastern Standard Time (EST) was Coordinated Universal Time (UTC) +10 hours. All time references for the Newbridge incident are EST.

<sup>&</sup>lt;sup>4</sup> Eastern Daylight-saving Time (EDT) was Coordinated Universal Time (UTC) +11 hours. All time references for the Wards River event are EDT.

movement data was captured by the Phoenix event logger. This data could be replayed to assist with the reconstruction of events and the examination of incidents.



Figure 1: Location of Newbridge and Wards River

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### Newbridge incident - 5 May 2010 1.2

The work planned for Newbridge on 5 May 2010 comprised reclamation of used rail. The work was to be undertaken at the 270.512 km mark and included cutting the reclaimed rail into manageable lengths with oxyacetylene equipment and then transferring the sections from the north side of the track to the south side of the track (Figure 2) for collection and removal by truck.



Figure 2: Worksite layout

The work group for this task consisted of a Protection Officer (PO), a 'hot-work' labourer (an employee qualified for cutting rail using oxyacetylene equipment) and an excavator operator. The hot-work labourer was to be responsible for cutting the long rail lengths while the excavator operator worked a track-mounted excavator and transferred the cut sections to the south side of the track. While the cut and uncut rail lengths were located outside the 'danger zone'<sup>10</sup>, the hot-work labourer and excavator would need to occupy the danger zone while the work was undertaken.

The excavator, a Komatsu PC40MR-2 (similar to Figure 3), was used to transfer the cut rail lengths to the south side of the track for collection and removal. The excavator had an operating weight of 4.79 t and was fitted with small, hydraulically retractable rail wheels enabling it to mount and operate on the track when required. The (rated) maximum speed of the excavator while on track was 4.6 km/h. The excavator had been parked on the north side of the track (right-hand side of the track in the direction of travel of train WT27), having





been left there from previous work. At the completion of the task it was intended to transfer the excavator back to the Bathurst depot by the truck that was being utilised at the worksite.



### Figure 4: Location of collision (near Newbridge)

The collision occurred on a tight (290 m radius) left-hand curve, in the direction of train travel, with a descending gradient of 1:77. The point of impact was at the

<sup>&</sup>lt;sup>10</sup> The Danger Zone is all space within 3 m horizontally from the nearest rail and any distance above or below this 3 m, unless a safe place exists or can be created.

270.512 track km point, about two-thirds along the curve (Figure 4). The bidirectional single line track<sup>11</sup> was constructed with 60 kg/m rail fastened to concrete sleepers in a bed of rock ballast. The posted track speed was 70 km/h, but had been temporarily reduced to 65 km/h.

### Train and driver information

The XPT passenger train (WT27) was a scheduled service, owned and operated by RailCorp (trading as CountryLink), that ran between Sydney and Dubbo in New South Wales. On 5 May 2010, the regular run to Dubbo was to be truncated at Orange due to scheduled track maintenance between Orange and Dubbo<sup>12</sup>. Train WT27 consisted of a lead power car XP2008, four trailing passenger cars, and a trailing power car XP2011 for a total mass of about 320 t and an overall length of about 130 m. The train was crewed by one driver, a passenger service supervisor, a senior passenger attendant, and two passenger attendants. There were 71 passengers on board at the time of the collision.

The driver of train WT27 was based at Dubbo and had been operating trains on this route since 1994. In 2002 he obtained a drivers' position with CountryLink, from which time he had driven XPT and Xplorer passenger trains over this route.

### Network Control Officer (NCO)

The NCO associated with the incident held the required competencies for the position and was certified as medically fit in accordance with the *National Standard for Health Assessment of Rail Safety Workers*. He was very experienced with over 28 years of service in the rail industry and had worked for over 3 years in the Broadmeadow train control centre. He was qualified to operate the train control board relevant to the Bathurst/Newbridge section.

### Protection Officer (PO)

The PO associated with the incident was employed by the ARTC. He had obtained qualification as a Protection Officer Level 2 in December 2008, about 18 months before the incident.

### Track workers

The track workers involved in the Newbridge incident were contracted to the ARTC from a labour provider. They were engaged on a semi-permanent basis as labourers for track work and/or maintenance purposes. Both were relatively inexperienced in the rail environment, having undertaken the minimum training requirements for work on track in November 2009 (about 6 months before the incident).

### 1.2.1 The occurrence

The driver of train WT27 signed on at 0448 on 5 May 2010 at the Meeks Road XPT depot in Sydney and was engaged in preparation duties until departing at 0608 for Sydney Central Station. After arrival at Sydney Central at 0614, he walked to the

<sup>&</sup>lt;sup>11</sup> 'Up' direction trains travel towards Sydney and 'Down' direction trains travel away from Sydney.

<sup>&</sup>lt;sup>12</sup> Advertised in ARTC Train Alteration Advice 0332-2010.

'sign on' room where he viewed/collected the train running notices before returning to the train to prepare for departure. He logged onto the CountryNet radio and MetroNet radio systems through Sydney Goods Control and performed a radio check. The train departed Sydney Central for Bathurst, a journey time of about 3 hours 30 minutes, on schedule at 0710.

The work group<sup>13</sup> involved in the incident signed on for duty at the Bathurst depot at 0700 and then attended a 'tool box' meeting to discuss planned work and other agenda items. This included an OH&S presentation on generic safe-work practices. The meeting ended about 1000. After the meeting, the work group had a short meal break before leaving the depot to conduct rail reclamation work near Newbridge. The PO and the hot-work labourer departed the Bathurst depot between 1015 and 1030 in a large flatbed truck, with the excavator operator following in a utility roadrail vehicle<sup>14</sup>.

Train WT27 arrived at Bathurst at 1046, 4 minutes later than scheduled. Apart from a door disarm device that was found to be faulty at Strathfield (shortly after departure from Sydney) and a speedometer that was reading slightly faster than actual speed, the driver said the journey to Bathurst was without incident. Before continuing the journey to Orange, an ARTC track maintenance supervisor boarded the lead power car to perform a regular cab-ride track inspection. The train departed Bathurst at 1050, 5 minutes later than scheduled.

At about the same time, the work group arrived at their worksite near Newbridge. The two vehicles (flatbed truck and road-rail vehicle) were parked side-by-side facing the Newbridge station (away from Bathurst); both vehicles were located on the south side, and several metres from the track. The PO advised that shortly after arrival at the work site, a pre-work safety briefing was conducted near the flatbed truck. At 1054, the PO called the NCO at Broadmeadow and requested a TOA between Bathurst and Newbridge. During the authorisation process all relevant sections of the TOA form were completed by the NCO and the PO before the authority was read back by the PO and confirmed by the NCO as correct at 1058. TOA number 11 was issued to the PO authorising:

- occupancy of the main line between Bathurst BT56 signal and Newbridge NE1 signal
- commencing at 1054 on 5 May 2010 to be fulfilled by 1320 on 5 May 2010
- work to be performed noted as 'track work'
- a joint occupancy  $^{15}$  behind train WT27.

The PO said that, after the TOA had been issued, he advised both the hot-work labourer and the excavator operator that a TOA was now in place and that they could prepare for work while he went to put the site protection measures in place

<sup>&</sup>lt;sup>13</sup> The Protection Officer (PO), hot-work labourer and the excavator operator.

<sup>&</sup>lt;sup>14</sup> A road vehicle fitted with retractable rail guidance wheels. (Source: ARA Glossary for the National Codes of Practice and Dictionary of Railway Terminology)

<sup>&</sup>lt;sup>15</sup> Joint occupancy is a term used to describe the simultaneous use of a track section by two trains, or by a train and track workers, or by several track workers (under defined conditions).

(warning flags and detonators<sup>16</sup>). The PO then continued to finalise the worksite protection plan while sitting in the cabin of the truck.

The hot-work labourer then moved the utility vehicle to a position alongside the track (south side) and laid the oxyacetylene hoses from the utility vehicle across the track to his work location on the north side of the track. The excavator operator went to the excavator, which was positioned on the north side of the track, and started the engine to warm it up to operating temperature.

Meanwhile, the PO changed into full wet weather apparel as there was light rain falling and he believed this would continue. He recalled that, at about this time, he noticed that the excavator operator was walking near the excavator. Shortly after, the rain eased and he decided the wet weather apparel would not be required, so he removed it.

At about 1116, XPT passenger train WT27 approached the worksite from an easterly direction, through a left-hand curve and cutting immediately before the collision site. The train driver said that the track maintenance supervisor, who was seated in the right-hand seat<sup>17</sup>, saw the excavator moments before he did due to the better line of sight afforded him. The track maintenance supervisor called out something like 'watch out'. The driver said he then saw the excavator and noticed that the retractable rail wheels were on the line. The driver, having already had the brakes applied lightly to control the train speed on the descending grade, placed the brake handle into the emergency brake position, allowed the dead-man pedal to drop out and braced for impact. The driver said that at impact the power car seemed to 'mount' the excavator and when it came back down that "the whole power car just shuddered, I've never felt anything like it in my life". Considering the violent nature of the impact, the driver thought the train had derailed. However, this was not the case.

The PO said that he did not see or hear the train approaching. He said that he was about to drive off towards Newbridge, to place the flags and detonators, when he heard a loud noise. He then turned his head and saw the XPT power car pushing the excavator along the track. Similarly, the hot-work labourer did not see or hear the train approaching. He said that he had cut two portions of rail when he too heard a loud noise, turned and saw the excavator being pushed by the train.

When the train had come to a stop, the driver placed an emergency call to train control via the CountryNet radio while also attempting to call using the mobile phone. The call was answered within about 5 seconds, whereupon the driver advised the NCO of the collision and location and that he believed there would be fatalities involved.

### 1.2.2 Post occurrence

First aid was rendered to the excavator operator by the PO, hot-work labourer, an off duty train driver and two off duty nurses until emergency services personnel (police and ambulance) arrived on the scene. The train was secured and protection was put in place. The remaining passengers were retained on the train while these

<sup>&</sup>lt;sup>16</sup> A detonator is a device that explodes on impact used to warn drivers and track vehicle operators of the condition of the track ahead.

<sup>&</sup>lt;sup>17</sup> The driver of an XPT operates from the left-hand seat in the drivers' cabin.

proceedings were underway. The train driver and the PO were breath tested by New South Wales Police on site; both returned zero readings.

At 1510, the four passenger cars, with passengers on board, were hauled back to Bathurst by the trailing power car XP2011, arriving at Bathurst at 1603. The passengers disembarked at Bathurst station and boarded buses to continue their journey. The leading power car (XP2008) remained in-situ until 1336 on 6 May 2010, when it was hauled away by another locomotive. The track between Bathurst and Newbridge was reopened for rail traffic at 1513 on 6 May 2010.

The track infrastructure received very minor damage. Power car XP2008 received moderate frontal damage. Both the ARTC utility vehicle and excavator were essentially unrepairable.

# 1.3 Wards River incident - 17 March 2011

On Thursday 17 March 2011, contractors to the track manager (ARTC) were intending to carry out vegetation control between Stroud Road (266.5 km point) and South Craven (290.5 km point). The worksite was to be a 6 km section of track between the 284 km point and the 290 km point. Work was to be undertaken by two work groups, one using a road-rail vehicle with spray booms and the other using portable equipment for 'spot spraying'. Initially, the two work groups were to be about 2 km apart and then work towards each other. The work group with the road-rail vehicle was to consist of three persons, including the contractor's PO, and the work group conducting the 'spot spraying' was to consist of two persons.

### Network Control Officer (NCO)

The NCO associated with incident held the required competencies for the position and was certified as medically fit in accordance with the *National Standard for Health Assessment of Rail Safety Workers*. He was very experienced with over 35 years of service in the rail industry and had worked for over 3 years in the Broadmeadow train control centre. He was qualified to operate the train control board relevant to the Stroud Road/South Craven section.

### **Protection Officer (PO)**

The PO associated with the incident was employed by a contractor engaged by the ARTC for track work and/or maintenance purposes. The PO had about 19 years experience in the rail industry, and had worked as a PO since 2008.

### 1.3.1 The occurrence

At about 0735 on the 17 March 2011, the PO involved in the incident contacted Broadmeadow network control from Wards River (283.084 km point) seeking a TOA to enable on-track work to commence. The NCO advised that four trains would travel through the area before access could be granted. He told the PO that he would probably be able to gain access to the track at about 0810 following train DU601. During the course of this conversation, the PO advised the NCO that he was intending to gain access to the track at Wards River. The two work groups then commenced vegetation spraying along the corridor outside the danger zone until the TOA could be issued. At about 0839, the PO again contacted the NCO to enquire about when they would be able to obtain a TOA. The NCO told the PO that the trains had gone and that the next traffic on the Stroud Road to Craven section would be a southbound train travelling through Craven at about 0920. This would give the PO a track access time of about 40 minutes. While completing the TOA process, the NCO asked if the PO would be 'taking off' at South Craven, and the PO responded by saying 'no, there's a Wards River in between the section'. The controller pressed the issue mid sentence and asked 'but you're going to take off, aren't you?', to which the PO replied in the affirmative.

The NCO commenced planning the TOA and said to the PO 'you know the train's in front of you, of course, going to Craven', to which the PO responded 'yep'. TOA number 50A was then issued authorising:

- occupancy of the single main (track) between Stroud Road and South Craven between signals 09-13 and signals 11-03
- to commence at 0840 and to be fulfilled by 0920
- a joint occupancy behind train DU601.

The PO telephoned the second work group and said they were able to go on the track. One member of the work group with the PO readied the road-rail vehicle for placement on track by unhooking the wheels, and the other member accessed the danger zone to lay out the spray hose. While preparing to access the track, a work group member and the PO (who were within the danger zone) saw the headlight of an approaching train at an estimated distance of 300 to 400 m travelling at about 70 km/h. Both workers immediately exited the danger zone; the PO gave the all clear to the train driver who responded by a short sounding ('pop') of the locomotive horn. The PO then used his mobile phone to contact the second work group that were about 2 km away and told them a train was coming and they should remain off the track.

At about 0852, about 12 minutes after the issue of the TOA, the PO contacted the NCO and told him what had happened. During the conversation it was ascertained that the NCO had thought the work group were at the start of the section at Stroud Road. However, the work group were actually at Wards River, about 15 km north of signal 09-13 at Stroud Road.

Both the NCO and the PO were removed from safeworking duties after the incident. They were tested for the presence of alcohol and illicit drugs following their suspension from duty. The tests produced negative results.

# 2 ANALYSIS

On 5 May 2010, investigators from the Australian Transport Safety Bureau (ATSB) attended the site of the collision near Newbridge to collect evidence, conduct a site survey, and take photographs and measurements. The train data loggers (Hasler tapes) from both power cars of train WT27 were obtained and examined at a later date. In the weeks following 5 May 2010, interviews were conducted with the Network Control Officer (NCO) and the Protection Officer (PO).

The safeworking incident at Wards River occurred on 17 March 2011. While a site visit was not conducted, investigators from the ATSB did interview the NCO and the PO who were involved.

Based on initial observations, it was determined that the two incidents exhibited a number of similarities. In both cases, the work groups had been issued with Track Occupancy Authorities (TOA) that authorised them to occupy defined portions of track for a specified period. However, in each case a train was within the limits of the TOA and, unknown to the PO, travelling towards their respective worksites.

The following analysis examines the rules associated with Track Occupancy Authorities and how these rules were applied at Newbridge and Wards River.

# 2.1 Sequence of events

For the incident that occurred at Newbridge on 5 May 2010, recorded event data was available from:

- the XPT power cars
  - Hasler data recorder that records speed, time, brake cylinder pressure (brake force), throttle position and vigilance acknowledgment
  - Fischer vigilance control module to manage and record the driver vigilance system operation
- Australian Rail Track Corporation (ARTC) voice logs
- ARTC Phoenix system.

Based on the recorded data, train WT27 departed Bathurst at 1050:11 and travelled as normal towards Newbridge, passing the Bathurst starting signal BT54 (located at the 241.640 km point) at 1051:46. From this point onwards there were no other mainline signals until NE1 at Newbridge.

### Figure 5: Bathurst to Newbridge



The PO rang the NCO at Broadmeadow Network Control Centre from the worksite at 1054:13 to request the TOA authorising them to conduct track work within the danger zone between Bathurst signal BT56 and Newbridge signal NE1, a track distance of about 31 km. The intended worksite was at the 270.500 km point, about 2 km from Newbridge (Figure 5). At the time that the TOA was requested, train WT27 was about 4 minutes into its journey towards the worksite, but was still about 22.3 km away.

At 1058:15, the PO completed his conversation with the NCO, having received authorisation (TOA number 11) to access the track. At this point in time, train WT27 was about 18.5 km away. According to the PO's statement, he then advised the hot-work labourer and excavator operator that the TOA had been obtained and that they could prepare for work while he went to put the site protection measures in place (warning flags and detonators).

The PO did not immediately depart the site to place protection measures, but remained at the truck to finalise the worksite protection plan and prepare himself for work (change into, and then out of, full wet weather apparel). The hot-work labourer and excavator operator however, moved off to prepare for their respective tasks. The hot-work labourer moved the utility vehicle to a position on the southern side of the track and laid the oxyacetylene hoses across the track to his 'hot-work' location on the northern side of the track. While the hot-work location was outside the danger zone, the oxyacetylene hoses were crossing the track and therefore inside the danger zone. He then began his task of cutting the rail into manageable lengths. The excavator operator went to the excavator, which was positioned on the northern side of the track, and started the engine to warm it up towards operating temperature. The excavator operator then drove the excavator up onto the track and placed the rail wheels in position on the rails. At this time, the PO was in the flatbed truck and had not yet departed to protect the worksite.

### Figure 6: Approach to collision site at Newbridge



Meanwhile, train WT27 continued to travel towards the worksite at speeds of between 50 km/h and 75 km/h. At about 1116, XPT passenger train WT27 approached from the east, through the left-hand curve and cutting immediately before the collision site. Figure 6 illustrates the train driver's view at about the point where the excavator would have been just visible, about 95 m from the point of collision. Based on recorded data, at 1116:05 train WT27 was travelling at 69 km/h as the throttle was moved to idle and the brake cylinder pressure increased, indicating that the train brakes had started to apply. Considering the limited sighting distance due to the track curvature and the cutting height, the train driver reacted quickly on sighting the track obstruction. However, there was insufficient time for the XPT to stop and a collision was inevitable. About 4 seconds and 66 m later, train WT27 collided with the excavator. The collision occurred at 1116:09, about 26 minutes after train WT27 departed Bathurst (at 1050) and about 18 minutes after the issue of the TOA (at 1058).

Neither the PO (who was still at the truck), nor the hot-work labourer (who had already cut two portions of rail) heard the train approaching. However, both heard a loud noise and looked up to see the excavator being pushed by the train.

Site observations by investigators revealed that the excavator had been propelled along the track for a distance of about 20 m until the extended boom struck the utility vehicle parked alongside the southern side of the track. The excavator derailed and, while entangled with the utility vehicle, was pushed off the track and came to rest on the formed embankment about 38 m from the point of initial impact (Figure 7). The operator of the excavator was ejected from the excavator sometime during the collision sequence and sustained fatal injuries. The leading end of train WT27 stopped about 196 m beyond the initial point of impact.



Figure 7: Incident site at Newbridge

Note: At the time of photo, the XPT passenger cars and trailing power car had been uncoupled and removed from the incident site.

### Animated representation of relevant recorded data

An animation of the Newbridge incident was prepared using Insight Animation<sup>TM</sup> software and is part of this report. A video file containing the animation in Windows Media Video format (.wmv) is available for download from the ATSB website. Three still screen captures of the animation are shown in Appendix A.

### Events at Wards River

The events that occurred at Wards River occurred on 17 March 2011 were very similar as far as the issuing of the TOA was concerned. That is, the PO was issued with a TOA authorising track workers to occupy the track between Stroud Road (266.5 km point) and South Craven (290.5 km point). However, as was the case at Newbridge, a train was within the limits of the TOA and, unknown to the PO, travelling towards their worksite at Wards River (283.1 km point). The approaching train was observed by the PO while he and other workers were preparing to start work. The workers immediately exited the danger zone and the train continued without incident.

### Summary

On examination of available evidence, it was established that for both occurences a TOA had been issued while a train was within the limits of the TOA, but the PO did not know that the train was approaching the worksite.

With respect to the incident at Newbridge, the workers entered the danger zone before site protection measures (warning flags and detonators) were put in place. The train driver responded very quickly and appropriately, especially considering he was not expecting to see workers on the track. Examination of site evidence found that on sighting the excavator there was insufficient time for the XPT to stop and it was unlikely that the driver could have done anything to diminish the consequences of the inevitable collision.

For the incident at Wards River, the PO did not intend to put site protection measures in place because he did not consider the site to be a fixed worksite (refer to section 2.2 Rules and procedures).

ARTC network rules permit a TOA to be given for a track section within which a train is already travelling (refer to section 2.2 Rules and procedures) providing the train has passed the worksite within the section. However for each of the two occurrences, it was established that the processes failed to ensure that the train was travelling away from (had passed) the worksites.

# 2.2 Rules and procedures

In general terms, safeworking rules and procedures are implemented to ensure the safe operation of multiple train movements and/or track occupancies over a rail network. A key principle for any railway safeworking system is to maintain adequate separation between rail traffic and any other rail vehicles or track workers that may be occupying or working on the running lines. The safeworking rules for the ARTC rail network in New South Wales 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 PO and work in the danger zone must not begin until the PO has put the required safety measures in place. The rule also specifies that only one of five methods may be used to conduct any work in the danger zone:

- 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 defined portion of track may be occupied for a specified 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 the purpose of crossing the track or using hand tools.
- No Authority Required (NAR)<sup>18</sup>, where only light, non-powered hand tools may be used.

ANWT-300 *Planning work in the rail corridor* notes that each method of work has mandatory minimum safety measures and states that work in the danger zone must not begin before the PO has put the required safety measures in place. The rule also states that the preferred methods for working on track are LPA or TOA. Considering that an LPA requires 7 days advance notice, the chosen method in this case was a TOA, which was adequate and consistent with the preferred method and type of work to be performed.

# 2.2.1 Rule - Track Occupancy Authority (TOA)

The ARTC document ANWT-304 *Track Occupancy Authority* prescribes the rules for authorising, issuing and using a TOA. The rule states that a TOA gives exclusive occupancy, but may allow joint occupancy under defined exceptions.

The relevant exception to examine in relation to this incident is 'joint occupancy following a train movement'. It was noted that this condition may be open to different interpretations. It could mean that joint occupancy is permitted when following in the path of a train movement. For example, a road-rail vehicle travelling in the same direction, but behind the train. Alternatively, it could be interpreted that workers are permitted to access a fixed worksite following (or after) a train, that is, it has passed that worksite.

<sup>&</sup>lt;sup>18</sup> 'No Authority Required' was changed to 'Lookout Working' in December 2010.

A statement made later in the document implies that the rule permits both interpretations. The rule states that:

Before issuing the Authority, the Train Controller must make sure that the preceding train has passed:

- the proposed worksite, or
- the starting point from which the track vehicle included in the Authority will travel.

Discussions with the ARTC confirmed that, while not clearly stated under the 'General' section of document ANWT-304 *Track Occupancy Authority*, the intent of the rule was to permit both interpretations. However, the key requirement is that the NCO must ensure the track is unoccupied and will remain unoccupied by rail traffic (except for approved track work), or that the train has passed the fixed worksite or track access point.

Regardless of the type of work to be carried out (fixed worksite or travelling vehicle), the rule specifying the limits of the TOA are the same. In this case, the incident occurred within an area controlled by fixed signalling. Consequently, the permitted limits of the TOA were the 'Home' signals for the yards either side of the proposed worksite (Signal BT56 at Bathurst and signal NE1 at Newbridge).

The rule also prescribes the obligations of the PO. In general, the PO's primary duty is to keep the worksite and workers safe. In the case of a fixed worksite, the PO must obtain the authority and provide the extra protection of three detonators and a red flag/red light, at least 500 m on each side of the worksite, or at the limits of the Authority. The rule also notes that if the TOA was for a track vehicle journey and that journey was stopped for the purpose of carrying out work within the danger zone, '... the work must be protected as a fixed worksite'.

Train movements through Newbridge and Wards River are managed using Rail Vehicle Detection (RVD) and fixed trackside signalling. While the NCO has the ability to electronically 'see' the location of a train and 'request' signals to clear via his control panel, the system only works for trains/vehicles that are sensed by the RVD system. TOA's are needed for situations when RVD cannot be used, such as accessing the track for maintenance purposes. Use of a TOA relies on verbally communicated information to ensure separation between rail traffic and track workers. Consequently, it is essential for the NCO and the PO to communicate all information that is critical to the TOA process. For example, the NCO cannot electronically 'see' where the worksite is, so relies on this information being communicated from the PO. Conversely, the PO does not know the whereabouts of trains, so relies on information being communicated by the NCO. Both sets of information are critical to safe work on track, especially where joint occupancy is a consideration.

### Summary

The rule for authorising, issuing and using a TOA was consistent with the proposed method and type of work to be performed at both Newbridge and Wards River. However, the system failed in that a TOA was issued when a train was within the TOA limits and still approaching the worksites. At Newbridge, the failure of the system resulted in a collision and the death of a track worker. Consequently, the documented procedures used to apply the requirements of the rules were examined.

### 2.2.2 Procedure - Track Occupancy Authority (TOA)

A key intent of rule ANWT-304 *Track Occupancy Authority* is for the NCO to ensure that the track is unoccupied and will remain unoccupied by rail traffic (except for approved track work) before issuing a TOA authorising workers to access the danger zone. Under a joint occupancy, the intent is for the NCO to ensure the train has passed beyond the worksite or track access point before issuing a TOA authorising workers to access the danger zone. ANPR-701 *Using a Track Occupancy Authority* documents the procedures for using a TOA. In particular the procedure specifies a series of steps to be followed by both the NCO and the PO.

In the context of the incidents at Newbridge and Wards River, the required procedure was:

• The PO contact the NCO, request a TOA and provide information such as his name, location of the work, type of work, the limits of the TOA, and the intended duration of work.

Whilst information was communicated, the location and type of worksite was not clearly identified.

- The NCO make sure that:
  - there is no rail traffic within the proposed limits of the TOA, or
  - rail traffic within the limits has passed beyond the proposed worksite or the starting point of the track vehicle journey ...

The accuracy of information passed by a PO to the NCO is critical in the issuing of a TOA. Without clearly communicating the geographic location of the worksite it is not possible for the NCO to ensure the train has passed beyond the worksite or track access point. However, for both the Newbridge and Wards River incidents, the NCO assumed that the workers were at the limit of the TOA (Bathurst and Stroud Road respectively) and therefore were behind the train that had already entered the section.

• The NCO applies blocking facilities<sup>19</sup> to prevent entry into the limits of the TOA.

For both the Newbridge and Wards River incidents, a train had already entered the section when blocking facilities were applied.

• The NCO must record all information about the authorisation and issue of the TOA in permanent form.

The TOA form provides the written record of the TOA information (refer to section 2.2.3 Form - Track Occupancy Authority (TOA) ). For both the Newbridge and Wards River incidents, a TOA form was completed by the NCO.

- If the TOA is to be authorised to start after a train movement, the PO must:
  - watch the train pass the point from which the track is to be occupied, and
  - give the NCO the identification number of the lead unit of the train.

<sup>&</sup>lt;sup>19</sup> A 'Block' is a facility used to prevent the unintended clearing of a signal or issue of a proceed authority.

For both the Newbridge and Wards River incidents, the TOA was issued regardless of this requirement because the NCO was under the belief that the workers were behind the train.

• The PO must record all information and repeat the details back to the NCO.

The TOA form provides the written record of the TOA information (refer to section 2.2.3 Form - Track Occupancy Authority (TOA) ). For both the Newbridge and Wards River incidents, a TOA form was completed by the PO. A read-back of the information was performed as was required.

• The PO must confirm with the NCO that blocking facilities have been applied and when authorisation had been issued, put site protection in place.

Blocking facilities were applied.

### Newbridge and Wards River incidents

In the context of the Newbridge incident, the worksite was at a fixed location within the limits of the proposed TOA. While the PO clearly requested that the TOA limits be between Bathurst signal BT56 and Newbridge signal NE1, there was no mention that the work was to be limited to a fixed worksite located about 29 km from Bathurst. Consequently, the PO did not comply with the requirments of procedure ANPR-701 by providing information such as '... location of the work ...'

The procedure also required the NCO to ensure no rail traffic was within the proposed limits of the TOA or that the train had passed beyond the worksite or track access point. For the Newbridge incident, the NCO only asked for the limits of the proposed TOA and made no attempt to determine the location of the work. Without this knowledge, it was not possible for the NCO to ensure the train had passed beyond the worksite as required by procedure ANPR-701. The investigation found that the NCO believed the workers were at Bathurst. He knew that train WT27 had already departed Bathurst, so he issued the TOA without requiring the PO to watch the train pass their worksite and report the identification number of the lead unit.

The scenario for the Wards River incident was similar in that the track access point for the work was about 16 km into the section defined by the limits of the proposed TOA. In this case, the location of the work (Wards River) was communicated at about 0735 when the TOA was first requested. However, due to a number of train movements through the section, the TOA was not issued until 0840 at which time the location of the worksite was not clearly identified. Similar to the Newbridge event and contrary to procedure ANPR-701, the PO did not clearly identify the location of the work and the NCO did not ensure the train has passed beyond the worksite or track access point.

### Inconsistencies in documented procedure

During the course of the investigation, procedure ANPR-701 (*Using a Track Occupancy Authority*) was found to be inconsistent with actual work practices. The procedure did not allow for a scenario that would otherwise be permitted, and intended, under rule ANWT-304 (*Track Occupancy Authority*). While the inconsistency did not contribute to the incidents at Newbridge and Wards River, it is documented hereunder for completeness and as an opportunity for improvement to the process for issuing a TOA.

As described previously, the rule (ANWT-304) states that the NCO must make sure that the preceding train has passed the proposed worksite or the starting point of the track vehicle movement. The procedure (ANPR-701) documents two obligations (NCO and PO) that address the requirement of the rule.

Step 2 of the procedures requires the NCO to make sure that:

... rail traffic within the limits has passed beyond the proposed worksite or the starting point of the track vehicle journey...

Step 10 of the procedures states that the PO must do the following:

If the TOA is to be authorised to start after a train movement:

- watch the train pass the point from which the track is to be occupied, and
- give the Network Control Officer the identification number of the lead unit of the train.

The ARTC advised that, at the time of the incidents at Newbridge and Wards River, there were a range of ways that an NCO could determine if a train had passed a given location, including options that did not require the PO to witness the train.

For example, a road-rail vehicle may have accessed the track under a TOA with the intent to travel through multiple track sections, fulfilling and taking out additional TOA's as required. The NCO may have just signalled a train to depart Bathurst Yard and travel the Bathurst to Newbridge section when he then receives a request for the road-rail vehicle to pass through Bathurst and continue through to Newbridge. Under rule ANWT-304, a TOA may be issued if the NCO ensures that the train has passed beyond the starting point of the track vehicle (road-rail) journey (in this case, the home signal at Bathurst). In this scenario, the PO cannot readily provide the lead locomotive number because the train has already departed Bathurst, but the NCO can confirm the train is travelling away from Bathurst because he had just signalled its departure.

The ARTC advised that this was accepted as a method of addressing the requirements of the rule. However, based on step 10 of the procedure, there are no provisions for a TOA to be issued unless the PO can provide the identification number of the lead unit of the train. It is therefore evident, that the procedure does not reflect the rule or a work practice that is occurring in the field.

It is essential that actual work practices are clearly documented in procedures, that in turn are consistent with documented rules. If undocumented work practices are sanctioned, the risk is that the procedures are seen to be non-manndatory, possibly resulting in the development of unsafe work practices (short-cuts).

### 2.2.3 Form - Track Occupancy Authority (TOA)

The NCO and the PO are required to record all information about the authorisation and issue of the TOA in permanent form. The recording tool used by both the NCO and the PO is the ARTC safeworking form ANRF-002 *Track Occupancy Authority*. While all parties must be conversent with the rule and procedures, it is the form that provides practical guidance for completing the steps required for obtaining a track occupancy authorisation (a sample form is illustrated in Appendix B).

There are two sections to the form, the second is only used if an extention of time is required for the TOA or if a second TOA is to be issued. The first section details nine steps for authorising track occupancy, three of which are optional and only

completed if required for the TOA requested. In this case, only step six was not required since the TOA was not within train order territory.

### Track occupancy authority at Newbridge on 5 May 2010

At about 1054 on 5 May 2010, the PO contacted the NCO and requested a TOA for the Bathurst to Newbridge section. Following the steps on the TOA form, the PO and the NCO communicated and recorded the relevant information for TOA number 11. However, examination of the ARTC voice logs from the Broadmeadow Network Control Centre and the statements from the PO and the NCO, revealed a source of confusion that was likely to have contributed to the collision between the XPT and the excavator.

At the time when the TOA was requested and the form was being filled out, train WT27 had just departed Bathurst. Consequently, the requirement to consider 'joint occupancy' was to be addressed. However, two critical pieces of information were not communicated clearly. Firstly, the PO requested a TOA between Bathurst signal BT56 and Newbridge signal NE1, but did not mention that it was for a fixed worksite located at the 270.500 km point. Secondly, the NCO did not mention that train WT27 had just entered the section at Bathurst. Consequently, neither the PO nor the NCO were aware that train WT27 was travelling towards the worksite near Newbridge.

An examination of form ANRF-002 found that the provision existed to record the limits of the TOA, but there was no provision to record the type of worksite (fixed or travelling) or the location of the proposed worksite or track access point. In addition, the only provision to address joint occupancy stated:

Train Number \_\_\_\_\_\_ is ahead; follow and be prepared to stop.

This wording is likely to guide a NCO's focus towards a vehicle travelling between the limits of the TOA rather than appreciating the existance of a fixed worksite located somewhere within the limits of the TOA.

In the case of the Newbridge incident, the NCO believed the track workers were at Bathurst preparing to access the track and follow train WT27 towards Newbridge, when in fact they were 29 km away at a fixed worksite. Even though the PO acknowledged the existence of train WT27 when reading back the details of the TOA form, he did not question the NCO about the location of the train and assumed it had already passed his worksite.

The ARTC form ANRF-002 *Track Occupancy Authority* provided practical guidance for issuing a TOA, but it was deficient for addressing all the requirements of the rules.

### Track occupancy authority at Wards River on 17 March 2011

For the incident that occurred at Wards River on 17 March 2011, the process for issuing TOA number 50A was very similar to that at Newbridge. In this case, the TOA authorised track work between Stroud Road and South Craven. However, the NCO believed the workers were accessing the track at a TOA limit (Stroud Road), when in fact the workers were about 16 km away at Wards River.

It was also noted that the PO had recorded train DU601 on his documentation, but he was unaware that the train was still approaching his location. This

misunderstanding was in part due to the NCO's initial comment that the train had 'gone'. Since the NCO believed the workers were accessing the track at Stroud Road, his comment was meant to advise the PO that train DU601 had already left Stroud Road. However, the PO was at Wards River and interpreted the comment as train DU601 had already gone past their location. In this case, when the PO had received the TOA he believed the section was clear and they could access the danger zone.

Again, with no provision to record the type of worksite (fixed or travelling) or the location of the proposed worksite or track access point, the information was open to misinterpretation by both the NCO and the PO.

### Authorised forms

Rule ANWT-304 Track Occupancy Authority states:

If a written Authority is issued, it must be issued on a Track Occupancy Authority form (ANRF-002).

The PO associated with the Newbridge incident recorded the information for TOA number 11 on the ARTC Track Occupancy Authority form (ANRF-002). However, the form used by the PO associated with the Wards River incident was a form developed by East Coast Corridor Services (ECCS), albeit a reproduction of the ARTC form.

According to the PO, ECCS believed that the ARTC did not make TOA forms available to contractors for recording written authorities, so they produced their own form. However, consistent with rule ANWT-304, the ARTC advised that the only form authorised for recording a TOA is form ANRF-002. The use of any other form was technically not permitted. The ARTC also advised that they make books of TOA forms (carbon copy) available, free of charge to all contractors, on request to the ARTC network control centre in Broadmeadow.

The use of an unauthorised form did not contribute to the incident at Wards River. However, using an unauthorised form increases the risk that critical changes may not be reflected in unauthorised documentation.

### 2.2.4 Site protection and work within the danger zone

Both the rule (ANWT-304) and procedure (ANPR-701) for conducting work on track under a TOA require fixed worksites to have extra protection<sup>20</sup>. In short, work in the danger zone must not begin before the required safety measures are put in place. In the case of a fixed worksite, the required safety measures are three detonators placed at least 500 m either side of the worksite and a red flag placed in the middle of the track, beside the detonator closest to the worksite (Figure 8). There is no requirement for extra protection if the TOA is for a track vehicle travelling through the section.

<sup>&</sup>lt;sup>20</sup> An exception is a single fixed worksite, either within train order territory or if a staff/half pilot staff can be secured for the duration of the TOA.

### Figure 8: Additional site protection



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### Site protection and work at Newbridge on 5 May 2010

At about 1058, the PO had completed his conversation with the NCO and had received authorisation (TOA number 11) to access the track. The PO then advised the hot-work labourer and the excavator operator that the TOA had been obtained, completed the pre-work safety brief and told the two workers they could prepare for work while he put the site protection measures in place. Based on the hot-work labourer's recollections, it was estimated that he and the excavator operator went to prepare for work at about 1106 (about 10 minutes before the collision).

With respect to placing site protection, the PO's intent was to place the detonators and flag at the Newbridge end of the worksite first. He then intended to travel back to the Bathurst end and place the required protection before returning to the worksite to start work. While the PO did not immediately leave the worksite to place the site protection measures (he was preparing himself for work), it is unlikely that he would have had time to place the detonators and flag at the Bathurst end of the worksite first before train WT27 passed through the worksite.

After the TOA had been received, the hot-work labourer and excavator operator moved off to prepare for their respective tasks. However, both the hot-work labourer and excavator operator accessed the danger zone before the site safety measures had been put in place. The hot-work labourer had laid the oxyacetylene hoses across the track while the excavator operator had driven the machine up onto the track.

It is unclear why the excavator operator took it upon himself to enter the danger zone and mount the excavator on the track. His actions could be attributed to his keenness to work and get the job done, as suggested by fellow work colleagues. The hot-work labourer could not provide a clear explanation as to why he accessed the danger zone, even though he was aware that accessing the danger zone was not permitted until protection had been put in place.

Whilst on the day, the PO did not explicitly state the hot-work labourer and excavator operator should not occupy the danger zone, both were aware that the accepted practice was receipt of a TOA then protection of the worksite, before accessing the danger zone was permitted. However, given the relatively limited railway experience of both the hot-work labourer and excavator operator (approximately 6 months each), it is possible that they both misinterpreted the issuing of the TOA as implying that no trains were approaching the worksite and in their haste to start work violated the procedures by accessing the danger zone. It is also possible that starting work in the danger zone before additional protection had been placed may have become a more common practice, though there was no evidence to support or refute the possibility. It is also possible that positive reinforcement requiring workers to not enter the danger zone until specifically

authorised by the PO, each time a TOA is taken out, may help ensure that rules and procedures are consistently followed.

### Site protection and work at Wards River on 17 March 2011

The work to be undertaken at Wards River involved two work groups about 2 km apart who were conducting vegetation control within a 6 km section of track. The work groups were working towards each other, one using a road-rail vehicle with spray booms while the other was using portable equipment for 'spot spraying'. Based on information from the PO, boom spraying from a road-rail vehicle can be achieved at speeds of up to about 14 km/h. Spot spraying using portable equipment covers about 2 km/h. Consequently, the PO's interpretation was that they were not a fixed worksite and as such did not require additional site protection measures (detonators and flags).

However, the PO's interpretation may not be appropriate when considering the intended definition of a fixed worksite compared to a travelling work vehicle. A travelling work vehicle would normally be a road-rail vehicle travelling through a track section, in many cases between the limits of the TOA. In this case, it could be argued that the two work groups at Wards River were working within a 6 km fixed worksite, noting that the limits of the TOA were 24 km apart.

Examination of the ARTC rules and procedures found no clear guidance for defining a fixed worksite or rail vehicle movement for the purpose of the TOA process. However, information provided by the ARTC during the course of the investigation advised that the scenario presented at Wards River was a fixed worksite. Consequently, the process applied at Wards River was not in accordance with the intent of the ARTC rules and procedures, since additional worksite protection was not put in place before workers accessed the danger zone.

While it is evident that additional worksite protection should have been put in place at Wards River, doing so would have made no difference to the TOA having been issued while a train was still approaching the worksite.

### 2.2.5 Examination of completed TOA forms

In the course of the investigation, the ATSB examined a large number of completed TOA forms to determine if the documented procedures were being followed.

### Broadmeadow Network Control Centre

On 10-11 June 2010, TOA forms authorised by NCO's on the West Board at Broadmeadow Network Control Centre between January 2010 and May 2010 were examined. A total of 1,709 TOA's were authorised, equating to about 12 per day. Virtually all forms had item 4 completed by describing the type of work to be performed. However, the description consisted of generic phrases such as track work, track patrol, welding, earthworks, adjacent line protection and in some cases abbreviated versions of these descriptions. Although the phrases and abbreviations captured a generic meaning of the type of work being performed, they were not consistent and did not describe if the work was at a fixed worksite or travelling through the section.

About 33 percent of the total were authorised with item 5 ticked and a train number recorded, indicating that the authorisation was subject to 'joint occupancy'

requirements. Of these records, about 63 percent were assessed as relating to fixed worksites, 33 percent following movement, 2 percent were illegible, and 2 percent showed no information on the type of work.

An examination of the joint occupancy TOA forms found that only about 50 percent made reference to the locomotive number, especially relevant for following movements. While it was recognised that the TOA form had no provision to record locomotive number, the procedures clearly stated that the PO must 'give the NCO the identification number of the lead unit of the train'. Control centre personnel advised the ATSB that the lead locomotive is identified on the train control graph. However, the practice of recording locomotive numbers on the train graph is independent of the TOA process and not a record that the joint occupancy requirements have been met. To explain further, the NCO must have prior knowledge of the lead locomotive number to be able to verify the PO's communication of locomotive number when it passes the worksite in the field. This 'prior knowledge' would normally be recorded on the train graph at some point in time before the PO communicates his observation. It is therefore unrealistic to also accept the locomotive number notation on the train graph as a record of correct communication from the PO of the train passing the worksite.

It was noted that under some conditions permitted by the rules, a TOA may be issued without the PO having communicated the lead locomotive number. Without a clear record of the locomotive number or other information in relation to the joint occupancy requirements, it could not be verified if, or how, the NCO ensured the train had passed beyond the proposed worksite or track access point before authorising the TOA.

### Bathurst maintenance depot TOAs

On 23-25 June 2010, TOA forms compiled by PO's based at the Bathurst maintenance depot, dating from 2004 to 2010, were examined. A total of 643 forms were examined, not including the forms compiled by non-ARTC PO's. The findings were very similar to the examination of the TOA forms at the Broadmeadow Network Control Centre. Virtually all forms described the type of work to be performed and about 27 percent were issued under 'joint occupancy' terms. In this case, about 20 percent of the joint occupancy TOA's did not have a leading locomotive number recorded on the form.

Further examination of the TOA forms (both sole and joint occupancy) found that numbers (in some cases, multiple numbers) had been noted on free areas of the form (for example, page margins). It was determined that the notations were locomotive numbers. Since a PO should only be required to identify one train as having passed the worksite, the evidence suggested that PO's may be recording lead locomotive numbers of any train observed just in case the NCO requested the information.

Similar to the forms completed at the Broadmeadow Network Control Centre, there was no clear evidence that the joint occupancy requirements of the TOA process were consistently followed. It was noted that there was no facility on the TOA form to record information such as locomotive number, so there was no evidence that the joint occupancy requirements were violated.

### 2.2.6 Summary of rules and procedures

The chosen method for authorising work on track was a Track Occupancy Authority (TOA), which was adequate and consistent with the preferred method and type of work to be performed. The rules and procedures governing the use of TOA's are distributed over a number of documents. The ARTC document ANWT-304 *Track Occupancy Authority* prescribes the rules for using a TOA, including joint occupancies associated with fixed worksites and following movements. Document ANPR-701 *Using a Track Occupancy Authority* prescribes the procedures for using a TOA and the safeworking form is shown in document ANRF-002 *Track Occupancy Authority*.

Rule ANWT-304 was adequate and consistent with the method and type of work to be performed at both Newbridge and Wards River. However, the system failed in that a TOA was issued when a train was within the TOA limits and still approaching the worksites.

For both the Newbridge and Wards River incidents, the PO did not clearly provide information regarding the location of the worksite. The NCO for each incident did not request the information that would allow him to ensure the train has passed beyond the worksite or track access point. As such, neither the PO nor the NCO complied with the requirments of procedure ANPR-701.

The Track Occupancy Authority form (ANRF-002) effectively provided practical guidance for completing the steps required for obtaining a track occupancy authorisation. However, it was found to be deficient for addressing all the requirements of the rules. In particular, there was no provision to record the type of worksite (fixed or travelling) or the location of the proposed worksite or track access point. In addition, the provision to address joint occupancy (...Train Number \_\_\_\_\_\_\_ is ahead; follow and be prepared to stop...) was likely to guide an NCO's focus towards a vehicle travelling between the limits of the TOA rather than recognising the potential that a fixed worksite could be located somewhere within

the limits of the TOA.

Both the rule (ANWT-304) and procedure (ANPR-701) require extra protection at fixed worksites<sup>21</sup>. The required safety measures are three detonators and a red flag placed at least 500 m either side of the worksite. For the Newbridge incident, the PO intended to put extra protection in place. However, both the hot-work labourer and excavator operator accessed the danger zone before this could be done. For the Wards River incident, the ARTC advised that the worksite should have been interpreted as fixed. However in this case, the PO did not consider the worksite to be fixed, so did not intend putting extra protection in place. While it is evident that additional worksite protection was a requirement for both incidents, the process of placing additional protection had no bearing on the TOA's having been issued while trains were still approaching the worksites.

The TOA form used by the contractor at Wards River was an unauthorised reproduction of the form ANRF-002. While use of an unauthorised form did not contribute to the incident, using an unauthorised form increases the risk that critical changes may not be reflected in unauthorised documentation.

<sup>&</sup>lt;sup>21</sup> An exception is a single fixed worksite, either within train order territory or if a staff/half pilot staff can be secured for the duration of the TOA.

An examination of the procedure (ANPR-701) found that it was inconsistent with actual work practices, though the inconsistency did not contribute to the incidents at Newbridge and Wards River. The investigation found that the procedure did not address the scenario whereby a train was within the section and could be verified (by means other than sighting the lead locomotive) as having passed the worksite or track access point, a senario that would be permitted under rule ANWT-304.

# 2.3 Human factor considerations

In general terms, human factor analysis examines how people interact within a system (involving other people or technical systems) and what psychological, physical or biological conditions may influence a person's behaviour. In this case, factors such as expectation, fatigue, medical condition and the effects of drugs and alcohol.

### Expectation

Research has shown that a person's perception of the probability that a given event will occur (or not occur) is strongly influenced by past experience and the frequency with which they encounter the event.<sup>22</sup> In effect, a person's performance is better if the event is expected and worse if it is unexpected. Furthermore, the user's perception that an event is likely to occur is reinforced every time the user encounters that event (and vice versa).

In this case, rule ANWT-304 *Track Occupancy Authority* prescribes that when issuing a TOA no rail traffic was to be within the proposed limits or, if there was a train, it had to have passed beyond the proposed worksite or track access point before the TOA was issued. It was established for the Newbridge incident, that neither the PO, hot-work labourer nor the excavator operator had regularly experienced a situation whereby a train had approached their worksite after receipt of a TOA. It is therefore reasonable to conclude that the three workers did not expect a train to approach their worksite on this occasion. Their perception was likely to be one of 'it is safe to access the danger zone because we have a TOA', regardless of whether or not additional site protection had been put in place. Their perception was likely to have been reinforced during the pre-work brief where the safety control relevant to the hazard of 'rail traffic' was identified as the TOA. While they may have been aware that accessing the danger zone was not permitted until additional site protection was in place, they may not have been aware of the reason for the requirement nor the potential consequence if ignored.

From the NCO's perspective, both fixed worksites and road-rail movements are relatively common, including those that involve joint occupancy with a train. Whilst it is unlikely that a NCO would expect a specific track work scenario, the process for issuing a TOA is guided by information provided by the PO and form ANRF-002 *Track Occupancy Authority*, which includes wording that is likely to guide an NCO's focus towards a vehicle travelling between the limits of the TOA rather than appreciating the existence of a fixed worksite located somewhere within the limits of the TOA.

<sup>&</sup>lt;sup>22</sup> Schoppert and Hoyt, 1968 cited in National Transportation Safety Board (1998a). Safety at passive grade crossing. Volume 1: Analysis. Safety study NTSB/SS-98/02. Washington DC.

On a day-to-day basis, it is the TOA form that provides practical guidance for personnel to complete the requirements of the rules. The TOA form only provided the facility to record the limits of authority and, with respect to joint occupancy, record the number of the train that is ahead before stating the workers may 'follow and be prepared to stop'. The form does not clearly provide for a fixed worksite or where access to the track may be partway through the track section, noting that rarely are road-rail access points provided at the locations permitted to be used as authority limits (for example, a yard limit). Consequently, it is possible that the TOA form may contribute to a controller's expectation that the TOA is intended to authorise a road-rail movement to follow a train and that access to the track is at a limit of the authority.

### Fatigue

In the context of human performance, fatigue is a physical and psychological condition which can arise from a number of different sources, including time on task, time awake, acute and chronic sleep debt, and circadian disruption (disruption to normal 24-hour cycle of body functioning). A review of fatigue research has noted that fatigue can have a range of influences, such as decreased short-term memory, slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance, and increased errors of omission.<sup>23</sup>

For the Newbridge incident, the work rosters for the NCO, track workers and driver were examined for the month leading up to the occurrence. Two separate software based fatigue management tools<sup>24</sup> were used to analyse the work rosters. The analysis suggested that, based on rostered hours, the NCO, track workers and train driver were unlikely to have been impaired by fatigue to a level that would affect safety at the time of the collision. However, it was noted that at various other times throughout the NCO's monthly duties, the models indicated that the NCO's fatigue levels were conducive to performance below a level that would be considered acceptable for safeworking operations. In particular, the elevated risk periods tended to coincide with successive overnight shifts.

While considered useful, bio-mathematical fatigue management tools have a number of documented limitations<sup>25</sup>. In general, software based models do not have the capacity to predict fatigue or fatigue induced errors in all cases for all individuals and should only be considered within the context of a broader fatigue risk management system.

In this case, there was insufficient evidence to determine conclusively if the NCO, track workers or train driver were affected by fatigue. However, analysis based on rostered hours, suggested that fatigue probably did not contribute to any performance degradation on the part of the NCO, track workers or train driver at the time of the collision.

<sup>&</sup>lt;sup>23</sup> Battelle Memorial Institute, 1998, An Overview of the scientific literature concerning fatigue, sleep, and the circadian cycle, Report prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, US Federal Aviation Administration.

<sup>&</sup>lt;sup>24</sup> FAID (Fatigue Audit InterDyne) and FAST (Fatigue Avoidance Scheduling Tool), both commercially available computer programs that derive a fatigue score based on hours worked or rostered.

<sup>&</sup>lt;sup>25</sup> ITSR, 2010, Transport Safety Alert 34 - Use of bio-mathematical models in managing risks of human fatigue in the workplace, <u>www.transportregulator.nsw.gov.au</u>

### Drugs, alcohol and medical condition

An examination of records indicated that all persons involved in the incidents at Newbridge and Wards River were medically fit and in-date as prescribed by the *National Standard for Health Assessment of Rail Safety Workers*. There was no evidence to suggest that medical or physiological factors affected their performance.

Post incident screening indicated that no involved persons were affected by drugs or alcohol. However, a post-mortem examination of the excavator operator determined that an antidepressant was present. Medical information<sup>26</sup> indicated that any psychoactive medication (such as the antidepressant detected) may impair judgment, thinking or motor skills, and that patients should be cautioned about operating hazardous machinery until they are reasonably certain that the treatment does not affect them adversely. Subsequent follow-up established that the excavator operator had been prescribed the drug for an anxiety related condition, had been regularly taking the antidepressant without signs of impairment and had declared the use to his supervisor.

Based on the available evidence and the incidental nature of prescribed drug use, there is no evidence to suggest that the use of prescribed drugs contributed to the collision.

# 2.4 Training

Rail organisations require all personnel working within the rail environment to be appropriately trained and qualified to conduct their specific tasks. The purpose of training and qualifications are to ensure the consistent application of safeworking practices by all employees.

In relation to an NCO, ARTC training includes all aspects associated with the application of operational safeworking rules and regulations, including those associated with issuing a TOA. For some tasks, NCO's are provided with tools to assist with various tasks. The tool provided for issuing a TOA is the TOA form. In this case, the TOA form was completed as required. However, the investigation established that the form was deficient in that it did not guide the NCO in establishing vital worksite locational information and this could result in issuing a TOA when it was not safe to do so.

There is no truly 'National' standard for training track workers. Consequently track managers (such as the ARTC and RailCorp) implement training programs specific to their rail networks. However, in some cases, track managers may recognise the training competencies of another organisation, but only if the training program is considered to be an acceptable equivalent. With respect to work on ARTC track, the minimum training level required is the ARTC training package titled 'National Track Safety Awareness', though the training is only 'national' in the context of track managed by the ARTC. In this case, the two track workers involved in the Newbridge incident held a 'Rail Safety Induction Certificate – Rail Industry Safety

<sup>&</sup>lt;sup>26</sup> Product information obtained from MIMS, a supplier of independent medical information to Australian healthcare professionals.

Induction' (sometimes referred to as a RISI Card), issued by RailCorp on 19 November 2009<sup>27</sup>.

The minimum training level required to take out a track occupancy authority (TOA) was a 'Protection Officer Level 2'. A Protection Officer (level 2) is trained to plan and coordinate work within the rail corridor under the protection of a TOA. The training consists of three parts, off-job (class room) training, on-job (workplace) training and competency assessment.

The PO involved in the Newbridge incident was appropriately trained and qualified as a Protection Officer Level 2 (qualification attained on 17 December 2008). On 5 May 2010, the day of the incident, the PO had completed a worksite protection plan, conducted a pre-work safety brief, which was acknowledged and signed by the hot-work labourer and excavator operator, and obtained a TOA from the NCO. The PO then advised the hot-work labourer and excavator operator that the TOA had been obtained and they could prepare for work while he put the site protection in place. In the context of the worksite safeworking process, the steps taken up to this point were consistent with mandated training documentation. That is, the two track workers had been briefed and were permitted to prepare for work, but had not been authorised to access the danger zone. However, a short time later, both the hotwork labourer and excavator operator accessed the danger zone before the worksite protection arrangements (detonators and flags) had been put in place.

Considering that the actions taken by the hot-work labourer and excavator operator directly contributed to the collision, the training documentation was examined to determine if the level of training was appropriate for the work that was being carried out. It was established that both workers had undertaken the minimum training requirements about 6 months before the collision occurred. That is, track safety awareness training.

Track safety awareness training is a prerequisite for entry to and work within the rail corridor, but it is not a safeworking qualification or an authority to enter the rail corridor. If the intent is for a person to perform work within the danger zone, there are a number of additional requirements, such as supervision by a suitably qualified worker responsible for establishing the appropriate protection for the worksite. In this case, the suitably qualified worker was the PO.

An examination of the training documentation for 'National Track Safety Awareness' (ARTC) and Rail Industry Safety Induction (RailCorp) indicated that track safety awareness training is the base level training that introduces a person to the key generic hazards of an operating rail environment. Training covers issues such as personal protection equipment, medical condition of workers, effects of drugs and alcohol and an awareness of the need to manage fatigue. Associated with working safely within the rail corridor, the training explains the danger zone and addresses various hazards such as electrocution (especially in areas using electric traction) and general hazards such as slips, trips and falls. With respect to collision between a vehicle (train or track machine) and a worker, the training documentation explains risks such as the potential approach of vehicles from either direction, vehicles on adjacent tracks and the difficulty of hearing vehicles when working with machinery.

<sup>&</sup>lt;sup>27</sup> The RISI training was recognised as an acceptable equivalent by the ARTC for track workers in New South Wales.

However, track safety awareness training does not cover the safeworking systems that the track worker may be expected to operate under and the risks that may be associated with those methods of work. For example, under a Local Possession Authority (LPA), the track is closed to all rail traffic. Under a Track Work Authority (TWA), the track may be occupied to carry out work between train movements. The hazards associated with rail traffic are different for each method of track protection (LPA and TWA). Protection Officer training addresses the hazards and the appropriate protection required for each work method. However, track safety awareness training does not specifically discuss the hazards and protections for each method, even though the hazards exist for all workers.

Workplace safety is best achieved when all workers are aware of the hazards, risks (likelihood and consequence) and protection measures associated with the worksite. In this way, all workers are able to contribute to ensuring the safety of the worksite, regardless of who is responsible for putting systems in place to protect against the hazards.

With respect to track work under a TOA, as was the case in this instance, exclusive occupancy is given except for:

- joint occupancy by mutual agreement with the holder of another TOA for the same limits or overlapping limits, or
- joint occupancy following a train movement, or
- joint occupancy by mutual agreement with the holder of a TWA, or
- joint occupancy with a disabled train.

Considering the joint occupancy provisions, it is possible for a track maintenance vehicle operating under a TWA or a second TOA to unexpectedly approach a fixed worksite. Consequently, there are requirements to provide additional protection at fixed worksites (detonators and flags) in order to provide a warning if a vehicle unknowingly enters the worksite. If workers are fully aware of this risk, it is likely that they will protect themselves by not entering the danger zone until detonators and flags are in place. However, as mentioned above, the minimum level of training for track workers does not specifically discuss the hazards and protections for each work method.

It is possible that on-job training may provide workers with information and experience in relation to the various forms of worksite protection which is not provided by the formal competency based training regime. For example, a pre-work brief is required to be undertaken before work commences on-site. The brief is intended to advise workers about potential hazards, associated risks and the planned safety precautions that are to be implemented.

However, an examination of the pre-work briefs implemented at Newbridge (on 5 May 2010) and Wards River (on 17 March 2011) found that the identified hazards were mostly related to general issues such as slips, trips and falls or hazards associated with work equipment (excavator and oxyacetylene cutting). The only mention regarding the hazard of potential rail traffic identified the TOA as the relevant safety control. There was no mention of unexpected approaches of other rail vehicles (joint occupancy) and the use of additional site protection as the relevant safety control.

### Summary of training

There is no truly 'National' standard for training track workers. The track workers involved in the Newbridge incident had each obtained a RailCorp RISI Card (Rail Industry Safety Induction) which was considered an acceptable equivalent to the ARTC's 'National Track Safety Awareness' training. In addition, the workers had participated in a pre-work brief before starting work at the Newbridge worksite. However, despite the training and briefing, the two workers had accessed the danger zone before the detonators and flags were put in place.

An examination of the training regime found that the minimum level of competency based training did not cover the hazards and required protections associated with work on track under a TOA and relied on the pre-work brief (on-job training) to communicate this critical information to track workers. While the PO had conducted a pre-work brief, there was no evidence to suggest that the brief specifically addressed the risks associated with the unexpected approach of rail vehicles and the part played by flags and detonators in protecting the worksite. Nor did the PO specifically direct the workers to stay away from the danger zone until all protection levels were in place.

While it is recognised that the pre-work brief may provide repetitive reinforcement of safety hazards/protections each time a worker is on-site, the knowledge is only attainable over time. An inexperienced worker would only have gained the knowledge presented in the competency based training (track safety awareness). Consequently, it is critical that the safety related information during all pre-work briefs be clearly and consistently presented to ensure an inexperienced worker is fully aware of the potential risks associated with working within the rail environment.

In this case, both track workers were relatively inexperienced in the rail environment, having undertaken the minimum training requirements for work about 6 months before the incident. Had the two workers clearly understood that there was a risk of an unanticipated train movement approaching their worksite, it is probable that they would not have entered the danger zone until the additional protection had been put in place. While the rules prescribe that a TOA should not have been issued until the XPT had passed the worksite, systems can fail as evidenced on this occasion.

# 2.5 Rail safety regulation

The regulatory model adopted in Australia is one of co-regulation, where the rail industry determines the minimum acceptable standards by which operations are conducted, and the relevant state rail safety regulator accredits and audits operators to ensure compliance with the relevant legislation and the proper implementation of their approved safety management system. In this case, the rail safety regulator in New South Wales (NSW) was the Independent Transport Safety Regulator (ITSR).

The issue of track worker safety has been a major focus of ITSR since 2006, with a number of strategies having been employed to educate industry on the direct risk to track workers. Such strategies included audits and onsite inspections. However, the risks associated with work on track are significant and have continued to result in serious incidents. The most serious have resulted in fatalities such as the incident at Newbridge on 5 May 2010 and the deaths of two rail workers at Singleton on 16 July 2007.

The actions taken by ITSR have included an analysis of worksite protection incidents and a program of scheduled and random compliance inspections on worksites throughout NSW. During February and March 2010, ITSR conducted briefings with unions and contractors to advise them of the compliance strategy for worksite protection. The briefings outlined current trends in worksite protection incidents, concerns relating to the training of PO's and the process by which ITSR intended to undertake its compliance strategy.

As a direct result of the incident at Newbridge on 5 May 2010, ITSR issued a Rail Industry Safety Notice (RISN No. 31) on 25 May 2010. The notice, issued for the attention of the general rail industry, reinforced the requirement that additional site protection is needed at fixed worksites. The notice also reinforced the procedures associated with a joint occupancy TOA, especially for verifying the last train had passed beyond the proposed worksite or the starting point of the track vehicle journey. The notice stated that, for all joint occupancy TOA's, the PO must:

- watch the train pass the point from which the track is to be occupied, and
- give the Network Control Officer the identification number of the lead unit of the train.

As a result of the incident at Newbridge and RISN No. 31, the ARTC issued instructions to all ARTC NCO's about the requirements of the procedure for authorising TOA's.

As discussed previously (section 2.2 Rules and procedures), the intent of rule ANWT-304 is to allow joint occupancy between a train and a TOA so long as the NCO verifies that the train has passed the proposed worksite or the track access point. However, both procedure ANPR-701 and form ANRF-002 did not provide clear guidance to address the intended requirements of the rule. While the action taken by the ARTC and ITSR (RISN No. 31, dated 25 May 2010) would appear to be appropriate for preventing a similar incident, the occurrence at Wards River on 17 March 2011 suggested that deficiencies in the TOA process still existed. It is possible that a review and modification to both the procedure (ANPR-701) and the form (ANRF-002), such that they both reflect the intended application of the rule (ANWT-304), may improve the TOA process and prevent similar incidents.

### 2.6 Au

# Australian Network Rules and Procedures

At the time of this incident, the Rail Industry Safety and Standards Board (RISSB) were in the process of developing a suite of nationally applicable safeworking rules and procedures for conducting work on track. The RISSB suite of rules is titled the Australian Network Rules and Procedures (ANRP). Considering the proposed integration of the ANRP into a consolidated rule book applicable to the ARTC rail network, the relevant components of the draft ANRP were examined with respect to the incident that had occurred at Newbridge on 5 May 2010.

Draft document ANRP-3005 *Track Occupancy Authority* prescribes the rules for authorising, issuing and using a TOA. Similar to the existing rules, ANRP-3005 states that a TOA gives exclusive occupancy, but may allow joint occupancy under defined exceptions such as following a 'unidirectional rail traffic movement'. The document clearly states that before issuing a joint occupancy TOA, the NCO must ensure that unidirectional rail traffic has passed completely beyond:

the limits of the proposed TOA, or

- the limits of the proposed worksite, or
- the starting point of the light track vehicle movement.

Draft document ANRP-3006 *Using a Track Occupancy Authority* describes the procedures for using a TOA. Again, the procedure is similar to the existing procedure in that it requires verification that there is no rail traffic within the proposed limits or, if rail traffic is within the limits, ensure it has passed beyond the proposed worksite or track access point. However, ANRP-3006 provides for two options for verifying a train as passed the worksite.

- confirming the identification number of the lead vehicle or last vehicle of the train, or
- confirming the location of the train with the train crew.

In addition, the procedure states that if the PO cannot confirm the identification of the lead or last vehicle of the train, the PO must confirm with the NCO that the section is clear of rail traffic or the train has passed beyond the worksite or track access point.

The draft ANRP procedure clearly recognises the inadequacies of the existing procedures in that it provides additional guidance for when a PO cannot provide identification of the lead vehicle number.

With respect to additional worksite protection, the ANRP provides an optional clause that states additional worksite protection is not required at all fixed worksites. The document only makes it mandatory to include additional worksite protection where a second TOA is issued within the limits. The intent of the optional rules regarding additional worksite protection would appear to be appropriate because a TOA should provide 'exclusive occupancy' such that no train movements exist within the limits of the TOA. However, had these rules applied in the case of the Newbridge incident, additional worksite protection would not have been required and the collision would probably have occurred as it did on 5 May 2010.

It was noted that the ANRP does not include a form for recording the details of a TOA. As described previously, it is the form that provides the practical guide for completing the steps required for obtaining a TOA. Without clear guidance as to the key elements of a TOA form, it is possible that an organisation may implement a process that contains similar deficiencies to that exposed by the incidents at Newbridge on 5 May 2010 and Wards River on 17 March 2011.

# 3 FINDINGS

# 3.1 Context

At about 1116 on 5 May 2010 a collision between a scheduled XPT passenger train and a track-mounted excavator occurred near Newbridge, New South Wales. The operator of the track-mounted excavator was fatally injured.

During the course of the investigation, a similar incident occurred near Wards River, New South Wales. On the second occasion there was no damage or injuries.

Due to the similarities between two occurrences, Wards River was investigated in conjunction with the fatal collision that occurred near Newbridge to establish the existence or otherwise of systemic issues.

From the evidence available, it was determined that there were common issues that existed and although the following findings relate directly to the Newbridge incident the findings equally apply for the Wards River incident. The following findings are made with respect to the Newbridge collision between train WT27 and the track-mounted excavator and should not be read as apportioning blame or liability to any particular organisation or individual.

# 3.2 Contributing safety factors

- The Protection Officer contacted the Network Control Officer requesting a Track Occupancy Authority but did not positively identify the location of the worksite as required by procedure ANPR-701 (*Using a Track Occupancy Authority*).
- The Network Control Officer issued the Track Occupancy Authority without positively determining the location of the worksite, so could not ensure the train had passed beyond the worksite or track access point as required by procedure ANPR-701 (*Using a Track Occupancy Authority*).
- The Protection Officer acknowledged the existence of train WT27 when reading back the details of the Track Occupancy Authority form, but did not comprehend that the Network Control Officer had incorrectly assumed that they were at Bathurst and therefore believed them to be behind the train that had already entered the section.
- The ARTC form ANRF-002 (*Track Occupancy Authority*) was deficient as there was no provision to record critical information regarding the location and type of worksite. Consequently, both the Protection Officer and Network Control Officer incorrectly concluded that the train had passed beyond the limits of the worksite. [Significant Safety issue]
- The hot-work labourer and excavator operator accessed the danger zone before the additional site protection measures (detonators and flags) had been put in place.
- The Protection Officer told the hot-work labourer and excavator operator that he was in receipt of a Track Occupancy Authority, but did not explicitly communicate that they should not occupy the danger zone until all site protection measures were put in place.

- The hot-work labourer and excavator operator were relatively inexperienced and may have assumed that following receipt of the Track Occupancy Authority they were safe to enter the danger zone as no trains would be approaching the worksite.
- The track workers were not provided with sufficient training (competency based or structured on-job training) in relation to the hazards and required protections for working under the authority in place at Newbridge on 5 May 2010. [Significant Safety issue]

# 3.3 Other safety factors

- The ARTC procedure ANPR-701 (*Using a Track Occupancy Authority*) was inconsistent in that it did not allow for a scenario that would otherwise be permitted, and intended, under rule ANWT-304 (*Track Occupancy Authority*). [*Minor Safety issue*]
- Some ARTC maintenance contractors were using non-authorised reproductions of the ARTC's Track Occupancy Authority form. [Minor Safety issue]
- It was possible that at times throughout the Network Control Officer's roster, fatigue levels were conducive to performance degradation. [Minor Safety issue]

# 3.4 Other key findings

- The chosen method for authorising work on track was a Track Occupancy Authority, which was adequate and consistent with the preferred method and type of work to be performed.
- There is no truly 'National' standard for training track workers. In this case, the workers held a certificate issued by RailCorp which was recognised by the ARTC as an acceptable equivalent to the ARTC track safety awareness training.
- The train driver reacted quickly to the track obstruction but there was insufficient time for the XPT to stop. It is unlikely that the driver could have done anything to diminish the consequences of the collision.
- As a direct result of the incident at Newbridge, the Independent Transport Safety Regulator (ITSR) issued a Rail Industry Safety Notice on 25 May 2010, for the attention of the general rail industry. The ARTC then issued instructions to all ARTC Network Control Officers about the requirements of the procedure for authorising Track Occupancy Authorities.

# 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.

Depending on the level of risk of the safety issue, the extent of corrective action taken by the relevant organisation, or the desirability of directing a broad safety message to the rail industry, the ATSB may issue safety recommendations or safety advisory notices as part of the final report.

All of the responsible organisations for the safety issues identified during this investigation were given a 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

### 4.1.1 Deficient track occupancy authority form

### Safety issue

The ARTC form ANRF-002 (*Track Occupancy Authority*) was deficient as there was no provision to record critical information regarding the location and type of worksite. Consequently, both the Protection Officer and Network Control Officer incorrectly concluded that the train had passed beyond the limits of the worksite.

### Action taken by the Australian Rail Track Corporation

The ARTC issued a safety alert (number 52) on 27 September 2011 to advise all stakeholders of improvements to the rules and procedures. The changes were effective from 13 November 2011 and included significant changes to the TOA form and instructions for completing the new form.

The 'Request' section (TOA form ANRF-002B) clearly requires the location of the protection officer to be recorded. The section also provides for two work methods, a track vehicle journey and a fixed worksite. In each case, the form requires the start location and the end location to be clearly recorded.

The 'Validation' section provides for two options if a train is known to be within the limits of the proposed TOA.

### Optional step 11 states:

Train Number [*number*] is still within the limits of the TOA proceeding towards [*location*] and the Protection Officer has observed the identification number of the lead unit of the train [*id number*] which has passed beyond the starting point of the track vehicle journey or fixed worksite boundary, if following be prepared to stop.

Note: The Network Control Officer must confirm the correct identification number of the lead unit of the train.

Optional step 12 states:

A track vehicle journey is to commence within the yard limits at [*location*]. Train number [*number*] is still within the limits of the TOA proceeding towards [*location*]. This train departed the starting point of the track vehicle movement, at [*time*, hours] follow and be prepared to stop.

### ATSB assessment of action

The ATSB is satisfied that the action taken by the Australian Rail Track Corporation adequately addresses this safety issue.

### 4.1.2 Minimum level of training for track workers

### Safety issue

The track workers were not provided with sufficient training (competency based or structured on-job training) in relation to the hazards and required protections for working under the authority in place at Newbridge on 5 May 2010.

### Response from the Australian Rail Track Corporation

The ARTC will reinforce with its Protection Officers the requirements of Work Method Statement TRA-001 (Access to and working on or about track) and in particular the requirement to:

- explain the requirements of the worksite protection plan
- ensure the plan is understood by all staff, and
- question staff on the protection in place and the location of safe places.

In addition, ARTC's internal audit program has been redirected to safeworking with a focus on reviewing safeworking documentation for compliance with ARTC's Network Rules and Procedures.

### ATSB assessment of action

The ATSB is satisfied that the Australian Rail Track Corporation has initiated action to address this safety issue.

### 4.1.3 Inconsistent track occupancy authority procedure

### Safety issue

The ARTC procedure ANPR-701 (*Using a Track Occupancy Authority*) was inconsistent in that it did not allow for a scenario that would otherwise be permitted, and intended, under rule ANWT-304 (*Track Occupancy Authority*).

### Response from the Australian Rail Track Corporation

The ARTC has trained its employees in this particular scenario and will review the procedure to ensure that it is consistent with the training and the TOA Form.

### ATSB assessment of action

The ATSB is satisfied that the Australian Rail Track Corporation has initiated action to address this safety issue.

### 4.1.4 Use of non-authorised forms

### Safety issue

Some ARTC maintenance contractors were using non-authorised reproductions of the ARTC's Track Occupancy Authority form.

### Action taken by the Australian Rail Track Corporation

In relation to the new TOA form, in order to ensure that it was distributed and used across its relevant networks, ARTC conducted extensive briefings with all employees and contractors who had worked on the ARTC network in NSW, in particular POs. In those briefings, the changes to the form were explained and it was made clear that, from the date of implementation (13 November 2011), only the new form could be used. Accordingly, new 'books' of forms were provided to those who attended and requested them, and further supplies are available on request.

### ATSB assessment of action

The ATSB is satisfied that the action taken by the Australian Rail Track Corporation will adequately address this safety issue.

### 4.1.5 Elevated risk due to fatigue

### Safety issue

It was possible that at times throughout the Network Control Officer's roster, fatigue levels were conducive to performance degradation.

### Response from the Australian Rail Track Corporation

The ARTC is applying continuous improvement processes to fatigue as it does with all safety related matters. Recent activities that ARTC has completed in relation to fatigue management include:

- Revising ARTC's fatigue policy and procedure to include more detailed hours of work guidelines, and information to support managers manage potential fatigue related matters,
- Scheduling managers to attend a supervisors fatigue management training course. This course trains managers in identifying and controlling possible fatigue related risks. This training supplements existing fatigue management training for all employees, and
- Rolling out an awareness campaign that has included sending a letter and pamphlet about rest and sleep directly to employee's homes, posters for display at all worksites, and a new safety blog to facilitate improved communications about safety matters.

### ATSB assessment of action

ARTC mangers develop rosters in accordance with the ARTC policies and procedures. Considering the ARTC's advice that the fatigue policy and procedure is to be reviewed along with additional training and awareness programs, the ATSB is satisfied that the Australian Rail Track Corporation has initiated action to address this safety issue.

# **APPENDIX A : Screen capture from animation**



Figure 9: Cab view – 100 m before collision (just before sighting point)

Figure 10: Cab view – 66 m before collision (throttle to idle)



Figure 11: Cab view – 33 m before collision (brake cylinder pressure increasing)



# APPENDIX B : Sample TOA form

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	between						and					
			location/nomi	nated clearance point	nt				location/nom	inated clea	arance point	
3	Duration	Commencing a	t	hou	ITS		Date	1	/20			
		To be fulfilled b	у	hou	ırs		Date	/	/20			
4	Work to be	performed										
5	Train Num	ber		is ahead;	follow a	nd be pre	pared to stor					
-												
6	Security co	de (Train Oro	der territo	ry only)								
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ANRF-002 Track Occupancy Authority. (document dated 4 August 2004)

# **APPENDIX C : New TOA form**

ANRF-002B *Track Occupancy Authority*. (as documented in ARTC safety alert dated 27 September 2011 and implemented on 13 November 2011)

1	TOA Number	
2	Protection Officer details	ì
	Protection Officer name Protection Officer contact number Current Location / kilometrage	, 700
3	hotwan and	B
	Location / nominute clearance point Location / nominute clearance point	Ϊ.
1	Type of work to be done	,s
5	Track Vehicle Journey from 10 Location / kiometrage at which the journey will commance Location / kiometrage at which the journey will commance	]
6	Fixed Worksite from to Workste loadfork light to Workste loadfork light tage	]
7	Another Track Occupancy Authority / Track Work Authority is current for this portion of line.	•
8	Protection Officers have agreed arrangements. Yes Tok when confirmed	
9	Agreed arrangements details	
_	1	Ś
	There are no Trains in the TOA limits.	E
		Ă
	Protection Officer has observed the identification number of the lead unit of the train	ō
	beyond the starting point of the track vehicle journey or fixed worksite boundary, if following be prepared to stop.	-
	NOTE: The Network Control Officer must confirm the correct identification number of the lead unit of the train.	
12	A track vehicle journey is to commence within the yard limits at	
	Train Number is still within the limits of the TOA proceeding towards	
	This train departed the starting point of the track vehicle movement, at hours, follow and be prepared to stop.	
13	Authority Duration Commencing at hours Date / /20	•
	To be fulfilled by hours Date / /20	
14	Security code (Train Order territory only)	A
	Train(s) standing on at	Ē
15	Staffe or Half Pilot Staffe – Section details	1 R
	Nide: In ad dition to section details insects all number where applicable	SS .
16	Blocking facilities have been applied at	1 T
17	The details of this form have been read back by the Protection Officer	]¥
	Protection Officer name	]
	Network ControlOfficer Isoution	, 1
18	Authorised by at	J
Use thi	s section only if the time of a TOA is extended	Ū
19	Extension of time until hours Date / /20	E
20	Authorised by at	SN
	Note: Relieving Protection Officers must sign and date the back of this form to acknowledge handover	<u></u>
Fulfilli	ng the TOA – Protection Officer must tell the Network Control Officer:	-
21	The correct TOA number Yes	-
22	All worksites have been cleared of workgroups, track vehicles and equipment	Ë
23	Worksite protection has been removed (including detonators, flags, point clips)	Ē
24	The track is certified as available for use Yes	E
25	Details of any operating restrictions to apply after fulfilment Yes	E N
26	Staffs, or Half Pilot Staffs, have been replaced (where used)	
47	I ne correct security code (Train Order terntory only) Yes	

# **APPENDIX D : SOURCES AND SUBMISSIONS**

# **Sources of Information**

The sources of information during the investigation included the:

- Australian Rail Track Corporation
- East Coast Corridor Services
- Independent Transport Safety Regulator
- RailCorp (trading as CountryLink)
- Rail Industry Safety and Standards Board (RISSB)

# References

- ARTC network rules and procedures
  - ANWT 300 Planning work in the rail corridor
  - ANWT 304 Track occupancy authorities
  - ANPR 701 Using a track occupancy authority
  - ANRF-002 Track occupancy authority
- RISSB suite of rules, titled the Australian Network Rules and Procedures
  - ANRP-3005 Track Occupancy Authority
  - ANRP-3006 Using a Track Occupancy Authority

# 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:

- Australian Rail Track Corporation
- RailCorp (trading as CountryLink)
- Independent Transport Safety Regulator
- a number of individuals.

Submissions were received from the Australian Rail Track Corporation, RailCorp and the Independent Transport Safety Regulator. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

### Australian Transport Safety Bureau

24 Hours 1800 020 616 Web www.atsb.gov.au Twitter @ATSBinfo Email\_atsbinfo@atsb.gov.au

# **ATSB Transport Safety Report**

Collision between Passenger train WT27 and track-mounted excavator near Newbridge NSW 5 May 2010 RO-2010-004

Final