Australian Government
Australian Transport Safety Bureau

Track worker fatally injured when struck by train W510

Clyde, New South Wales, on 18 June 2016

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2016-008 – 20 April 2020

This investigation was conducted under the *Transport Safety Investigation Act 2003* (Cth) by the Office of Transport Safety Investigations (NSW) on behalf of the Australian Transport Safety Bureau under a Collaboration Agreement.

Released in accordance with section 26 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 2463 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Addendum

Page	Change	Date

Safety summary

What happened

On 15 June 2016, Sydney Trains' maintenance staff identified the 64 crossover points[1] (64 points) at Clyde yard as unfit for service and arranged to book the points out of use. 63B points on the Up Main line were also booked out of service to prevent rail traffic from operating over 64 points.

On 18 June 2016, Sydney Trains' maintenance staff obtained a Track Occupancy Authority (TOA) to protect civil rectification work on 64 points. The protective limits of the TOA extended only to defined clearance points on either side of 64 points and did not include 63B points.

At approximately 0530, as the repairs neared completion, two members of a signal maintenance team (SMT) tasked to test and certify the operation of 64 and 63B points, arrived at Clyde yard. Both members of the team entered the danger zone near 63B points where train W510 struck and fatally injured one worker.

What the ATSB found

Sydney Trains' work-planning process, involving multiple work groups, did not assure the consideration of worksite safety for all tasks undertaken by each involved party over the duration of the work and when returning the rail infrastructure into service.

The Protection Officer (PO), who was part of the civil maintenance team, was aware of the signal team's work tasks but did not consider these in his worksite protection arrangements. The PO had briefed the civil maintenance team, but did not brief the signal team, and the signal team did not seek a pre-work briefing before commencing work on-track. The PO was not provided with a briefing on the scope of the signal team work and did not provide protection at 63 points.

The signal team assumed their workplace was within the limits of the TOA and did not plan their own worksite protection. The signal team entered the danger zone unprotected and unaware of the approach of W510, and the Clyde Signaller did not recognise the signal team were in an unprotected area.

Network communications by various parties in Sydney Trains were not in accordance with the principles underpinning the network rules.

Although not contributing to the accident, the ATSB also found that Sydney Trains' preference to keep the Up Main operational influenced the selection to use the clipped and locked 63B points to protect the worksite at 64 Points. The worksite protection method presented an increased risk in that if track workers inadvertently exited the worksite, they would be in the immediate vicinity of operational main line rail traffic.

The Sydney Trains worksite briefing process did not compel a new work group to seek a worksite protection pre-work briefing when accessing an existing worksite.

Finally, the lack of use of train headlights at night and the absence of any supplementary lighting (such as beacons) may have increased the likelihood of a train driver not seeing workers in the danger zone.

---

[1] 64 points was a set of crossover points, designed to allow rolling stock to cross over from one track to the other over the set of points. Crossover points have two ends (turnouts) that attach to the two rail lines. 64 points allowed trains to cross over from the Up storage siding to the Down through road (see Figure 7).

What has been done as a result

Sydney Trains delivered on a number of safety actions and commitments following the incident.

Some of the direct actions to address the contributing factors to the incident were:

- Review and validation of proposed worksite protection plans is required through Sydney Trains' Corridor Safety Centre.
- Increased numbers of rail safety coaches and mentors, with a required coaching session for all Protection Officers at least once per year.
- Protection Officers are required to implement a form of worksite protection at least once every quarter to remain eligible to be re-certified as a Protection Officer, this activity is monitored by the Corridor Safety Centre.

Additionally, Sydney Trains established a Post Incident Assurance Group (PIAG) to respond to the incident. This group established key focus areas to promote the safety of workers and avoid future incidents. These areas included; Worksite protection, Culture, Planning for maintenance work and Safety critical communications.

The PIAG later established the Safety Focus Program, which included key initiatives:

- Safety Focus Sessions
- Safety Culture Program
- Improvements to Protection Officer selection and training
- Signal Key Switch Project
- Safety Critical Communication Enterprise Wide Program
- Maintenance Access Planning Project, and
- ATRICS ASB.

Safety message

This accident highlights the importance of planning and integrating safety across the entire scope of work. It also highlights the importance of briefing all workers and all workers seeking a safety briefing about the worksite protection plans before work commences and when circumstances change.

Contents

The occurrence

In the early morning of 18 June 2016, a civil maintenance team (CMT) neared completion of their work to replace sleepers under the crossover at 64 points in the Clyde Yard, New South Wales. A Track Occupancy Authority (TOA) protected the civil team's worksite from approaching rail traffic.

A signal maintenance team (SMT) comprised of an electrician and mechanic were to then test and certify the operation of 64 points, and another set of points (63B) that had been booked out of service previously. During the testing, both members of the SMT left the area protected by the TOA to work on 63B points. As the SMT worked on the track at 63B points, an interurban passenger train (W510) travelling along the same track struck and fatally injured the SMT Mechanic.

Events triggering the civil task at 64 points

On 15 June 2016, a team of civil and signal engineering staff from Sydney Trains' Clyde Network Base undertook an inspection of track infrastructure at Clyde Yard in response to ongoing drainage issues causing damage to the track and signalling equipment.

During the inspection, team members identified deficiencies associated with 64 points involving subsidence in the track formation material and decaying timber sleepers. The team categorised the deficiencies as an E2[2] defect and arranged Infrastructure Booking Authorities[3] (IBA) to remove 64 points and other signalling infrastructure from service. As an E2 defect required action to minimise risk within 24 hours, the team also recommended booking 63B points out of service to prevent trains accessing 64 points from the Up[4] Main Line (Figure 1).

On 16 June at 1020,[5] network based signal staff booked 63 points (A and B end) out of service and applied a point clip[6] to the 'B' end. On completion, the signal staff issued the signaller at Clyde Signal Box (Clyde Signaller) with IBA number 160616TPA, recording that 63B points were out of service. At 1340, network-based civil workers applied point clips to 64 points, issuing a separate IBA number 160616 to the Clyde Signaller.

The Clyde Signaller later identified the train plan could not be met for the Rosehill race event scheduled for 18 June 2016, as the IBA 160616 affected access to the siding leading off 64 points to allow storage of additional passenger trains on race day.

Planning of the civil task

On 17 June, the Assistant Area Manager, West Signal Box operations, sought advice from civil maintenance staff about the possibility of returning 64 points to service in time for the scheduled race day trains. Maintenance staff relayed the request to the manager for civil works based at the Clyde Network Base (Manager Civil), who initially denied the request due to the unavailability of sufficient materials, labour and plant.

After another request from train operations staff, the Manager Civil contacted the civil maintenance team leader (CMT Leader) who agreed to arrange labour for the repairs to the track

---

2 E2 (Emergency 2) is a category in Sydney Train's maintenance standards. An E2 category defect required an action to minimise the risk to rail operations within 24 hours under normal operations.

3 An Infrastructure Booking Authority (IBA) informs Network Control Officers that infrastructure is temporarily or permanently removed from service ('booked out of use'), or installed or returned to service ('booked into use').

4 Trains travelling toward Sydney are referred to as Up trains while trains travelling from Sydney are referred to as Down trains. The tracks that they travel on are referred to as 'Up' or 'Down' lines.

5 All times referred to in this report are Australian Eastern Standard Time (EST).

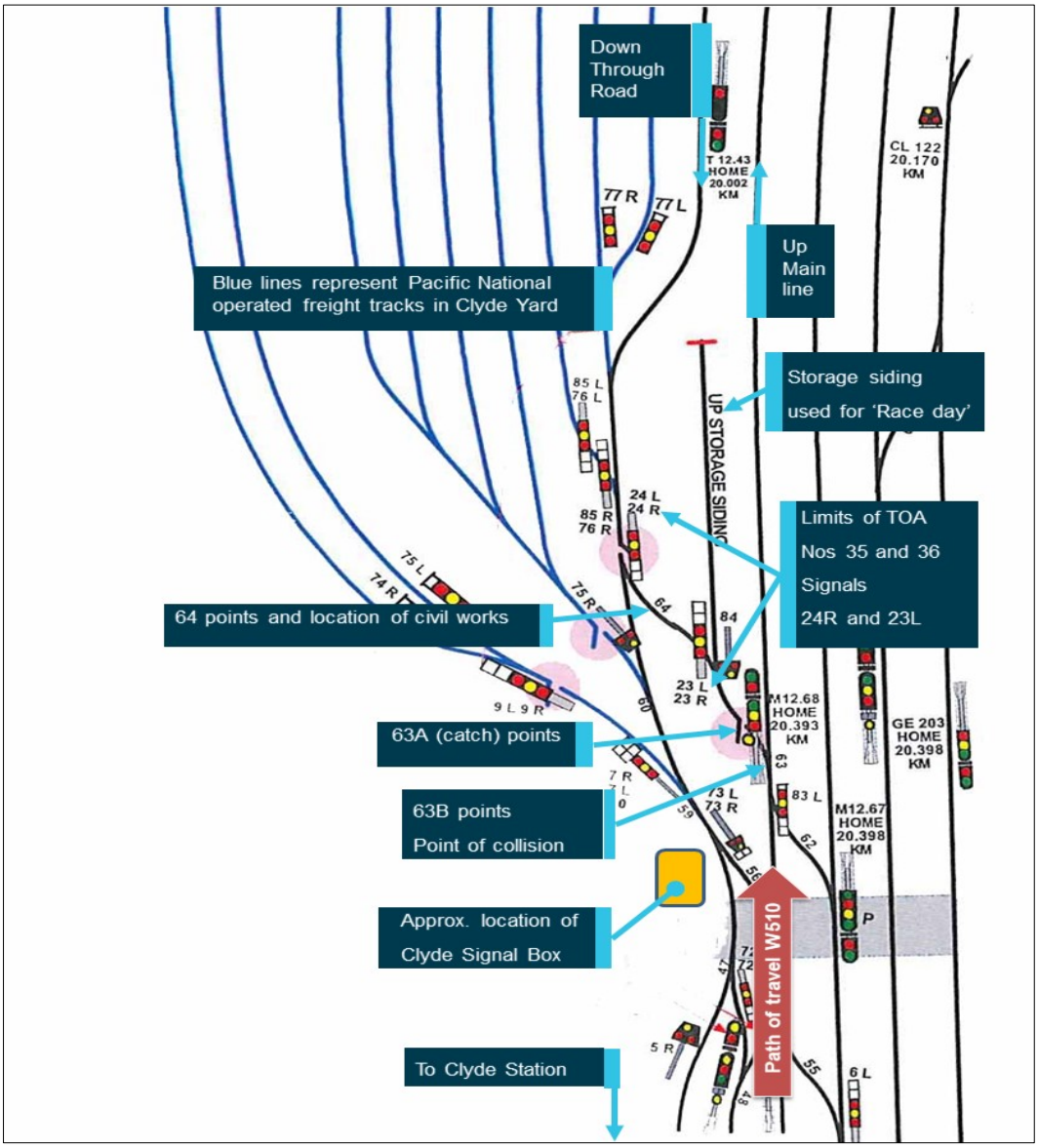
6 A point clip manually secures a point switch to the stock rail. A point clip can be used when the points are in either the normal or reverse position and is padlocked to prevent unauthorised removal.

at 64 points as an ‘emergency call-out’. Later that afternoon, the CMT Leader confirmed the availability of resources for the repair work to commence that night.

The civil maintenance team (CMT) were tasked with replacing a pattern of four timber sleepers under 64 points that had rotted, potentially affecting the safe operation of train services. The replacement of the sleepers would restore the condition of the track to comply with the Sydney Trains infrastructure standard. The Manager Civil allocated work tasks to the Protection Officer (PO) and CMT Leader near the end of their day shift. The expectation was that the work later that night would take about three hours to complete.

At 1442, the Signals Team Leader e-mailed the night shift SMT Electrician informing him the civil team would be fixing civil issues on 63 and 64 points that night and identified where the SMT Electrician would find the IBA and a handwritten disconnection list for various signalling infrastructure.

Figure 1: Site map of Clyde showing area of civil works and involved points



Source: Sydney Trains, annotated by ATSB

Arranging worksite protection for the civil task

At about 1900, the PO telephoned the Clyde Signaller to discuss the planned work and to enquire whether a Track Occupancy Authority (TOA) (see *Network Rules*) was required from the Clyde Signaller or if protections through the Pacific National Clyde Yard Master (PN Clyde Yard Master) were sufficient, as the PO understood 64 points to be within the PN yard[7]. The Clyde Signaller referred the PO to Pacific National for clarification.

About an hour later, the PO telephoned the Clyde Signaller to discuss further the rail infrastructure affected by the work. After confirming that the Clyde Signaller controlled 64 points, the PO discussed the requirement for a TOA to protect the worksite. There were several interruptions during the telephone call while the Clyde Signaller attended to other tasks. The PO informed the Clyde Signaller that he and the CMT Leader had to postpone discussions, as they needed to attend to a call-out at another location. They agreed to meet at the Clyde signal box on their return to continue planning the protection arrangements. In the meantime, the Clyde Signaller informed the Train Controller for the Goods Board (Goods Controller) of the PO's plan for protecting the work in the Clyde Yard.

At about 2100, the SMT members commenced their rostered shift and began planning their night's work, including reviewing e-mails from the signals team leader. About 30 minutes later, all of the CMT members had returned to work and signed on for their overtime shift at the Clyde Network Base. Shortly after, the SMT Electrician spoke to CMT members seeking additional information about the proposed work, who advised the SMT Electrician to contact the PO.

At about 2200, the PO provided a worksite protection pre-work briefing to the five members of the CMT, who each signed the worksite protection pre-work briefing form recording their attendance. The SMT were not asked and did not attend this briefing. However, the SMT Electrician reported making multiple attempts to contact the civil team in an attempt to understand the scope of works and timings. The SMT Electrician also recalled that around this time he contacted the PO who advised that the start time for the work on track was unknown.

At 2215, the Goods Controller contacted Infrastructure Control staff (ICON) enquiring if they knew of the civil work at Clyde Yard 64 points. ICON was not aware as Clyde Network Base had not informed them of the work. ICON undertook to confirm what was happening and contacted the CMT Leader to establish if they were to work on 64 points. ICON called the Goods Controller back to confirm that the civil team were working out protection with the Clyde Signaller, and to expect to hear from them.

Shortly after, the PO contacted ICON enquiring if they knew of the work at 64 points and again discussed the possible requirements for implementing a TOA. The PO and ICON discussed whether this required possession of the Main line as the PO maintained that the protecting signal must be greater than 500 m from the worksite[8] even though locking 63B points in the normal position already excluded rail traffic accessing 64 points from the main line. ICON questioned whether the PO really needed to take possession of the Up Main line referring the PO back to the Goods Controller.

The PO contacted the Goods Controller advising the need to take possession of the Up Main line and explaining that while locking 63B points in the normal position prevented rail traffic accessing 64 points, the points were within 500 m of the worksite. The Goods Controller referred the PO back to the Clyde Signaller to determine the TOA requirements.

---

7 64 points were in the PN yard but under the control of the Clyde Signaller.

8 The Network Rules require the protecting signal for a worksite to be at least 500 m from the worksite. Unless a set of points can be clipped and locked to prevent *access* to the portion of track within the TOA limits, the distance between the signal protecting the limits of the TOA and the worksite must not be less than 500 m (see NWT 304 Track Occupancy Authority for more information).

Shortly after, the PO and the CMT members signed a 'permit to work' enabling access to the Pacific National (PN) managed portion of the Clyde yard. Around the same time, the PO contacted the Goods Controller advising the PN Clyde Yard Master would place blocking facilities[9] (blocks) in Clyde Yard preventing access to the worksite from the east and that the last PN train into the yard would arrive at approximately 0130.

While waiting for the last PN train to arrive, the CMT commenced some preparatory work in the PN yard area under the permit to work. During these preparations, members of the CMT accessed the track at 64 points to mark out the pattern for sleeper replacement and to remove some track fastenings. The work to remove the sleepers did not commence until after the last train had cleared and protection arrangements were in place for an excavator to cross tracks and access the worksite at 64 points (see *Civil task at 64 points* below).

At 2306, the Clyde Signaller and the Train Controller for the Outer Board (Outer Controller) discussed the protection needed for the work. The Outer Controller sought clarification of why a TOA would include the Up Main line to which the Clyde Signaller identified the 63B points were within 500 m of the worksite. The Outer Controller expressed the view that with 63B points clipped and locked in the normal position he could not see a risk, as trains could not access the worksite. The Clyde Signaller sought clarification if additional signal protections on the main line were necessary. The Outer Controller repeated that the only identified risk was from rail traffic entering from the east end of the yard, as the clip and lock on 63B points prevented rail traffic entering from the west end of the yard.

Shortly after, the Clyde Signaller contacted the PO confirming the work could go ahead with 63B points clipped and locked in the normal position. The PO again questioned the proposed protections, as 63B points were within 500 m of the worksite. The Clyde Signaller told the PO of the discussion with the Outer Controller and that they could not see a problem as long as 63B points were in the normal position and locked. The Clyde Signaller then advised the PO that the Outer Controller wanted to talk to him.

The PO contacted the Outer Controller repeating his view that protections had to be located 500 m from the worksite for a TOA. The Outer Controller replied 'not necessarily' and discussed with the PO that 63B points locked in the normal position 'eliminated the risk'. The PO understood that the points excluded trains from the worksite but expressed an uncertainty about what protections were required and who would be approving them (Goods Controller or PN Clyde Yard Master). The Outer Controller informed the PO that an authority (TOA) was required, and advised he would talk to the Clyde Signaller about it.

The PO and Clyde Signaller then met at the Clyde signal box to discuss the details of the TOA in person before the Clyde Signaller called the PN Clyde Yard Master to inform him of the proposed arrangements for the TOA. The PN Clyde Yard Master was satisfied with the arrangements as long as it did not affect train movements in Clyde yard.

At 0005 on 18 June, the Clyde Signaller called the Outer Controller[10] to seek authorisation for the TOA. After going through the TOA details, and confirming the section was clear of traffic, and the signals had been set and blocks applied, the Outer Controller advised that TOA 35 had been authorised at 0011.

Civil task at 64 points

There was a delay to the start of the civil works until 0131 to clear a freight train movement into the PN yard before the CMT's excavator could cross the tracks to access the worksite. After the freight train cleared, the Clyde Signaller advised the PO that he had placed blocks on several

---

[9] A 'blocking facility' is 'A facility or device used by a Competent Worker to prevent either the unintended issue of an Occupancy Authority, or the operation of points or signalling equipment'.

[10] Due to a shift change, this was now a different person to who the Clyde Signaller had made the previous arrangements

points (54, 56, 57, 60) to exclude rail traffic and protect the excavator as it accessed the worksite. The PO repeated the point numbers and recorded their details on the worksite protection plan.

At 0222, the Clyde Signaller informed the Outer Controller the IBA on 63B points would impact on the Race day program as the points were required to access the Up-storage siding. In a subsequent three-way telephone hook-up between them and ICON, the ICON representative informed the Clyde Signaller and the Outer Controller that he would get signals staff on the following day shift from Clyde Network Depot to book 63B points back in at about 0630. Around this time, the SMT Electrician contacted the PO advising they were in transit to the worksite when the PO asked them to collect a chainsaw en-route. The SMT arrived at Clyde yard at about 0318 and delivered the chainsaw before departing about 20 minutes later and returning to Homebush to wait for the work on 64 points to be completed.

At 0420, the PO called the Clyde Signaller to request an extension of TOA 35 by one hour to 0600, as the work was taking longer than expected. The Clyde Signaller confirmed the request with the Outer Controller before contacting the PO and extending the TOA.

Completion of the civil task and commencement of electrical testing of points 63 and 64

At 0523, the SMT Electrician contacted the PO to enquire on the progress of the civil works. He reported that he informed the PO that the SMT would not return until the TOA was back in place. The PO confirmed that the civil works were just about finished. Shortly after, the SMT arrived at the worksite and the SMT Electrician recalled that the PO told him there was a TOA in operation that would expire at 0600, but did not go into the details of the area that the TOA covered. The SMT Electrician recalled that there was no pre-work briefing provided by the PO and the SMT did not sign the pre-work briefing form. The PO recalled that he did not meet with the SMT on their return, so no pre-work briefing was possible.

At 0541, the SMT Electrician telephoned the Clyde Signaller to test the operation of 64A/B points. After removing a clip and lock, the SMT Electrician confirmed the correct operation of that point to the reverse and normal positions. The SMT Electrician then told the Clyde Signaller he would call him back when he got to the other end of 64 points.

At 0547, the PO contacted the Outer Controller to inquire if he could get a second extension to TOA 35. The extension of time was required to inspect the track before booking it back in to service. The Outer Controller advised the PO to contact the Clyde Signaller to arrange, as they could not extend a TOA more than once. The PO contacted the Clyde Signaller who then called the Outer Controller to arrange the second TOA, which was authorised as TOA 36. The Clyde Signaller then called the PO to provide details of the new TOA, confirming it was authorised and to fulfil TOA 35.

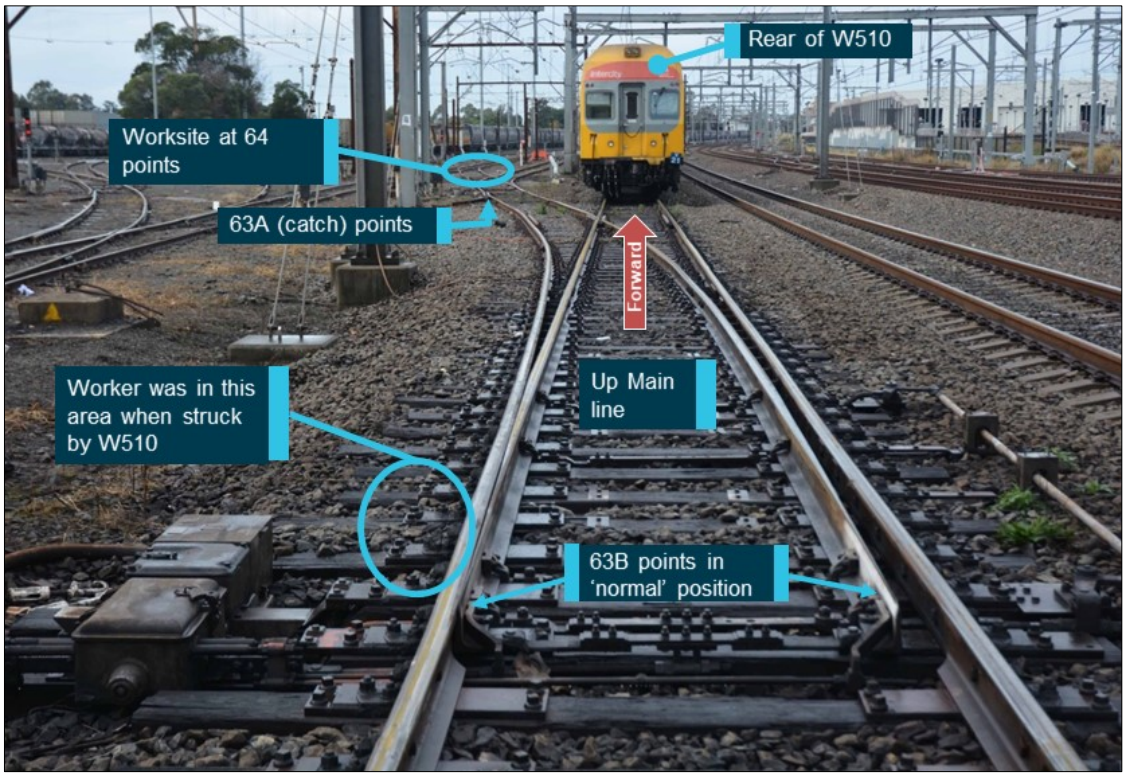
At 0604, the SMT Electrician telephoned the Clyde Signaller to complete testing of 64 points. The SMT Electrician then told the Clyde Signaller, ‘okay, I’m finished with 64…. Just got to take the point clip off 63’. The SMT Electrician then commenced walking toward 63B, while maintaining the mobile telephone connection with the Clyde Signaller. The Clyde Signaller asked the SMT Electrician to ‘hold on a minute’ while he contacted the Outer Controller to advise the time that TOA 35 was fulfilled.

Around the same time, the SMT Electrician had begun removing the point clip and lock from 63B points but had difficulty, so he called out to the SMT Mechanic to bring a podger (metal crow bar).

At 0607, the SMT Mechanic arrived at 63B point with the bar and took over removal of the point clip and lock. Both members of the SMT had entered the danger zone unprotected and unaware of approaching train movements. Concurrently, train W510 travelling on the Up Main line at a speed of about 67 km/h passed through Clyde Station and approached 63B points.

The SMT Electrician recalled he was conversing with the Clyde Signaller regarding the IBA for 63B points while opening the lid to the point machine to check for lock and detection when he noticed the approaching train and yelled a warning to the SMT Mechanic. About the same time, train W510 passed over 63B points, striking and fatally injuring the SMT Mechanic.

Figure 2: 63B points in normal position prevents movements towards 64 points



Source: ATSB

Post-collision

The collision caused the air brakes on the train to apply[11] and the train came to a stand about 20 seconds and 200 m later. The train driver contacted the Clyde Signaller informing him that the train had come to a stand after striking something then losing the air, and he could not build air pressure back up. The Clyde Signaller informed the train driver that the train had struck a worker on the track.

At 0611, the Clyde Signaller called the Outer Controller and requested the emergency services to attend to the site. The Outer Controller commenced notifications, initiated incident management procedures and commenced diverting other rail traffic from the area. He arranged with the Clyde Station Duty Manager and Sydney Trains Security for Police and Ambulance to arrive on site. At 0615, the Incident Response Commander received notification and arrived on site at 0653. A supporting Incident Response Commander arrived on site at 0720.

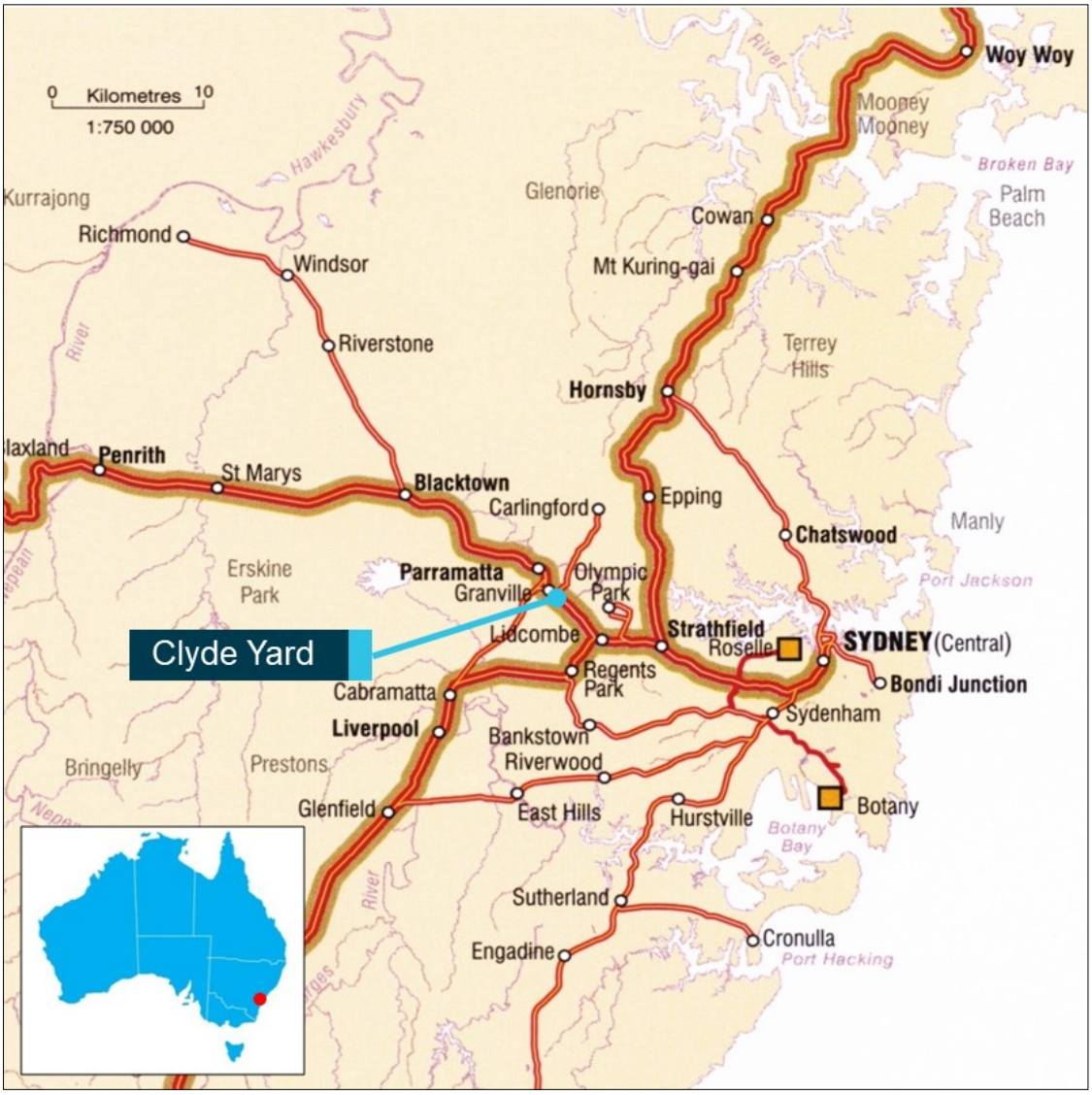
[11] The brakes automatically applied on W510 when the trip valve activated and air pressure in the brake pipe was vented and lost. The trip valve is an assembly on the brake pipe that connects the automatic braking system through each car for the entire length of the train. It is a mechanism mounted on the leading axle box of a train to stop a train should it pass a signal at stop without authority. Its arm vents the brake pipe pressure when struck. The venting causes an emergency application of the air brakes and the train to lose power. In this incident, it is highly likely that the trip valve was activated by the physical impact with the SMT Mechanic.

Context

Location

Clyde Yard is located in the Main Western rail corridor approximately 20.660 km[12] by rail from Sydney Terminal (Figure 3). Clyde is a junction of the Main West and Carlingford rail lines.

Figure 3: Location of Clyde



Source: NatMap, Railways of Australia, Geoscience Australia, annotated by ATSB

Clyde Yard is on the northern side of the Main Western line and is utilised by Sydney Trains for through movements and stabling of passenger trains and by Pacific National for the stabling of freight trains and limited maintenance activities.

Track layout at Clyde

The Up and Down Main lines and Up and Down Suburban lines at Clyde, between Auburn (18.551 km)[13] and Granville (21.148 km), are part of the Sydney Trains-controlled Metropolitan

[12] All kilometres are measured from No.1 platform at Central railway station, Sydney Terminal.

[13] The rail kilometrages shown for Auburn and Granville stations were referenced from NLA 200 and NLA 206 respectively.

Rail Area network. Sydney Trains was responsible for track maintenance, signalling, network control and incident management functions in this corridor. The posted track speed for the Up Main line through Clyde station and over 63B points was 80 km/h for electric passenger services.

The Clyde signal box provided the control and monitoring function for all signals and points on the Up Main line around the 63 and 64 points together with other signalling equipment within the area of control. This area encompassed the Main West line spanning approximately 1.2 km to include the entry/exit to/from the Carlingford line, Pacific National freight yard (Country end) and Auburn Maintenance Centre (Country end). The control area abutted Auburn signal box (on the Sydney side) on the Down Main, Suburban, Relief and Through Roads, Granville signal box (on the Countryside) on the Up Main and Suburban lines, and Parramatta Road signal box on the Carlingford line.

The Pacific National rail freight yard consisted of a system of tracks used for shunting and marshalling of freight trains (Figure 1). The PN Clyde Yard Master[14] was responsible for coordinating, managing and directing the safety of all rail movements within the PN yard area.

Operational interfaces and staff involved

Train Controller

The primary responsibility of train controllers is to manage train paths for the safe and efficient transit of rail traffic. Train controllers and their supervisory staff were located within the Rail Management Centre (RMC) at Sydney Central Station along with representatives of other supporting functions including ICON, customer and information services, security, train crewing and train monitoring. The RMC provided 24/7 integration and coordination of all operational train services (both Sydney Trains and non-Sydney Trains services) in the area bounded by Nowra, Macarthur, Newcastle and Lithgow. For the works at Clyde on 17–18 June, the train controllers (Goods Controller and Outer Controller) had visibility of the layout and status of the points, signals and other monitored equipment at Clyde via an overview (mimic) panel.

Signaller at Clyde Signal Box

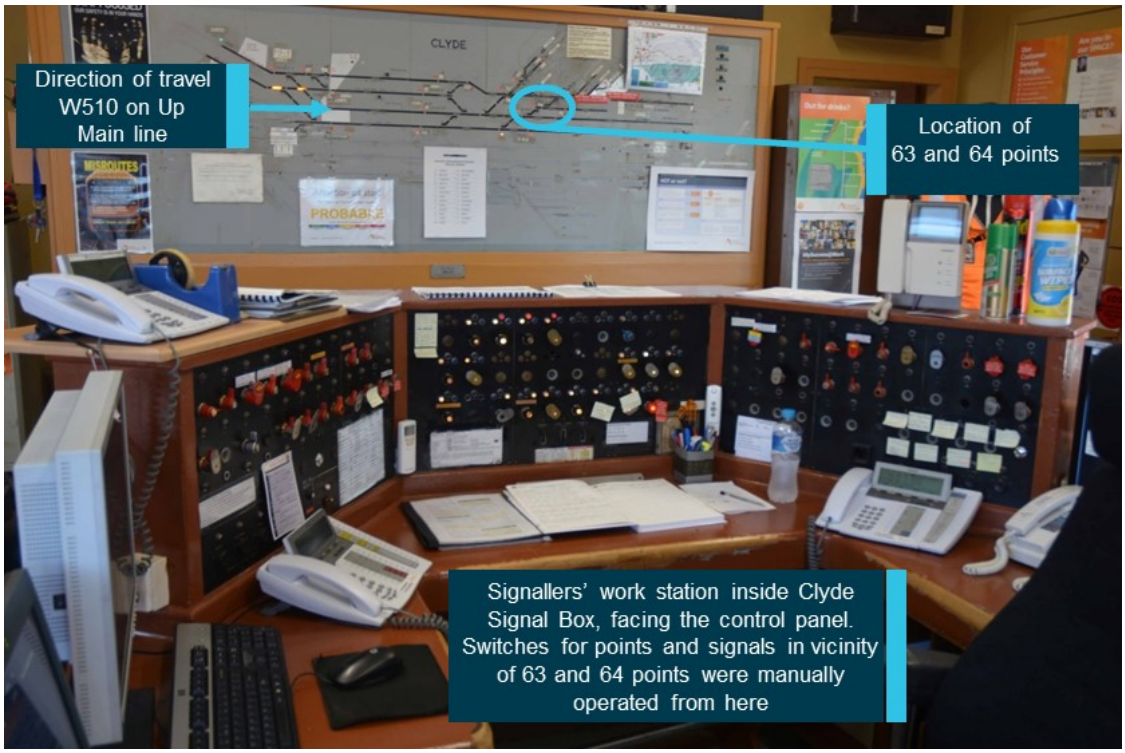
The primary responsibility of the Signaller is to issue Occupancy Authorities and control points, signals and other signalling equipment to manage routes for the safe and efficient transit of rail traffic through the area of their control. The Signaller is also responsible for issuing work on track authorities (LPA and TOA) and work on track methods.

The signaller at the Clyde signal box (Clyde Signaller) was a Sydney Trains employee with 34 years' rail experience. The Clyde Signaller held the required qualifications and competency for the role performed and was assessed fit for duty in accordance with the requirements of the National standard of Health Assessment for Rail Safety Workers.

Although the Clyde Signal Box was located in close proximity to the worksite, the Clyde Signaller could not physically see the civil worksite at 64 points or persons moving within the worksite or yard area on 17-18 June 2016. This is because the signalling system is an electronic system that does not require a line of sight for the signaller to operate. In this instance, the Clyde Signaller's work station faced away from the windows that looked out to the Clyde Yard and the worksite location (Figure 4 and 5). The Clyde signaller was not required or expected to watch the actual work activities in the Yard.

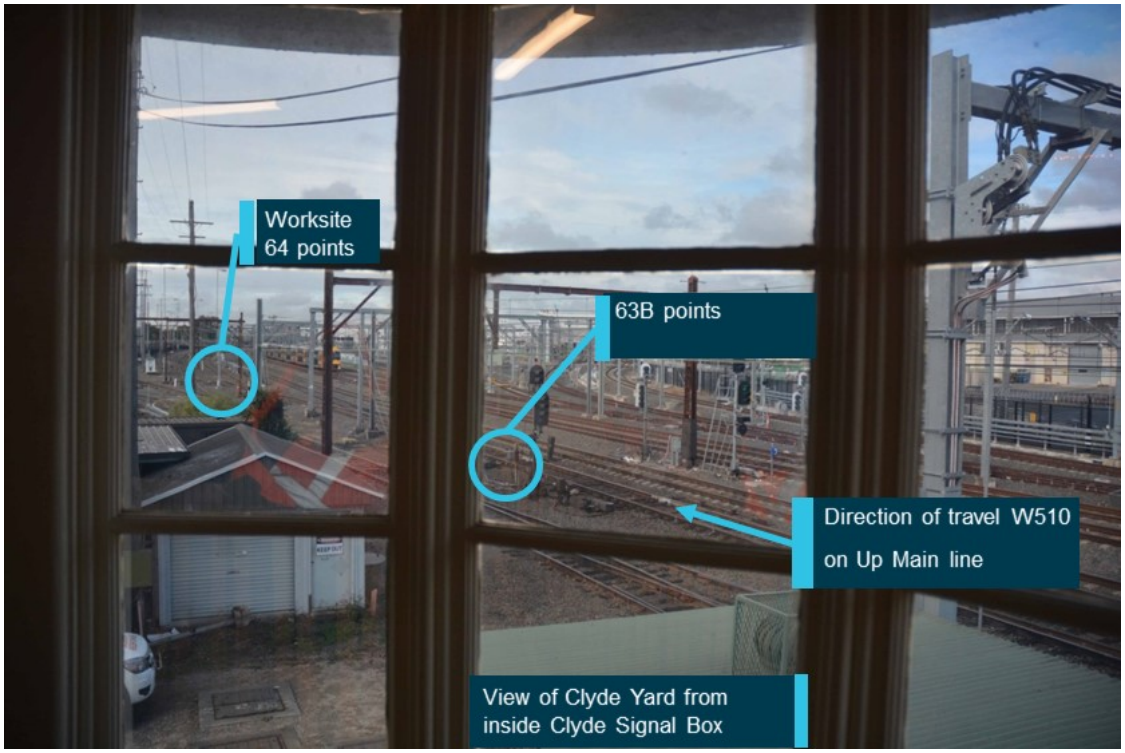
[14] The PN Clyde Yard Master was also responsible for liaising with third parties and where required authorising and issuing 'permits to work' to those whom required to undertake work within that defined area. On the night of the accident, the PN Clyde Yard Master was also responsible for ensuring that rail traffic within their defined area did not enter the work area. The PN Clyde Yard Master did not have visibility of the worksite, equipment or individuals involved with the work on 64 points, 63 points, or that area of the danger zone more generally.

Figure 4: Clyde Signaller's workstation



Source: ATSB

Figure 5: Daylight view of Clyde yard from Clyde Signal Box



Source: ATSB

Civil Maintenance Team

The civil maintenance team (CMT) comprised:

- A PO (responsible for managing worksite protection)
- an acting team leader (CMT Leader) responsible for managing the rectification work
- three civil infrastructure workers under the direction of the CMT Leader
- a third party contract excavator operator.

All members of the CMT, except the excavator operator, were Sydney Trains employees based at the Clyde Network Base. All the Sydney Trains CMT members had worked their rostered day shift between 0700 and 1500 prior to returning to work at 2130 to repair 64 points on an overtime shift.

The Protection Officer

A Protection Officer (PO) was responsible for managing the rail safety component of worksite protection to keep the work site and the workers in the work site safe from rail track movements. The PO was a Sydney Trains employee with five years rail experience. The PO held the required qualifications including a worksite protection competency (protection officer level 2) for the role performed and was assessed fit for duty in accordance with the requirements of the National standard of Health Assessment for Rail Safety Workers.

On 17 June, the PO commenced his rostered shift at 0539, although the PO was not involved in the planning of the repair work, he concluded his shift at 1500 with the understanding that the CMT would return later the same day and commence an overtime shift at 2130 and he would be arranging protection for this emergency work.

Signal Maintenance Team

The Clyde Network Base signals work group comprised two signal electricians and two signal mechanics, a Senior Signals Engineer and Signals Team Leader. The signals work group were responsible for checking signals and points were operable before going back into service, conducting out-of-course repairs and minor routine maintenance to signalling equipment and points throughout the rail network bounded by Clyde, Macdonaldtown, North Strathfield, Sefton and Marrickville. Additional areas of responsibility included the Up and Down Yards at Clyde, the Carlingford line, the Olympic Loop line, the Goods line at Chullora and Enfield Yard. The signals work group regularly worked with the civil maintenance teams undertaking repairs to track and other civil infrastructure.

General supervision and tasking of signal maintenance staff was the responsibility of the Senior Signals Engineer and Signals Team Leader. However, as these positions worked weekday business hours, there was little interaction outside business hours, with tasking routinely made via notes or e-mail.

The signal maintenance team members (SMT) involved in the accident included a signal electrician (SMT Electrician) and a signal mechanic (SMT Mechanic).

On the 17 June 2016, the Signals Team Leader emailed the SMT Electrician with the tasking and instructions for their shift that night. The Signals Team Leader wrote:

> Tonight [CMT] will be chucking a few new timber in points in Clyde Up Yard. They are planning on starting at 2200. They will only be fixing the civil issues on 63 and 64 points not cleaning the rusty rails. On my shelf there is a disconnection list and IBA for you. Hopefully it goes smoothly. Also I've chucked a two Loc's at CLJ onto T4 but it won't let me attach them to this email so I sent a different one.

The SMT Electrician was a Sydney Trains employee with 13 years' rail experience. The SMT Electrician held the required qualifications for the role performed as well as competencies in worksite protection (protection officer level 3). The SMT Electrician was assessed fit for duty in

accordance with the requirements of the National standard of Health Assessment for Rail Safety Workers.

The SMT Mechanic was a Sydney Trains employee with 26 years' rail experience. The SMT Mechanic held the required qualifications for the role performed as well as competencies in worksite protection. The SMT Mechanic was assessed fit for duty in accordance with the requirements of the National standard of Health Assessment for Rail Safety Workers.

Network Rules

The Sydney Trains Network Rules prescribe the requirements to manage safety on the network for train operations and working in the rail corridor.

NWT 300 Planning work in the rail corridor

Network Rule NWT 300 Planning Work in the Rail Corridor required a safety assessment of the work and of its potential to intrude on the danger zone. Work in the danger zone must use one of the protection methods listed below and not begin until the required safety measures were in place:

- one of three authorities:
    - Local Possession Authority (LPA)
    - Track Occupancy Authority (TOA)
    - Track Work Authority (TWA)
- or method of protection:
    - Absolute Signal Blocking (ASB)
- or safety measure:
    - Lookout Working.

The level of safety must not be reduced to allow rail traffic movements and each work on track method had mandatory minimum safety measures with the highest protections provided by an LPA to the least provided by Lookout Working.

The preferred methods for working on track were the LPA and TOA. In addition to the safety assessment and selection of protection method, Network rule NWT 300 required the PO to:

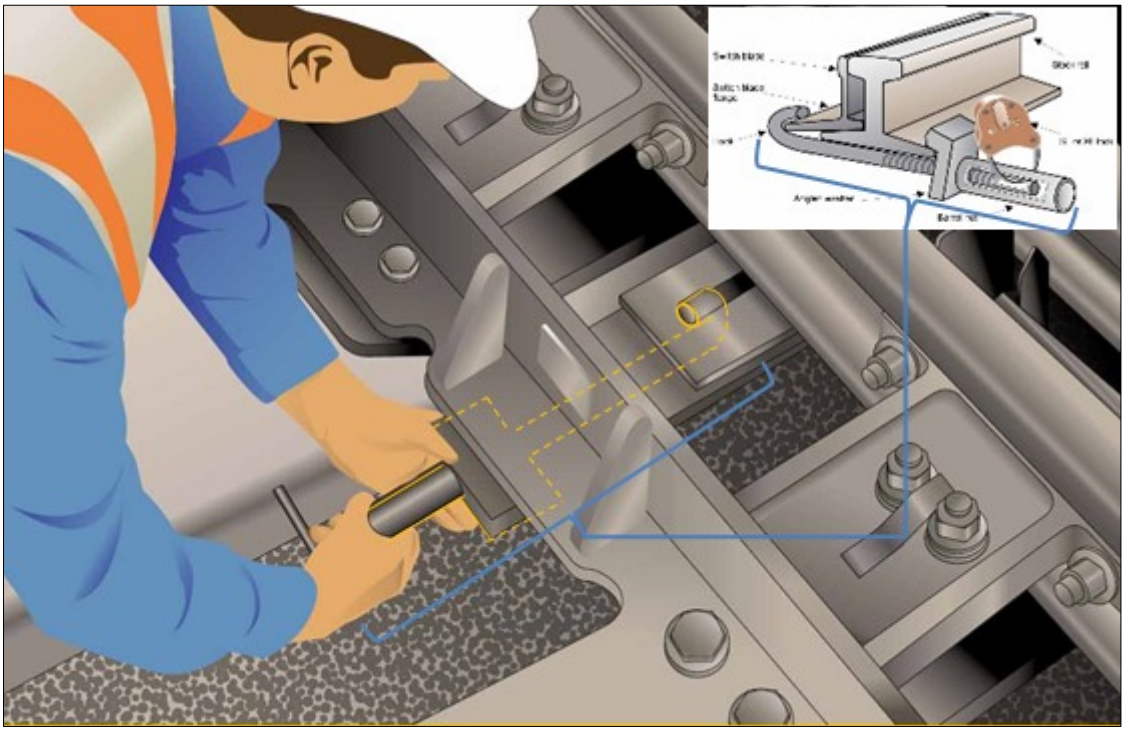
- brief workers about the rail safety component of worksite protection
- make sure that the rail safety component of the work is done safely
- keep records about the method used for working safely on track and protection arrangements, and
- communicate with the Network Control Officer about the work.

Sydney Trains form NRF 015 *Worksite Protection Plan* defined the type and format of information recorded by an assigned PO. In completing the worksite protection plan for the civil works at Clyde 64 points, the PO had several discussions with operational staff to determine the protection arrangements for the work.

The PO's initial plan for the TOA included locating worksite protection (track signals, flags/lights) on the main line, to provide the specified distance of 500 m between the worksite and the worksite protections. However, the Train Controller advised that there was no need for an occupancy on the main line, as with the 63B points clipped and locked in the normal position trains could not access the worksite area from the main line.

To clip and lock points, a qualified rail safety worker fits and secures a mechanical clamp to the track securing the point blades to the desired lie (normal or reverse). Once installed, the lie of the points cannot change until the point clamp is removed; ensuring the direction of any rolling stock movement is only possible in the configured direction (Figure 6).

Figure 6: Application or removal a point clip



Source: Sydney Trains, annotated by ATSB

NWT 304 Track Occupancy Authority

The basic principle of work-on-track rules is to provide clear separation between track workers and trains. A Track Occupancy Authority (TOA) achieves this by authorising exclusive occupation of track within specified limits for undertaking work on track, for an agreed period. Sydney Trains' Network Rule NWT 304 *Track Occupancy Authority* prescribed the rules for authorising, issuing and using a TOA. The rule defines the TOA limits as being between yard limits, or between defined clearance points,[15] or may be a combination of the two. The worksite lies within the TOA limits and has defined boundaries/limits.

The network rule (NWT 304) defined the requirements for protecting both the TOA limits and for protecting the worksite. The rule stated:

> Protecting TOA limits
>
> - All points of entry into the TOA limits must be protected.
> - The Signaller must apply blocking facilities[16] to prevent unauthorised rail traffic entry into the TOA limits.

In addition:

> Protecting Worksites
>
> - Worksites must be protected by three Railway Track Signals and red flags/red lights placed at least 500m from each side of each worksite.

[15] A clearance point or clearance location is defined as a location that, once clear of rail traffic, allows a following movement. Source: RailSafe Glossary

[16] Blocking facilities are a facility or device used by a Qualified Worker to prevent the unintended issue of an Occupancy Authority, or the operation of points or signalling equipment.

Worksite within 500m of TOA limits

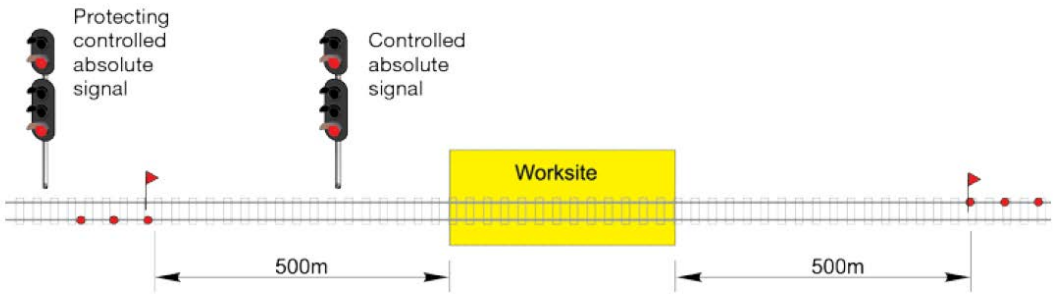
- Unless a set of points can be clipped and locked to prevent access to the portion of track within the TOA limits, the distance between the signal protecting the limits of the TOA and the worksite must not be less than 500m.

A second document, NPR 701 *Using a Track Occupancy Authority*, provides additional information regarding the procedures for using a TOA, including some examples illustrating the methods for protecting worksites.

Figure 7 illustrates the typical protection arrangements for a worksite on straight track. A signal at least 500 m from the worksite is required for the 'Protecting Controlled Absolute Signal'. Blocking facilities applied to the protecting controlled absolute signal provides the primary method for excluding rail traffic from the worksite.

If a train driver inadvertently passes the protecting controlled absolute signal, the train would subsequently pass over the worksite protection (track signals, flags/lights) 500 m before reaching the worksite. This, in effect, provides a second layer of defence whereby the train driver receives a warning that they are approaching a worksite and must take action to prevent entry into the worksite.

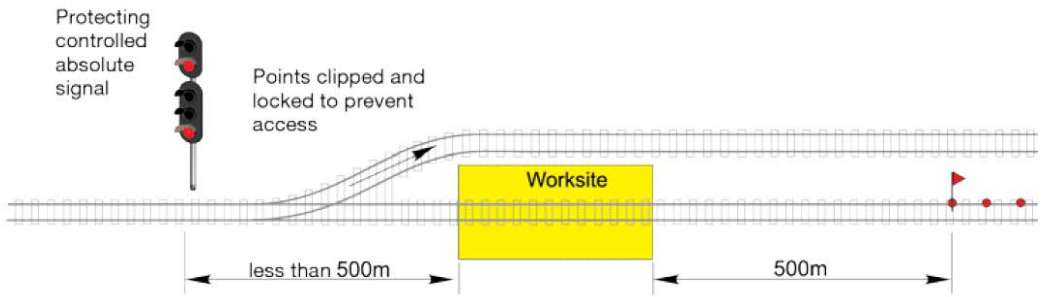
Figure 7: Worksite protection



Source: NPR 701 Using a Track Occupancy Authority

Figure 8 illustrates the protection arrangements for a worksite where the protecting controlled absolute signal is within 500 m of the worksite, but a set of points is available to route trains on a track other than the one containing the worksite. In this scenario, the points must be set, clipped and locked for the alternative route to prevent trains accessing the TOA limits and the worksite contained within. The signaller could also apply blocking to the point controls as part of the protection arrangements.

Figure 8: Worksite protection



Source: NPR 701 Using a Track Occupancy Authority

When implementing the TOA on the night of 17 June 2016, the PO thought protection had to be implemented as per the scenario illustrated in Figure 7. That is, the facilities providing worksite protection were to be located on the main line, at least 500 m from the worksite.

However, after several discussions with train controllers, signallers and ICON, the PO was made aware the application of protections could be done as illustrated by the scenario in Figure 8. That is, since the IBA on 63B points meant they were set, clipped and locked for the main line, rail traffic was excluded from the track containing the worksite. The scenario also negated the requirement to place worksite protections (track signals, flags/lights) 500 m from the worksite. The solution proposed by Sydney Trains' operations staff provided the operational advantage of not occupying the main line, leaving it active for the passage of rail traffic.

Worksite protection arrangements

The Network Rules for work on track require the PO to brief the workers about the site-specific hazards and the protection measures in place before work begins. The Site Supervisor may also provide a briefing of the work planned. The PO must record details of the worksite protection pre-work briefing and the workers who attended the briefing, or amendment to the briefing, on the Network Form NRF 014 *Worksite Protection Pre-work Briefing*.

Additionally, the Sydney Trains' guidance document *Working Safely Handbook* advised it was a responsibility of all workers to ensure they attend a pre-work brief before starting work.

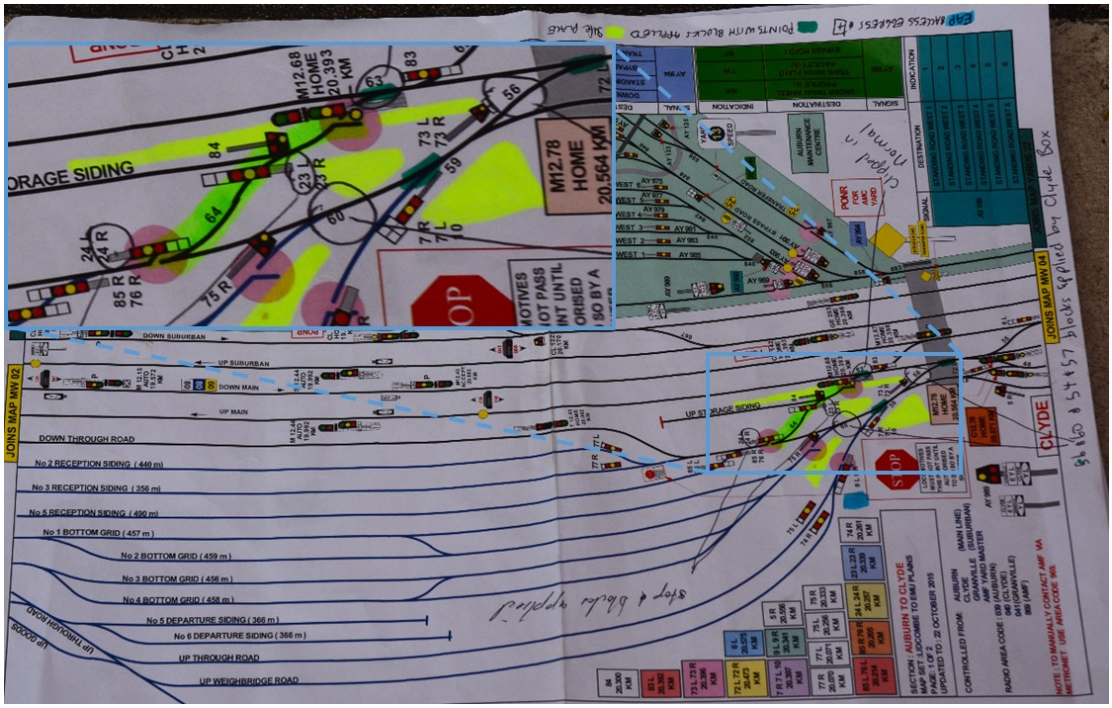
Implementation of the worksite protection and pre-work briefing for civil works

The PO undertook the worksite protection pre-work briefing with the CMT members at the Clyde Yard. The briefing documentation included the Worksite Protection Plan (WPP), Pre-work Briefing form (PWB) and documentation specific to the use of an excavator under live overhead wiring.

The WPP and PWB required the PO to produce or attach a diagram/map to represent the worksite protection arrangements. The PO in this instance used a Drivers Route Knowledge Diagram (DRKD) to illustrate the location of points, signals, tracks, protections and safe areas.

The DRKD did not identify all signals and points used by the PO and Clyde Signaller to protect the movement of the excavator when crossing the tracks to access the worksite (Figure 9).

Figure 9: Photograph of PO's work plan with annotation on the DRKD



Source: ATSB, annotated by ATSB

The PO annotated the DRKD to record that the Clyde Signaller applied blocking facilities to 54, 56, 57 and 60 points that were outside the limits of TOA 35. The limits of TOA 35 were the Clyde end of Storage Siding to Down through Road between 23L Signal and 24R Signal and indicated by a light green highlighted area on the DRKD (Figure 9). In order to protect the limits of the TOA, the Clyde Signaller placed 23L and 24R signals at stop and applied manual blocking facilities on the route and track (including points) ahead of those signals. The application of the blocking facilities was a second layer of control to prevent the inadvertent clearing of the signals and movement of points.

NGE 204 Network communication

The procedure NGE 204 *Network communication* prescribed the rules for spoken and written communication in the network. In principle, Sydney Trains required that communications must be clear, brief and unambiguous, relevant to the task, and agreed as to its meaning before being actioned.

If the communications related to safeworking arrangements, parties must utilise the 24-hour clock, phonetic alphabet, spoken numbers and standardised terminology to identify items such as train and signal identifiers.[17] The procedure mandated the receiver of the message repeat the message back to the sender for communications such as a work on track authority and work on track train running information. NGE 204 contained a 'WARNING' that:

> Qualified Workers must not assume that a receiver has understood a message before the receiver confirms that the message has been understood.

After returning to work, the PO communicated with various train controllers and the Clyde Signaller to discuss the civil work requirements, and establish the work location in the Clyde yard relative to areas of control and the method for applying worksite protections. Similarly, the train controllers, Clyde Signaller and PO communicated to establish and record details of the safeworking arrangements associated with the TOA's.

Passenger service W510 and train crew

Train W510 was an intercity electrical multiple unit passenger service operated by NSW Trains. W510 was crewed by a driver and a guard. It consisted of the lead set V26 made up of cars 8081 (lead car), 9105, 9037 and 8077; and the rear set V21 made up of cars 8032, 9032, 9036 and 8036.

The service departed from Lithgow at 0338 and was on schedule. The service, carrying 49 passengers, had just departed from a scheduled stop at Granville and was travelling according to 'proceed' signal indications on the Up Main Line toward the next scheduled stop at Strathfield. The train was travelling at 67 km/h at the time of the accident. The collision activated a trip mechanism causing the release of brake pipe air and automatic application of the train brakes. The train continued for a further 19 seconds travelling approximately 200 m before coming to a stop.

Train crew

The driver had 20 years' rail experience, which included 16 years' driving passenger and freight trains. The driver, from the NSW Trains depot at Lithgow held the required qualifications for the role performed. The driver was assessed fit for duty in accordance with the requirements of the National standard of Health Assessment for Rail Safety Workers.

The guard was travelling in the last carriage 8036, and did not have any involvement in the accident sequence.

---

[17] RailSafe NPR 721 Spoken and written communication.

External train lighting

The Rail Industry Safety Standards Board (RISSB) coordinated the development of Australian Standards, Codes of Practice, Guidelines and Rules for the rail industry.[18] RISSB developed a standard for rail traffic lights and markers.[19] Adoption of the RISSB product was not mandatory and it was the responsibility of the Rail Transport Operator to develop a train lighting standard relevant to the safety risks being managing within its network. Sydney Trains, as an accredited rail transport operator,[20] developed a train lighting standard specific to its network requirements.

Sydney Trains lighting standard

Network rule NTR 406 *Using train lights* prescribed the use of train headlights for the Sydney Trains Network requiring:

> Trains must have a working headlight fitted to the leading locomotive, and travel with the headlight switched on, when the train travels beyond the:
>
> - Sydney area, including intermediate branch lines, bounded by Helensburgh, Macarthur, Emu Plains and Cowan, or
> - Newcastle area, including intermediate branch lines, bounded by Newcastle, Fassifern and Islington Jct, or
> - Wollongong area, including intermediate branch lines, bounded by Thirroul and Unanderra.
>
> **NOTE**
> Unless headlights are needed for safety, trains fitted with headlights must have their headlights switched off when travelling through the areas prescribed above.
>
> **Switching headlights off**
> Headlights must be switched off during approach to another train.
> Headlights must be switched off or dimmed during approach to:
>
> - A motor vehicle on a nearby road
> - A platform
> - A signal box
> - A location where shunting is in progress
>
> Headlights may be switched off to prevent back-reflection into a driver's or track vehicle operator's eyes.
>
> Before headlights are temporarily switched off, visibility lights, if fitted, must be switched on.

Sydney Trains rules therefore required the driver of train W510 must, unless needed for safety, have the headlights switched off as it was operating within the Sydney metropolitan area and near the Clyde Station platform and Clyde Signal Box.

Event recorders from W510 and the Clyde Station CCTV footage confirmed the driver had extinguished the headlights of train W510. The leading car displayed two white marker lights; two visibility (ditch) lights and one coupler light (Figure 10).

The marker lights (top left and right) indicated the front (white) or rear (red) of a train. Ditch lights (bottom left and right) illuminated the track immediately in front and improved detectability of the train. The coupler light provided illumination to assist train crew in coupling/uncoupling passenger cars when required.

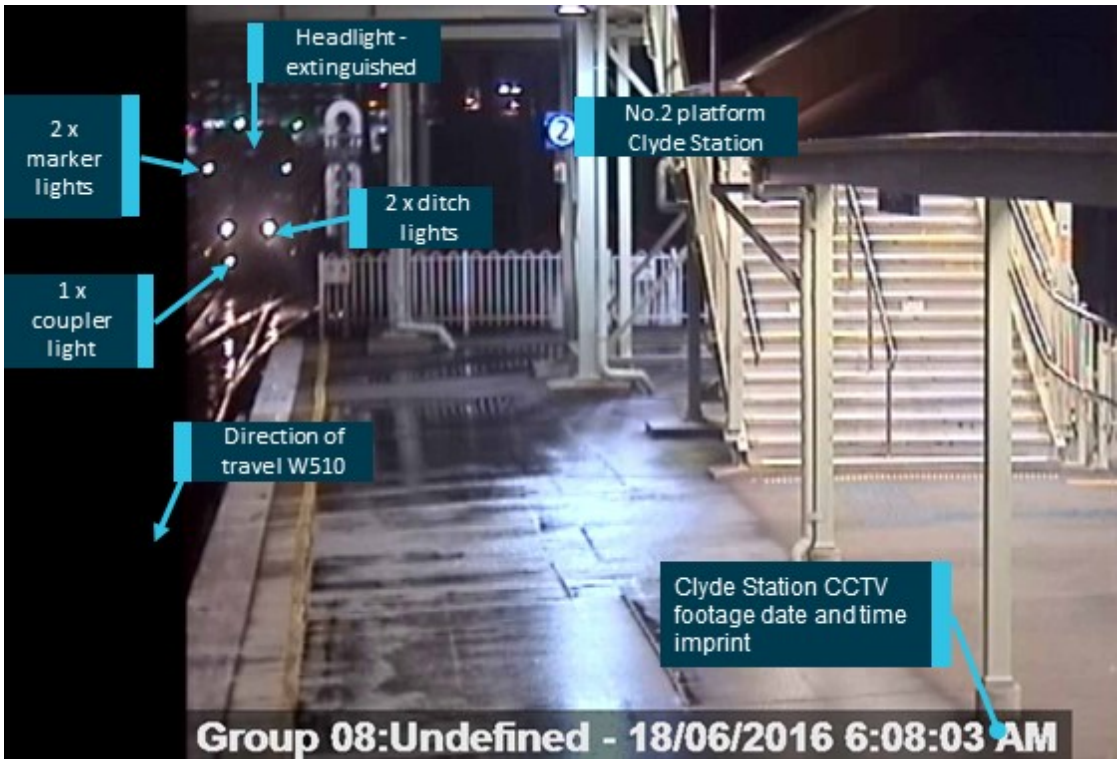
---

[18] www.rissb.com.au/about/our-role-in-industry/

[19] Australian Network Rules And Procedures (ANRP 4005) *Rail Traffic Lights and Markers*

[20] The Office of the National Rail Safety Regulator (ONRSR) as a Rail Transport Operator accredits Sydney Trains and Sydney Trains has a duty to manage the risks associated with their operation. ONRSR monitors Sydney Trains implementation of their safety management system.

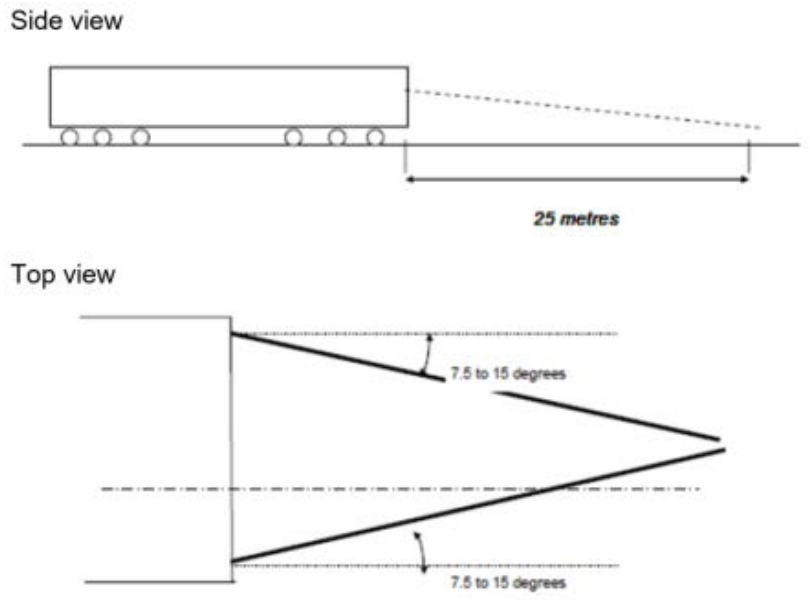
Figure 10: Train lighting on front of W510 as it approached Clyde Station



Source: Sydney Trains, annotated by ATSB

The primary purpose of visibility lights was to improve detectability of the train by road users. The engineering standard detailing the minimum operating standards for rolling stock[21] specified the visibility lights were to project at least 25 m in front of the vehicle at top of rail and then be aimed/turned cross-eyed to between a minimum of 7.5 degrees and maximum of 15 degrees to the longitudinal centreline of the vehicle (Figure 11).

Figure 11: Side view and Top view of visibility light aiming



Source: RSU 600 Series – Minimum Operating Standards for Rolling Stock – Multiple Unit Train Specific Interface Standards v 1.0

[21] Transport NSW Engineering standard ESR 0001 – 600 RSU – *Minimum Operating Standards for Rolling Stock – Multiple Unit Train Specific Interface Standards,* section 8.1

Figure 12, taken from a similar Sydney Trains K-Set type car showing the typical illumination pattern and forward illumination of the track provided by the visibility lights.

Figure 12: Similar train type showing visibility (ditch) lights illuminating track ahead

Source: ATSB

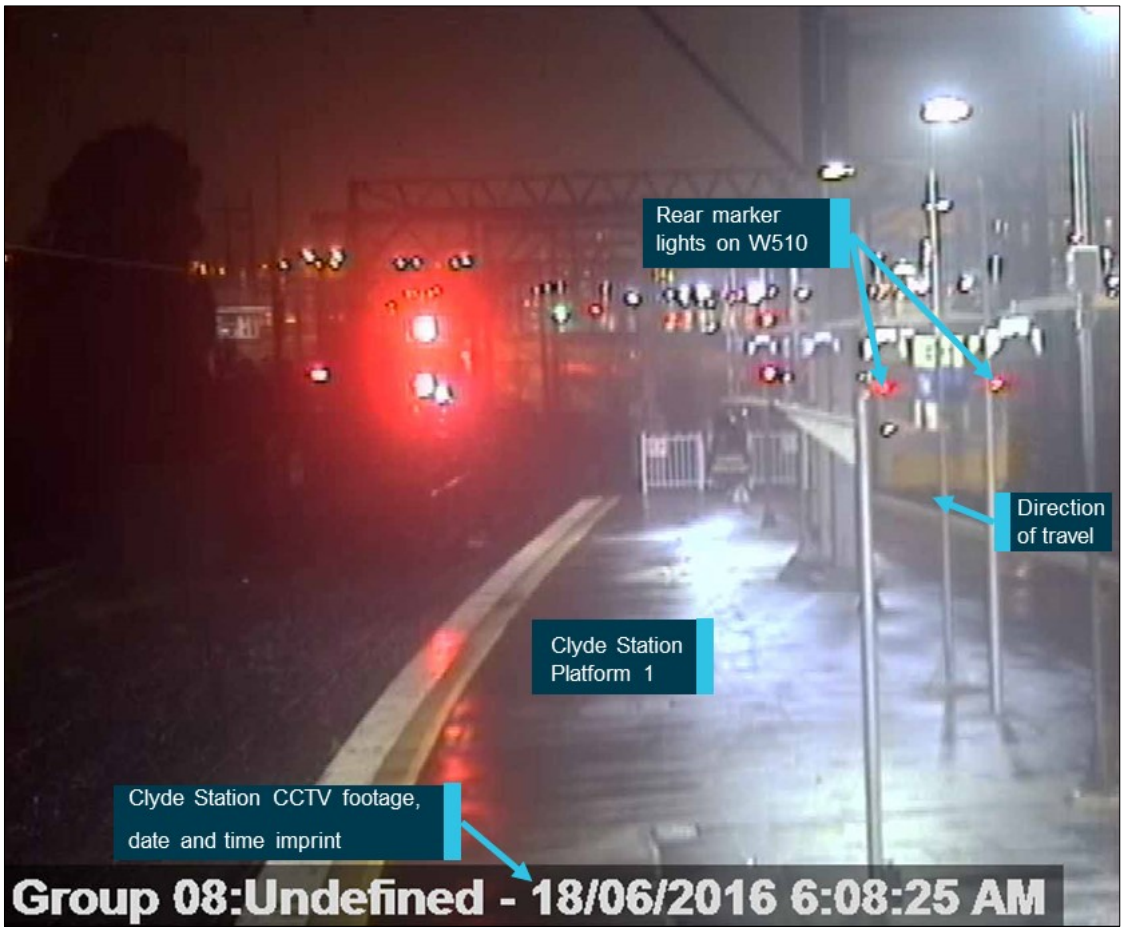
Environmental factors

The morning of 18 June 2016 was cool and cloudy with 4.8 mm of rainfall recorded in the 24 hours to 0900. The overnight minimum temperature was 12.4 °C as recorded by the Bureau of Meteorology at Sydney Olympic Park, approximately 5.3 km (East) from Clyde station.

At the approximate time of the accident, there was little ambient lighting in the area around 63B points. The floodlighting used by the CMT during the sleeper replacement works was off and the CMT team leader and SMT were working on the tracks using torchlight.

CCTV footage from Clyde Station and the nearby Auburn Maintenance Centre illustrated the likely level of ambient lighting present and the presence of steady rainfall around the time of the accident (Figure 13).

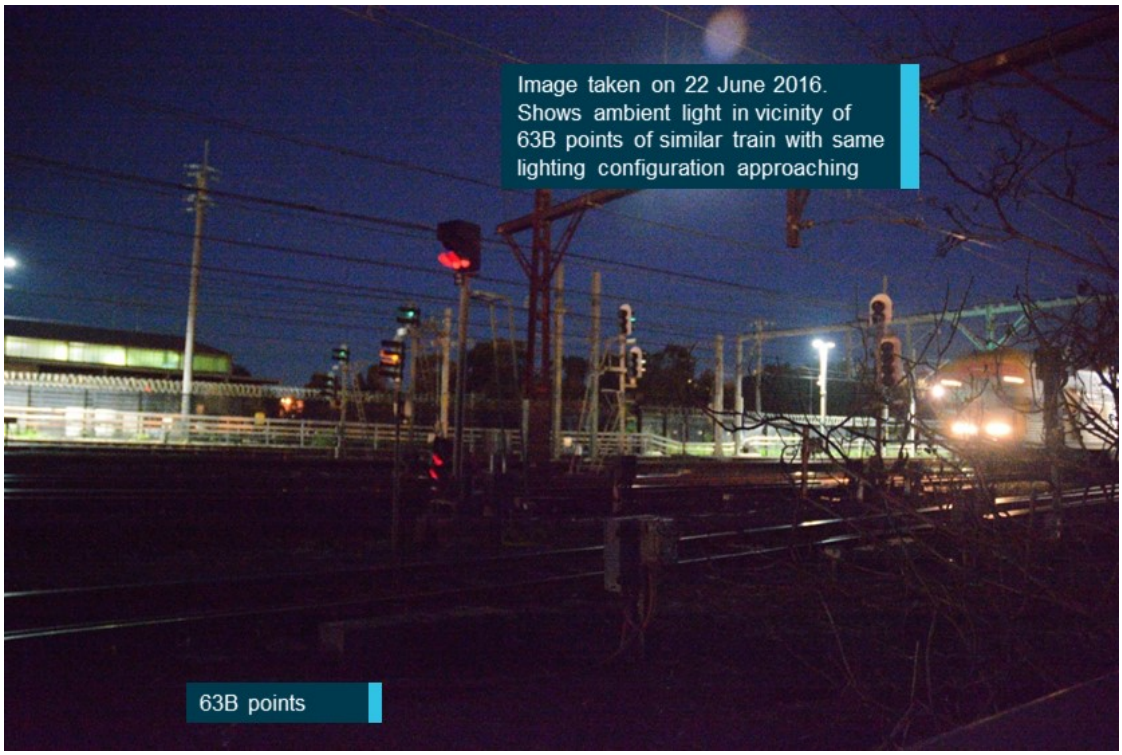
Figure 13: CCTV footage depicting environmental conditions as W510 passed through Clyde station moments before the accident



Source: Sydney Trains, annotated by ATSB

A site visit on 22 June 2016 conducted at a similar time to the accident photographed the ambient lighting conditions at 63B points (Figure 14). The train service shown had a similar lighting configuration to the lead car on train W510. A slight increase in illumination in close proximity to the front of the train due to the visibility lights is evident.

Figure 14: Ambient lighting near 63B points on 22 June 2016



Source: ATSB

Conspicuity of workers on or about the track

All rail safety workers when on or about the track, are required to wear approved Personal Protective Equipment which included high-visibility safety vests/wet weather attire with reflective markings.

The SMT Electrician was wearing standard cotton drill pants and high visibility reflective shirt and the SMT Mechanic was in similar attire but additionally wearing a recommended wet weather jacket that also had high-visibility reflective striping over the shoulders, with a cross on the back and strips around the cuffs. In darkened conditions, reflective clothing exhibit little utility unless they were self-illuminating, or exposed to some form of external light source that caused them to reflect.

To mitigate risk in low light conditions, Sydney Trains Safe Work Instruction D2015/7605 *Use of Flashing Beacons in the Danger Zone at night*[22] required workers to display a flashing beacon when entering the Danger Zone at night. Sydney Trains identified the use of flashing beacons as an effective means of improving the visibility of workers operating within the danger zone at night. The beacons were designed to increase rail traffic driver's visibility of workers at night. Each workgroup required at least one beacon, with additional beacons displayed where there was a distance of more than 50 m between workgroups. Positioning of the beacons were required to ensure they are clearly visible to approaching train drivers.

The Sydney Trains instruction and related *SafeTracks* bulletins identified that:

> The use of flashing beacons does not reduce or replace the requirements in the Network Rules or Procedures relating to worksite protection.

Neither the CMT nor SMT members deployed flashing beacons at the worksite or wore them individually during the works at the Clyde yard on the 17 and 18 June 2016.

---

22 SWI was created 02/04/2014 and approved by the GM Network Maintenance.

Fatigue management

The National Transport Commission (2008) defines fatigue as:

> A human condition primarily caused by prolonged wakefulness and/or insufficient or disturbed sleep. It includes physical, cognitive, psychological and physiological dimensions that interact with each other to reduce human performance and lead to uncontrollable sleep onset.

Humans cycle through numerous circadian rhythms with daily peaks and troughs. The *National Rail Safety Guideline on Management of Fatigue in Rail Safety Workers* (NTC 2008) highlights aspects of circadian rhythms that are relevant to fatigue management of rail safety workers. Alertness, physical and mental performance both reach their circadian low in the early morning (between about 0300 and 0500) when the physiological drive for sleep is greatest. The occurrence happened shortly after the circadian low.

Sydney Trains were required to manage the risk of fatigue in its rail safety workers. This included scheduling of work to allow for sufficient sleep opportunity as well as systemic management of fatigue through Fatigue Risk Management Systems. The Sydney Trains Fatigue Risk Management program included procedures on how to manage fatigue risk and the rostering principles outlined the safe hours of work (maximum of 12 hours) and rest (minimum of 12 hours) for typical hours of duty and planned overtime.

The operating procedure for the management of fatigue risks[23] outlined a risk management approach to identify, assess and implement control measures to mitigate risk exposure to rail workers in workgroups and worksites where shift work and extended hours' arrangements were undertaken.

The investigation explored the possibility that the time of day, working during the circadian low point (3am to 5am) and the rostered work hours may have contributed to an increased feeling of fatigue in some of the workers on duty that night.

The ATSB assessed the probable fatigue levels of the SMT members, the CMT Leader, the PO and Clyde Signaller. Information taken into account included sleep (quantity and quality) in the previous 24 hours, workload, time at work, work break (rest and food) opportunities, and the use of two bio-mathematical fatigue models (FAST and FAID).

Of the workers assessed, shift duration and the time of day affected them equally and were assessed to have a moderate likelihood that their alertness on duty may have been affected.

Only the PO and the CMT Leader were assessed as likely to be experiencing a level of fatigue known to affect performance. However, in the context of the work tasks they were involved in on the night and their performance of these tasks, the ATSB did not consider their level of fatigue influenced decisions made on the night of the accident.

Drug and alcohol testing

The Rail Safety National Law (NSW) prescribed the post-incident testing of a rail safety worker for the presence of a proscribed drug or alcohol. The legislation required rail safety workers involved in a prescribed incident to undergo a breath test and provide a sample (oral, blood, or urine) within 3 hours of an incident. The Shift Manager within the RMC coordinated the testing of Sydney Trains rail safety worker/s directly involved in a prescribed incident.

Between 0640 and 1000 on 18 June 2016, the two-crew members from W510, PO, Clyde Signaller and the SMT Electrician undertook the testing and all parties returned a negative result.

The toxicology results from the post-mortem showed no presence of alcohol or other drugs in the deceased.

---

[23] Operating Procedure 08: Manage Fatigue Risks, SMS-08-OP-3129, v1.1, 14 September 2015

Safety analysis

Planning for the full scope of work

For any track rectification work, the section of track requiring work needs: firstly, to be booked out of service; secondly, worked upon and rectified; and thirdly, tested and booked back into service. At each stage, where workers are required to access or occupy the rail track, suitable safety measures are implemented to protect those people on track.

Each phase of work can be and was often completed independently.

For the work on 64 points crossover, 63 and 64 points were booked out of service on 16 June 2016. The signals team booked out and clipped 63 points and arranged their own protection to do this safely. The civil team booked out 64 points and arranged their own protection to do this safely.

For the rectification works on 64 points crossover, the civil team implemented safety measures that protected the workers at 64 points.

For the electrical testing of 63 and 64 points prior to booking them back into service, the SMT could have done this independently of the civil team. However circumstances on the night meant the two work teams and their tasks interacted.

At no point prior had there been any discussion about planning for the work teams to interact and how to manage safety of the workers should this scenario occur.

Sydney Trains' system controlled this scenario by requiring the PO or Supervisor to provide a pre-work brief and for the PO to ensure all workers sign the pre-work briefing form. In the vast majority of cases, this singular control had been effective.

For the work on 64 points crossover, the local management chose to conduct the work under emergency provisions and planning was completed close to the start of works.

The job did not go to plan with significant delays to the start time and during the job. At the time the SMT arrived on site to electrically test points and "support the civil team", the PO and Supervisor were pre-occupied managing the work and did not brief the SMT.

Sydney Trains' planning process for emergency works was ineffective in that it tolerated local management at Clyde Network Base triggering the repair of the defective sleepers under emergency work provisions to expedite the return of a siding track into service for stabling race day trains the following day without consideration of the full scope of work.

The responsibility for coordinating access to the track for the repair work and planning for worksite protection subsequently transferred on the night of the works from local managers to the CMT team leader, SMT team leader and PO respectively. The CMT team leader and PO were directly involved in planning the sleeper rectification work and its worksite protection. The SMT members were not involved in planning the work and the SMT Electrician only received instruction from the Signals Team Leader via an e-mail read at the commencement of the SMT Electrician's night shift.

The instruction contained in the e-mails from the Signal Team Leader to the SMT Electrician were ambiguous appearing to link 63 and 64 points to the proposed civil works. This likely influenced the perception of the SMT Electrician that the 63B points were part of the civil task and the assumption that they would therefore be within the limits of the protections implemented by the PO.

Although the PO was aware of the requirement for the SMT to attend at the Clyde yard toward the end of the civil work, the PO directed his attention to the immediate task of accessing the track and implementation of worksite protections for the commencement of civil work at 64 points. The SMT members were not asked and did not attend the pre-work briefings involving the CMT workgroup conducted by the PO at either the Clyde yard or PN yards.

It was likely that the PO considered the SMT were functioning as a separate workgroup managing their own protections. Consequently, there was no consideration in the planning for the civil work, or the associated worksite protections, of the scope of work intended by the SMT as a part of the civil workgroup or as a separate workgroup interfacing with the civil group to remove an IBA and return rail infrastructure into service.

Fatigue management

Circadian effects, time on task (including breaks between shifts) and inadequate sleep opportunity are some of the recognised primary risk factors for fatigue related performance degradation. The Signal Mechanic and the Signal Maintainer were working to their normal rostering pattern and mostly likely the least affected, if at all, by fatigue.

The Civil Protection Officer and the Civil Team Leader were rostered on a day shift and then after a 4-5 hour break returned for the emergency overtime shift. The length of the break in between shifts was significantly less than that applied from the Sydney Train's typical rostering principles requiring a minimum of 12 hours' rest to allow for recovery and sleep. The break, considering time allocated for commuting, meals and hygiene, allowed for considerably less than 5 hours sleep, which according to Dawson and McCulloch (2005), would be 'inconsistent with a safe system of work'. With the limited sleep obtained and limited sleep opportunity provided between shifts; it is likely that the Protection Officer and Civil team Leader were experiencing levels of fatigue known to affect performance. However, in the context of the work tasks they were involved in on the night and their performance of these tasks, the ATSB did not consider their level of fatigue influenced decisions made on the night of the accident.

The planning and approval processes for the emergency works at Clyde yard did not consider, in the case of the PO and Civil team leader, the possibility and consequences of worker fatigue during the emergency overtime works arising from limited rest opportunity between shifts, time on task and extended wakefulness increasing the risk of fatigue and fatigue-related errors. With the absence of oversight by line management, the risk control for the management of fatigue relied solely on self-assessment by the workers onsite.

Worksite protection arrangements

At about 1900 on 17 June 2016, the PO contacted the Clyde Signaller to initiate discussion about the night's work. At that point, the PO was seeking advice whether the permit to work within the PN yard adequately protected the worksite and the need to take out a TOA from Sydney Trains. Over the following 5 hours, multiple phone conversations between the PO and various parties discussed the work and necessary protection arrangements.

While the PO participated in a number of these discussions, many were between various operations staff to determine how to apply the proposed protection arrangements. By about 2320, the train controller confirmed that a TOA was required and advised the PO there was no problem with using 63B points clipped and locked in the normal positon as protection against trains entering the worksite from the main line.

The PO repeatedly raised his understanding that if the protecting controlled absolute signal was within 500 m of the worksite, an occupancy of the main line was required to provide a 500 m separation between the worksite and the worksite protections, he was not aware the Network Rules afforded an alternative option but accepted the advice of other operations staff.

Following the completion of the pre-work briefing and an hour later, the PN permit to work, members from the civil work group accessed the danger zone at 64 points to undertake preparatory work. Although no trains were in the area at that time, and with points 63B clipped in the normal positon mechanically preventing access by trains from the main line, CMT personnel had entered the danger zone and commenced work around 2 hours before the required safety measures were in place through the authorisation of TOA 35.

By the time civil works neared completion, there was no record of the SMT members participating in a pre-work briefing with the PO before accessing the worksite to commence their work. At this time, the civil workgroup members were preoccupied with packing up equipment. Around the same time, the PO was arranging with operations staffs to take out another TOA (as TOA 35 was to expire), so the civil team leader could complete a final inspection of the track before returning it to service. The civil team member's and PO's attention was almost certainly directed toward completing their tasks as soon as possible and not the activity of the SMT.

There were recollections of discussions between SMT and CMT members upon the SMT entering the civil group's worksite area and when commencing tests of the electrical functionality of 64 points. None of the discussions pertained to the limits of the TOA or extent of worksite protections.

There were variances in recollections between the civil team leader, SMT Electrician and PO of the content of the verbal exchanges that occurred regarding the TOA and worksite protection arrangements in place. It is likely that:

- The PO understood the SMT and their task were separate to the civil task and workgroup, and therefore assumed they would arrange their own worksite protections to undertake the electrical testing of points as experienced on previous occasions when a signals work group were involved with a civil work group.
- The SMT members were aware a TOA was in place protecting the civil worksite but were not alerted to the TOA limits and details of worksite protections during the verbal exchanges with civil team members onsite.
- The SMT members had formed an assumption, based on information provided to them at the beginning of their rostered shift that, points 63B were included in the civil scope of work and would therefore lie within the limits of the TOA.

There was no evidence that the SMT received, or sought to receive, a formal pre-work briefing from the PO about the rail safety component of worksite protection prior to commencing their work on 64 points. The Sydney Trains' network rules for work in the rail corridor placed responsibility on the PO and Site Supervisor to brief workers, but did not similarly compel a worker arriving at a worksite to ensure they sought out the PO/Site Supervisor, explained their task, and did not commence any work until the requirements of pre-work briefing were completed.

The absence of an understanding of the TOA limits and its associated protections, together with the lack of track signals, flags/lights or any additional facility to remind/alert workers of the worksite limits, the SMT members unknowingly exited the protected worksite area and into the immediate vicinity of operational main line rail traffic.

The SMT Electrician commenced the removal of the point clip potentially compromising the effectiveness of the protections associated with TOA 36. Although the SMT Electrician was in mobile phone contact with the Clyde Signaller and narrating his intended actions, the Clyde Signaller did not realise the SMT had exited the protected worksite area. This was likely due to the Clyde Signaller directing attention toward fulfilling TOA 35 with the Outer Board Controller.

Following the fulfilment of TOA 35 at 0600, the subsequent issuance of TOA 36 maintained worksite protections for the Sydney Trains network. However, the authority to occupy the track provided by the PN permit to work expired at 0500. There is no record of an extension of the PN permit to work between 0500 and the fulfilment of TOA 36 at 0654.

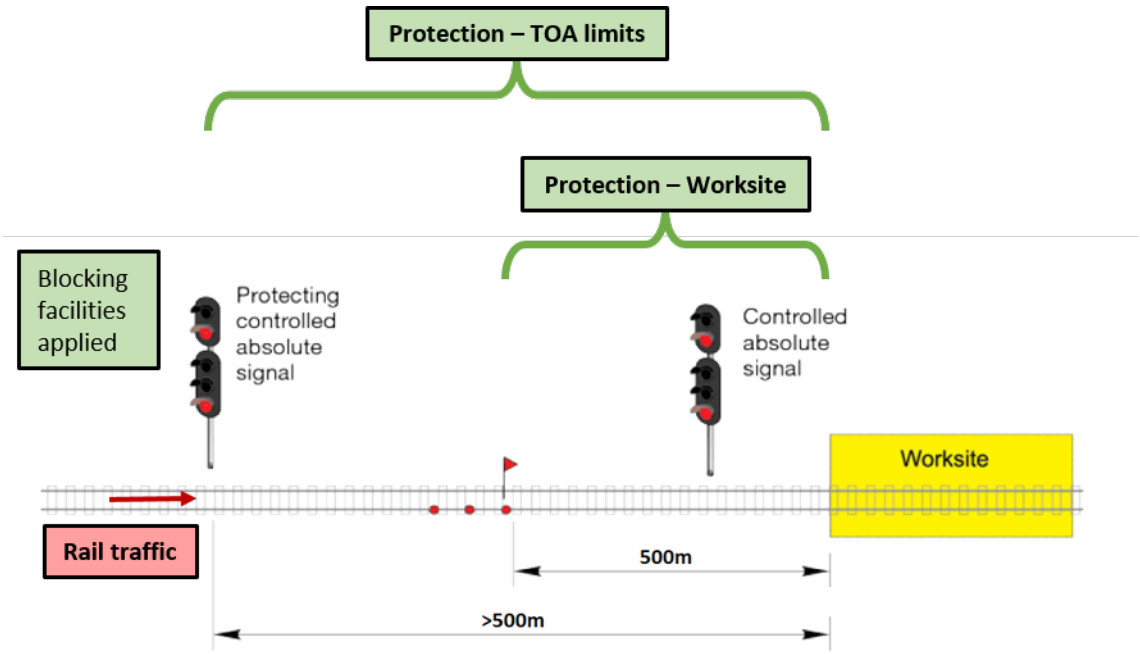
Worksite protections of a TOA

The fundamental principles of the work-on-track rules were to provide clear separation between track workers and trains. A TOA achieved this through providing exclusive track occupancy for track workers undertaking work on track.

Under a TOA, worksite protection (track signals, flags/lights) was normally placed at least 500 m from the worksite and blocking facilities applied to all entry points into the TOA limits. In effect, this

provided a buffer zone of at least 500 m outside a worksite, plus a further train exclusion zone in excess of 500 m from the worksite. That is, trains must stop at the protecting controlled absolute signal. If a train inadvertently passes the protecting signal, then the train will trigger the audible track signal warning devices at least 500 m before reaching the worksite (Figure 15). This delivered an additional level of control to track workers by providing advice of an approaching train.

Figure 15: Worksite protection

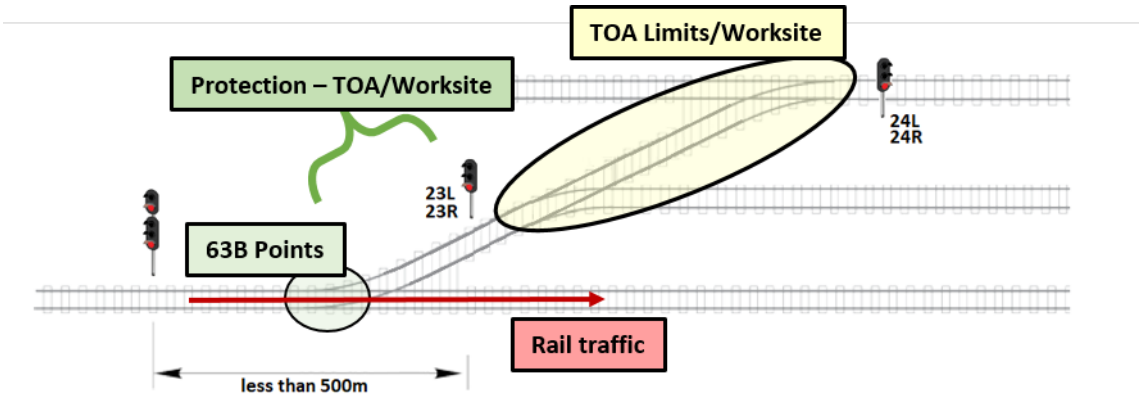


Source: NPR 701 Using a Track Occupancy Authority – modified and annotated for clarity

The TOA rule (NWT 304) and procedure (NPR 701) also provide for a scenario where the protecting controlled absolute signal may be less than 500 m from the worksite, so long as points can be clipped and locked for a different route. It was this scenario that was considered for the night of 17 June 2016.

In this case, the authority (TOA 35) defined the limits as the track between 23L signal and 24R signal. This also reflected the worksite boundaries since both signals were relatively close to 64 points. No further protection was provided on the main line, since 63B points were already clipped and locked. Consequently, the main line remained available for unrestricted rail traffic while work was undertaken on 64 points (Figure 16). This method did not provide advice of approaching trains on the Up Main.

Figure 16: Worksite protection



Source: ATSB

Under the arrangements implemented on 17/18 June 2016, the buffer zone between the worksite and unrestricted main line rail traffic was considerably less than 500 m, noting the distance between the worksite and 63B points was about 50 m. It is evident that under this arrangement, there is an increased probability, a track worker could move along the track, inadvertently exit the worksite, and subsequently be in the immediate vicinity of operational main line rail traffic. The arrangement did not include any additional audible or visual warning devices for approaching trains, or any facilities for reminding track workers of the worksite limits.

In addition, the arrangement allowed main line rail traffic to operate normally over the facilities used for protecting the TOA limits and worksite, a condition not permitted under any other protection arrangement defined in the TOA rules.

The worksite protection method presented an increased risk, in that track workers might inadvertently exit the worksite, and subsequently be in the immediate vicinity of operational main line rail traffic. Sydney Trains network rules and procedures for a Track Occupancy Authority did not identify the increased risk associated with the chosen worksite protection method.

Conspicuity of track workers on or about the track

Unless needed for safety, Sydney Trains network rules required drivers to extinguish train headlights within selected metropolitan areas. At the time, Sydney Trains was accredited to operate with headlights off based upon a risk assessment that highlighted the potential hazards of the headlight glare dazzling approaching train crews or other persons in or adjacent to the railway.

In low ambient light conditions, high-visibility garments rely on light reflected from their surface to be directed back along the path of the incoming light beam. An observer will not gain the benefit of a retroreflective article unless he/she is observing it from a position closely aligned with, usually just behind, the light source.[24]

On the morning of 18 June 2006, the area near 63B points presented as a low light condition. The SMT members were using handheld torchlights directed towards their work (63B points).

Although the Sydney Trains safe work instruction mandated the use of flashing beacons at a fixed worksite or by individual workers in the danger zone, neither the CMT nor SMT members deployed flashing beacons at the worksite or worn individually during the works at the Clyde yard on the 17 and 18 June 2016.

[24] Rail Industry Safety and Standards Board, Australian Standard AS 741:2019 Australian rail Personal protective equipment – Minimum requirements

Since the accident, Sydney Trains engaged a team of human factors specialists to conduct a review of the use of personal flashing beacons. The study found that personal flashing beacons were ineffective in many situations due to the beacon being lost within other artificial lights within the driver's field of view. They also found use of beacons transfers the responsibility of safety to the driver and may provide a false sense of security to the rail safety worker. The study further found the beacon may be out of the driver's line of site depending on the location the beacon is worn on the rail safety worker.

While addressing risks associated with headlight glare, the practice of extinguishing the headlights and reverting to visibility lights may have increased the risk that a train driver would not sight workers on or about the track during times of low ambient light conditions.

Effective communications

Network procedures prescribing the rules for spoken and written communication in the network acknowledged that effective written, radio and telephone communication was essential for safety in the network. The voice recordings of the telephone conversations between the train controller/s, Clyde Signaller and PO in determining the method for applying worksite protections associated with the TOA were conversational, centred toward discussing pros and cons of the protection options available under the rules for using a TOA. The conversations occurred over a five-hour period between the parties (at remote locations from each other) and featured some minor misunderstandings/confusion, which resulted in several repeat exchanges to clarify views. While there was a considerable exchange of information, combined with sporadic distractions to perform other functions associated with the individuals' respective roles, the parties understood and agreed on the requirement for an authority and that the clip on 63B points provided worksite protection within the TOA, avoiding an occupancy on the main line.

Other voice recordings between the parties addressing the safeworking arrangements for the TOA were also primarily conversational and in some instances subjected to sporadic distractions. Although the parties did not adhere to the procedures for spoken and written communication, the information relayed and recorded on the TOA's was correct and understood by the Clyde Signaller and the Civil Team.

A telephone conversation occurred between the SMT Electrician and the Clyde Signaller immediately before the collision during which the SMT Electrician asked the Clyde Signaller to operate 64 points to confirm the correct operation. The SMT Electrician advised testing of 64 points was complete before commenting that he had to take the point clip off 63. The Clyde Signaller did not respond to the SMT Electrician, remaining silent as the SMT Electrician walked towards 63B points. As occurred on previous occasions, the Clyde Signaller's attention diverted briefly during the call toward another task, which was to communicate the fulfilment of TOA 35 to the Outer Controller. When returning to the call with the SMT Electrician, in which the SMT Electrician mentioned difficulty in removing the point clip, the Clyde Signaller did not recognise that the SMT members were in the danger zone and unprotected from the approaching train W510.

Although the network procedures require spoken communication to be clear, unambiguous and agreed to its meaning before being acted upon, the information relayed during the telephone conversation between the SMT Electrician and the Clyde Signaller during testing of the points was insufficient to alert either party that 63B was an unprotected work area.

Findings

From the evidence available, the following findings were made with respect to the track worker fatally injured when struck by train W510, Clyde, New South Wales on 18 June 2016. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (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 operating environment at a specific point in time.

Contributing factors

- **Sydney Trains' work-planning process, involving multiple work groups, did not assure the consideration of worksite safety for all tasks undertaken by each involved party over the duration of the work and when returning the rail infrastructure into service.** [Safety Issue]
- The PO civil was aware of the signal team's work tasks but did not consider these in his worksite protection arrangements.
- The PO had briefed the civil team, however did not brief the signal team, and the signal team did not seek a pre-work briefing before commencing work on-track.
- The PO civil was not provided with a briefing on the scope of the SMT work and did not provide protection at 63 points.
- The signal team assumed their workplace was within the limits of the TOA and did not plan their own worksite protection.
- The signal team entered the danger zone unprotected and unaware of the approach of W510.
- The Clyde Signaller did not recognise the signal team were in an unprotected area during his communication with the signal team, possibly due to being distracted on other tasks.
- **The network rules and procedures require communications to be clear, brief and unambiguous. Network communications by various parties in Sydney Trains were not in accordance with the principles underpinning the network rules.** [Safety Issue]

Other factors that increased risk

- Sydney Trains' preference to keep the Up Main operational influenced the selection to use the clipped and locked 63B points to protect the worksite at 64 Points.
- **The worksite protection method presented an increased risk, in that track workers might inadvertently exit the worksite, and subsequently be in the immediate vicinity of operational main line rail traffic. Sydney Trains network rules and procedures for a Track Occupancy Authority did not manage the increased risk for the chosen worksite protection method.** [Safety Issue]
- **The Sydney Trains worksite briefing process did not compel a new work group to seek a worksite protection pre-work briefing when accessing an existing worksite** [Safety issue]

Other findings

- The workers were conducting work during the circadian low and in poor environmental conditions. It is possible that this contributed to an increased level of fatigue in some of the

workers on duty that night, but was unlikely to have influenced decisions made contributing to the accident.

- The lack of use of train headlights at night and the absence of any supplementary lighting (such as beacons) may have increased the likelihood of a train driver not seeing workers wearing reflective clothing and subsequently sounding the train horn.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and 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 directly involved parties were provided with 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.

The initial public version of these safety issues and actions are provided separately on the ATSB website to facilitate monitoring by interested parties. Where relevant the safety issues and actions will be updated on the ATSB website as information comes to hand.

Work-planning process and multiple work groups

Safety issue number:	RO-2016-008-SI-01
Safety issue owner:	Sydney Trains
Operation affected:	Urban passenger network
Who it affects:	Sydney Trains track work

Safety issue description

Sydney Trains' work-planning process, involving multiple work groups, did not assure the consideration of worksite safety for all tasks undertaken by each involved party over the duration of the work and when returning the rail infrastructure into service.

Proactive safety action

Action taken by:	Response to safety issue by Sydney Trains
Action number:	RO-2016-008-NSA-022
Action type:	Proactive safety action
Action status:	Closed

Safety action taken: Sydney Trains established a Post-Incident Assurance Group (PIAG) to respond to the incident. This group established key focus areas to promote the safety of workers and avoid future incidents.

To address this safety issue, a key focus area on 'planning for maintenance work' was established which was aimed at providing safer and more effective options to allow work to be carried out in the rail corridor.

Under a specific project (Maintenance Access Planning Project), integration of planned maintenance windows with the "daily working timetable" will see maintenance work, such as the maintenance work carried out in this incident, taking place during a planned maintenance window, which would be free from rail traffic during that time.

Status of safety issue

Issue status: Partially addressed

Justification: The ATSB is satisfied that once implemented, all maintenance work parties can complete maintenance work in the planned maintenance windows. There remains an opportunity for maintenance work, such as booking points out and back in to occur outside of the planned maintenance windows. However, it remains a responsibility of the Protection Officer to follow the rules and ensure they protect themselves as required.

Network Communications

Safety issue number:	RO-2016-008-SI-02
Safety issue owner:	Sydney Trains
Operation affected:	Urban passenger network
Who it affects:	Sydney Trains track work

Safety issue description

The network rules and procedures require communications to be clear, brief and unambiguous. Network communications by various parties in Sydney Trains were not in accordance with the principles underpinning the network rules.

Proactive safety action

Action taken by:	Response to safety issue by Sydney Trains
Action number:	RO-2016-008-NSA-023
Action type:	Proactive safety action
Action status:	Closed

Safety action taken: Sydney Trains established a Post Incident Assurance Group (PIAG) to respond to the incident. This group established key focus areas to promote the safety of workers and avoid future incidents.

To address this safety issue, a key focus area on ‘safety critical communications’ was established which was aimed at improving network communication processes in order to mitigate the risk of safety incidents occurring in the future.

Under a specific project (Safety Critical Communications Enterprise Wide Program) the aim was to improve the overall quality of network communications. To enable this, a separate system, the (Safety Critical Communications Audio Monitoring System) was implemented in September 2018 and provides an ability for safety critical communications to be captured, analysed and audited for compliance and improvement opportunities.

Status of safety issue

Issue status: Adequately addressed

Justification: The ATSB is satisfied that this Audio Monitoring System will improve the safety critical communications as it is used to audit network communications for compliance and to identify improvement opportunities.

TOA limitations

Safety issue number:	RO-2016-008-SI-03
Safety issue owner:	Sydney Trains

Operation affected:	All rail networks
Who it affects:	Sydney Trains track work

Safety issue description

The worksite protection method presented an increased risk, in that track workers might inadvertently exit the worksite, and subsequently be in the immediate vicinity of operational main line rail traffic. Sydney Trains network rules and procedures for a Track Occupancy Authority did not manage the increased risk for the chosen worksite protection method.

Proactive safety action

Action taken by:	Response to safety issue by Sydney Trains
Action number:	RO-2016-008-NSA-024
Action type:	Proactive safety action
Action status:	Closed

Safety action taken: Sydney Trains has made changes to their Network Rules and Network Procedures, specifically NWT300 Planning work in the Rail Corridor; NPR712 Protecting work from rail traffic on adjacent lines; and NRF014 Worksite Protection Pre-work Briefing. While the changes to these procedures decreases ambiguity, the success of the procedures is reliant on a compliant workforce to be effective.

ATSB comment: The ATSB acknowledges Sydney Trains is implementing an Enterprise Safety Culture Program that if successful will provide the impetus to strengthen the network rules and network procedures.

Status of safety issue

Issue status: Partially addressed

Justification: The action taken by Sydney Trains does not make any change to the TOA network rule, however Sydney Trains seeks to address the risk by bolstering other network rules that require the protection officer to plan and deliver worksite protection arrangements.
The more specific instruction decreases ambiguity for the protection officer. Further, the program to improve safety culture, if successful, will provide greater impetus for workers to adhere to the rules.

Worksite protection pre-work briefing

Safety issue number:	RO-2016-008-SI-04
Safety issue owner:	Sydney Trains
Operation affected:	Urban passenger network
Who it affects:	Sydney Trains track work

Safety issue description

The Sydney Trains worksite briefing process did not compel a new work group to seek a worksite protection pre-work briefing when accessing an existing worksite.

Proactive safety action

Action taken by:	Response to safety issue by Sydney Trains
Action number:	RO-2016-008-NSA-025
Action type:	Proactive safety action

Action status: Closed

Safety action taken: Sydney Trains has made changes to their Network Rules and Network Procedures, specifically NWT300 Planning work in the Rail Corridor; NPR712 Protecting work from rail traffic on adjacent lines; and NRF014 Worksite Protection Pre-work Briefing.
To address this safety issue, the changes to NRF014 Worksite Protection Pre-work Briefing make it clear;

> On any worksite, all workers are required to be briefed on both the protection measures in place (by the Protection Officer) and the work to be performed (by the Workplace Supervisor).

ATSB comment: The ATSB also acknowledges Sydney Trains is implementing an Enterprise Safety Culture Program that if successful will provide the impetus to strengthen the network rules and network procedures.

Status of safety issue

Issue status: Adequately addressed

Justification: The changes in the document NRF014 Worksite Protection Pre-work Briefing make it clear that all workers on a worksite are required to be briefed on both the protection measures and the work to be performed.

Additional safety actions

Sydney Trains delivered on a number of safety actions and commitments following the incident.

Some of the direct actions to address the contributing factors to the incident were:

- Review and validation of proposed worksite protection plans is required through Sydney Trains' Corridor Safety Centre.
- Increased numbers of rail safety coaches and mentors, with a required coaching session for all Protection Officers at least once per year.
- Protection Officers are required to implement a form of worksite protection at least once every quarter to remain eligible to be re-certified as a Protection Officer, this activity is monitored by the Corridor Safety Centre.

Additionally, Sydney Trains established a Post-Incident Assurance Group (PIAG) to respond to the incident. This group established key focus areas to promote the safety of workers and avoid future incidents. These areas included; Worksite protection, Culture, Planning for maintenance work and Safety critical communications.

The PIAG later established the Safety Focus Program, which included key initiatives;

- Safety Focus Sessions
- Safety Culture Program
- Improvements to protection officer selection and training
- Signal Key Switch Project
- Safety Critical Communication Enterprise Wide Program
- Maintenance Access Planning Project, and
- ATRICS ASB.

General details

Occurrence details

Date and time:	18 June 2016 – 0608 EST	
Occurrence category:	Accident	
Primary occurrence type:	Collision (track worker struck by train)	
Location:	Clyde, New South Wales, approximately 20.66 km by rail West of Central railway station.	
	Latitude: 33° 50.249' S	Longitude: 151° 1.171' E

Train details

Train operator:	NSW Trains	
Registration:	W510	
Type of operation:	Passenger - Regional	
Persons on board:	Crew – 2	Passengers – 49
Injuries:	Crew – 0	Passengers – 0
Damage:	Minor	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- NSW Police
- NSW Trains
- Pacific National
- Rail Industry Safety and Standards Board (RISSB)
- Sydney Trains
- The Bureau of Meteorology
- The Office of the National Rail Safety Regulator
- The Sydney Trains protection officer
- The Sydney Trains work group leader (Civil Worksite Supervisor)
- The Sydney Trains Signaller Clyde signal box
- The Sydney Trains Work Group Leader (Signal Electrician)
- The Sydney Trains Train Controller
- The Sydney Trains Team Leader signals
- The Sydney Trains Group Manager, Safety and Standards
- The Sydney Trains Group Manager, Rail Corridor Safety
- The Sydney Trains Systems Support and Assurance Specialist
- Transport for NSW, Asset Standards Authority.

References

RailSafe Glossary July 2012 Version 7.0

Rail Industry Safety and Standards Board (RISSB, Dec 2010). *National Guideline Glossary of Rail Terminology.*

Sydney Trains General Rule NGE 200 − July 2014.

RailCorp General Rule NGE 204 − November 2008.

RailCorp General Rule NGE 212 − November 2008.

Sydney Trains Network Local Appendices NLA 200.

Sydney Trains Network Local Appendices NLA 206.

Sydney Trains Network Procedure NPR 701 − March 2016

Sydney Trains Network Procedure NPR 703 − March 2016

RailCorp Network Procedure NPR 707 − July 2012.

RailCorp Network Procedure NPR 711 − December 2010.

Rail Safety National Law National Regulations (2012) − Made under the *Rail Safety National Law (NSW).*

Sydney Trains Network Form NRF 002 − July 2014

Sydney Trains Network Form NRF 003 − July 2014

RailCorp Network Rule NSY 500 − August 2005.

Sydney Trains Network Rule NTR 406 – July 2014.

Sydney Trains *Driver Route Knowledge Diagrams – Main West Line, maps 02 to 05*.

Sydney Trains Work on Track Rule NWT 300 − July 2014.

Sydney Trains Work on Track Rule NWT 304 − March 2016.

Sydney Trains Work on Track Rule NWT 308 − March 2016.

Sydney Trains Work on Track Rule NWT 310 − July 2012.

Sydney Trains Working Safely Handbook – June 2014

Technical Note – TN 036:2015 Update to passenger trainstop braking, braking, and traction performance requirements

Train Operating Conditions (TOC) Manual – April 2016

Transport NSW Engineering standard ESR 0001 – 600 RSU – Minimum Operating Standards for Rolling Stock – Multiple Unit Train Specific Interface Standards, Version 1.5, December 2012.

Duncan, J., Martens, S., Ward R. (1997) Restricted attentional capacity within but not between sensory modalities. *Nature* 387, 808-810. https://www.nature.com/articles/42947

Redick, T. S., Shipstead, Z., Meier, M. E., Montroy, J. J., Hicks, K. L., Unsworth, N., Kane, M. J., Hambrick, D. Z., Engle, R. W. (2016). Cognitive predictors of a common multitasking ability: Contributions from working memory, attention control, and fluid intelligence. *Journal of Experimental Psychology: General*, 145(11), 1473–1492. http://dx.doi.org/10.1037/xge0000219

Taoka, George T, Brake Reaction Times of Unalerted Drivers, *ITE Journal*, March 1989

Taylor, J. (2011). Technology: Myth of Multitasking. Is multitasking really more efficient? https://www.psychologytoday.com/au/blog/the-power-prime/201103/technology-myth-multitasking

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (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:

- NSW Coroner
- NSW Police
- NSW Trains
- Pacific National
- Sydney Trains
- The Office of the National Rail Safety Regulator
- The Sydney Trains Protection Officer
- The Sydney Trains Work Group Leader (Civil Worksite Supervisor)
- The Sydney Trains Signaller Clyde signal box
- The Sydney Trains Work Group Leader (Signal Electrician)
- The Sydney Trains Train Controller
- The Sydney Trains Team Leader Signals
- Transport for NSW.

Any submissions from those parties will be reviewed and where considered appropriate, the text of the draft report will be amended accordingly.

Appendices

Appendix A – Bio mathematical modelling

Bio-mathematical models are tools for predicting operator fatigue levels, performance levels and the provision of opportunity for rest, based on an understanding of scientific relationships between work hours, sleep and performance. All bio-mathematical models have limitations that must be understood to ensure their appropriate use within an FRMS.

Sydney Trains' assessment of rosters for managing fatigue risk is based primarily on the use of a bio-mathematical fatigue-modelling program known as Fatigue Audit Interdyne (FAID).

FAID requires hours of work as a single input.

> "It assigns a recovery value to time away from work based on the amount of sleep that is likely to be obtained in non-work periods, depending on the length and time of day that they occur" (Roach, Fletcher and Dawson, 2011)

FAID does not predict fatigue but rather predicts sleep opportunity, demonstrating only that the organisation has provided employees with an adequate opportunity to sleep (Dawson and others, 2011).

The ATSB used FAID and Fatigue Avoidance Scheduling Tool (FAST®). FAST is a software decision aid designed to assess and forecast performance changes induced by sleep restriction and time of day. No planning software, including FAST, can predict fatigue or fatigue-induced errors in all cases for all individuals.

Both FAID and FAST have been applied in investigation RO-2016-008 for consideration, with full awareness of the limitations of these systems.

Australian Transport Safety Bureau

The ATSB is an independent Commonwealth Government statutory agency. The ATSB 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 the ATSB's 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 operations involving the travelling public.

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 factors related to the transport safety matter being investigated.

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 factor: a 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 factor would probably not have occurred or existed.

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

Other findings: 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.