Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Rail Occurrence Investigation RO-2008-001

Final

Level Crossing Collision
Birkenhead, South Australia
5 March 2008

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The satellite view of the Stirling Street level crossing and adjacent surrounds depicted in this publication as Figure 1 is reproduced with the permission of Google Earth.

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Abstract

At about 1448 on Wednesday 5 March 2008, a double road-train loaded with bulk cement drove into the path of a train that was conveying four empty fuel tankers at the Stirling Street level crossing, Birkenhead, SA. The impact speed of both the train and road-train was low (about 15 km/h) but nevertheless sufficient to roll the prime mover and the first semitrailer onto their sides and to derail the lead bogie of the train's locomotive. The road-train driver was slightly injured; the two train drivers were shaken but otherwise unhurt.

Road traffic at the Stirling Street level crossing was controlled by 'Stop' sign assemblies. At the time of the collision, the level crossing was in the process of being converted from passive (Stop sign) to active control (flashing lights and boom barriers) as part of a major road upgrade called the 'Port River Expressway Project'. The investigation found that the Stop sign assembly was moved from its original position sometime during the upgrade and a 'Stop' line was not visible on the road surface. In the absence of a Stop line, visibility along the rail line was, at best, intermittent.

The investigation concluded that it is likely the road-train did not stop at the Stop sign assembly and travelled over the Stirling Street level crossing at a relatively constant speed of about 15 km/h. The investigation also found that the road-train involved in the collision was not authorised to operate on Stirling Street as no Heavy Vehicle Permit (HVP) for this vehicle had been issued by the Department for Transport, Energy and Infrastructure.

Safety issues identified by the investigation relate to compliance of the level crossing with relevant standards, notification to the rail infrastructure manager of a non-compliance identified at audit and the issuing of HVP's for road-train routes that involve level crossings. The ATSB has acknowledged proactive safety action taken by relevant parties in response to those identified safety issues. In addition, the ATSB has issued four safety recommendations.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory Agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

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

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

Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the 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 (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

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, risk controls and organisational influences.

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

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

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

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

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

- **Critical safety issue**: associated with an intolerable level of risk.
- **Significant safety issue**: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable.
- **Minor safety issue**: associated with a broadly acceptable level of risk.

EXECUTIVE SUMMARY

At about 1448 on Wednesday 5 March 2008, a double trailer road-train loaded with bulk cement drove into the path of train 4A13N at the Stirling Street level crossing, Birkenhead, SA. The road-train driver was slightly injured while the two train drivers were shaken but otherwise unhurt.

Train 4A13N was conveying four empty fuel tankers for loading at the Mobil fuel depot that is about 1 km beyond the Stirling Street level crossing. The road-train had just departed from the Adelaide Brighton Cement Works at Birkenhead with a consignment of cement that was bound for Roxby Downs in central SA.

The Stirling Street level crossing is located on the dual gauge Dry Creek to Outer Harbor 'freight only' rail corridor. Stirling Street is a short, sealed, two-way dead end street that provides access to bulk fuel and cement facilities in the immediate vicinity.

For about 34 months before the collision, the Port River Expressway Project had been underway on the Dry Creek to Outer Harbor rail corridor. The project included the re-laying of the rail line and the upgrade of the Stirling Street level crossing from passive control ('Stop' sign) to active control (flashing lights and boom barriers). These works were only partially completed at the time of the collision.

On the day of the collision, the Stirling Street level crossing was within a worksite that was associated with the Port River Expressway Project. In accordance with the protection measures for the worksite, train 4A13N had been stopped by a flagman about 130 m from the level crossing. When all personnel and equipment were clear of the track, train 4A13N was given permission to proceed into the worksite and over the Stirling Street level crossing. Several witnesses confirmed that, at this time, the locomotive horn was sounded several times and that the locomotive headlight was illuminated.

Shortly after, the train driver made an emergency application of the train brake when he realised that there was a collision risk at the level crossing with an approaching road-train. Train 4A13N collided with the lead trailer of the road-train almost at the centre of the pneumatic cement tank. The impact speed of both the train and road-train was low (about 15 km/h) but nevertheless sufficient to roll the prime mover and the leading trailer onto their sides and to derail the lead bogie of the train's locomotive.

While evidence in regard to the sequence of events in the moments before the collision varies considerably, the investigation concluded that it is likely the road-train did not stop at the Stop sign assembly and travelled over the Stirling Street level crossing at a relatively constant speed of about 15 km/h into the path of train 4A13N. It is very unlikely that the road-train driver stopped at the Stop sign assembly, but if he did, he displayed poor judgement in electing to accelerate normally from a position that was effectively blind to oncoming rail traffic.

The investigation found that the double trailer road-train did not have a Heavy Vehicle Permit (HVP) to operate on Stirling Street at the time of the collision. As such, the owner and driver of the double trailer road-train did not hold any authority to operate this vehicle over the Stirling Street level crossing. In addition, the ARTC had not recently been approached to issue clearances for other level crossings in SA by either the permit applicant or the Department for Transport Energy and Infrastructure when HVP's were issued for 'fixed-term' operations.

The investigation also found that the Stop sign assembly had been moved from its original position (3.5 m from the rail line) to its position at the time of the occurrence (9.1 m from the rail line) sometime during the upgrade of the level crossing. Similarly, the Stop line (pavement marking) had either not been reinstated or not maintained in a serviceable condition after road resurfacing. In the absence of a visible Stop line, the sight distance along the rail line from the Stop sign assembly was inadequate when assessed against the Australian Standard. While inadequate sighting was unlikely to have contributed to this collision, it was still considered a safety issue with respect to road traffic that obeyed the road rules and stopped as required.

Safety issues identified by the investigation relate to the compliance of the level crossing to the relevant standard, notification to rail infrastructure management of non-compliances identified at audit and the issuing of HVP's for routes that involve level crossings. The ATSB has acknowledged proactive safety action taken by relevant parties in response to those identified safety issues. In addition, the ATSB has issued four safety recommendations.

1 FACTUAL INFORMATION

1.1 Overview

At about 1448 on 5 March 2008, a low speed collision occurred between a train and a double trailer road-train at the Stirling Street level crossing at Birkenhead, SA. Birkenhead is a suburb of the City of Port Adelaide Enfield that is in close proximity to Adelaide's port facilities at Port Adelaide and Outer Harbor.

The road-train driver received minor injuries but the two train drivers were unhurt. The road-train incurred extensive damage to the prime mover and leading trailer, damage to the train was confined to the locomotive.

1.1.1 The rail corridor

The Stirling Street level crossing is located on the Dry Creek[1] to Outer Harbor rail corridor. This corridor services a number of sidings en route where steel products, grain, petroleum and container consignments are loaded or unloaded. The rail track is dual gauge (1600 mm/1435 mm) and is managed by the Australian Rail Track Corporation (ARTC).

At the time of the collision a civil engineering construction project known as the 'Port River Expressway Project' was underway. This project was a combined SA Government and Commonwealth Government initiative that was supported by the AusLink Investment Program. A new grain terminal and wharf, deepening of the Outer Harbor shipping channel, rail upgrade and various other infrastructure improvements were components of the project. Key elements of the rail upgrade included the elimination or upgrade of level crossings (from passive to active control)[2], the construction of a new high level opening rail bridge over the Port River and the elimination of a 'common access' section of rail track that existed between Port Adelaide and Glanville[3].

The new rail bridge was opened for traffic on 1 August 2008, some 5 months after the collision at the Stirling Street level crossing. Routing the ARTC Outer Harbor freight rail line over the new bridge shortened the distance between Dry Creek and Outer Harbor by about 3 km (to about 15 km) and eliminated the common access ARTC/TransAdelaide section between Port Adelaide and Glanville, thereby separating the ARTC freight rail line from the TransAdelaide suburban passenger rail line. The Stirling Street level crossing at Birkenhead was converted from passive to active control on 1 August 2008.

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1 The Outer Harbor junction at Dry Creek is about 1 km from the Adelaide Freight Terminal. Dry Creek is located on the Adelaide to Port Augusta main line.

2 At a passive level crossing road traffic is controlled by signs/devices that are not activated during the approach or passage of a train. At an active level crossing road traffic is controlled by devices such as flashing lights, gates, or barriers or a combination of these, where the device is actuated prior to and during the passage of a train through the level crossing. (NCoP Volume 2 Glossary)

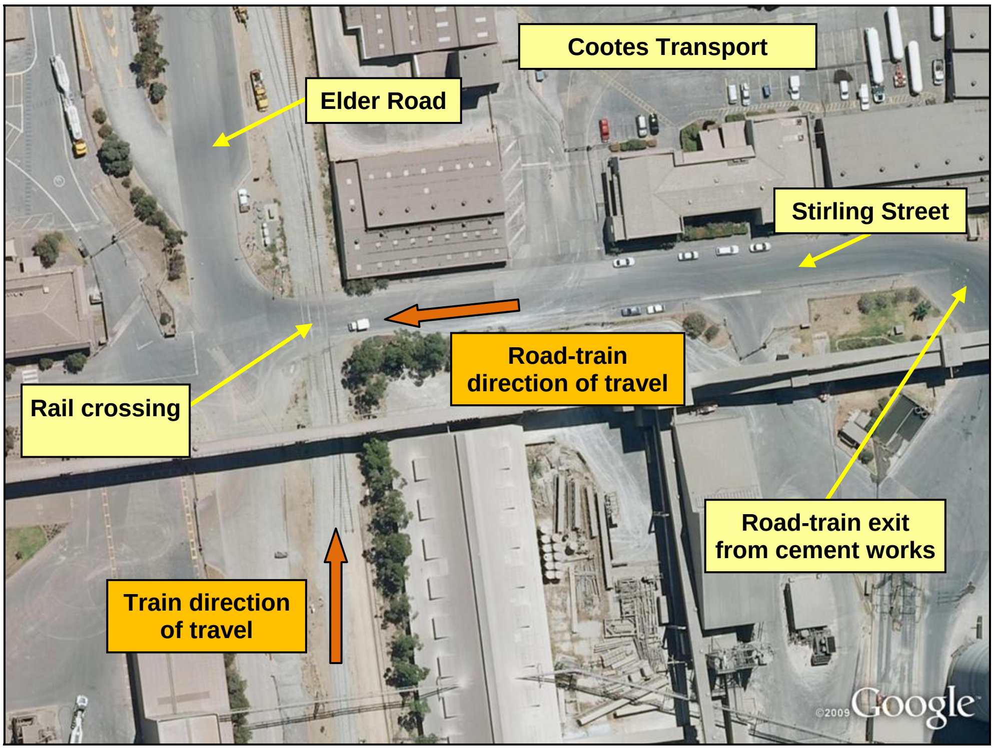
3 This section was about 3 km long. Access was shared with the TransAdelaide suburban railcar services.

1.1.2 Road and rail layout

Stirling Street is a short, two-way, dead-end, sealed road that is used by road traffic requiring access to the fuel and cement terminals that are located in the immediate vicinity (Figure 1). Road traffic using Stirling Street, in the main, consists of employee's private vehicles and heavy vehicles conveying bulk cement and petroleum products (including liquefied petroleum gas) from the respective storage/loading terminals.

Stirling Street intersects Elder Road at a 90 degree angle about 15 m beyond the level crossing.The rail line to Outer Harbor runs parallel to Elder Road. The orientation of Stirling Street is roughly east-west, the orientation of Elder Road and the Outer Harbor rail line is roughly north-south. Elder Road is a gazetted road-train vehicle route and is the primary access route to Outer Harbor and Port Adelaide for industry that is located in the Birkenhead precinct. Stirling Street is gazetted for B-Double truck[4] access and road-train access is by Heavy Vehicle Permit (HVP) only. The road authority for Stirling Street and Elder Road is the Port Adelaide Enfield City Council.

Figure 1: Aerial view of Stirling Street



At the time of the collision, the Stirling Street level crossing was passively controlled by 'Stop' sign assemblies. In the months preceding the collision, extensive track and level crossing upgrade works had been undertaken in

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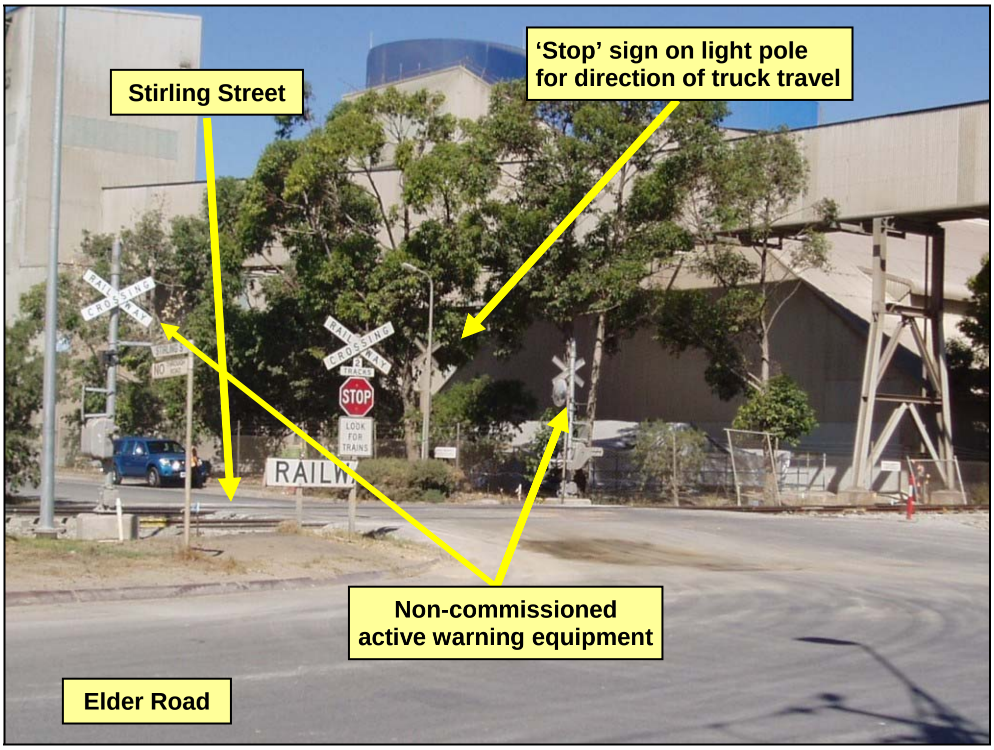
4 B-Double means a combination consisting of a prime mover towing two semitrailers where the first semitrailer is connected to the prime mover by a fifth wheel coupling and the second semitrailer is connected to the first semitrailer by a fifth wheel coupling. A road-train means a combination consisting of a prime mover towing two, three or four semitrailers in which the first semitrailer is connected to the prime mover by a fifth wheel coupling and the subsequent trailers are connected to each other by an 'A' frame converter dolly.

conjunction with the Port River Expressway Project. As at 5 March 2008, these works were still on-going. The works had included the removal of a (disused) parallel rail line that was to the west of the main rail line, the re-surfacing of Stirling Street in the vicinity of the level crossing and the partial erection of active level crossing equipment for the pending conversion from passive to active control. At the time of the collision this equipment consisted of posts and cross-bucks only, the lights and boom barriers were yet to be fitted (Figure 2).

Figure 2: Partial erection of active warning equipment as at 5 March 2008



1.1.3 Train and crew information

Train 4A13N was owned and operated by Pacific National Pty Ltd (PN). It weighed 225 t, was 79.4 m long and was being hauled by locomotive 8046.

Train 4A13N was a local 'shunting' train that was conveying four empty PTMY[5] fuel tankers from the PN Adelaide Freight Terminal (AFT) to the private Mobil sidings at Birkenhead for loading with distillate. The entrance to the Mobil sidings is about 1 km past the Stirling Street level crossing.

Train 4A13N was crewed by two drivers; a principal driver[6] and a trainee. At the time of the accident the trainee was performing the driving duties.

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5 PTMY wagons weigh 26 tonnes when empty; 76 tonnes when fully loaded. They are rated to hold up to 68,000 litres of distillate. However, diesel fuel has a Specific Gravity of 0.82 – 0.95 per litre. A volume of 68,000 litres would weigh between 55.76 and 64.6 t. As the PTMY wagons have a maximum load of 50 t the capacity of 68,000 litres would appear to be a design characteristic rather than an achievable payload.

6 A principal driver is a driver who is rostered with a trainee for the purpose of providing practical tuition as the trainee progresses through the various stages of driver training.

The principal driver had been a train driver for 28 years and had driven a variety of locomotive hauled passenger and freight trains over much of SA. The trainee had been rostered with the principal driver for just under two years and had been qualified to drive trains such as 4A13N since March 2007.

Both driver's qualifications and medical requirements were current at the time of the collision.

1.1.4 Road-train, company and driver information

The road-train consisted of a 1990 Kenworth model T950 prime mover hauling two identical trailers loaded with cement. The overall length of the road-train was about 32.5 m and the weight 79 t. It was owned and operated by Golding Transport Industries Pty Ltd, an Adelaide based company that specialises in pneumatic discharge bulk haulage.

At the time of the collision, the road-train had only just (minutes before) departed from the Adelaide Brighton Cement Works with a load of cement bound for the central SA mining township of Roxby Downs. The road entrance/exit to the Adelaide Brighton Cement Works used by the road-train is 145m to the east of the Stirling Street level crossing[7]. The distance between Adelaide (Birkenhead) and Roxby Downs is about 575 km and the haulage of cement on this route is a regular consignment for Golding Transport Industries. On the return from Roxby Downs, fly ash is often loaded at Port Augusta for transport to Adelaide.

The road-train driver was a 45 year old male who had been driving trucks for about 25 years. He had driven for Golding Transport for about 3 years and was employed on the Birkenhead-Roxby Downs-Adelaide cement/fly ash run on a regular basis.

The road-train driver held a current MC class licence. This allowed him to drive any motor vehicle or combination of vehicles other than a motor bike or a motor trike.

1.2 The occurrence

1.2.1 Pre-collision

Both train drivers signed on duty at the Adelaide Freight Terminal at 1230 on Wednesday 5 March to work what is known locally as a 'metro movement'. In essence, the shift contained a number of duties such as shunting local sidings, preparation of mainline trains and the servicing and provisioning of locomotives. On this occasion the first duty was to convey four empty distillate rail tankers to the Mobil private sidings at Birkenhead. Preparation duties were duly carried out and departure from the AFT (as train 4A13N) was at about 1400.

At Gillman Junction the train was held for about 6 minutes awaiting a path between TransAdelaide suburban railcars on the Port Adelaide to Glanville dual gauge section of track. Departure from Gillman Junction was at 1412 and Glanville was

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7 There are two entry/exits to the Adelaide Brighton Cement Works; 96m and 145m from the level crossing.

passed at 1434. During this time, an access authority that gave authority to proceed beyond Glanville to Birkenhead was obtained from ARTC train control via radio by the principal driver. Train 4A13N then proceeded along the Outer Harbor 'freight only' line towards Birkenhead.

At Birkenhead, a Track Work Authority (TWA) was in force in order to protect a worksite where personnel were carrying out track works associated with the Port River Expressway Project. As per the requirements of a TWA, a Stop board was positioned 50 m from the worksite. The Stirling Street level crossing was within the worksite and was about 130 m from the Stop board.

Train 4A13N arrived at the Stop board at about 1440. After a delay of about 6 or 7 minutes, a verbal authority to proceed through the worksite was obtained from the track work supervisor who was at the Stop board. The train drivers said they then sounded the horn and proceeded towards the Stirling Street level crossing at an estimated 10 to 15 km/h. They also said that the headlight was illuminated on high beam, having been left on since departure from Port Adelaide. At this time, the principal driver, who was performing the co-driver duties, was communicating by mobile telephone to the coordinator at the Mobil siding, planning the impending shunt.

The road-train driver had commenced work at the Golding Transport depot at Dry Creek at about 1100. He drove the empty road train to the Adelaide Brighton Cement plant at Birkenhead for loading but problems at the plant delayed his departure for about 2 hours. Once loaded the road-train driver said he proceeded through the plant wash bay, turned left and headed west down Stirling Street in the usual manner, mindful of the vehicular traffic that enters and exits from the driveways of Cootes Transport Company and the Adelaide Brighton Cement Works. The road-train driver said he then intended to turn right at the Stirling Street/Elder Road intersection that was 15 m beyond the level crossing and proceed along Elder Road in a 'northerly' direction. He said that at this time the side windows were closed, the quarter vent 'flipper' windows were open, the air conditioning was on and the UHF radio was turned off.

1.2.2 The collision

The trainee train driver, who was in control of the locomotive, said that when they were about 20 m from the level crossing, he saw a truck approaching from the right (eastern) side[8]. He estimated that the truck was travelling at about 20 km/h and that it was '... about 10 m from the rail line, almost at the Stop sign ...' when he first saw it. He said the truck '... went straight through the Stop sign, he wasn't going fast but he just didn't stop, he just proceeded through.' At this time he estimated that they (the train) were travelling at about 10 to 15 km/h. Within moments of sighting the truck he made an emergency application of the train brake and sounded the locomotive horn, however the truck continued into the path of their train. He then instinctively ducked down below the control console as they were about to collide.

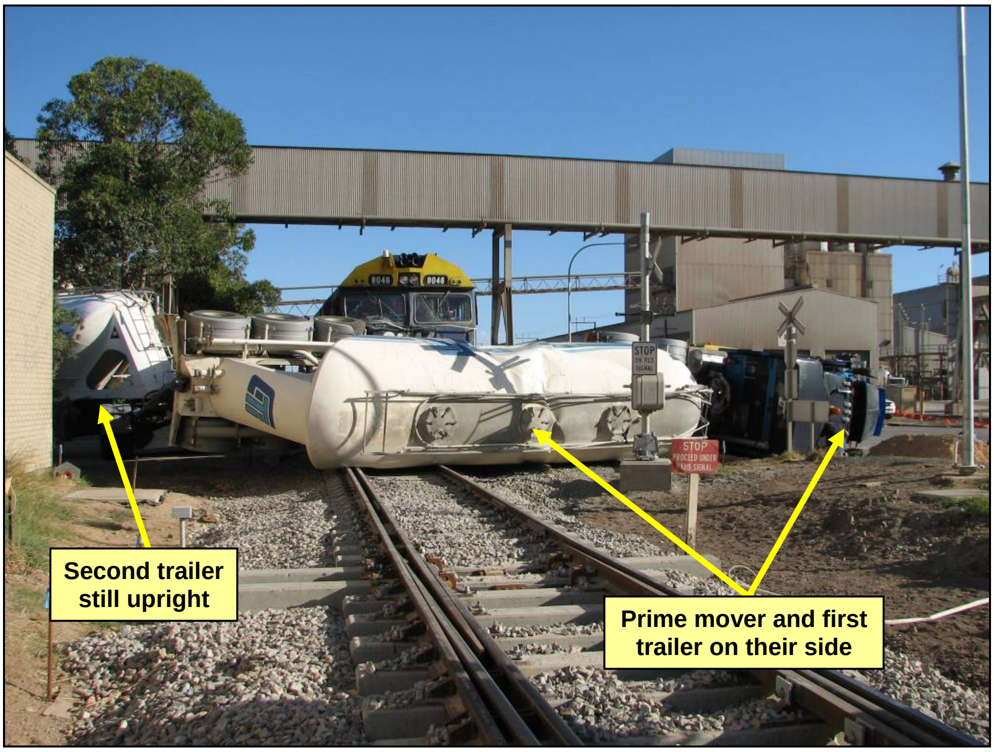
The principal driver said that he had just finished his call to the coordinator at the Mobil siding and looked up to see the cab of the prime mover right in front of the locomotive. At this time he estimated that they were about 20 m from the level

8 The trainee driver was seated on the left side of the locomotive.

crossing and travelling at about 10 km/h; he estimated that the truck was travelling at a similar speed. He then dived on the floor as the train and truck were about to collide. The principal driver said that although he did not see the truck actually drive through the Stop sign, the constant rate at which it was travelling implied that it had not stopped.

The road-train driver stated that he stopped the road-train in the vicinity of the Stop sign before proceeding over the level crossing. He said that he was unable to see along the rail line to the north or south due to the buildings and shrubs/trees that were adjacent to the rail line. After stopping he moved off in the normal manner towards the level crossing with the intention of traversing the crossing and turning right into Elder Road. However, within moments of doing so, he heard a train horn. He immediately looked to his left and saw that a train was very close and that a collision was imminent. He then applied maximum power in an attempt to get the prime mover clear of the level crossing.

Figure 3: Collision consequence



The locomotive collided at about the middle of the pneumatic cement tank of the first trailer, which rolled onto its right side. The first trailer remained secured to the prime mover turntable thereby rolling the prime mover in the same direction. However, the rear trailer remained upright on all wheels because the 'A' frame converter dolly[9] coupler between the first and second trailer twisted. Consequently, this action steered the dolly bogie that was under the leading end of the second trailer in the same direction that the train was travelling (Figure 3). During this sequence, the forward (east to west) movement of the road-train exerted sufficient lateral force on the locomotive to derail all wheels of the leading bogie to the western side of the track.

9 Dolly – the 'A' frame draw-bar and bogie that connects the trailers of a road-train to each other.

1.2.3 Witness accounts

The track work supervisor who was in charge of the worksite at Birkenhead said that he held train 4A13N at the Stop board for several minutes until an excavator that was being used at the worksite had cleared the track. He gave permission for the train to proceed when he was told by the excavator operator that the rail line was clear. He said that the locomotive horn was then sounded for a ‘good 2 to 3 seconds’ as the train moved off. He also said that as the locomotive approached the Stop board he was able to see that the locomotive headlight was illuminated. Although he was unable to determine whether it was on high or low beam, he did say the headlight was bright and clearly visible from where he was standing at the Stop board.

He then walked to his work vehicle that was parked beside the rail line with the intention of closing the TWA with ARTC train control via telephone. He heard a loud noise and looked up and saw a truck on its side. He said he did not recall hearing another sounding of the train horn before the collision.

An employee of Cootes Transport Group Pty Ltd (a truck driver) was in his private vehicle on his way to work when the collision occurred. At the time of the collision he was positioned behind a truck on Elder Road on the western side of the level crossing. This truck and some ancillary equipment associated with the rail line obscured his vision of the level crossing to some degree. However, he was able to see the train ‘stopped up at the new section of track, where they always stop’ and heard the locomotive horn sounding as the train moved off from this position. He said he then turned his attention to gathering his belongings in preparation for his shift when he heard the train horn again. He looked up and saw a truck and a train on a collision course. He estimated that the train and truck were both travelling at about 20 km/h when the collision occurred.

1.2.4 Collision aftermath

Within seconds of the impact, the principal driver radioed an emergency message to ARTC train control; he said train control responded almost immediately. At the same time, the trainee driver shut the locomotive engine down from the stop button on the control stand. Because they initially thought the road-train was a fuel tanker, they quickly vacated the locomotive cabin. Once on the ground they saw the road-train driver was walking around; he seemed to be somewhat agitated and/or in shock. When it was ascertained that the road-train was not carrying flammable product, the locomotive was re-boarded, electrical power was isolated and the handbrake applied. The train drivers said they had minimal dialogue with the road-train driver after the collision.

The road-train driver said he was thrown about the prime-mover cabin as the prime-mover was turned on to its side. He said that once out of the prime-mover cabin, he ‘just got away’ from the immediate vicinity of the collision site. Several people came over to check on his condition and, after what seemed a short time, the ambulance and police arrived[10]. During this time, he borrowed a mobile telephone and rang the operations manager of Golding Transport to inform him of the collision. He also complained to several persons that the signals (flashing lights) at

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10 SA Police records show that by 1505 the ambulance and fire brigade were on site.

the level crossing were not yet working. He was later taken to hospital for further examination.

The track work supervisor said he was aware that the train drivers were speaking with ARTC train control so he contacted his supervisor from Transfield. He said that he spoke to the road-train driver who complained that the railway signals were not yet working. He told the road-train driver that this was because they were not complete or commissioned yet.

Both train drivers and the road-train driver were tested for the presence of alcohol. The train drivers were tested on site and the road-train driver was tested at hospital. In addition, the road-train driver was also tested for the presence of illicit substances. All tests returned negative results.

At interview, both train drivers and the road-train driver said that they felt alert and well in the hours leading to the accident. All had been off duty the night before, the train drivers ceased previous duty at 1930 on Tuesday 4 March and the road train driver ceased previous duty at about 1100 on Tuesday 4 March. The road-train driver said that he had slept well the previous night and that no personal/domestic issues were bothering him.

1.2.5 Environmental conditions

The weather at the time was fine, warm and cloud free. The sun was high in the north-western sky in a position that would not have inhibited the road-train or train drivers’ visibility.

2 ANALYSIS

ATSB investigators from the Adelaide field office arrived on site at the Stirling Street level crossing at about 1615 on 5 March 2008. The investigators examined and photographed the accident scene with the wreckage in situ. The road and rail approaches to the level crossing were also examined. In July 2008, investigators returned to the accident site to conduct level crossing sighting and road-train acceleration tests.

Evidence was sourced from various witnesses, the owner of the road-train, the rail track manager, local contractors, the operators of the train and SA Governmental agencies. In addition, the investigation examined the locomotive Hasler recorder instrument, road-train driver and train drivers' employment histories, relevant standards pertaining to level crossings and the operation of road-trains, and evidence regarding previous layout of the level crossing equipment/signage.

Preliminary examination and analysis of this evidence revealed that performance degradation of the train drivers and the road-train driver did not contribute to the occurrence. Likewise, all safe-working requirements associated with the passage of train 4A13N were seen to be met and environmental conditions were ruled out as a contributing factor to the accident.

However, the following factors associated with the accident were subject to further analysis:

- The differing evidence between the road-train driver and the train drivers in regard to whether or not the road-train stopped at the level crossing 'Stop' sign assembly
- Potential non-compliances with the Stirling Street level crossing
- The manner in which the level crossing upgrade was carried out
- Permits that allow the operation of road-train trucks on Stirling Street.

2.1 Sequence of events analysis

2.1.1 Data recorder examination

The Hasler data recorder, as fitted to locomotive 8046, is an electro-mechanical device which records information on a waxed paper tape (roll). The data recorded includes time, distance, speed, brake-pipe pressure, vigilance equipment acknowledgement and limited information regarding locomotive power (on or at idle). Hasler recorders do not record the operation of the locomotive headlight or horn.

When examining Hasler data for investigation purposes, it is important to recognise the limitations of the recording device and the tolerances relevant to the analysis methods. The main limitation is the electro-mechanical mechanism of the Hasler data recorder. This generally limits the accuracy for some recorded parameters at train speeds below 5 km/h. In this case, the Hasler limitations were minimal in the period immediately before the collision because the train was travelling greater than 5 km/h.

When the train is moving, data is recorded as a function of distance. However, when events occur within a relatively short distance, analysis of the data can become difficult, especially in relation to the time and distance parameters or parameters that are rapidly changing. In this case, train speed immediately before the collision could be considered to be reasonably accurate. However, the locations (distance) at which brake-pipe pressure reduced (brake application) and disruption of the speed trace (collision) have higher associated tolerances.

The key elements recorded by the Hasler recorder on locomotive 8046 are listed below. Due to the associated tolerances, times and distances are approximate and a data range is provided where possible.

- The distance from where the locomotive was stationary (in the vicinity of the stop board) to the point of impact was about 130 m.
- The time between when the train moved off from the Stop board and the point of collision was about 39 seconds.
- The train was travelling at about 15 km/h when the first reduction of brake-pipe pressure occurred, about 33 seconds after leaving the Stop board.
- The train was still travelling at about 15 km/h when it collided with the truck, but the brake-pipe pressure had reduced to about 250 kPa (full pressure is about 500 kPa).
- The approximate time between brake-pipe pressure reduction and the point of collision was between 3 and 6 seconds.

2.1.2 Train driver action

The train driver stated that they were approaching the Stirling Street level crossing at between 10 and 15 km/h. He said that when they were about 10 m, and no more than 20 m, from the crossing, he observed the truck approaching from the east. The driver estimated that the truck was about 10 m from the crossing and believed that it was not going to stop. The driver sounded the horn and made an emergency application of the train brake before ducking behind the control console as they were about to collide.

The second driver stated that just as he had just finished talking to the depot on the telephone as they were approaching the crossing. He looked up to see the cab of truck right in front of the locomotive at about the same time that the first driver sounded the train horn. His response was also to protect himself by diving onto the floor of the locomotive cab. The second driver’s estimation was that the train was travelling at about 10 km/h and they were about 20 m from the crossing when he saw the truck.

The locomotive data log showed the train travelling at about 15 km/h. The log also indicated that the train brake was applied between 3 and 6 seconds before impact. This coincides with a calculated distance of between 12.5 m and 25 m. Both distance and speed are generally consistent with the driver’s recollection.

The train driver’s contention that the locomotive headlight was illuminated and that the horn was sounded several times while in the vicinity of the level crossing (including once immediately before impact) is supported by the evidence of several witnesses who were in the vicinity at the time of the collision.

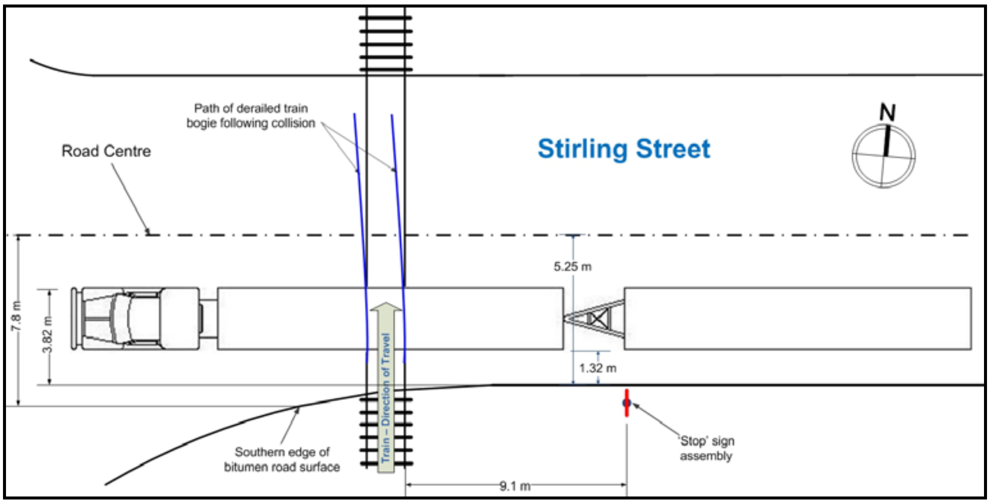
2.1.3 Road-train driver actions

The road-train driver stated that he had stopped in the vicinity of the Stop sign before proceeding over the level crossing. He said that within moments of starting, he heard the train horn and realised that a collision was imminent. He attempted to clear the crossing but the locomotive collided with the first trailer of the road-train.

Examination of the engine monitoring system fitted to the road-train prime mover provided no information regarding engine revolutions or road-train speed. As a consequence, the site examination of the locomotive's wheel flange marks and the road-train's tyre marks on the road surface, the point of impact on the first trailer and the road-train's acceleration rate, are key factors in the analysis of the road-train driver's actions.

Figure 4 illustrates the location of the truck at the point of collision. Site observations and measurements indicate that the road train was essentially in the centre of the westbound lane at the point of impact. The locomotive impacted the first trailer of the road-train almost 'dead centre', about 11.7 m from the prime mover (front) bull-bar.

Figure 4: Diagram of road-train position at time of collision



There were no tyre skid marks from the road-train at the site that were attributable to braking before impact. The only tyre marks found were the result of the road-train being struck by the train and moved laterally with respect to its direction of travel (Figure 5). The three sets of tyre marks seen are scuff marks from the tri-axle bogie of the lead trailer. These marks indicate that the leading trailer was forced sideways for just over 2 m before it rotated and that the wheels were still turning as this was happening. This indicates that the brakes of the leading trailer were not on at impact. However, behind the 'A' frame converter dolly bogie there were skid marks, indicating that the brakes of the dolly bogie were applied. The length of these skid marks indicated that the dolly bogie brakes applied at or within moments of impact. This was almost certainly due to the air line between the lead trailer and the 'A' frame converter dolly being vented to atmosphere during the collision sequence.

The tyre marks on the bitumen surface support the evidence of the road-train driver who said he did not apply the brakes before or at impact.

Figure 5: Tyre marks of rear bogie leading trailer

2.2 Did the road-train stop?

The road-train driver said that he stopped the road-train in the vicinity of the Stop sign at the Stirling Street level crossing. From this position, he was unable to see along the rail line to the north or south due to the buildings and shrubs/trees that were adjacent to the rail line. He said that he then moved off in the normal manner towards the level crossing until he heard the sound of the train horn. He said that upon sighting the train he applied full power.

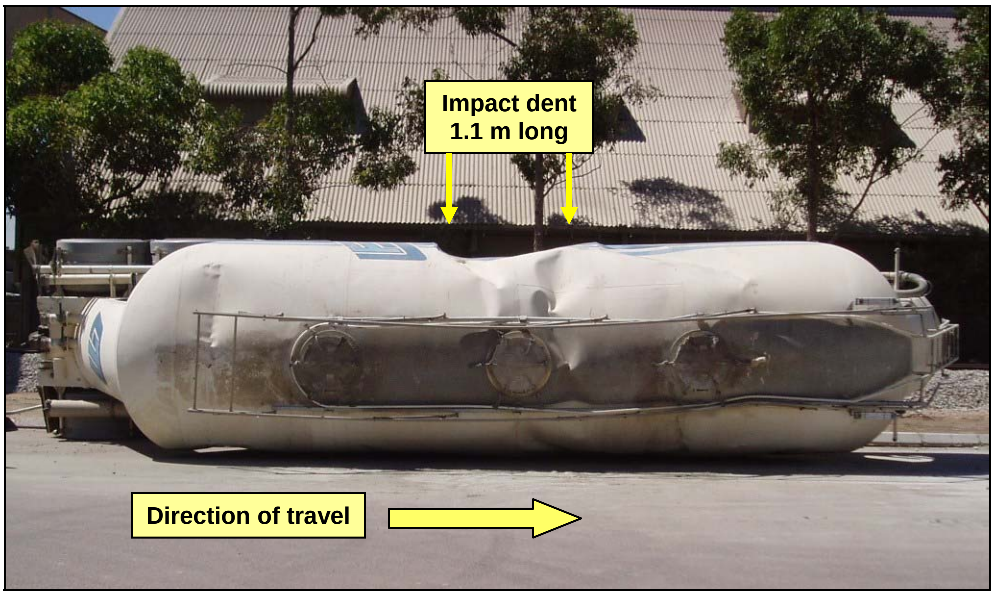
The critical factor in regard to assessing the probability of whether or not the road-train driver stopped at the Stop sign assembly is the positional relationship between the truck and train at the point where the train driver perceived that a hazard existed. Various pieces of evidence can be used to build a picture of the most likely scenarios:

- The locomotive data log indicated that the train was travelling at about 15 km/h and the brakes were applied between 3 and 6 seconds before impact.
- The train driver saw the road-train when it was less than 10 m from the crossing and applied the train brake because he believed the truck was not going to stop.
- The truck driver stated that he had stopped in the vicinity of the Stop sign before proceeding over the level crossing. In the absence of any evidence to verify this statement, the scenario that he did not stop must also be considered.
- The truck driver said that when he heard the train horn, he realised that a collision was imminent and tried to clear the crossing to avoid the collision. This would imply that when the train horn was sounded, the truck was either on the crossing or very close to the crossing, such that stopping the truck would have

guaranteed a collision. This is consistent with the second driver’s observation that he looked up to see the cab of the truck right in front of the locomotive at about the same time that the first driver sounded the train horn and applied the train brake.

- A number of witnesses estimated that the truck was travelling at about 20 km/h as it passed over the Stirling Street level crossing.
- The locomotive impacted the first trailer of the road-train almost ‘dead centre’ of the pneumatic cement tank (Figure 6), about 11.7 m from the prime mover (front) bull-bar. Therefore, the road-train had to travel 21.4 m from the ‘Stop’ sign assembly for the locomotive to have impacted the leading trailer at this point.

Figure 6: Leading trailer after removal from site



In July 2008, three tests were carried out over a distance of 21.4 m with the same prime mover (repaired), the same road-train driver and the same loaded double trailer road-train configuration. In the first test, the road-train driver was asked to accelerate in his normal manner. In the second, he was asked to drive as he did on the day of the collision, that is, accelerate from a stand normally and then at maximum power when he saw the train. In the third test, he was asked to accelerate as hard as reasonably possible.

The term ‘point of perception’ refers to that place where a person has first realised that a hazard confronts them which requires some action on their part. In this case, the train driver’s reaction to a hazard was the application of the train brake. Assuming a 1.5 second reaction time[11], the train driver’s point of perception was calculated to be between 19 m (4.5 seconds) and 31 m (7.5 seconds) from the point of impact. The sight line from a vehicle at the Stop sign (9.1 m from track)

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11 Research has shown that average reaction time in an unexpected situation exhibited by a person unaffected by drugs, alcohol, fatigue, or illness etc usually ranges from 1.0 to 1.5 seconds. However, many drivers will take longer to react. Therefore, for design purposes such as highway design manuals and sighting distance calculations for level crossings, a figure of 2.5 seconds is typically applied to ensure that sufficient reaction time is allowed for the majority of people.

coincides with a train located about 40 m from the crossing, including an intermittent view through the vegetation (refer to 'Sight distance' in section 2.3.3 Level crossing configuration as at 5 March 2008). It is evident that the train driver would have been able to see the Stop sign when the train was at the furthest calculated point of perception. Therefore, it is conceivable that the train driver's action could have been due to the truck moving past the Stop sign or the new flashing light mast.

Scenario 1

Scenario 1 looked at the likelihood that the truck stopped in the vicinity of the Stop sign (9.1 m from the track) before moving across the Stirling Street level crossing level crossing.

The acceleration test results for the road-train travelling over a distance of 21.4 m are shown in Table 1. This illustrates the time between moving past the Stop sign and the point of impact. Also shown is the calculated time taken for the truck to move from the Stop sign to the rail crossing (9.1 m) and the speed the truck would be travelling at that point.

Table 1: Test results and calculations for scenario 1

	Time for truck to travel 21.4 m (From 'Stop' sign to point of impact)	Time for truck to travel 9.1 m (From 'Stop' sign to rail track)	Truck speed 9.1 m after start (when at rail track)
Test 1	11.5 sec	7.5 sec	8.7 km/h
Test 2	10.8 sec	7.0 sec	9.3 km/h
Test 3	8.0 sec	5.2 sec	12.5 km/h

Note: Test 1 – normal acceleration
Test 2 – normal plus hard acceleration when train sighted
Test 3 – acceleration as hard as possible

If the train driver applied the brakes due to the truck passing the Stop sign, the train would take between 4.5 seconds and 7.5 seconds to move from the driver's point of perception and the point of impact. This time range is shorter than each of the times taken for the truck to move from the Stop sign to the impact point.

Evidence suggests that the train driver sounded the horn and applied the brakes at about the same time the truck was passing over the rail track. This action would be about 1.5 seconds (reaction time) after the truck passed the Stop sign (point of perception). However, in each test case, the truck would have taken significantly more time to move from the Stop sign to the rail track (a distance of 9.1 m).

A number of witnesses stated that they estimated the truck was travelling at about 20 km/h as it passed over the crossing. However, in each test case, the calculated truck speed at the rail crossing is well under 20 km/h.

Based on various sources of evidence (including the truck acceleration tests), it is unlikely that the truck could have accelerated from a stopped position in the vicinity of the Stop sign to the collision point (a total distance of 21.4 m) in the time available.

Scenario 2

Scenario 2 looked at the likelihood that the truck did not stop at the Stop sign, but travelled through the Stirling Street level crossing at relatively constant speed. Table 2 shows the calculated travel times for a truck travelling at a constant approach speed. The times have been calculated for distances of 21.4 m (Stop sign to point of impact), 9.1 m (Stop sign to rail track).

Table 2: Travel time calculations for constant approach speed

	Time for truck to travel 21.4 m	Time for truck to travel 9.1 m
10 km/h	7.7 sec	3.3 sec
15 km/h	5.1 sec	2.2 sec
20 km/h	3.9 sec	1.6 sec

The train driver's point of perception was calculated to be between 4.5 seconds and 7.5 seconds before the point of impact. In relation to the truck, the time taken to travel the 21.4 m between the Stop sign and the point of impact are the relevant figures to compare against. Referring to Table 2, the travel time for a speed of 10 km/h and 15 km/h are within this range or very close (0.2 of a second).

As explained previously, reaction time usually ranges between 1.0 to 1.5 seconds, but could be as high as 2.5 seconds. In relation to the truck, the time taken to travel the 9.1 m between the Stop sign and the rail track are the relevant figures to compare against. Referring to Table 2, the travel time for a speed of 15 km/h and 20 km/h are within this range.

Based on these figures, it is possible that the truck travelled through the level crossing at a relatively constant speed without stopping. It is also possible that the train driver saw the truck approaching when the truck was within 10 m of the crossing, as stated by the train driver. Similarly, the train driver applied the brakes and sounded the horn as the truck passed over the crossing.

The most likely truck speed was about 15 km/h. While this is not quite as fast as the witness recollections of 20 km/h, it is significantly closer than the calculated speeds required for scenario 1.

2.2.1 Road driver actions to address train visibility issues

The road-train driver said that, when stopped at the Stirling Street level crossing, road users were unable to see along the rail line to the north or south due to the buildings and shrubs/trees that were adjacent to the rail line. However, despite the location of the Stop sign assembly and lack of pavement marking, motorists had been successfully negotiating the level crossing for some time, possibly many months. Indeed, the road-train driver himself said that to get through 'that wall' (sighting impediments) '...you have to creep that truck more or less onto the line to have a look.' This contention was supported by the train drivers who said that they had seen road vehicles pull slowly out from behind the line of trees and shrubs and stop where a clear view could be obtained. They said that, on occasions, they had even seen road vehicles reverse a short way to ensure they were clear of the rail line after the motorist sighted the train.

The evidence indicates that, if a stop was made[12], 'creeping-up' was the manner in which the level crossing was often negotiated by vehicles travelling west along Stirling Street. Such a practice is, of course, in no way desirable or acceptable. However, the lack of pavement markings and the limited visibility along the rail line from the Stop sign assembly made it necessary for motorists, in the interests of self preservation, to draw past the Stop sign assembly to a point where approaching rail traffic could be sighted.

The road-train driver also said that when he had previously encountered a train at the Stirling Street level crossing, that a flagman or contractor's vehicles were usually present. He said '...you just can't get through on these occasions because they are letting a train through and they stop you.' Other witnesses were asked if they had encountered (or, in the case of Transfield witnesses, if they had provided) flagmen for the purpose of controlling road traffic when a train was approaching the level crossing. Each answered no. The only control measures encountered (or provided) that were applicable to road traffic were said to be for the protection of workers and equipment when work was being carried out on or around the Stirling Street level crossing itself.

While there is no reason to doubt the road-train driver's account that he had usually seen 'flagmen' or vehicles blocking access to the level crossing when a train was encountered, the probability is that such measures were for the purpose of protecting workers and equipment that were on or about the level crossing from road traffic rather than protecting motorists from the passage of a train. If a train did move through the crossing while such work was being undertaken, the likelihood is that the protection would remain in place for the passage of the train as there would be no logical reason to remove it at the time.

It is possible that past experiences led to an expectation on the part of the road-train driver that a train would not move through the level crossing 'unannounced'. Regardless of this expectation, to drive over the crossing without stopping and giving due consideration to any approaching trains unnecessarily increased the risk of a collision. Similarly, to stop at the Stop sign assembly and accelerate normally from a position that was essentially blind to oncoming rail traffic and without giving due consideration to any approaching trains also increased the risk of a collision.

2.2.2 Summary

Evidence was gathered from a number of sources in an endeavour to determine the sequence of events immediately before the collision, in particular, whether or not the road-train stopped in the vicinity of the Stop sign assembly.

Based on the information available, it is likely that the road-train did not stop at the Stop sign assembly and travelled over the Stirling Street level crossing at a relatively constant speed of about 15 km/h. It is likely that the train driver saw the truck approaching, applied the brakes and sounded the horn as the truck passed over the crossing.

12 Evidence from nearly all witnesses indicated that it was a regular practice for road vehicles not to stop at the level crossing.

It is possible that past experiences led to an expectation on the part of the road-train driver that a train would not move through the level crossing unannounced. Regardless of this expectation, to drive over the crossing without stopping and giving due consideration to any approaching trains unnecessarily increased the risk of a collision. Similarly, to stop at the Stop sign assembly and accelerate normally from a position that was essentially blind to oncoming rail traffic and without giving due consideration to any approaching trains also increased the risk of a collision.

2.3 Stirling Street level crossing

In the months preceding the collision, extensive track and level crossing upgrade works had been undertaken in conjunction with the Port River Expressway Project. It was evident that the works were on-going when the collision occurred.

Initial observations revealed that active level crossing equipment had been partially erected[13], the RX-2 Stop sign assembly (applicable to westbound road traffic) appeared to have been relocated to a light pole about 9.1 m from the nearest rail line and no pavement markings were visible. The Stop sign was clearly visible to road traffic, but when standing adjacent the Stop sign, it was evident that sighting a train (approaching from either direction) was restricted due to a building to the north and vegetation to the south.

Considering the temporary nature of the Stop sign assembly, the investigation examined the original configuration of the crossing, the situation during the project and the configuration on the day of the collision.

Compliance against Australian Standards

The placement of warning signs, lay-out of road markings and use of other devices to control road traffic at public railway level crossings in Australia are to conform to the requirements of Australian Standard AS 1742.7 *Manual of uniform traffic control devices - Railway crossings*.

The standard states that the application of passive traffic control treatments '... shall be determined by the sight distance available to a road vehicle driver to an approaching train'. If adequate sight distance is available, the standard specifies the required positioning for the control devices (signs and pavement marking) relevant to various road approach configurations.

If there is inadequate sight distance available for passive control, the standard states:

> If the crossing is to remain open, alternative measures shall be applied. These may include restoration of sight distance by sight benching in cuttings, clearing, geometric alteration of the crossing or change to active control.

Level crossing risk assessment

The Australian Level Crossing Assessment Model (ALCAM) is an assessment tool used to assess the relative safety risk at railway level crossings. The intent of

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13 Consisting of posts and cross-bucks only. Lights and boom barriers were not installed.

ALCAM is to provide a risk score against over 70 elements of a level crossing installation to enable comparison of relative risk across all level crossings within a given jurisdiction. This comparison allows an infrastructure owner/manager to prioritise remedial works or upgrades for individual level crossings under their control. While ALCAM is not intended to provide verification of compliance against standards, it can be used as a tool in conjunction with additional analysis to examine compliance.

2.3.1 Level crossing configuration before upgrade works

An ALCAM assessment was carried out by the Department for Transport, Energy & Infrastructure (DTEI) in 2003[14]. The assessment contained clear evidence that the Stop sign assembly was originally positioned 3.5 m from the nearest rail line (Figure 7).

The assessment identified that a Stop line was located about 4.0 m from the rail, but the pavement markings were faded and difficult to see. It was noted that an attempt had been made to resolve inadequate sight distance to the north by installing a mirror for westbound road traffic and by requiring rail traffic to stop and proceed under hand signal. However, the assessment found that sighting to the south was also inadequate, but no measures had been implemented to resolve the issue. The assessment concluded that the crossing did not conform to the requirements of AS 1742.7 due to inadequate sight distance and recommended a similar restriction be placed on rail traffic approaching from the south and for pavement markings to be reinstated. It could not be confirmed if these recommendations had been implemented before the upgrade works started.

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14 The site survey was conducted in May 2003 and a report titled 'Railway level crossing risk mitigation project' (dated November 2003) summarised the findings of the assessment.

Figure 7: Original position of 'Stop' sign assembly (photographed 2003)

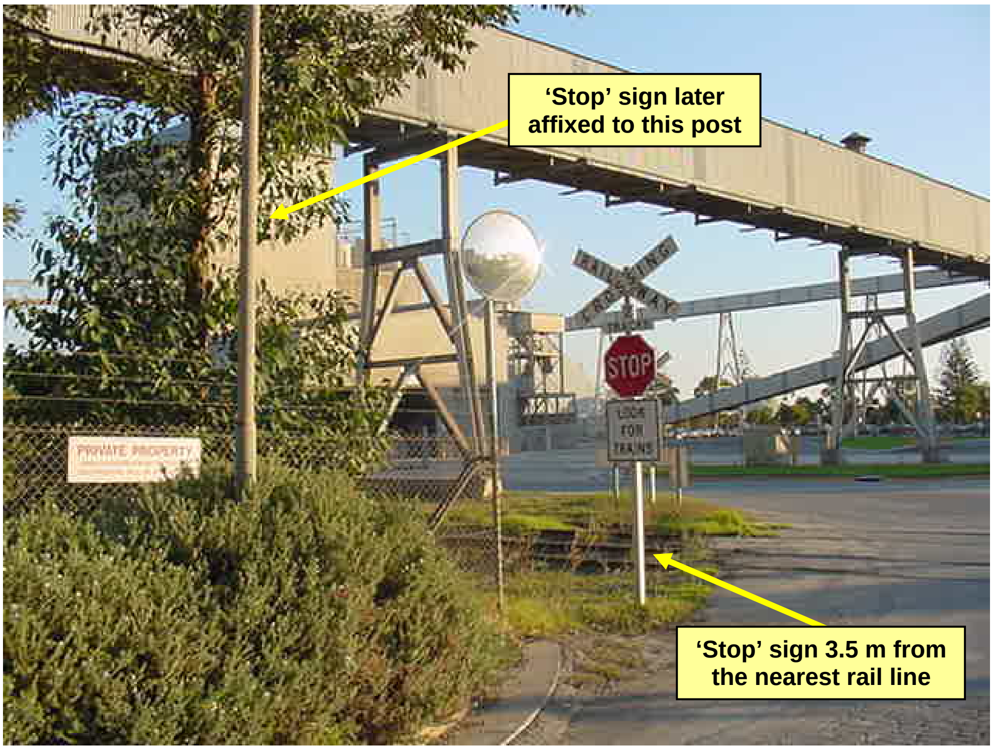
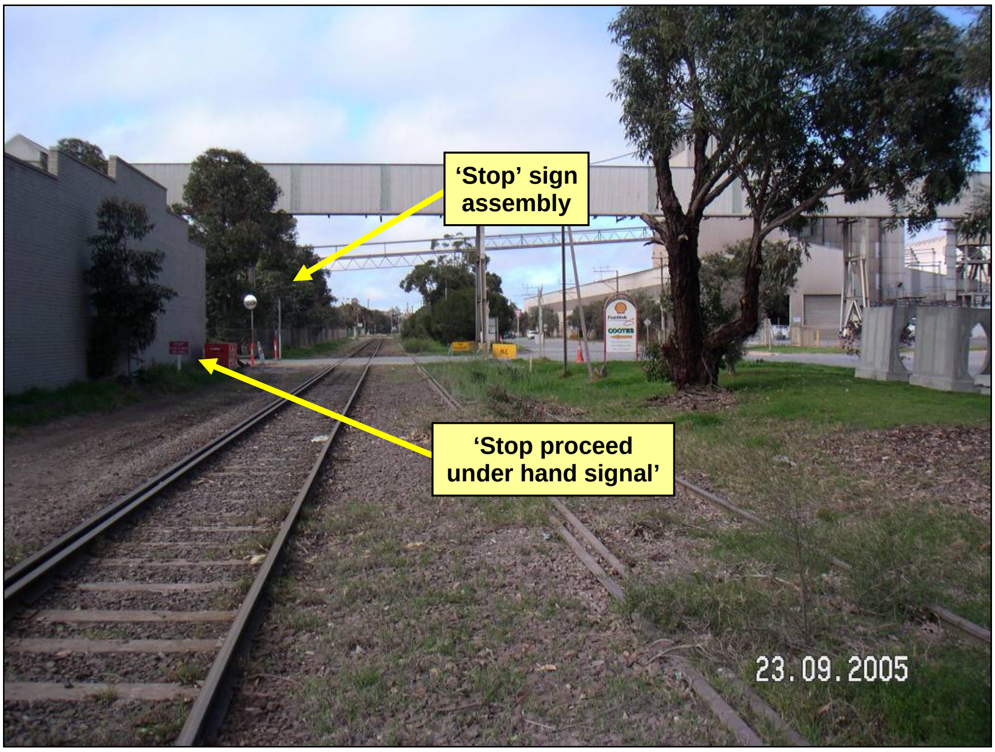


Figure 8: Original position of 'Stop' sign assembly (photographed 2005)



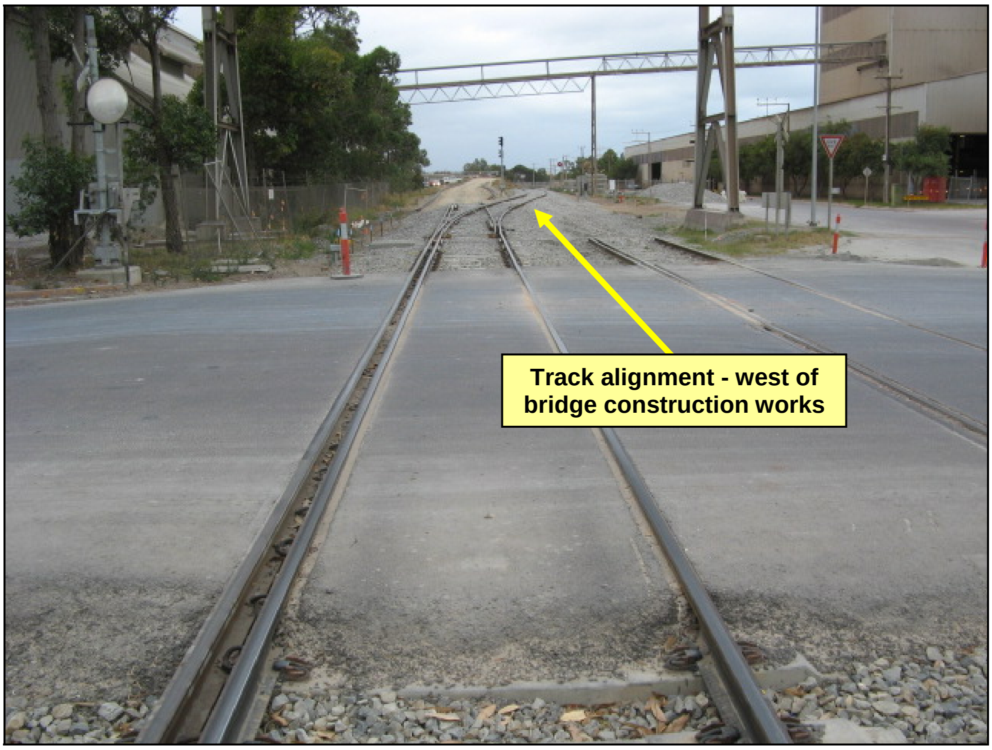
It was evident that the primary track used for rail traffic was the eastern track over Stirling Street (left track in Figure 8). Rail traffic approaching on this track provided the most restrictive view to road traffic stopped on the eastern side of the crossing. Consequently, it is likely that both the obstructions and the track geometry contributed to the inadequate sight distance assessment identified in 2003.

Considering that the agreements and contracts for the upgrade works were signed on 8 July 2005, it is evident that the Stop sign was positioned 3.5 m from the nearest rail line as work was about to commence on the project. However, it is also likely that the crossing did not conform to the requirements of AS 1742.7 at this time, due to inadequate sight distance.

2.3.2 Changes to level crossing configuration due to upgrade works

Part of the Port River Expressway Project involved the construction of a rail bridge over the Port River. The alignment of the bridge was such that the eastern track, south of Stirling Street, would require removal during construction. Consequently, rail traffic was transferred to the western track which was also realigned further west to avoid conflict with construction works. At a later date, the western track was realigned a second time to join the original alignment of the eastern track immediately south of Stirling Street and remained in this configuration until the collision on 5 March 2008 (Figure 9). The track to the north was similar in that it deviated from the eastern track to the western track immediately north of the level crossing. A consequence of the track realignment, with respect to road traffic on Stirling Street, was to improve sight distance to both the north and south.

Figure 9: Track configuration on 5 March 2008



About 3 months before the collision, the road in the vicinity of the level crossing had been re-sealed in conjunction with the track realignment works. This was to be a temporary arrangement as the western track over Stirling Street was to be removed in the coming months and, as a consequence, the road would require re-sealing again. Similarly, the eastern Stop sign assembly had been removed from its original position and relocated to a temporary position about 9 m from the rail line.

It would be normal practice for a temporary Stop line to be painted on the road until permanent pavement marking is applied. In this case, it is apparent that a Stop line was not installed at the completion of the road re-surfacing works, or a temporary line was marked but not maintained in an appropriate condition. While the DTEI confirmed that a contractor working for the Port River Expressway Project had re-positioned the Stop sign assembly, they could not confirm if the contractor had marked a temporary Stop line. Irrespective, it was evident that a Stop line was not visible on the day of the collision.

Level crossing assessment

As part of the Port River Expressway Project, the project team requested another assessment of the Stirling Street level crossing. On 6 February 2008, about 4 weeks before the collision, officers from the Level Crossing Safety Unit of the DTEI conducted an assessment in accordance with the ALCAM process. The assessment recorded the RX-2 Stop sign assembly as being 9.1 m from the nearest rail line. No 'Stop' line was visible on either side of the track.

In the absence of a Stop line, sight distance is taken from a point adjacent the Stop sign. In this case, it was evident that sight distance was inadequate due to a building to the north and, trees and shrubs to the south. The assessment found that the visibility of trains when a vehicle was stopped at the level crossing singularly accounted for 27 percent of the identified risk factors[15]. It was noted that the crossing did not comply with the requirements of AS 1742.7 and the lack of pavement markings was highlighted.

2.3.3 Level crossing configuration as at 5 March 2008

A site examination was conducted following the collision on 5 March 2008 and the locations of all control devices were recorded. In general, the location of the control devices was consistent with the configuration documented in AS 1742.7 except for the location of the RX-2 Stop sign assembly and the lack of pavement markings on the road surface.

Sight distance

Sight distance is the primary criteria for determining compliance against the standard for passive traffic control. For crossings protected by Stop signs, the standard states that a road user that has stopped at the crossing:

> ... needs to be able to see far enough along the railway to be able to start off, cross and clear the crossing safely before the arrival of any previously unseen train.

The Australian Road Rules state that the stopping point for traffic is '... as near as practicable to, but before reaching, the Stop line or, if there is no Stop line, as near as practicable to, but before reaching, the Stop sign'. At the time of the collision, there was no Stop line in place on either side of the level crossing. Consequently, the 'Stop' sign was the reference traffic control device relevant to road traffic stopping at the level crossing.

The RX-2 Stop sign assembly, applicable to westbound traffic on Stirling Street, was tied to a light pole that was 9.1 m from the nearest rail line (Figure 10).

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15 The proportion of heavy vehicle traffic made up 19 percent of the identified risk factors.

Evidence suggests that the RX-2 Stop sign assembly was originally located about 3.5 m and a Stop line about 4.0 m from the nearest rail line, consistent with minimum distance specified in the standard. However, it is likely that the Stop sign's relocation and the lack of a Stop line were due to the upgrade works being undertaken to install active traffic control. While AS 1742.7 does not stipulate a maximum distance at which a Stop sign assembly or pavement marking can be located from the nearest rail line, the requirement for adequate sight distance still applies.

Figure 10: Stop sign assembly on the day of the collision

Appendix 'D' of AS 1742.7 specifies the procedures to be followed in assessing the sight distance available at passive control crossings controlled by Stop signs. The design vehicle to be adopted for these calculations is dependent on the type of vehicle commonly using the crossing. While semitrailer and B-double trucks (gazetted B-double route) had access to Stirling Street, a number of double road-train configurations had permits to access the street.

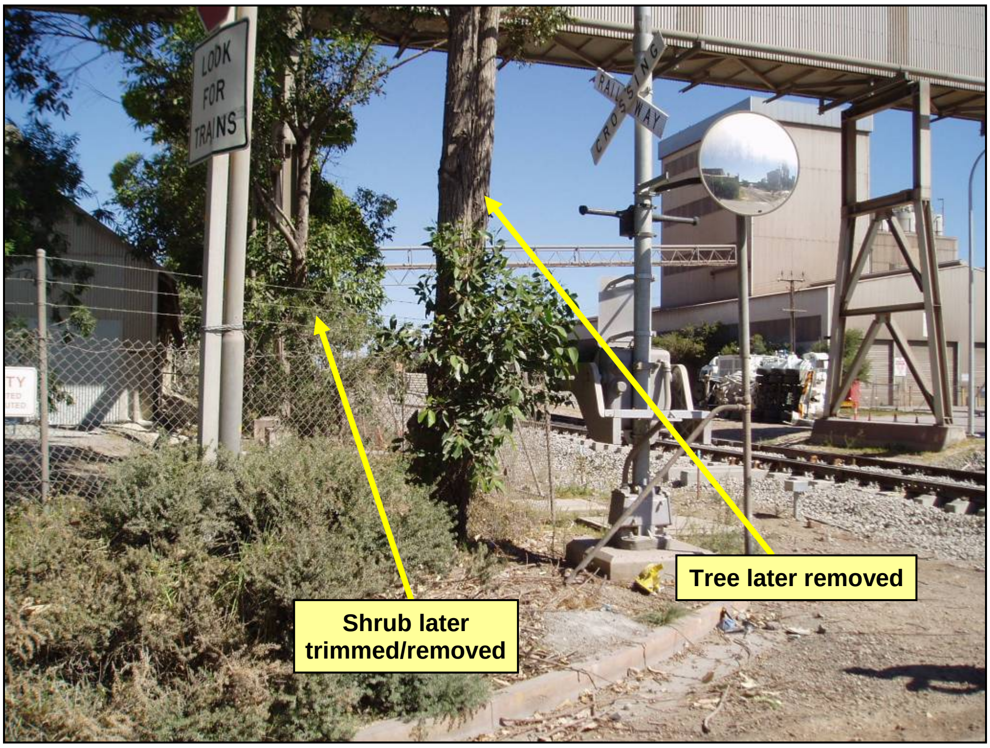
The 'worst case' design vehicle for calculation of sight distance is a double road-train. However, for comparative purposes, calculations were made for semitrailer, B-double and double road-train configurations. Table 3 illustrates the sight distance requirement for each truck configuration at a crossing protected by a Stop sign located at 9.1 m and/or pavement marking located at 4.0 m.

Table 3: Sight distance requirements as per AS 1742.7[16]

Vehicle configuration	'Stop' sign location 9.1 m	Stop line location 4.0 m
Semitrailer	122.0 m	108.5 m
B-double	130.4 m	116.7 m
Double road-train	160.0 m	147.5 m

Figure 11 illustrates the view from the Stop sign on the day of the collision. The photo was taken from a standing position at the approximate location that a vehicle driver would be when stopped at the Stop sign. It is evident that sighting along the rail line was limited and intermittent at best.

Figure 11: Visibility along rail line from ground level at Stop sign assembly, on the day of the collision



In July 2008, sighting tests at the Stirling Street level crossing were conducted. These tests were conducted on the same day as the acceleration tests and used the same prime-mover and double trailer road-train configuration, and the road-train driver who was involved in the collision on 5 March 2008. By this time the project to convert the level crossing from passive to active protection had been completed.

The nose of the prime-mover was positioned at the location where the Stop sign assembly was on the day of the accident, 9.1 m from the nearest railway line. The photograph in Figure 12 was taken at this point from the driver's seat. From this

16 Based on a level road grade and a train speed of 25 km/h.

elevated position and without the tree and shrub[17] that had been removed by this time (Figure 11), sight distance for trains approaching from the south was about 40 m, including the intermittent view through the vegetation. This is significantly less than the 160 m required by the standard for a double road-train or for any other configuration of articulated heavy vehicle. It should also be noted that the sight distance for trains approaching from the north was almost negligible due to an adjacent building

Figure 12: Visibility from prime-mover, nose 9.1 m from the nearest rail

Figure 13 illustrates the view from the driver’s seat when the truck was positioned with its nose about where a Stop line would normally be located. It is evident that the view is greatly improved from this location, particularly when noting that the active level crossing warning equipment (post, lights, boom barrier arm) depicted in Figure 13 were not in place at the time of the collision. From this location, sight distance far exceeded the 147.5 m required by the standard for a double road-train.

17 The line of trees and shrubs are about 5 m from the rail line.

Figure 13: Sighting distance, original position of the Stop sign assembly

Pavement markings

Australian Standard 1742.7 requires sealed roads to have pavement markings on the approach to level crossings. The standard states that a Stop line '...shall be used on all approaches in all cases', and no-overtaking lines (barrier or single continuous dividing lines) '...shall be used on all undivided road approaches where the sealed width is 5.5 m or greater'. The purpose of the Stop line (along with the Stop sign assembly) is to indicate a safe place for a motorist to stop and visually search the rail line for oncoming rail traffic. The no-overtaking line is to indicate it is unsafe for a road vehicle to pass vehicles that may have stopped at the crossing due to an approaching train.

As a minimum, there should have been a Stop line at the Stirling Street level crossing, no less than 300 mm wide, extending to the centre of the road and at right angles to the road centre-line. The line would normally be positioned adjacent to the Stop sign and should be no closer than 3.5 m from the nearest rail. In addition, there should have been a no-overtaking line if the road approach width was 5.5 m or greater. In this case, the total road width was about 11 m, implying that a no-overtaking line may have been required.

At the time of the collision, the Stop line and the barrier/continuous dividing lines were not in place on either side of the level crossing. Stirling Street carries a considerable amount of heavy vehicle traffic. The regular passage of these vehicles over the centre of the road as they turn to enter and exit the premises located on either side of Stirling Street would no doubt result in considerable wear of road markings. Therefore, it may be that centre road markings and a Stop line had been in place at various times in the past.

Although not contributors to the collision in this instance, the lack of pavement markings are a non-conformance of some concern as they assist in the control of traffic at and on the approach to level crossings.

2.3.4 Summary

In the months preceding the collision, extensive track and level crossing upgrade works had been undertaken in conjunction with the Port River Expressway Project. At the start of the project, it is likely that the crossing did not conform to the requirements of AS 1742.7, due to inadequate sight distance.

Part of the Port River Expressway Project involved realignment of the railway track both north and south of the Stirling Street level crossing. In both cases, the track deviated from the eastern track at the road crossing to the western track a short distance away from the crossing. A consequence of the track realignment, with respect to road traffic on Stirling Street, was to improve sight distance to both the north and south.

An ALCAM assessment was conducted at the Stirling Street level crossing on 6 February 2008 (about 4 weeks before the collision). At that time, the Stop sign was located about 9.1 m from the track and no Stop line was visible on the road surface. The assessment found that the crossing did not comply with the requirements of AS 1742.7 due to inadequate sighting and noted the lack of pavement markings.

On the day of the collision, the traffic control treatment implemented at the Stirling Street level crossing did not comply with the Australian Standard AS 1742.7. The areas of non-compliance were:

- No pavement markings were installed at the Stirling Street level crossing.
- The sight distance at the Stirling Street level crossing was inadequate when a Stop sign was positioned 9.1 m from the nearest rail and no Stop line was visible.
- No alternative measures were applied to address the issue of inadequate sighting distance, even though the crossing was to remain open.

2.4 Organisational context

The upgrade of the Stirling Street level crossing was part of the Port River Expressway Project. The $178 million project (jointly funded by the State and Australian governments) involved the construction of a new road and rail transportation route linking South Australia’s major port and rail terminals (at Port Adelaide) directly with the national road network and interstate mainline rail network.

The works associated with the rail track, including the Stirling Street level crossing upgrade, were the subject of an agreement between the Commissioner of

Highways[18] (DTEI – the project manager) and the ARTC (the rail track owner/manager), which stated:

> The commissioner will be primarily responsible for ensuring the seamless integration of Stage 3 (including the signalling system) into ARTC's infrastructure.

A site access licence, signed by the Commissioner of Highways and the ARTC, was an annex to the agreement. In general terms, the licence granted the project managers (DTEI) access to the railway site (with conditions) for the purpose of facilitating their responsibilities under the agreement. The ARTC's responsibilities were to provide advice, coordination and track occupancy approvals with consideration to train running schedules.

The principal contractor, engaged by the Commissioner of Highways in July 2005, was Abigroup Contactors Pty Ltd. The contract included design, construction and maintenance (10 years) of the Port River Expressway project works.

2.4.1 Upgrade works at the Stirling Street level crossing

The investigation found that the works associated with the Port River Expressway project caused changes to the configuration of the Stirling Street level crossing. The configuration on the day of the collision was such that when road traffic stopped in accordance with the road rules, sighting along the railway track was inadequate.

In this case, inadequate sighting is unlikely to have contributed to the collision since it is unlikely the road-train stopped in accordance with the road rules. However, inadequate sighting due to the configuration of traffic control devices was still considered a safety issue with respect to road traffic that obeyed the road rules and stopped as required.

Section five of the site access licence deals with obligations of the licensee (DTEI) and reads in part:

> 5.1 Without limiting any other clause of the agreement, the licensee will:
>
> (b) ensure it and its Associates operate to all relevant standards applicable for the *Projects Works* construction, including engineering and operating standards, procedures and National Code of Practice including clearances for railways.

With respect to traffic control devices, the relevant series of standards are Australian Standard AS 1742: *Manual of uniform traffic control devices*. The requirements for traffic control at railway level crossings are specified in Part 7, *Railway crossings*. The primary criteria for determining the appropriate control measure is sight distance, which was inadequate in this case. However, if an installation was previously non-compliant it would be unreasonable to expect a licensee, upon signing an agreement, to be responsible for immediately making the installation compliant. This was the case for the Stirling Street level crossing, which due to inadequate sighting, was non-compliant (with AS 1742.7) before the site access licence was signed.

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18 In State legislation, the 'Commissioner of Highways' is charged with the duty of carrying out the requirements of the Highways Act 1926. In practice, these responsibilities are carried out by the Department for Transport, Energy and Infrastructure (DTEI).

The AS 1742 series of standards includes Part 3, *Traffic control for works on roads*. This standard is relevant when works are underway on roads and specifies the traffic control measures used to warn, instruct and guide road users safely through a work site. A basic principle of this standard is:

> Where works require the relocation of regulatory traffic control items, they shall be relocated or reinstalled promptly in positions where they are visible and can perform their regulatory function.

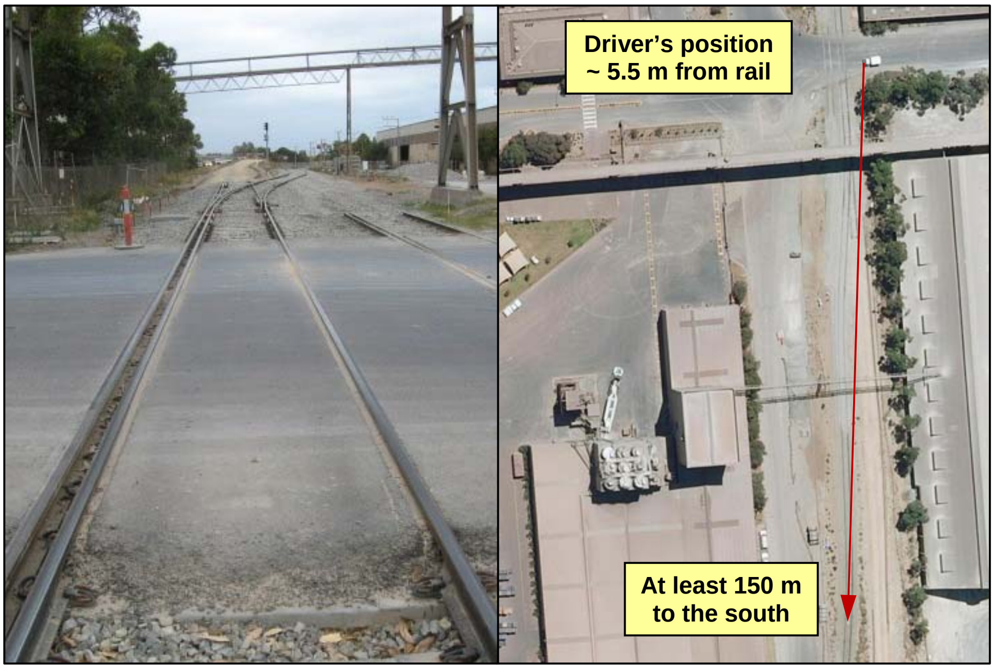
At Stirling Street level crossing, the regulatory traffic control device was the Stop sign. At railway crossings, the function of a Stop sign is to advise road users of the requirement to stop, look for trains, then move off and clear the crossing before the arrival of a previously unseen train. The point at which the driver must stop is determined by the Stop line, or in its absence, the location of the Stop sign. The ability to look for trains is determined by the sight distance calculations in Part 7 of AS 1742.

Based on the basic principle of AS 1742.3, it would be reasonable to expect that, at any point in time, relocation of a traffic control device would not degrade its regulatory function further than it may have been before the device was relocated. At the very least, it would be reasonable to expect that actions would be 'promptly' taken to ensure its regulatory function was maintained. In this case, the Stop sign had been relocated and the Stop line had not been reinstated or maintained in a serviceable condition. Even though the crossing did not comply with the requirements of AS 1742.7 before the upgrade works, these actions had the effect of degrading the regulatory function of the Stop sign and therefore, could not comply with the intent of AS 1742.3.

Had the Stop sign assembly been promptly returned to its original position (3.5 m from the rail) or had a Stop line been visible on the road (4.0 m from the rail), it is likely that sight distance would not have been degraded. In fact, considering the track alignment on the day of the collision, it is likely that sight distance would have fully complied with the requirements of AS 1742.7.

Figure 14 illustrates the track geometry and sighting to the south of Stirling Street level crossing when the ALCAM assessment was conducted in February 2008. Analysis verified that, if a Stop line was visible about 4 m from the rail, sight distance to the south would have exceeded the requirements of AS 1742.7 (refer to section 2.3.3, Table 3 Sight distance requirements as per AS 1742.7).

Figure 14: Sighting to the south of Stirling Street level crossing



Left image from 2008 ALCAM assessment, right image from Google Earth ©

Similarly, Figure 15 illustrates the track geometry and sighting to the north of Stirling Street level crossing when the ALCAM assessment was conducted in February 2008. Analysis verified that, if a Stop line was visible about 4.0 m from the rail, sight distance to the north is likely to have exceeded the requirements of AS 1742.7. In addition, the mirror and the restriction for trains to stop and proceed under hand signal had remained in effect for rail traffic approaching from the north.

Figure 15: Sighting to the north of Stirling Street level crossing

Left image from 2008 ALCAM assessment, right image from Google Earth ©

Project management

The works associated with the Port River Expressway project had been contracted to Abigroup Contactors Pty Ltd, who in turn subcontracted components of the project to other contractors. However, responsibility for project management and oversight remained with the DTEI.

While contractual documents clearly reference both Part 3 and Part 7 of AS 1742, the DTEI, as project managers and licensee under the signed access agreement, cannot fully absolve their responsibilities by contracting works to a third party. In fact, with respect to regulatory devices, the contract documentation (DTEI specification, Part 120, *Provision for Traffic*) not only states that the contractor shall ensure traffic control devices are used in accordance with AS 1742.3, but also states:

> The Contractor shall not place or remove, obstruct or conceal, any regulatory devices (such as regulatory signs or pavement marking), without the approval of the Superintendent.

This implies a shared responsibility; the contractor for undertaking the works subject to the contract documentation and the DTEI for approval and oversight of the works, including those associated with regulatory devices.

In this case, the traffic control devices at the Stirling Street level crossing had been relocated (Stop sign) or removed and not replaced/maintained (pavement marking). The consequence was to degrade its regulatory function and safety value by reducing the sight distance available for road users to see approaching trains. While the contractor had an obligation to comply with AS 1742.3, the DTEI also had a responsibility to oversee and approve works associated with regulatory devices.

Part of the project management team's approach in addressing their responsibilities was to request a number of ALCAM assessments to be conducted by the DTEI Level Crossing Unit. The ALCAM process assesses risk at a particular point in time. In this case, an assessment was carried out while the upgrade works were underway, the Stop sign assembly was 9.1 m from the nearest rail line and no Stop line was visible on either side of the track.

ALCAM assessments are primarily for the purpose of identifying longer term priority works status rather than compliance audits and normally, rail infrastructure management and road authorities would conduct their own audits and not rely on the DTEI Level Crossing Safety Unit to identify deficiencies in a level crossing installation. Notwithstanding this, it is reasonable to assume that, if a significant non-compliance is found during an ALCAM audit, the rail infrastructure management or road authority should be advised with a degree of urgency. In this case, the results of the ALCAM assessment were communicated to Port River Expressway Project management on 5 March 2008 (Four weeks after the site survey and, ironically, only hours before the collision at Stirling Street).

Regardless of the delay in communicating the results of the ALCAM assessment, both the DTEI and its contractors were responsible to ensure the works complied with the requirements of AS 1742 (specifically Part 3 and Part 7). While it could not be confirmed if a temporary Stop line was originally installed, it is evident that it was not maintained and possible that pavement marking had not been visible for some months (road re-surfacing had occurred three months earlier).

2.4.2 Long term level crossing management

The construction, upgrade or general maintenance of a level crossing involves a number of different parties. The purpose of an interface coordination plan is to ensure that all risks associated with a given level crossing are managed in a transparent and safe manner with clear accountabilities between the parties (so far as is reasonably practicable).

As of 5 March 2008, no interface coordination plan between the Port Adelaide Enfield City Council and the ARTC had been formalised for the Stirling Street level crossing.

In the past, South Australia's *Rail Safety Act 1996* and the associated *Rail Safety Regulations 1998*, prescribed that accredited SA rail organisations had to conform to the Australian Standard on railway safety management, AS 4292-1995 *Railway safety management.* Part six of the standard, *Railway interface with other infrastructure*, required rail infrastructure managers to have an interface coordination plan with the owner of any infrastructure that interfaces with the railway. However, there was no reciprocal requirement on the part of road managers.

The *Rail Safety Act 2007* commenced in South Australia on 29 September 2008 and is based on the National Transport Commission's *Model Rail Safety Bill 2006*. The *Rail Safety Act 2007* superseded the requirements of AS 4292 but it currently contains no specific provisions regarding joint interface coordination plans between rail infrastructure managers and road authorities at public level crossings. It is noted though that the National Transport Commission's *Rail Safety (amendment No 2) Bill 'Interface Coordination Plan'* has been approved by the Australian Transport Council. This amendment requires that, on public roads, the rail infrastructure manager and the road authority must have an interface coordination plan to manage the risks associated with level crossing interfaces, including the installation and maintenance of pavement marking (for example the Stop line). It is anticipated that amendments to South Australia's *Rail Safety Act 2007* in 2009 will incorporate this element.

It is envisaged that the setting of clear accountabilities for all parties (road and rail), as proposed by the *Rail Safety (amendment No 2) Bill 'Interface Coordination Plan'* will place renewed emphasis on the importance of ensuring that interface coordination plans are in existence at public level crossings in South Australia.

2.4.3 Summary

The Commissioner of Highways, as licensee, had a clear responsibility to ensure that the project works were conducted in accordance with all relevant standards. The DTEI had put various processes in place to manage this responsibility, but in this instance, the relocation of the RX-2 Stop sign assembly and the lack of pavement marking with no alternative traffic control measures, resulted in non-compliance with Part 3 and Part 7 of the Australian Standard 1742 and increased the risk of collisions. Consequently, the Commissioner of Highways and its contractors did not fully comply with section 5.1 of the site license agreement.

Considering the track alignment on the day of the collision, it is likely that the requirements of AS 1742 would have been fulfilled if the Stop sign assembly had been promptly returned to its original position (3.5 m from the rail) or a Stop line been visible on the road (4.0 m from the rail).

An ALCAM assessment on 6 February 2008 identified visibility of trains by vehicle drivers stopped at the level crossing as having a significantly high risk score. The assessment noted that the crossing did not comply with AS 1742.7 and the lack of pavement markings was highlighted. However, the results of the ALCAM assessment were not communicated to Port River Expressway Project management until 5 March 2008 (Four weeks after the site survey and only hours before the collision at Stirling Street).

At the time of the collision the ARTC and the Port Adelaide Enfield Council did not have an interface coordination plan that defined each organisation's responsibilities with respect to the maintenance of the Stirling Street level crossing.

2.5 Road-train operation South Australia

Road-train routes

Although the design of road-trains gives them considerable manoeuvrability in terms of their size[19], they are nevertheless larger and heavier that General Access Vehicles[20]. As such, road-trains are classified as Restricted Access Vehicles[21] (RAV's) and are restricted to routes that are specifically approved by the South Australian Minister for Transport or a designated officer.

A RAV can operate on all or part of the South Australian road network by exemption. There are two ways in which this exemption is applied, by the government gazettal of a route or by issue of a HVP. Government gazettal means granting of a general exemption for a RAV and covers all vehicle combinations that satisfy the exemption requirements. Exemption by HVP means that a written authorisation is issued either as a 'one off' or for a specified period to exempt a specific RAV (or a specific RAV combination) over a given route.

A HVP is issued:

- only for the specific individual vehicle
- only to the registered owner of the vehicle
- for oversize and/or over mass vehicle and/or loads
- when a RAV needs to operate on roads that are not part of the approved route network.

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19 The Australian Vehicle Standards Rules (AVSR) is based on the Australian Design Rules and provides the framework for in-service standards. The operation of road-train combinations is allowed under the AVSR.

20 General Access Vehicles are those road vehicles that can operate on the road network without any route or time restrictions other than locally imposed controls such as load limits on bridges.

21 Restricted Access Vehicles are a vehicle that exceeds either the general mass or the general dimension limits contained in the Road Traffic Act 1961 and can only travel on approved routes.

It is deemed to be the operator's and/or driver's responsibility to ensure that they are either:

- operating on a route that has been approved for road-train use; or
- they have an applicable HVP.

As mentioned at Section 1.1.2 of this report, road-train access to Stirling Street is by HVP only.

2.5.1 Issue of a Heavy Vehicle Permit

Before a HVP is issued, the DTEI have to ensure that the safe travel of the driver and vehicle, the safety of other road users and the general community and the protection of the road infrastructure and the environment, are not compromised.

A HVP is a legal document that provides a written authority for the vehicle to travel on the nominated route. The permit contains all the terms and conditions that apply to the vehicle when on the nominated route and must always be carried in the vehicle when operating on the nominated route.

In order to obtain a HVP, the owner or operator of the RAV must submit a completed permit application form to the DTEI Vehicle Permits Unit. The DTEI then undertakes a number of checks aimed at ensuring the proposed route is suitable for further assessment. If so, the applicant is advised accordingly and requested to engage an authorised assessor (at the applicant's expense). An authorised assessor:

- Must be able to demonstrate an ability to undertake a restricted access vehicle route assessment to the satisfaction of the manager of the DTEI
- Agrees to comply with all relevant guidelines including appropriate DTEI operational instructions
- Shall be an accredited road safety auditor.

The authorised assessor then prepares a report on the suitability of the route for the specified vehicle. As well as identifying technical aspects, details of environmental and community impact, the authorised assessor is required to obtain clearances regarding 'external' interfaces that may be encountered on the nominated route, including railway level crossings. Clearances, in this context, refer to any interface on the nominated route that the operation of an RAV may have an effect on and, as set out in the permit application form, include:

- Electricity Trust South Australia/Vision Stream
- Optus
- Australian Rail Track Corporation
- Australia Southern Railway
- TransAdelaide
- Telstra/NDC
- Council (or local Government).

Specifically, the clearance in respect of level crossings requires the authorised assessor to obtain a rail clearance certificate from each railway owner responsible for any level crossing along the proposed route. The DTEI then consider a number of factors in regard to the permit type, vehicle dimensions, route details and so on before issuing the HVP.

The ARTC have advised that they have been routinely requested to provide clearances for level crossings during the process of gazetting RAV routes and when HVP's for 'specific one off' oversize and/or over mass movements are sought in South Australia. As of November 2008, ARTC had issued over 1,000 clearances for specified individual RAV movements across South Australian level crossings under their management during the calendar year 2008. However, in the case of RAV's that are routinely operating on routes with HVP's for specified periods, such as Stirling Street, the evidence is that the ARTC have not been asked to provide clearances.

2.5.2 Operation of road-trains, Stirling Street

A route assessment for road-train access to Stirling Street was completed by a private assessor and submitted as a component of a HVP application for access to the Shell terminal in 1999. Significant quantities of bulk cement and petroleum products (including liquefied petroleum gas) have been transported across the Stirling Street level crossing in RAV's since this time. Despite this, the ARTC have advised that at no time have they been approached to provide clearances for this traffic over the Stirling Street level crossing.

The DTEI advised that, as at 5 March 2008, no HVP for access to Stirling Street had been issued for either the prime mover involved in the accident or for the company operating it. This meant that, at the time of the collision, the double road-train and, by implication, the owner and driver, had no authorisation to operate on Stirling Street.

A HVP was subsequently issued for the vehicle and company by the DTEI on 16 April 2008, some 5 weeks after the collision. The permit authorised the operation of the double road-train over the Stirling Street level crossing for a 12-month period. In regard to this particular HVP, the ARTC advised that they had not been approached to provide a clearance for the Stirling Street level crossing.

2.5.3 Summary

An important component in assessing an application, and granting authorisation, for the operation of a RAV, whether or not the route is gazetted or by HVP, is the requirement to obtain a clearance from the owner/ manager of any interface that may be affected by the operation of these vehicles. The evidence indicates that while a clearance is routinely sought from the rail infrastructure manager during the process of gazetting a road as a road-train route and for the issue of individual HVP permits for oversize or over mass HVP vehicles, clearances have not been sought from the rail infrastructure manager before granting a HVP for RAV's that operate on a non gazetted route by exception for a specified period.

The underlying purpose of a clearance is to ensure that the manager/owner of the interface is able to assess any risk that the operation of the RAV may present. In the case of level crossings, critical issues in regard to the weight and length of these vehicles can have adverse consequences on the vehicle's ability to negotiate the level crossing safely. For example, the length and acceleration capabilities of the vehicle will affect the time it takes to clear the level crossing[22]. Also, braking capabilities and proximity to intersections can have an impact on the sighting distances and intersection clearances required. In recognition of these issues, clause 1.6 (Restricted access vehicles) from AS 1742.7 reads:

> This standard applies generally to the use of railway crossings by standard road vehicles of the type permitted unrestricted access under the applicable traffic regulations. If restricted access vehicles (e.g. road-trains) or vehicles operating under permit (e.g. over dimensional vehicles) are to be allowed to use a railway crossing, requirements for the safe operation of the crossing may need to be modified or any increase risk managed in another appropriate way.

Obtaining a clearance from the rail infrastructure manager is a fundamental step in achieving this goal.

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22 See ATSB supplementary report 2006/*015 Results of Trial for Heavy Vehicle Clearance Times at Level Crossings* and rail occurrence report 2006/015 *Level crossing collision between The Ghan passenger Train (1AD8) and a Road-Train Truck Ban Ban Springs, NT* for further analysis of this issue.

3 FINDINGS

3.1 Context

At about 1448 on Wednesday 5 March 2008, a double trailer road-train was driven into the path of a local ‘shunting’ train at the Stirling Street level crossing at Birkenhead, SA. Birkenhead is a suburb of the City of Port Adelaide Enfield.

From the evidence available, the following findings are made with respect to the collision and should not be read as apportioning blame or liability to any particular organisation or individual.

3.2 Contributing safety factors

- It is very likely that the road-train did not stop at the Stop sign assembly and travelled over the Stirling Street level crossing at a relatively constant speed of about 15 km/h.

3.3 Other safety factors

- At the time of the collision and at times in the past, the required road pavement markings have not been present or appropriately maintained on the sealed surface of Stirling Street. *[Safety Issue]*
- The RX-2 Stop sign assembly that controlled west-bound road traffic at the Stirling Street level crossing had been relocated. In the absence of a Stop line, there was inadequate sight distance for a road user when stopped at the Stop sign. No alternative measures were applied to address the issue of inadequate sighting distance, even though the crossing was to remain open.
- Despite various processes to manage responsibilities, the Commissioner of Highways and its contractors did not ensure that the projects works associated with the Stirling Street level crossing were conducted in accordance with all relevant standards, as required by section 5.1 of the site license agreement. *[Safety Issue]*
- On 6 February 2008, officers of the Department for Transport, Energy and Infrastructure’s Level Crossing Safety Unit identified visibility of trains by vehicle drivers stopped at the level crossing as having a significantly high risk. The assessment noted that the crossing did not comply with AS 1742.7 and the lack of pavement markings was highlighted. However, inadequate processes were in place to communicate the results of this ALCAM assessment, resulting in a 4-week delay in providing this significant safety information to the Port River Expressway Project management staff.*[Safety Issue]*
- At the time of the collision, the Australian Rail Track Corporation and the Port Adelaide Enfield Council did not have an interface coordination plan to manage the risks associated with the Stirling Street level crossing interface, including the installation and maintenance of pavement marking. *[Safety Issue]*
- The Australian Rail Track Corporation had not been approached as part of the Department for Transport, Energy and Infrastructure’s process of issuing Heavy

Vehicle Permits for routine ‘fixed term’ Restricted Access Vehicle operations. Consequently, the process may preclude the opportunity to determine all risks associated with a railway level crossing, or identify changes to a railway level crossing risk profile that may have occurred over a period of time. *[Safety Issue]*

- The double trailer road-train involved in the collision on 5 March 2008 did not have authorisation (a Heavy Vehicle Permit) to travel on Stirling Street. *[Safety Issue]*

3.4 Other key findings

- Considering the track alignment on the day of the collision, it is likely that the requirements of AS 1742 would have been fulfilled if the Stop sign assembly had been ‘promptly’ returned to its original position (3.5 m from the rail) or a ‘Stop’ line been visible on the road (4 m from the rail).
- It is very unlikely that the road-train driver stopped at the Stop sign assembly. If he did, it would be considered poor judgement to accelerate normally from a position that was basically blind to oncoming rail traffic and without giving due consideration to any approaching trains.
- Train 4A13N had the appropriate authority to occupy the section of track that the Stirling Street level crossing is located on and was being operated in accordance with the applicable rules and procedures in terms of speed, headlight illumination and the sounding of the locomotive horn.

4 SAFETY ACTIONS

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

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

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

4.1 Department for Transport, Energy and Infrastructure

4.1.1 Conformance to site license agreement

Safety issue

Despite various processes to manage responsibilities, the Commissioner of Highways and its contractors did not ensure that the projects works associated with the Stirling Street level crossing were conducted in accordance with all relevant standards, as required by section 5.1 of the site license agreement.

Response by the Department for Transport, Energy and Infrastructure

The Department for Transport, Energy and Infrastructure advised that the project works involved upgrading the level crossing to incorporate active traffic control devices and that those works have since been completed.

ATSB assessment of response/action

The main area of non-compliance against standards was related to inadequate sight distance. The installation of active traffic control devices (flashing lights and boom gates) removes the requirement for a road user to see an approaching train. The road user must be able to see and respond accordingly to the flashing lights. It is likely that completion of the upgrade project would result in an installation that complied with the requirements of the Australian Standard.

4.1.2 Advice of non-compliance of level crossing

Safety Issue

On 6 February 2008, officers of the Department for Transport, Energy and Infrastructure's Level Crossing Safety Unit identified visibility of trains by vehicle drivers stopped at the level crossing as having a significantly high risk. The assessment noted that the crossing did not comply with AS 1742.7 and the lack of pavement markings was highlighted. However, inadequate processes were in place to communicate the results of this ALCAM assessment, resulting in a 4-week delay in providing this significant safety information to the Port River Expressway Project management staff.

Response by the Department for Transport, Energy and Infrastructure

The Department for Transport, Energy and Infrastructure acknowledged that the ALCAM assessor should have communicated the identified issues earlier than occurred in this case. To assist in resolving this safety issue, a process has been implemented whereby the auditor initiates action using a defects report, particularly where safety critical issues have been found.

ATSB assessment of response/action

It is likely that the new process and defects report form will encourage prompt action if safety critical issues are identified during an ALCAM assessment.

4.1.3 Clearances when issuing Heavy Vehicle Permits

Safety Issue

The Australian Rail Track Corporation had not been approached as part of the Department for Transport, Energy and Infrastructure's process of issuing Heavy Vehicle Permits for routine 'fixed term' Restricted Access Vehicle operations. Consequently, the process may preclude the opportunity to determine all risks associated with a railway level crossing, or identify changes to a railway level crossing risk profile that may have occurred over a period of time.

Response by the Department for Transport, Energy and Infrastructure

The Department for Transport, Energy and Infrastructure advised that the route over the Stirling Street level crossing had been assessed in 1999 under the standards relevant at that time. They advised that permits for over-size or over-mass vehicles would be negotiated with rail authorities on a per request basis. However, if a route had already been assessed as suitable for issuing Heavy Vehicle Permits, it was not normal practice to reassess that route every time a new Heavy Vehicle Permit was requested.

ATSB assessment of response/action

While it is acknowledged that transport routes need not be reassessed every time a Heavy Vehicle Permit is requested, it should also be recognised that elements of that route may change over time. In this case, the route over the Stirling Street level crossing had not been reassessed for almost 10 years. It would be reasonable to assume that local conditions and/or standards may have changed over this time which may affect the route assessment.

ATSB safety recommendation RO-2008-001-SR-026

The Australian Transport Safety Bureau recommends that the Department for Transport, Energy and Infrastructure take further action to address this safety issue.

4.2 Port Adelaide Enfield City Council

4.2.1 Interface coordination plan

Safety Issue

At the time of the collision, the Australian Rail Track Corporation and the Port Adelaide Enfield Council did not have an interface coordination plan to manage the risks associated with the Stirling Street level crossing interface, including the installation and maintenance of pavement marking.

ATSB safety recommendation RO-2008-001-SR-021

The Australian Transport Safety Bureau recommends that the Port Adelaide Enfield City Council takes action to address this safety issue.

4.2.2 Pavement markings

Safety issue

At the time of the collision and at times in the past, the required road pavement markings have not been present or appropriately maintained on the sealed surface of Stirling Street.

ATSB safety recommendation RO-2008-001-SR-022

The Australian Transport Safety Bureau recommends that the Port Adelaide Enfield City Council takes action to address this safety issue.

4.3 Australian Rail Track Corporation

4.3.1 Interface coordination plan

Safety Issue

At the time of the collision, the Australian Rail Track Corporation and the Port Adelaide Enfield Council did not have an interface coordination plan to manage the risks associated with the Stirling Street level crossing interface, including the installation and maintenance of pavement marking.

Response by the Australian Rail Track Corporation

The Australian Rail Track Corporation (ARTC) acknowledged that an interface coordination plan did not exist between the ARTC and the Port Adelaide Council at the time of the collision. While the ARTC agrees with the intent behind interface coordination plans, it also noted that there was no legislative requirement regarding joint interface coordination plans between rail infrastructure managers and road authorities at public level crossings.

ATSB assessment of response/action

The ATSB acknowledges that the legislation does not contain specific provisions regarding joint interface coordination plans. However, the National Transport Commission's *Rail Safety (amendment No 2) Bill 'Interface Coordination Plan'* requires that, on public roads, the rail infrastructure manager and the road authority must have an interface coordination plan to manage the risks associated with level crossing interfaces. This highlights the importance of ensuring that interface coordination plans are in existence at public level crossings and as such, the lack of interface coordination plans is considered a safety issue.

ATSB safety recommendation RO-2008-001-SR-025

The Australian Transport Safety Bureau recommends that the Australian Rail Track Corporation takes action to address this safety issue.

4.4 Golding Transport Industries Pty Ltd

4.4.1 Lack of Heavy Vehicle Permit, Accident Road-train

Safety issue

The double trailer road-train involved in the collision on 5 March 2008 did not have authorisation (a Heavy Vehicle Permit) to travel on Stirling Street.

Action taken by Golding Transport Industries Pty Ltd

A Heavy Vehicle Permit was issued by the Department of Transport, Energy and Infrastructure to Golding Transport Industries Pty Ltd on 16 April 2008 applicable to the accident road-train.

APPENDIX A: SOURCES AND SUBMISSIONS

4.5 Sources of information

- Cavill Power Products
- Golding Transport Industries
- Pacific National
- Road Traffic Act 1961
- Telstra
- The Australian Rail Track Corporation
- The Australian Transport Council
- The Department for Transport, Energy and Infrastructure
- The National Transport Commission
- The road-train truck driver
- The South Australian Police
- The train drivers
- Transfield
- Two witnesses to the collision.

4.6 References

- ATSB report 20060015 – Level Crossing Collision between The Ghan Passenger Train (1AD8) and a Road-Train Truck, Ban Ban Springs, NT, 12 December 2006.
- Australian Level Crossing Assessment Model.
- Australian Standard 4292 1995: Railway safety management
- Australian Standard 1742.7-2007: Manual of uniform traffic control devices – Railway crossings.
- Australian Standard 1742.3-2002: Manual of uniform traffic control devices – Traffic control devices for works on roads.
- Australian Vehicle Standards Rules
- *Rail Safety Act 2007*
- *Rail Safety (amendment number 2) Bill 'Interface Coordination Plan'*.
- *SA Rail Safety Act 1996*
- *SA Rail Safety Regulations 1998*.

4.7 Submissions

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

A draft of this report was provided to:

- Golding Transport Industries
- Pacific National
- Port Adelaide Enfield City Council
- The Australian Rail Track Corporation
- The Department for Transport, Energy and Infrastructure
- The road-train truck driver
- The train drivers.

The Australian Rail Track Corporation and the Department for Transport, Energy and Infrastructure made a number of comments and observations on the draft report issued to directly involved parties. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Level Crossing Collision, Birkenhead, South Australia, 5 March 2008