Australian Government

Australian Transport Safety Bureau

Collision involving a motor vehicle and train 4460S

10 km south of Port Germein, South Australia | 19 March 2012

Investigation

ATSB Transport Safety Report

Rail Occurrence Investigation

RO-2012-003

Final – 19 April 2013

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

Publishing information

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Safety summary

What happened

On 19 March 2012, Pacific National ore train 4460S travelling on the interstate main line between Port Augusta and Port Pirie collided with an eastbound motor vehicle on the Port Flinders Causeway Road level crossing, about 10 km south of Port Germein in South Australia. The level crossing was controlled by passive approach warning signs and a 'Stop' sign at the crossing.

There were two occupants in the motor vehicle. The passenger was fatally injured and the driver suffered serious injuries. The crew of the train were physically unhurt.

What the ATSB found

The ATSB found that the driver of the road vehicle involved in the collision did not come to a complete stop at the railway crossing and entered the crossing in the path of the approaching ore train. The ATSB concluded that the motorist's attentional resources might have been diverted during a critical period when they would normally have stopped to look for a train.

What's been done as a result

Minor corrective action was taken to replace a missing 'Railway Crossing' assembly which should have been situated on top of the 'Stop' sign on the western approach to the crossing. The absence of the 'Railway Crossing' assembly was not considered a factor that contributed to the collision as it was found that the motorist regularly used the crossing and the 'Stop' sign was still in place.

Safety message

The occurrence highlights the need for drivers of motor vehicles to be vigilant and obey road traffic signage.

Contents

The occurrence

On 19 March 2012 train 4460S was scheduled to operate a regular ore service from Port Augusta to Port Pirie in South Australia. The two train drivers operating the service signed on for duty at Port Augusta at 0550[1]. They joined the train at about 0800 and completed prescribed engine, brake and safety checks before departing Port Augusta at 0809. The train was operating under the direction of an Australian Rail Track Corporation (ARTC) Network Control Officer located in Adelaide.

Later the same morning, a resident of Weeroona Island[2] and an accompanying family member departed Weeroona Island at about 0925 in a motor vehicle. The intended journey to Port Pirie, which normally took about 20 minutes, was via the Port Flinders Causeway Road level crossing.

Train 4460S passed through Port Germein at about 0929 about 10 km to the north of the Port Flinders Causeway Road level crossing travelling at a speed of about 80 km/h. The train then slowed to 50 km/h about 450 m in advance of the level crossing in accordance with a 50 km/h Temporary Speed Restriction (TSR)[3].

At a distance of about 200 m from the level crossing the train driver saw two motor vehicles travelling in an easterly direction approaching the crossing. He immediately sounded the train's horn while maintaining a speed of about 50 km/h. Although the first car, a yellow Hyundai Accent, appeared to be slowing, the train driver said he sounded the horn a second time just as the vehicle disappeared from his view behind some thick vegetation located on the western side of the level crossing. As the car emerged from behind the vegetation, the train driver said it appeared to be slowing down and looked as if it would stop at the crossing. He sounded the horn a third time, continuously, as the car approached the crossing.

Figure 1: Vehicle and train involved in collision

Source: ATSB

---

1 The 24-hour clock is used in this report. Local time was Australian Central Daylight Time (CDT), UTC +10:30 hours.

2 Weeroona Island is about 17 km north of Port Pirie.

3 The speed restriction had been in place since 4 January 2012 due to the condition of the track.

The driver of the motor vehicle vaguely recalled hearing a horn at about the time of the collision and next remembered being on the crossing with the train looming over the car. The motorist could recall little else regarding events prior to the accident.

At about the time the car entered the level crossing the train driver responded by making an emergency brake application. Moments later (0939) the train collided with the passenger side of the motor vehicle (Figure 1).

The train driver immediately radioed through to the network control centre in Adelaide requesting urgent assistance from the SA Police and Ambulance services.

The front of the train came to a stand approximately 256 m past the level crossing.

Post occurrence

The impact had severely damaged the motor vehicle with the passenger being fatally injured and the driver sustaining serious injuries. The locomotive crew were shaken but not hurt. There was only minor damage to the lead locomotive (NR29) and negligible damage to the track and fixed infrastructure.

The response by the SA Police and Ambulance services was within minutes of the collision. SA Police took control of the accident site until evidence was gathered. The site was then handed over to the track owner, the ARTC. Drug and alcohol testing of the train drivers was undertaken by the SA Police and returned zero readings.

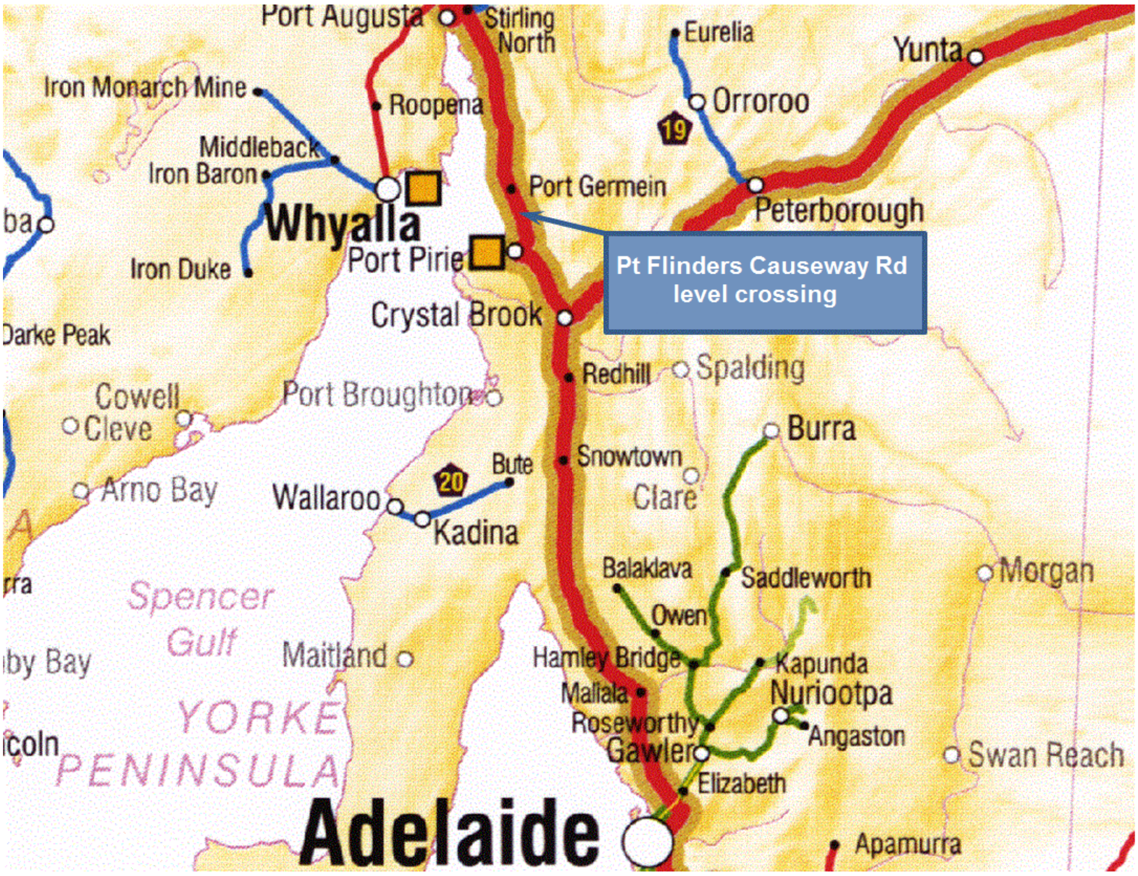
There was one independent witness (a motorist in the vehicle behind the one involved in the collision) who observed the collision.

Context

Location

The Port Flinders Causeway Road level crossing (Figure 2) is located on the Defined Interstate Rail Network (DIRN) between Port Augusta and Port Pirie. It is about 17 km north of Port Pirie (10.6 km south of Port Germein) and 1.06 km west of the Princes Highway. The road is a fully sealed local road with a speed limit of 80 km/h.

Figure 2: Port Flinders Causeway Road, South Australia



Source: Geoscience Australia

Level crossing protection and risk control

Given the size and weight of most trains it is not possible for them to brake at anywhere near the rate of a road vehicle. Heavy freight and passenger trains may take several kilometres to stop from high track speeds.

In most circumstances a train driver is unlikely to sight an approaching motor vehicle, and then determine whether it will stop or not, until the train is relatively close to the level crossing, by which time a collision may be imminent. In such circumstances a train driver is unable to take any effective action to avoid the collision other than sounding the locomotive horn to warn the motorist, and (if time permits) making an emergency brake application.

By comparison, a road vehicle can be stopped relatively quickly. It is for this reason that, regardless of the type of crossing control, the onus to take appropriate action to avoid a collision rests almost entirely with the motorist. Consequently, it is important that road signage is effective at warning a motorist that they are approaching a level crossing and provides sufficient distance to stop safely. Similarly, it is important that from the stopped position there is sufficient sighting distance available for the motorist to decide whether it is safe to proceed across the level crossing.

Traffic control - Port Flinders Causeway Road level crossing

The traffic controls installed at the Port Flinders Causeway Road level crossing are passive controls (Figure 3) that require the road user to stop[4] the vehicle at the 'Stop' sign/line and detect the presence of a train through direct visual observation.

Figure 3 Motorist's view of level crossing, travelling in an easterly direction

Source: ATSB

'Stop' signs, rather than 'Give-way' signs, were required for this location in accordance with the provisions of Australian Standard AS1742.7-2007 *Manual of uniform traffic control devices Part 7: Railway crossings*[5].

Figure 4 Motorist's view about 125 m from stop sign, travelling in an easterly direction

Source: ATSB

4 At level crossings controlled by 'Stop' signs, a motorist must come to a complete standstill at the crossing in order to have the opportunity to sight an approaching train and make an informed decision whether it is safe to proceed over the crossing.

5 At the time of the collision AS1742.7-2007 prescribed the requirements for traffic control devices used at level crossings throughout Australia.

This was because visibility of the rail line to the north (direction of train approach) was intermittently obscured to an eastbound motorist by low lying trees and bushes (Figure 4). Sighting continued to be obscured until a vehicle was about 10 m from the crossing (near the stop line), where it then opened up and sighting was in excess of 610 m.

Level crossing compliance

An examination of the signage on the western approach to the crossing (Figure 5), the direction of the motor vehicle travel, revealed that the signage was generally in compliance with the requirements of the AS1742.7-2007 (Figure 6).

Figure 5 Signage at level crossing

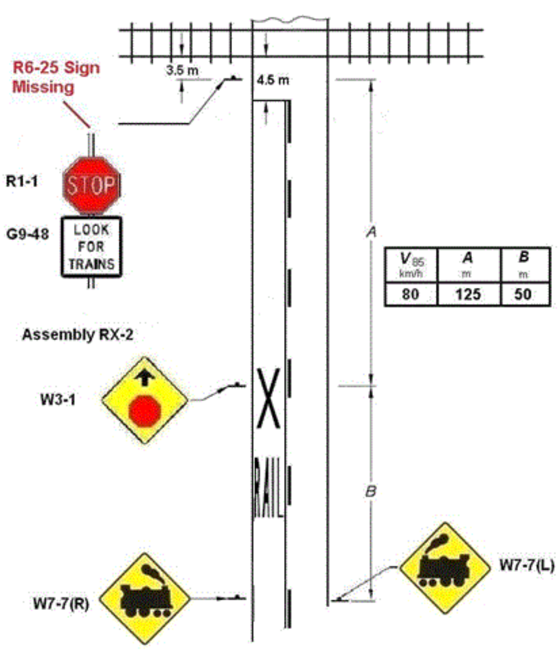
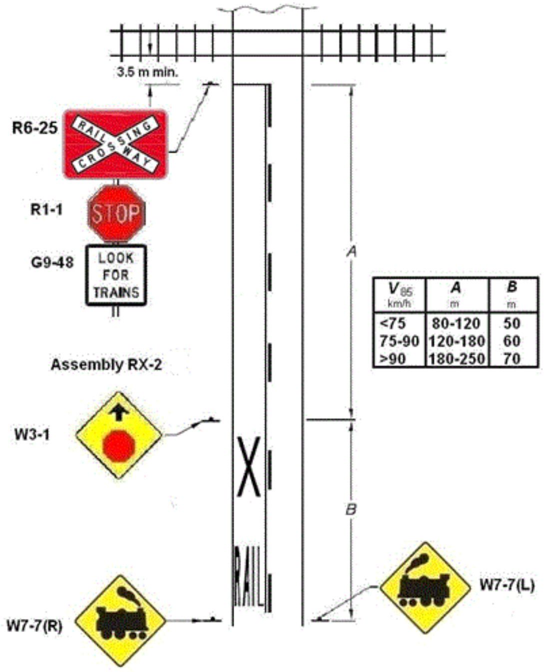


Figure 6 Signage prescribed in AS1742.7 with W7-7(L) being optional



Source: ATSB

There were some minor non-conformances, but these were unlikely to have been factors that contributed to the collision:

- The 'Railway Crossing' assembly (R6-25) was missing from the 'Stop' sign assembly (RX-2). This sign had been removed by persons unknown and had not been replaced during a routine maintenance cycle. However, the 'Stop' sign was still in place.
- The stop line was set back from the RX-2 assembly by about 1.0 m. The standard indicates that the stop line and RX-2 assembly should be adjacent to one another.
- The distance between the 'Railway level crossing ahead' signs W7-7 and the 'Stop Sign Ahead' sign W3-1 was 10 m less than specified in the standard. There was nevertheless more than adequate distance to sight all signs and stop at the crossing when travelling at the legal speed limit of 80 km/h.

At the time of the collision the RX-2 assembly was maintained by Transfield for the ARTC[6]. Maintenance of the road, road surface markings (RAIL X, Stop Line and Barrier Line) and associated approach warning signs was undertaken by the District Council of Mount Remarkable.

---

6 As of January 2013 ARTC was undertaking all maintenance in the area.

Sighting

For a level crossing having 'Stop' sign control, AS1742.7-2007 requires:

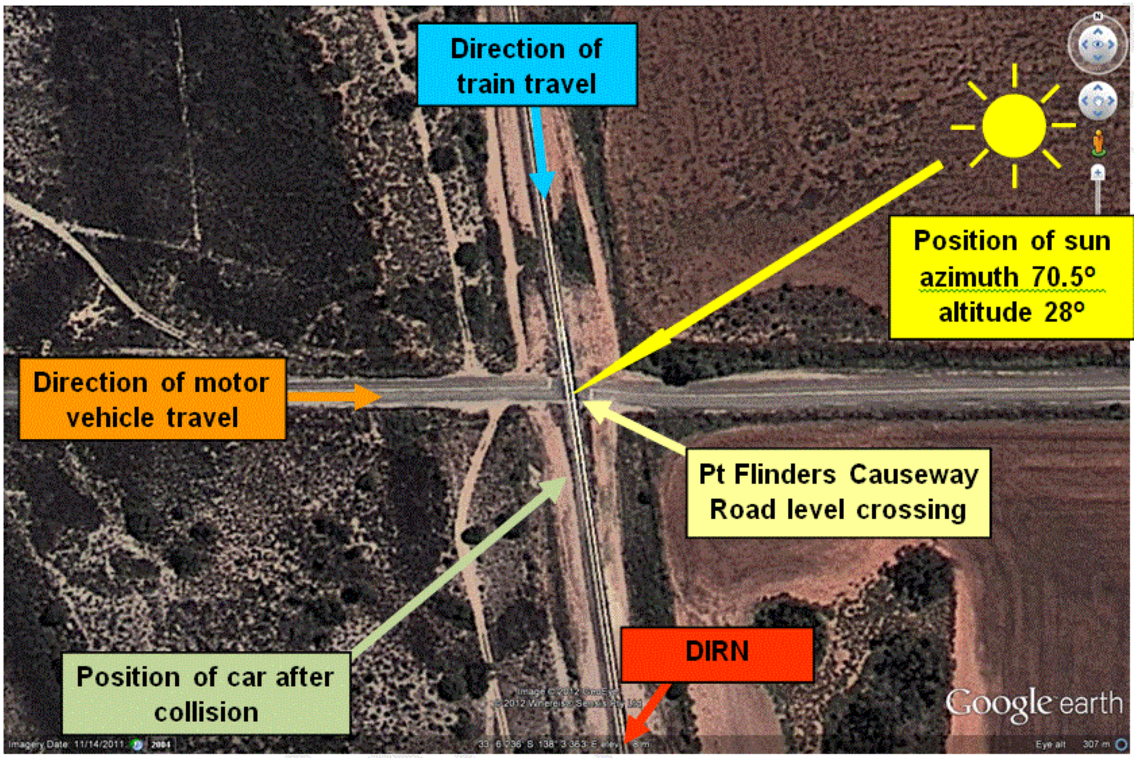
> *The sight distance shall be sufficient for the road vehicle driver stopped at the railway crossing stop line to be able to start off and clear the crossing before the arrival of a previously unseen train.*

Using the formulae contained within AS1742.7-2007, a semi-trailer[7] stopped at the stop line on the western side of the Port Flinders Causeway Road level crossing needs about 564 m sighting to safely clear the track with a train approaching at 115 km/h (the normal track speed). It was established that the sighting distance for a vehicle stationary at the western side stop line was in excess of 610 m, and thus exceeded the requirements of the Standard.

Further, there was a temporary speed restriction in place 50 m to the north of the level crossing with trains traversing the crossing limited to a maximum speed of 50 km/h. Applying the AS1742.7-2007 formulae with a train speed of 50 km/h and the acceleration rate for a small passenger vehicle, a sighting distance of about 200 m was all that was necessary for such a vehicle stopped at the crossing to accelerate and safely clear the track.

The roadway crosses the level crossing at an angle close to 78 degrees (Figure 7). Australian Standard 1742.7-2007 prescribes that the maximum viewing angle measured at the stop line, when looking to the left for an approaching train, shall not exceed 110 degrees. An assessment of the Port Flinders Causeway Road level crossing's geometry revealed a viewing angle of 101 degrees for a motor vehicle stopped on the western side at the stop line. This is better than the 110 degrees specified by the standard and indicates that the amount 'head twist' required of the driver was not excessive.

Figure 7: Aerial view of the Port Flinders Causeway Road level crossing, South Australia



Source: ATSB

[7] The required sighting distance was based on a loaded semi-trailer, 19 m in length (maximum allowable for this road) and having an acceleration of 0.36 m/s². The 564 m minimum sighting distance for such a semi-trailer applied to all vehicle types that were allowed to use the Port Flinders Causeway road level crossing.

The collision occurred at 0939 about two hours after sunrise (0720). At the time, the sun's azimuth[8] was 70.5 degrees at an altitude[9] of 28 degrees. Sun glare is usually at its worst when the sun is low near the horizon and occurs just after dawn or just before sunset[10].

Driver of the motor vehicle

The driver of the motor vehicle involved in the collision had been a resident at Weeroona Island for about 14 years and had regularly traversed the Port Flinders Causeway Road level crossing (up to 12 times per week in an easterly and westerly direction of travel) while travelling to and from Port Pirie. The SA Police advised that the motorist had held a driver's licence for many years, did not have a history of traffic law infringements and had not previously been involved in any major road accidents or incidents.

Testing for drugs following the accident was positive only for prescribed medication which should not have affected the driver's performance. There were also traces of post-accident medication detected in the driver's blood sample. It was determined that this was medication administered by paramedics for pain relief and trauma control purposes. Testing for alcohol returned zero results.

Passage of the motor vehicle over the level crossing

Both train drivers saw the vehicle travelling slowly towards the level crossing. It appeared to be stopping but continued at low speed onto the crossing and into the path of the train.

The witness in the following motor vehicle also indicated that the vehicle was travelling slowly and appeared to be stopping but in the last moment continued forward onto the level crossing and into the path of the train.

There were no signs of tyre skid marks[11] on the road pavement approaching or on the level crossing. This indicated that the motorist probably did not make a sudden brake application before entering or while traversing the crossing. It was concluded that when the motorist finally realised the collision was imminent there was probably insufficient time to accelerate in an attempt to clear the crossing.

The vehicle involved in the collision was inspected by SA Police following the accident and was assessed to have been in a reasonable condition prior to the collision. The inspection did not reveal any mechanical defects which would have been a factor in the collision.

Other occurrences

There are 750 crossings on public open roads in South Australia of which 483 are passively controlled. All level crossings in South Australia have been assessed by the Department of Planning Transport and Infrastructure (DPTI) Level Crossing Unit (LCU) using a computer based risk assessment model, the Australian Level Crossing Assessment Model (ALCAM). The model takes into account over 70 factors including geometry, traffic density and speed to calculate a risk score for a level crossing.

Based on the ALCAM the Port Flinders Causeway Road level crossing was assessed as a low-risk crossing. The sighting constraints at the crossing had been identified as trains are intermittently obscured by low lying vegetation until a road vehicle is approximately 10 m from the

---

8 Azimuth is the clockwise horizontal angle (in degrees minutes and seconds) from true north to the sun/moon. (Source: Australian Government, Geoscience Australia).

9 Altitude is the vertical angle (in degrees minutes and seconds) from an ideal horizon, to the sun/moon. (Source: Australian Government, Geoscience Australia).

10 Gray, R. & Regan, D. (2007). Glare susceptibility test results correlate with temporal safety margin when executing turns across approaching vehicles in simulated low-sun conditions. Ophthalmic & Physiological Optics, 27, 440-450.

11 The absence of skid marks could be for various reasons: not being aware of the train, well-controlled braking by the motorist and/or an anti-lock braking system (ABS); although the Hyundai Accent involved in this collision did not have ABS.

crossing. This reaffirmed the need for 'Stop' sign control at the location as per AS1742.7-2007. Sighting along the tracks was nevertheless excellent, provided that a motorist came to a complete standstill at the 'Stop' sign/line.

The LCU undertakes level crossing audit surveys and the information captured is managed in the Level Crossing Management (LXM) database. The overall risk at a level crossing is based on the score provided by the ALCAM together with other information which includes accident history and near miss data.[12]

While investigating this accident the ATSB did note that there have been three previously reported near miss occurrences at this level crossing:

Date:	Location - Port Flinders Causeway Road level crossing
26 March 2005	Near miss white van failed to stop at the crossing.
13 December 2004	Near miss with a white Nissan Tarago.
11 February 1998	Near miss with motor vehicle which skidded onto the crossing then reversed clear.

The Port Flinders Causeway Road level crossing has been identified for upgrade to active control as part of the Government of South Australia's Level Crossing Infrastructure Improvement Program but based on the current funding availability is not at present programmed for the upgrade.

Train and Crew

A review of available evidence determined that there were no apparent mechanical defects or deficiencies with the train which would have contributed to the accident. The train crew were appropriately trained, qualified, certified as competent and medically fit at the time. The train driver's hours of duty for the days preceding the accident indicated that fatigue was unlikely to have been a factor in the collision. Train handling and train speed were not considered factors in the collision.

12 The ALCAM does not take into account accident or near miss history for a level crossing when calculating a risk score.

Safety analysis

Introduction

Rail is one of the safest modes of transport, but where road and rail interface at level crossings accidents can and do occur that may result in fatalities, serious injuries and extensive damage to infrastructure. The collision between Pacific National ore train 4460S and a light motor vehicle at the Port Flinders Causeway Road level crossing on the morning of 19 March 2012 was a serious accident that resulted in the fatality of the passenger and serious injuries to the driver of the motor vehicle.

Factors influencing the motor vehicle driver's behaviour

Based on witness and train driver observations it was established that the motor vehicle involved in the collision was travelling at slow speed as it approached the Port Flinders Causeway Road level crossing. It continued to slow down and appeared to be stopping but in the last moment continued at low speed across the railway line and into the path of the oncoming train.

The remaining analysis will focus on two main questions:

- why the motorist did not stop at the 'Stop' sign, and
- why the motorist did not perceive the approaching train?

Human information processing is limited in that each person has finite mental or attentional resources available to attend to information or perform tasks during any particular time period. In general, if a person is focussing on one particular task, then their performance on other tasks will be degraded.[13] In the context of a motor vehicle driver approaching a passive level crossing, the extent of performance degradation may depend on factors such as:

- the extent to which the target (train) is conspicuous or easy to observe/hear
- the extent that a train is expected
- the motorist's workload at that point in time and the existence of any distractions
- task competence including factors such as driving experience and history of any driving violations/errors
- the influence of other factors such as fatigue, drugs, alcohol or a medical condition.

The following section examines possible factors which may have influenced the driver's actions just before the collision.

Conspicuity

In go/no-go decisions in driving, such as executing a turn across approaching traffic or crossing a train line in front of an approaching train, the driver must make an estimate of the time to collision (time that is left until a collision occurs if both vehicles continue on the same course and at the same speed)[14] and the time required to execute the manoeuvre. If the time to execute the manoeuvre is judged to be sufficiently less than the time to collision, then the driver will perform the manoeuvre. There are two key visual conspicuity factors which can affect this judgement: glare and contrast.[15]

---

13 Kahneman, D. (2011). *Thinking Fast and Slow*. Farrar, Straus & Giroux: New York.

14 Vogel, K. (2003). A comparison of headway and time to collision as safety indicators. Accident Analysis and Prevention, 35, 427-433.

15 Gray, R. & Regan, D. (2007). Glare susceptibility test results correlate with temporal safety margin when executing turns across approaching vehicles in simulated low-sun conditions. Ophthalmic & Physiological Optics, 27, 440-450.

Glare and contrast

In high glare conditions, such as occur in low sun just after dawn or just before sunset, visibility of objects is reduced due to the reduction of retinal image contrast caused by light scattered over the fovea[16]. This effect is increased for low contrast objects, causing drivers to overestimate the time to collision and hence perform manoeuvres with a reduced safety margin, increasing the risk of collision. Of note, the use of 'Daytime Running Lights' (DRLs) has been shown to decrease the likelihood of collision with approaching vehicles, and a number of nations have now implemented regulatory requirements for DRLs.[17]

The collision occurred at 0939, some two hours after sunrise. The train was approaching the level crossing from the north. It was established that the motorist's view of the train was unlikely to have been adversely affected by glare caused by low sun. This was corroborated by a witness who indicated that the sun did not interfere with his view of the train. Furthermore, the locomotive was yellow in colour, suggesting a good contrast against the sky and surrounding vegetation, and it had both the ditch and headlights operating to enhance conspicuity.

Based on available evidence it was concluded that the motorist's vision of the train was unlikely to have been affected by either glare or contrast issues.

Train horn audibility

A Whistle Board[18] was located 674 m in advance of the northern side of the Port Flinders Causeway Road level crossing. An examination of the 'loco log data' file (graph at Appendix A) showed that the train horn was not sounded at the Whistle Board as required, but was sounded three times while closer to the crossing. The first was 11 seconds (155 m) in advance of the crossing, followed by a further two soundings before the collision, at approximately 5-6 seconds, and 1-2 seconds in advance of the crossing respectively.

Calculations show that with a car travelling at 80 km/h had the motorist heard the locomotive horn when the train was at a distance of 155 m from the crossing, there would have been ample time to stop the motor vehicle before entering the crossing. Similarly had the motorist detected the horn at the second sounding, there was probably still sufficient time to avoid the collision.

However, detectability of a train horn by a motorist is subject to a number of influencing factors, including the acoustic properties of the horn, other noise or noise buffering properties in the listening environment, such as terrain, vegetation, road surface noise, engine and/or fan and other ancillary device noise, as well as the sound insulation properties of the vehicle.[19, 20]

The motorist vaguely recalled hearing the horn sound twice in the period preceding the collision. The witness in the following motor vehicle clearly recalled hearing the train horn.

Although some people can detect train horns at lower levels, relevant standards for auditory warnings state that auditory danger signals should be at least 10 dB(A) higher than the ambient background noise (at some frequencies) in order to assure that the signal is detectable by most people.[21, 22]

---

[16] Part of the eye, located near the centre of the retina.

[17] Gray & Regan (2007).

[18] Had the normal track speed of 115 km/h been in place sounding of the train horn at the Whistle Board would have provided 21 seconds warning.

[19] Dolan, T. G. & Rainey, J.E. (2005). Audibility of Train Horns in Passenger Vehicles. *Human Factors, 47 (3),* 613-629.

[20] National Transportation Safety Board (1998). *Safety at Passive Grade Crossings, Volume 1 Analysis*: *Safety Study NTSB/SS-98-02:* Washington DC.

[21] English, G.W., Russo, F.A., Moore, T.N., Lantz, M.E. & Shwier, C. (2003). *Locomotive horn evaluation: Effectiveness at operating speeds.* Report TP14103E prepared for Transport Canada.

[22] Dolan & Rainey (2005).

When the horn was first sounded 11 seconds prior to the collision, the train and car were probably about 200 m apart. At that distance, the horn level was likely to be about 88 dB(A)[23] or less with the presence of vegetation and other obstructions between the train and car. The insertion loss in most cars is in the order of 30-35 dB(A) with the windows closed,[24, 25] so the horn's sound level in the car would have been about 58 dB(A) or less. The background ambient noise level in cars varies widely depending on the use of a ventilation fan, whether the car is moving, the road surface and the use of a radio. One study measured ambient noise levels in a car of over 65 dB(A) with the fan on high and the engine idling, and up to 60 dB(A) with the fan off but travelling at 50 km/h.[26] Interview evidence suggests that the windows of the car were probably closed, and that there was music playing on approach to the level crossing.

In summary, at 11 seconds prior to the collision, the horn sound level would have been lower than or close to the ambient noise level of a car under common driving conditions, and would have been below the levels needed to ensure all or most drivers would be sufficiently alerted to conduct an effective response. The Whistle Board was about 520 m further away from the crossing, so if the train driver had sounded the horn at this point it would have been even less detectable by the approaching motorist.

At 6 seconds prior to the collision, the train and car were probably about 100 m apart, and the horn sound level in the car would have been 64 dB(A) or less. Although more drivers would have heard the horn, it would still not have been at a level sufficient to ensure that all or most drivers would be sufficiently alerted to conduct an effective response. The detectability would also vary greatly depending on the motorist's focus of attention and the presence of distractions. In this case, the motorist recalled hearing the horn sound twice, and it is likely that the second sounding of the horn was the first heard by the motorist, but was not at a level sufficient to trigger an effective response.

At 2 seconds prior to collision, the car would have been about 30 m from the train and the horn's sound level in the car would have been 74 dB(A). The horn would have been easily detectable by most drivers, but there would probably not have been sufficient time to conduct an effective response if the motorist was not already committed to stopping at the crossing. It is most likely this last sounding of the horn is what the motorist recollected hearing in the moments prior to the collision.

Expectancy

Prior to the day of the collision, the motorist regularly (up to 12 times per week in an easterly and westerly direction of travel) traversed the Port Flinders Causeway Road level crossing when travelling to and from Port Pirie. The motorist estimated that they would encounter a train at the crossing 2 to 3 times per week. A review of driver behaviour at level crossings has found that drivers generally do not expect to encounter a train at a level crossing, and found that this behaviour was partially attributable to familiarity with an area. That is to say, drivers who were familiar with a crossing were more likely to be involved in a level crossing incident than drivers unfamiliar with the crossing.[27]

Notwithstanding the motorist's statement that they always stop at the crossing, it is possible that familiarity with the crossing created a low expectation of encountering a train thereby contributing to a failure to stop. Witness observations established that the motor vehicle had slowed as it

---

23 Draft Code of Practice for the Defined Interstate Rail Network (2002). Volume 5: Rolling stock. Part 5 – Specific requirements for locomotives (Section 10.3.2).

24 Dolan & Rainey (2005). Audibility of Train Horns in Passenger Vehicles, *Human Factors, 47 (3),* 613 – 629.

25 Brach, R.M. & Brach, R.M. (2009). Insertion loss: *Train and light-vehicle horns and railroad-crossing sound levels*. Paper presented at the 158th meeting of the Acoustical Society of America, San Antonio, Texas.

26 Dolan & Rainey (2005). Audibility of Train Horns in Passenger Vehicles, *Human Factors, 47 (3),* 613 – 629.

27 Yeh, M. & Multzer, J. (2008). *Driver Behaviour at Highway-Railroad Grade Crossings: A Literature Review from 1990-2006. Human Factors in Railroad Operations.* United States Department of Transportation, Federal Railroad Administration: Washington DC.

approached the crossing, suggesting that the motorist had at least recognised the requirement to look for and give way to trains. The failure to perceive the train and stop at the crossing indicates that their conscious attention was not directed to this task at the time.

Workload and distraction

Cognitive Workload

Because the level crossing was positioned on a route which the motorist frequently traversed, it could be argued that familiarity with the crossing reduced the cognitive resources utilised to negotiate this route. When tasks are novel, they require increased attention. As people become familiar with the task they increasingly apply reduced attention to the details; operating more on a rule based or even skill based level where actions are largely automatic.[28] The motorist stated that it was their normal procedure to stop at the crossing and to then look for trains, rather than to look for trains as the vehicle approached the crossing. On this occasion the motorist did not stop at the crossing and consequently did not look for trains, as was their 'rule'. The failure to stop meant that the next step in their procedure (to look) was not triggered. The driver did not recall noticing the presence of the train until moments before the collision indicating that their conscious attention was elsewhere.

Driver Distraction

The motorist was travelling with a single passenger in the vehicle, seated in the front passenger seat. Conversations with passengers have been demonstrated to be less distracting than mobile phone conversations while driving due to the passenger's shared situational awareness and ability to direct the motorist's attention to the driving task. However passengers who are unable to assist in directing the attention of the driver to the driving task (children, or the cognitively impaired, for example) have a potentially negative impact on driving performance.[29] Some research has found that attending to children while driving accounts for up to 12% of driver distractions, and can divert attention from the driving task (eyes away from the road) for somewhere between three and eight seconds.[30] The motorist's recollection of the moments leading up to the collision is unclear. The motorist could recall conversing with the passenger, who was cognitively impaired, during the approach to the crossing, but was unable to recall at what distance from the crossing this conversation had taken place. The next event that the motorist recalled was hearing the train horn, closely followed by being on the track and seeing the train immediately prior to the collision. It is therefore quite possible that the conversation with the passenger was sufficient to distract the motorist from the driving task during the moment at which they would normally stop to look for trains, resulting in the car entering the crossing at low speed and colliding with the train.

Driver competence

Based on SA Police records it was established that the motorist had held a driver's licence for many years, did not have a history of traffic law infringements and had not been involved in any major road accidents or incidents. Their propensity to partake in risky driving behaviour is therefore considered low. It is considered unlikely that the driver deliberately violated the requirement to stop at the level crossing.

Medical and toxicology

The motorist had some health issues, none of which precluded them from driving a motor vehicle of the class involved in the collision. The investigation established that the motorist had high blood

---

28 Reason, J. (2008). *The Human Contribution.* Ashgate: Aldershot.

29 Drews, F.A., Pasupathi, M, & Strayer, D. (2008). Passenger and cell phone conversations in simulated driving. *Journal of Experimental Psychology, 14 (4)*, 392-400.

30 Kopell, S., Charlton, J., Kopinathan, C & Taranto, D. (2011). Are child occupants a significant source of driving distraction? *Accident Analysis and Prevention, 43*, 1236-1244.

pressure, diabetes, mild depression and reflux. The driver was taking medication prescribed for each of these conditions however they should not have affected the driver's performance.

In conclusion, while medication was unlikely to have been a factor in this collision, the medical condition of the driver cannot be ruled out as a possible factor.

Fatigue

In the context of human performance, fatigue is a physical and psychological condition which can arise from a number of different sources, including time on task, time awake, acute and chronic sleep debt, and circadian disruption (disruption to normal 24-hour cycle of body functioning). A review of fatigue research notes that fatigue can have a range of influences on performance, such as decreased short-term memory, slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance, and increased errors of omission.[31]

Interview evidence indicated that the motorist had adequate sleep on the night prior to the morning of the collision. There was no indication that the effects of fatigue were present either leading up to or at the time of the collision.

[31] Battelle Memorial Institute (1998). *An Overview of the scientific literature concerning fatigue, sleep, and the circadian cycle.* Report prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, US Federal Aviation Administration.

Findings

On Monday morning 19 March 2012 Pacific National ore train 4460S travelling on the interstate main line between Port Augusta and Port Pirie collided with a light motor vehicle on the Port Flinders Causeway Road level crossing located about 10.6 km south of Port Germein in South Australia.

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.

Contributing safety factors

- The driver of the road vehicle involved in the collision did not come to a complete stop at the railway crossing as required and entered the crossing into the path of the approaching ore train.

Other safety factors

- There were some minor non-conformances with the level crossing signage, in particular the ‘Stop’ sign assembly and positioning of the ‘Stop’ line on the western side of the Port Flinders Causeway Road level crossing. *[Minor safety issue]*
- Based on historical data supplied by Department of Planning Transport and Infrastructure (DPTI) there was evidence to suggest that some motorists may not be stopping at the ‘Stop’ signs at the Port Flinders Causeway Road level crossing as required.

Other key findings

- A review of the Port Flinders Causeway Road level crossing geometry revealed that for motor vehicles stopped at the crossing, available sighting distance and viewing angle was better than that prescribed in Australian Standard 1742.7-2007.
- The motorist involved in the collision had many years of driving experience. They had been a resident at Weeroona Island for about 14 years and were fully aware of the crossing and the need to stop.
- The driving record of the motorist involved in the collision gave no indication of factors likely to have contributed to the accident. Testing for alcohol and illicit drugs showed zero readings.
- It is possible that the motorist’s attention may have been diverted to attending to the needs of a passenger during the period when they would normally have stopped to look for trains.
- There were no deficiencies identified with the mechanical condition of the motor vehicle that contributed to the collision.
- There were no deficiencies identified with the mechanical condition of the train that contributed to the collision. Train speed, locomotive braking and headlight illumination were appropriate.
- The train horn was not sounded at the Whistle Board as required, but was sounded three times when the train was closer to the crossing. It is unlikely that sounding the horn at the Whistle Board would have been effective in alerting the motorist to the presence of the train in this instance.
- The actions of the train crew were appropriate in the circumstances. There was little effective action they could have taken to prevent or minimise the impact of the collision.

Safety issues and actions

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

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

Level crossing signage

Number:	RO-2012-003-SI-01
Issue owner:	Australian Rail Track Corporation
Operation type:	Track owner
Who it affects:	Civil maintenance
Risk:	Minor

Safety issue description:

There were some minor non-conformances with the level crossing signage, in particular the ‘Stop’ sign assembly and positioning of the ‘Stop’ line on the western side of the Port Flinders Causeway Road level crossing.

Proactive safety action taken by: the Australian Rail Track Corporation

The Australian Rail Track Corporation has advised that the signage at the Port Flinders Causeway Road level crossing had been reinstated.

General details

Occurrence details

Date and time:	19 March 2012 – 0939 CSuT	
Occurrence category:	Accident	
Primary occurrence type:	Level crossing	
Type of operation:	Ore freight train	
Location:	10.6 km south of Port Germein, South Australia	
	Latitude:33^{o} 6.238' S	Longitude: 138^{o} 3.363'

Train details

Train operator:	Pacific National	
Registration:	4460S	
Type of operation:	Ore freight train – fully loaded carrying lead concentrate. The train comprised one locomotive (NR29) hauling 27 loaded wagons. The train was 301 m long with a trailing mass of 2052 t.	
Persons on board:	Crew – 2	Passengers – N/A
Injuries:	Crew – 0	Passengers – N/A
Damage:	Minor	

Train crew information

Train drivers:	The train crew consisted of two drivers. The driver in control at the time of the collision had been employed with Pacific National since 1995. He was appropriately qualified, assessed as competent and signed on as medically fit for duty. The second driver was a trainee. He commenced employment with Pacific National in October 2011. At the time of the collision he had signed on as medically fit for duty.

Vehicle details

Vehicle type:	Car – 2004 Hyundai Accent	
Registration:	Private	
Persons on board:	Driver – 1	Passengers – 1
Injuries:	Driver – Serious	Passengers – Fatality
Damage:	Destroyed	

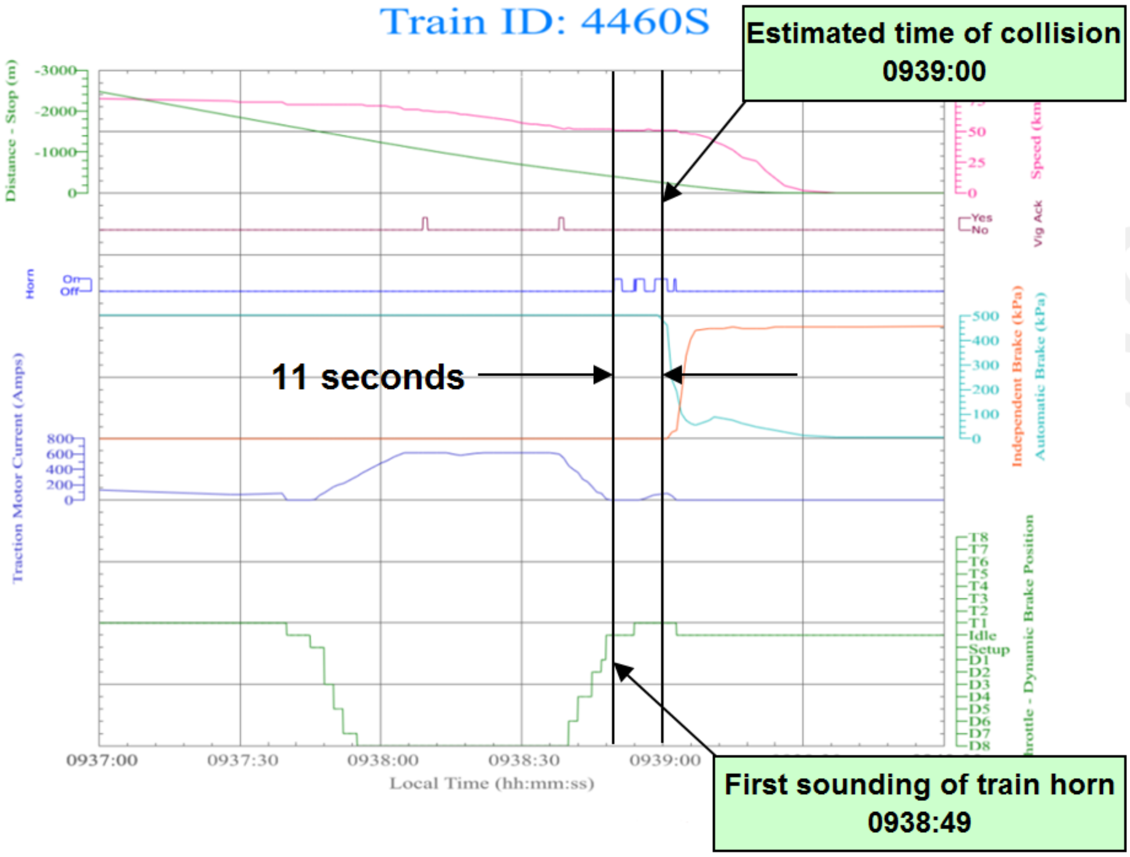
Track structure

Track:	Track through the Port Flinders Causeway Road level crossing comprises standard gauge (1435 mm) 47 kg/m rail fastened to concrete sleepers using resilient clips on a ballast bed (minimum depth of 250 mm) supporting prestressed concrete sleepers spaced at approximately 667 mm centres.

Appendix A – Extract of Technical Analysis Report

The locomotive (NR29) data logger was a Wabtec Pulse system. Following the collision the data files were extracted and used to derive the graph at Figure 8. Captured data included time, speed, distance, brake, horn and vigilance activation.

Figure 8: Extract from NR29 locomotive data log



Source: ATSB

The speed recorded by the data logger was corrected for wheel diameter to accurately determine the train speed. An examination of data from the locomotive was used to reconstruct train specific events leading up to the collision.

Based on this information the following was concluded:

- Train 4460S was travelling at a speed near 50 km/h, about 450 m before the collision, in preparation for a 50 km/h speed restriction located 50 m in advance of the (northern side) of the Port Flinders Road level crossing. At the time of collision the train was travelling at a speed of 51 km/h.
- The collision occurred at 0939.
- The train brakes were recorded as activating at about the time of collision.
- Based on site measurements, the front of the train came to a stand 256 m beyond the point of collision. Deceleration was consistent with the braking effort achievable by this class of train.
- The data logger shows that the headlights were illuminated for the entire time the train approached the level crossing. A subsequent examination of the headlights and ditch lights found that they were in good working order.

- The data logger shows that the train horn was sounded as it approached the crossing. This was corroborated by the witness (driver directly behind the vehicle involved in the collision). The motorist involved in the collision also recalled hearing a horn in the period preceding the collision.

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Australian Rail Track Corporation
- Pacific National Pty Ltd (Asciano Ltd) including train driver and train co-driver
- The Department for Planning Transport & Infrastructure
- The SA Coroner
- The SA Police

References

Australian Government, Geoscience Australia

Australian Level Crossing Assessment Model ALCAM

Australian Standard1742.7-2007

Battelle Memorial Institute (1998). *An Overview of the scientific literature concerning fatigue, sleep, and the circadian cycle.* Report prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, US Federal Aviation Administration.

Brach, R.M. & Brach, R.M. (2009). *Insertion loss: Train and light-vehicle horns and railroad-crossing sound levels.* Paper presented at the 158th meeting of the Acoustical Society of America, San Antonio, Texas.

Dolan, T. G. & Rainey, J.E. (2005). Audibility of Train Horns in Passenger Vehicles. *Human Factors, 47 (3),* 613-629.

Draft Code of Practice for the Defined Interstate Rail Network (2002). Volume 5: Rolling stock. Part 5 – Specific requirements for locomotives (Section 10.3.2).

Drews, F.A., Pasupathi, M, & Strayer, D. (2008). Passenger and cell phone conversations in simulated driving. *Journal of Experimental Psychology, 14 (4),* 392-400.

English, G.W., Russo, F.A., Moore, T.N., Lantz, M.E. & Shwier, C. (2003). *Locomotive horn evaluation: Effectiveness at operating speeds.* Report TP14103E prepared for Transport Canada.

Gray, R. & Regan, D. (2007). Glare susceptibility test results correlate with temporal safety margin when executing turns across approaching vehicles in simulated low-sun conditions. *Ophthalmic & Physiological Optics, 27*, 440-450.

Kahneman, D. (2011). *Thinking Fast and Slow*. Farrar, Straus & Giroux: New York.

Kopell, S., Charlton, J., Kopinathan, C & Taranto, D. (2011). Are child occupants a significant source of driving distraction? *Accident Analysis and Prevention, 43,* 1236-1244.

National Transportation Safety Board (1998). *Safety at Passive Grade Crossings, Volume 1 Analysis*: *Safety Study NTSB/SS-98-02:* Washington DC.

Reason, J. (2008). *The Human Contribution*. Ashgate: Aldershot.

Yeh, M. & Multzer, J. (2008). Driver Behaviour at Highway-Railroad Grade Crossings: A Literature Review from 1990-2006. *Human Factors in Railroad Operations*. United States Department of Transportation, Federal Railroad Administration: Washington DC.

Vogel, K. (2003). A comparison of headway and time to collision as safety indicators. *Accident Analysis and Prevention, 35*, 427-433.

Submissions

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

A draft of this report was provided to the Australian Rail Track Corporation, Pacific National Pty Ltd, the Department for Planning Transport & Infrastructure, the SA Coroner, the SA Police and a number of individuals. Submissions were received from the Australian Rail Track Corporation and the Department for Planning Transport & Infrastructure. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

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

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

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

Purpose of safety investigations

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

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

Developing safety action

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

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

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

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

Terminology used in this report

Occurrence: accident or incident.

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

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

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

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

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

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

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

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

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

Australian Transport Safety Bureau

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

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
Collision involving a motor vehicle and train 4460S
10 km south of Port Germein, South Australia, 19 March 2012
RO-2012-003 – 19 April 2013
Final