Australian Government
Australian Transport Safety Bureau

Derailment of freight train 2DA2

Union Reef, Northern Territory | 30 December 2013

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2013-028
Final – 17 February 2015

Source: Cover photo Genesee & Wyoming Australia.

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

Addendum

Page	Change	Date

Safety summary

What happened

On 30 December 2013 at 1547, train 2DA2 (travelling from Darwin to Adelaide) derailed while traversing the points into the loop line at Union Reef. Shortly beforehand, the train crew had commanded the points to reverse for entry into the loop line, however the automated points system was unable to complete the reversal movement – leaving the points in an unsafe open position.

There were no injuries sustained during the derailment, but about 100 m of track infrastructure was damaged, and the main line between Darwin and Tarcoola was blocked for about 5 days.

What the ATSB found

The ATSB found that the northern points at Union Reef had most likely failed to fully transition for the crossing loop because of ore product build up and inadequate lubrication. It had been previously recognised that this location was prone to ore product build up in the four foot and points, but the inspection and maintenance regime had not been adjusted to address this localised issue and the potential increase in risk to rail operations that it presented.

The ATSB also found that the train crew were distracted by several conflicting responsibilities at a time when they were also expected to be preparing for entrance to the crossing loop. While the driver was operating the train at a speed he considered appropriate for traversing the points, he did not expect the point enhancer to remain at red (or the points to be unsafe), and as such, he was unable to stop the train before the open points. Reduced sighting of the point indicator/enhancer due to track curvature and track side vegetation had limited the opportunity for early identification and response to the red indication, even though a repeater indicator had provided prior warning as to its unsafe status.

What's been done as a result

Following this occurrence, Genesee Wyoming Australia (GWA) reviewed the reliability, inspection and maintenance frequency of motorised self-restoring points machines. Similarly, with a view to identifying and addressing any increased risk in these locations, GWA specifically undertook to monitor the functionality and performance of track/points exposed to the accumulation of mining products.

Responding to the human element, GWA advised that a Critical Safety Zones program will be introduced to provide clarification to train crews on acceptable speeds and necessary caution required when approaching points with reduced sighting distances.

Safety message

Rail operators and train crews are reminded that distraction can have a profound impact on safety during critical phases of train operation. To combat situations where signals (often the final defence against an incident) are affected by reduced sighting distances, strengthened guidance should be given to train crews on ensuring that appropriate approach speeds are established and maintained throughout the critical areas.

Contents

The occurrence

At 1100[1] on 30 December 2013, the crew of Genesee Wyoming Australia (GWA) train 2DA2 signed on duty at the Berrimah Freight Terminal Darwin for departure to Adelaide. At about 1200, after attending to sticking handbrakes on locomotive GWU001 (which was being hauled as unpowered), the train departed Berrimah for Katherine under authority N847, where the plan was to cross train 2MD3.

During the journey to Katherine, the sticking handbrake issue on locomotive GWU001 recurred on two separate occasions, each requiring train 2DA2 to stop for attention. The train then continued towards Katherine, but was about 90 minutes behind the planned schedule.

Due to the late running of train 2DA2, the transport controller decided to change the plan and cross trains 2DA2 and 2MD3 at Union Reef. The controller contacted train 2DA2 to cancel authority N847 and, at 1541, issued a new authority N849 for train 2DA2 to proceed to Union Reef, take the crossing loop and wait to cross train 2MD3.

Less than 1 minute later (1541:54), train 2DA2 passed the Union Reef location board, 4500 m (Figure 1) from the crossing loop, at about 69 km/h. The location board is a trigger point for train crews to follow a procedure to remotely operate the points via a four digit code transmitted by UHF[2] radio.

Figure 1: Union Reef location board at 4500 m – as seen from 2DA2.

Source: Genesee & Wyoming Australia, General Electric LocoCAM, annotated by the ATSB.

At 1542:21 a dual tone multi frequency (DTMF) code was transmitted via UHF radio, requesting the points to reverse for travel into the crossing loop. The trackside equipment data log recorded the colour light point indicator (repeater) change from a green to red indication. The control circuits began a time delay of 120 s before the points began to change position at 1544.26. At 1544:51,

---

1 The 24-hour clock is used in this report. Local time was Central Standard Time (CST)

2 Ultra High Frequency

the data log recorded the system having aborted the movement and the colour light point indicators remained at red.

At 1545:43, train 2DA2 passed the colour light point indicator [repeater] located 1183 m from the points, at about 53 km/h (Figure 2); the indicator still displaying red. The crew members cross-called the displayed indication[3] as per the GWA procedure.

Figure 2: Points repeater as seen from 2DA2.

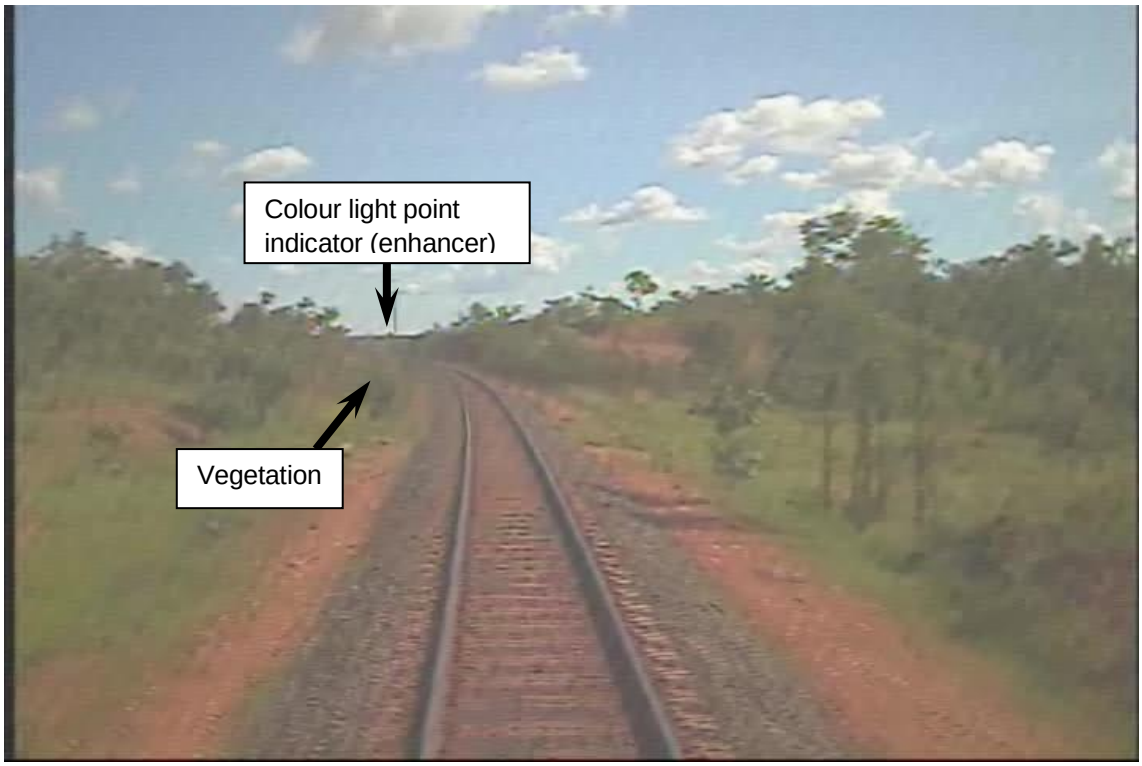
Source: Genesee & Wyoming Australia, General Electric LocoCAM.

Train 2DA2 continued towards the crossing loop at Union Reef, gradually reducing speed. The train approached Union Reef travelling at 47 km/h around a large radius left-hand curve, rising towards the points on the northern end of the crossing loop.

At 1546:53, when 178 m from the points (Figure 3), the train crew observed the points stand indicator was displaying an unclear indication and applied the train brakes. Both crew members then noticed that the points had not fully transitioned for access onto the loop track.

[3] The processes to ensure both drivers are aware of the indication displayed.

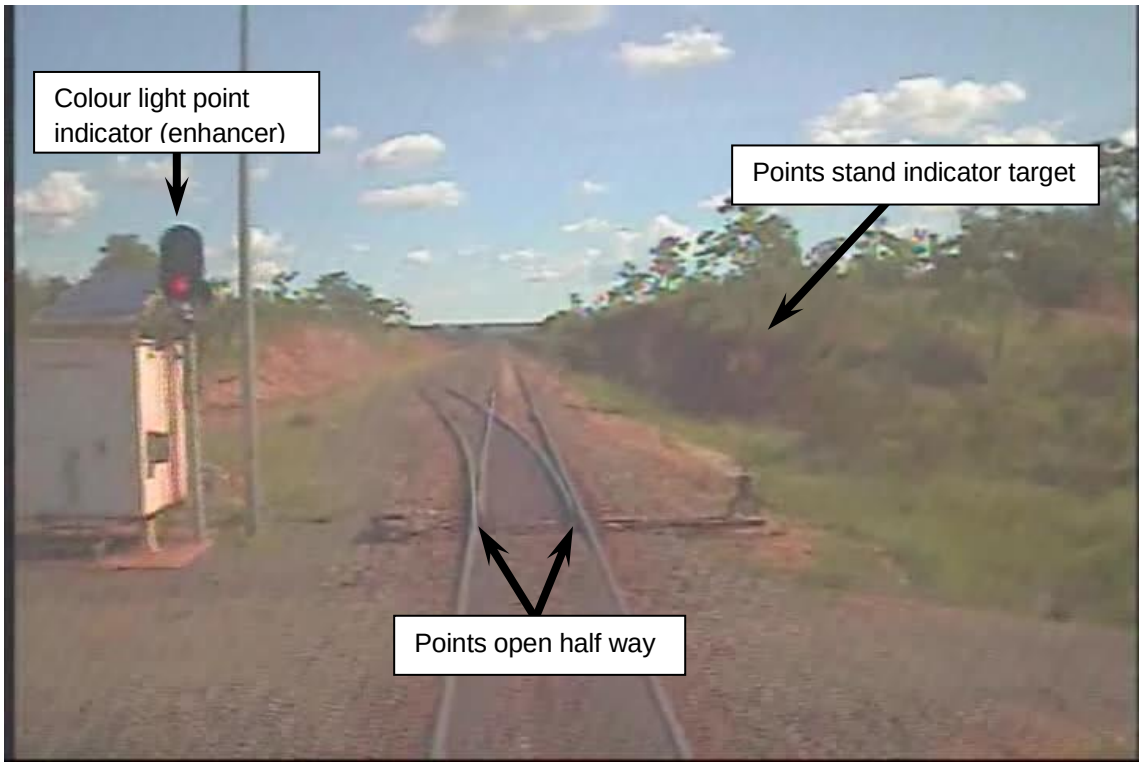
Figure 3: Time of brake application, as seen from 2DA2.



Source: Genesee & Wyoming Australia, General Electric LocoCAM, annotated by the ATSB.

Train 2DA2 was unable to stop and, at 1547:08, it travelled over the open points (Figure 4) at 40 km/h and derailed. The train continued to travel derailed for a further 107 m, coming to rest between the main and loop lines.

Figure 4: Points indicators and points at Union Reef as seen from 2DA2.



Source: Genesee & Wyoming Australia, General Electric LocoCAM, annotated by the ATSB.

The crew checked the condition of the train and the resting crew in the crew van, and then reported the incident to the transport controller at 1555. Arrangements were then made to respond to the incident site and commence recovery and investigative activities.

The track was restored for main line traffic only on 4 January 2014. The loop line was restored on 7 January 2014 and normal operations resumed.

Context

Location

Union Reef is located at the 2553 track kilometre point[4], about 200 km south of Darwin on the Adelaide to Darwin railway line known as the Central Australian Railway. The railway line consists of a bi-directional single line with crossing loops (short sections of double track) provided at regular intervals to allow trains to cross (travelling in opposing directions) or pass (travelling in the same direction).

The section of track between Alice Springs and Katherine passes over relatively flat arid country, while the topography between Katherine and Darwin (including Union Reef) is more undulating. The 1937 m long loop line was installed at Union Reef in July 2007, primarily to allow the loading of ore trains clear of the main line, but could also be used as a crossing/passing location. The track speed through Union Reef is limited to 110 km/h on the main line and 30 km/h when crossing the points to the loop.

Train details

At the time of the occurrence train 2DA2 consisted of two locomotives (GWU004 leading, CLP14 trailing), hauling an inline fuel tanker, crew van, an unpowered locomotive (GWU001), and 35 freight wagons. The train was 1295 m long and had a gross mass of 2030 t. The crew van accommodated the off-duty crew during the rest cycle of the 8 hour rotating relay shift.

Based on an analysis of the available evidence, the condition and serviceability of train 2DA2 did not affect its handling at the time of the occurrence and was not considered a factor in the derailment.

Crew details

The driver of train 2DA2 had 34 years of driving experience. The co-driver was an advanced trainee driver with 8 months driving experience. While both drivers knew the route well, neither had been into the crossing loop at Union Reef in that time.

Both crew members held the required qualifications to operate a train and were assessed as medically fit for duty. After the derailment, both operating crew members were tested for alcohol and other drugs - returning zero readings.

Fatigue

The crew had worked a train from Port Augusta to Darwin in previous days. They had arrived in Darwin at about 1730 on 29 December 2013 as a ‘rest in’ crew. That is, they were resting in the crew van. The crew then went to their designated motel accommodation in Darwin, had dinner, and then went to bed. On the following day, the crew signed on duty at 1000 for an 1100 scheduled departure as the ‘working out’ crew. Both crew members reported having an uninterrupted full night’s sleep.

Based on an analysis of the available evidence, the performance of the crew of train 2DA2 was not affected by fatigue at the time of the occurrence.

---

[4] Distance in kilometres from a track reference point located at Coonamia in South Australia.

Environmental conditions

At the time of the occurrence the weather was dry, with temperature about 35 °C and 90% humidity. The sky was slightly overcast with about 1/8 cloud cover. The sun was at about 45 degrees in the west.

Considering the conditions, and with reference to the forward-facing video recorded on-board the train, it was evident that the visibility and conspicuity of the colour light indicators or points stand indicator target had not been adversely affected at the time of the occurrence.

Train control

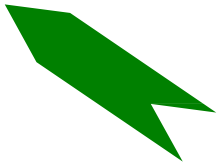
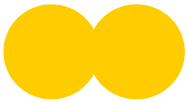
Genesee Wyoming Australia (GWA) controlled all train movements from the Northgate Block Point (about 6 km north of Tarcoola in South Australia) through to Darwin. Train control for GWA services was provided from Dry Creek in South Australia, with communications provided by a combination of terrestrial and satellite phone systems.

Train movements along the railway to Darwin were managed by *Train Order Working* (TOW) procedures. Train Order Working is a system of safeworking whereby the transport controller verbally issues an authority to train crews to travel between locations, with a set of instructions for each authority. On the day of the derailment the authorities issued to train 2DA2 were compliant with GWA requirements and valid.

Points indicator and remote control systems

Union Reef is equipped with two systems to indicate the position of the self-restoring motorised points to approaching trains. Each set of points has a *points stand indicator target* (Table 1) that is mechanically connected to the points. It displays whether the points are in the reverse (crossing loop line) or normal (main line) position and is reliant on approaching trains having a line-of-sight to the target.

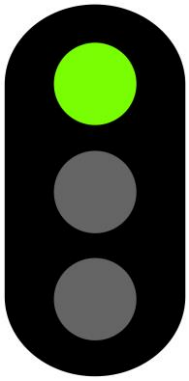
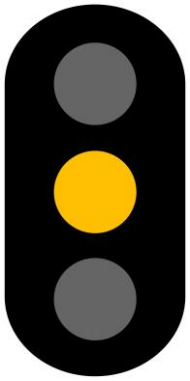
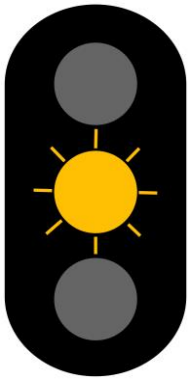
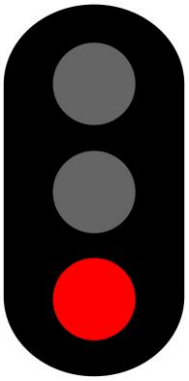
Table 1: Points stand indicator target aspects

	
Green arrow	**Yellow dumb bell**
Points are set for the main line. The arrow points up and away from the line.	Points are set for the crossing loop.

In addition to the points stand indicator target, colour light points indicators were also installed. One colour light indicator was directly opposite the points stand indicator, on the inside of the curve. This colour light indicator, called the *points enhancer*, mimics the information provided by the points stand indicator and provides some additional (or enhanced) information. Another colour light indicator was located 1183 m from the points and its function was to repeat the indication of the points enhancer. The repeater was installed due to the track curvature that restricted the sighting distance of the points enhancer and points stand indicator target. Both colour light indicators displayed four individual indications to approaching trains[5], as shown in Table 2.

[5] Genesee & Wyoming Australia *Addendum to the Code of Practice (Volume 3) for the Australian Rail Network 3* December 2007.

Table 2: Colour light indicator aspects

 **Steady green**	 **Steady yellow**	 **Flashing yellow**	 **Steady red**
• Facing points are correctly set and locked for the main line. • Trailing points are correctly set and locked for the main line. • Proceed at authorised speed in accordance with the train authority.	• Facing points are correctly set and locked for the main line. • Trailing points are NOT correctly set and locked for the main line. • Proceed in accordance with Train Authority only to the clearance point at the other end of the location. • Stop and inspect or set trailing points.	• Facing points are correctly set and locked for the crossing loop. • Proceed onto the crossing loop only to the clearance point at the other end of the location. • Stop and inspect or set trailing points.	• The run down timer is in operation; or, • The points locking track circuit is occupied; or, • The points are not correctly set and locked for either route; or, • The points may be out of adjustment. • Stop and inspect the points.

The colour light indicators consist of light emitting diodes (LEDs) and are more conspicuous than the mechanical points stand indicator target, as well as providing additional information on the lay of points at the other end of the crossing loop.

Assuming the points were correctly set for the crossing loop as was intended, both the points enhancer and its repeater would display a flashing yellow indication. In the subject occurrence however, the points had not fully transitioned for access onto the loop track, so the enhancer and repeater displayed a red indication. The required action was to stop and inspect the points.

Radio remote control points operation.

The crossing loop at Union Reef was installed with radio remote control, self-restoring points. The system allowed drivers to select access onto the loop line while still approaching Union Reef and the points automatically return (self-restore) to the normal (main line) position after the train had fully entered the loop line.

The GWA addendum to the Code of Practice contained instructions for train crews when approaching locations with self-restoring motorised points. The instructions stated:

> Arriving train movements shall approach the points at a speed at which the movement can be stopped short of the points.

Drivers were required to transmit (by UHF radio) a four digit DTMF points operating code that would initiate the points control sequence. The points indicators (enhancer and repeater) would display red and, after a 120 s time delay, the points would move for access into the crossing loop. When the points were detected in the correct position and locked for the loop line, the indicators would display a flashing yellow light and the train could pass into the loop at no greater than 30 km/h. If the point movement was unable to complete or lock, the indicators would remain red and trains would be required to stop short of the points.

Post incident testing

Following the derailment, mechanical and electrical testing was conducted on the points. An initial assessment was conducted on the day of the incident and found that, electrically, the equipment worked as designed. Examination of the electrical equipment data logs confirmed the acceptance of the DTMF transmission from train 2DA2, the enhancer and repeater indicators restoring to a red display, the run-down timer, movement and eventual timing-out of the action after the points had not reached the reversed position.

A number of follow up tests confirmed that the points were mechanically correct and within specified tolerances. However, there was evidence of iron ore product build-up between the point blade and the stock rail that prevented the points fully transitioning from the normal to the reverse position.

Both mechanically and electrically, the system worked as designed and had failed to a safe condition by maintaining the indicators at red after the points had not moved fully to the reverse position.

Railway corridor maintenance

The section of track between Darwin and Katherine incorporating Union Reef was maintained in accordance with the National Code of Practice, Volume 4 Infrastructure. The document outlines two complementary inspection types:

- Scheduled inspections; and,
- Unscheduled inspections.

At the time of derailment, GWA mandated that scheduled inspections for this section of track be performed by track patrols (at intervals not exceeding 7 days), 'front-of-train inspections' (at intervals not exceeding 6 months), and the track geometry car (twice yearly). More specific inspections of the points and indicator systems were scheduled at intervals not exceeding 3 months, with detailed inspections scheduled at intervals not exceeding 12 months.

Unscheduled inspections usually occurred in response to defined events such as system failures or extreme weather conditions that were known to increase the risk of track geometry defects. Unscheduled inspections could also be initiated through third-party feedback such as train driver reports.

Scheduled inspections

Maintenance documents indicated that the points colour light indicator system was inspected on 5 November 2013 and noted, on the self-restoring switches examination checklist, that the '4-foot' needs cleaning from switches to clearance point full of product'[6]. Previously, the systems were inspected on 5 September 2013 with minor work completed.

Regular weekly track inspections were also being conducted, but no faults or observations were noted with regard to fouled track.

Unscheduled inspections

A number of unscheduled inspections had been triggered by point irregularities. In the three years prior to the occurrence, 6 irregularities had been identified at the northern end of Union Reef. Two of those irregularities were in December 2013 as a result of excessive product built up in the four foot on the loop line.

No other external reports had been received for the area on the northern end of Union Reef.

---

[6] A term used to describe the area between the two running rails of standard gauge 1435 mm.

Special locations

The ARA Code of Practice for the Australian Rail Network documents a process for classifying, as *special locations*, areas that exhibit a proneness to an event that may increase the risk of an incident, for example, repetitive failures due to product build-up.

The intent was to identify infrastructure that has the potential to exceed its functional capability during its life, which could lead to an incident or accident unless special preventative action is taken. For such infrastructure, the conditions (i.e. the defined events) under which the event could arise should be specified, and appropriate remedial measures must be defined and put in place to manage the risk to train operations.

Train handling

The recorded data showed that the driver of train 2DA2 had passed the colour light points repeater at 53 km/h, gradually reducing speed, before braking and traversing the points at 40 km/h. Although the rules and procedures state that approaching trains 'shall approach the points at a speed at which the movement can be stopped short of the points', the crew expected the route to be cleared before arrival. It was evident that the driver approached the turnout with the intention of traversing the points at the defined turnout speed of 30 km/h, rather than stopping at the points. It was also evident that the driver misjudged the proximity of the turnout, since the train traversed the points 10 km/h above the defined speed limit.

On sighting the open points, the driver reacted almost immediately in applying the train brakes. However, the train did not stop within the available 180 m before derailing through the open points.

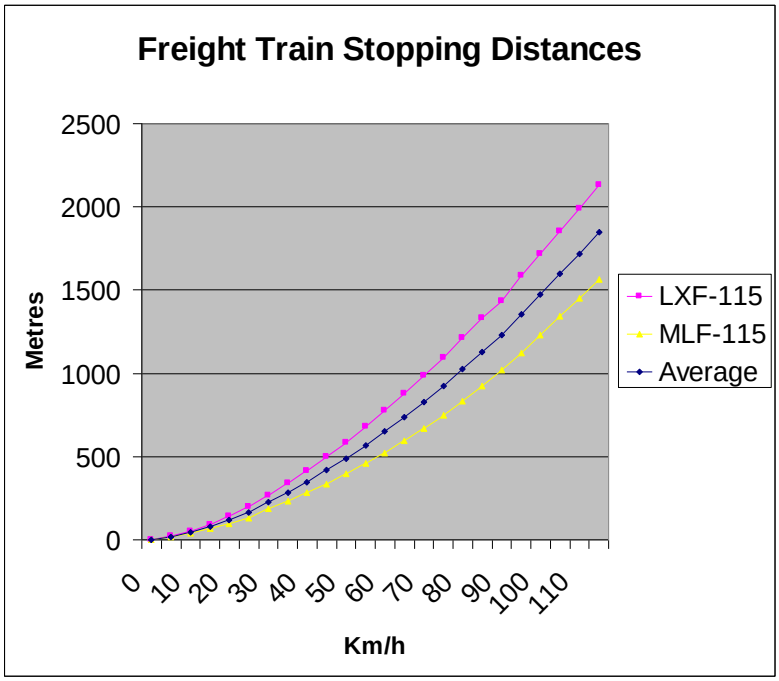
Sighting of the points indicator was limited by the track curvature and embankments. A post occurrence report conducted by GWA on 3 January 2014 noted that:

> The north end switch enhancer could be clearly seen from a distance of 250 m from a standing height in middle of track. Small amount of vegetation is compromising sight line by approximately 30 m.

The General Electric LocoCAM forward facing video camera footage, although not clear, indicates that the sighting of the colour light enhancer was not continuous and unimpeded. Based on the footage, the enhancer was only clearly visible about 180 m from the points, which coincides with the driver making the brake application (Figure 3).

While the two assessments of sighting distance varied slightly, neither provided sufficient braking distance for a train travelling at 47 km/h to come to a stand before the points. Based on a 180 m sighting distance, and an average full service braking curve for freight trains (Figure 5), the maximum approach speed for trains to stop before the points should be no more than about 25 km/h.

Figure 5: Freight train full service braking curve.



Source: ATSB

Safety analysis

Inspection and maintenance

It is likely that the points at the northern entry into the Union Reef crossing loop failed to completely move fully from the normal to reverse position due to iron ore product obstruction. As a result of this obstruction, the points were unable to be detected and locked at the reverse position (Figure 4), resulting in the colour light indicator system maintaining the indications at red. Furthermore the points appeared to be dry and lacking adequate lubrication (Figure 6), adding further resistance to movement and increasing the likelihood of failure.

Figure 6: Points at Union Reef - lacking lubricant.

Source: Genesee & Wyoming Australia,

Based on analysis of the available evidence, the indicator system, wayside equipment, and corridor were regularly inspected - generally in accordance with GWA's requirements. Of these inspections, ore product fouling the loop track had been identified on several occasions. In addition, ore product fouling of the points had been observed following a number of unscheduled inspections initiated due to reported point failures. Track inspections however, had not noted the vegetation interfering with the sighting distance of the northern points enhancer, or the ore product fouling the points at Union Reef. Similarly, no driver reports had been received regarding sighting of the point indicator, but this could be attributed to most train movements (other than ore trains) travelling straight through Union Reef rather than taking the crossing loop.

Special locations

The crossing loop at Union Reef was being regularly used as a loading point. Front end loaders would collect ore product from a stock pile alongside the line and dump it directly into hopper wagons standing on the loop line. Once loaded the train would depart through the northern points.

Quite often ore product would spill over during the loading process and/or trickle out through the wagon hopper doors as they pass over the points.

It was evident that this location was prone to product build up in the four foot and points. If undetected and corrected, the build-up could lead to failure of the points and an increased risk of derailment. Despite this however, the area had not been identified as a *special location* as defined in the ARA Code of Practice for the Australian Railway Network, which may have resulted in more rigorous inspection and maintenance regime.

While a repeater indicator provided advance warning of the status of the points at Union Reef, the visibility of the main points indicator was partly obstructed by trackside vegetation. Management of such vegetation may improve the opportunity for drivers to take earlier action if the points fail to fully transition due to malfunction or ore product build up.

Factors affecting crew actions

Train driving is a complex task performed in a dynamic environment, requiring the processing of information from outside the cab (e.g. signals, speeds, landmarks) combined with a detailed body of experience and acquired route knowledge. Efficient train handling demands sustained attention over long periods, during which the driver must respond to current task demands while also using higher level cognitive processing to plan ahead with mental time-distance estimations.[7] [8] Furthermore, this demanding role is also often performed in a time constrained organisational context.

Both route knowledge and two driver operations are widely considered to be key defences for human performance limitations as they apply to train driving.

Route knowledge and expectancy

Expectancy can be understood as the extent to which an event or condition is expected to occur or be present at a particular time and place. An individual's expectation can influence their attention to (and preparation for) that event or condition[9]. In this case, the train crew said they did not expect to see the colour light points enhancer at red. The co-driver, who had driven through this area on numerous previous occasions, noted that he had never used the crossing loop and that the colour light indicators had always displayed a green indication. Similarly, the driver, who was very experienced on the route, could not recall ever using the crossing loop at Union Reef from either direction. Accordingly his experience in this area suggested that the colour light indicators had always displayed a green indication.

Both drivers also commented that when approached, it was rare for any colour light point indicator to display red after the points had been activated by UHF radio. In almost all instances, the point indicator would display a flashing yellow, indicating the points were correctly set for the crossing loop.

Thus, it can be interpreted that the crew (through considerable experience), had come to trust that the automated points movement system was highly reliable, so that despite the colour lights points *repeater* displaying red when passed, they had no expectation that they would encounter any issues with the points, and anticipated that the *enhancer* would be displaying flashing yellow as they rounded the bend.

This effect is consistent with automation research which has found that systems which have been shown to be reliable can create an effect of over-trust, so that people will over-depend on the

---

7 Naweed, A. (2013). Psychological factors for driver distraction and inattention in the Australian and New Zealand rail industry. *Accident Analysis and Prevention, 60,* 193-204.

8 Naweed, A. (2014). Investigations into the skills of modern and traditional train driving. *Applied Ergonomics, 45,* 462 - 470.

9 Wickens C.D. & McCarley, J.S. (2008). *Applied Attention Theory*. CRC Press: Boca Raton. pp 55-57.

automation, and pay less attention to the true behaviour of the system (in this case, the points and points indicator) which is being controlled by the automation.[10]

Both drivers' previous experience of the area, as well as their trust in a normally reliable automated system, created an expectation that the points would be set, detected, and locked for the crossing loop. This affected the driver's mental calculations of an appropriate approach speed using his knowledge of the trackside landmarks, in that these calculations did not adequately account for the possibility of having to stop the train, even though it was a requirement to travel at a speed appropriate for stop before the points.

Role of the co-driver

In train operations where two drivers are in the cab, the second person provides a risk control for the normal variability of human performance, in that a single driver may miss critical driving cues whereas two drivers are less likely to do so. Additionally the second driver assists in the provision of safeworking functions and the management of fatigue, and mitigates risk arising from the sudden incapacity of a driver.

Co-driver's focus of attention

As previously discussed, due to the delays caused by the handbrake issues, a decision was made to cancel the previously issued train authority through to Katherine, and to subsequently issue a new authority to the Union Reef crossing loop. However, this new authority was issued at a time when the train crew would need to immediately prepare for entrance to the crossing loop. This meant that the time available to complete the associated paperwork was compressed, and the co-driver was still focussed on this task as the train approached Union Reef. As a result, while looking down at the paperwork, he did not see the colour light points enhancer until very close. Had the co-driver's attention been directed towards looking out for the enhancer, it is possible this would have enabled him to alert the driver to stop train 2DA2 prior to the points.

People have finite cognitive resources available to attend to and process information. Particularly in visual situations, attention tends to be directed to one source of information at a time. While attention can be shared between two or more tasks, performance on secondary tasks will generally be degraded.[11] In this case, the co-driver's attention was directed to the completion of the authority paperwork, and this meant that the safety critical function of cross checking the appropriate train speed and enhancer indications did not receive his full attention – thus undermining the risk control / defence provided by the presence of a second driver.

Due to the late issuing of the train authority, the co-driver was presented with two safeworking tasks, which were essentially competing for his attention. The completion of the train authority documentation was a necessary requirement of the safeworking system. However, in this case, the co-driver's attention to this task prevented him from also performing the safety critical task of checking approach speed and signal indications. Attention research has described this engagement in lower priority tasks at the cost of safety critical driving tasks[12] as 'misprioritised attention.'[13]

---

10 Wickens & McCarley (2008). p59.

11 McLeod, R.W., Walker, G.H., & Moray, N. (2005). Analysing and modelling train driver performance. *Applied Ergonomics, 36,* 671-680.

12 Hancock, P.A., Mouloua, M., & Senders, J.W. (2008). On the philosophical foundations of the distracted driver and driving distraction. In M.A. Regan, J.D. Lee, & K.L. Young (Eds). *Driver distraction: Theory, effects and mitigation.* CRC Press: Boca Raton. pp 11-30.

13 Regan, M.A., Hallett, C. & Gordon, C.P. (2011). Driver distraction and driver inattention: Definition, relationship and taxonomy. *Accident Analysis and Prevention, 43,* 1771-1781.

Rail resource management

The effective use of a two driver team is maximised when tasks are appropriately distributed and performed, and planning and decision making is shared.

The training and application of nontechnical skills aimed at managing human error has been introduced to the Australian rail industry as rail resource management (RRM), and is based on nontechnical skills training used in aviation and other high risk industries. RRM seeks to complement the technical skills of drivers, guards, train controllers, signallers and other workers, by developing their skills to anticipate and manage operational threats and errors, thus preventing incidents and accidents from occurring[14]. The core topics for RRM include leadership, task management, teamwork, communication, risk management, situational awareness, decision making, emergency management and self-management[15].

RRM skills relevant to this event include risk management, task management, decision making, and situational awareness – all underpinned by sound communication strategies and protocols.

When the situation changed, with the cancellation and subsequent issue of a new train authority, the tasks for each of the train crew members also changed. However, there was very limited time available for the crew to discuss the implications of these changes, or the relative priority of the associated tasks in the now shortened time frame available.

Had the crew time to develop a team strategy for approaching the points and entering the crossing loop, by openly considering and discussing potential threats to the operation and identifying, prioritising and allocating each task, this would have:

- enhanced the situational awareness of both crew members
- identified the risk associated with the possibility of the points failing to operate correctly
- identified an agreed approach speed which would permit the driver to pull up the train if required
- focussed the co-driver on the higher priority task of cross checking the train speed and enhancer indications.

Guidelines

GWA specify the responsibilities of train drivers in the GWA addendum to the Code of Practice, Section 10. Part 10.2 lists responsibilities including vigilance and attention to duty. Subsection (a) states: …*not participate in activities which may in any way distract them from the principal activity of their duties*. However, the addendum does not specify what the principal activity is, or the hierarchical structure of activities. More broadly, GWA did not have specific policies or procedures in place that were aligned with the principles of rail resource management and aimed at support train crews during times of conflicting tasks.

The GWA addendum to the Code of Practice contains instructions that state arriving train movements shall approach the points at a speed at which the movement can be stopped short of the points. Historically, the rule was intended to stop approaching trains when only the mechanical points stand indicator target was used and the points were manually switched depending on the required movement. This process was reliant on sighting of the points stand indicator target. The installation of remote operated self-restoring motorised points also included the provision of colour

---

[14] Rail Safety Regulators' Panel (2007a). *Guidelines for Rail Resource Management. National Rail Resource Management Project.* Available from: http://www.onrsr.com.au/__data/assets/pdf_file/0003/2973/Guideline-Rail-Resource-Management-2007.pdf

[15] Rail Safety Regulators' Panel (2007a). p54.

light indicators to provide more advanced notice to approaching trains and limiting the need to stop.

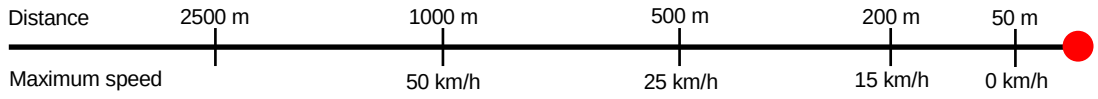
It is not uncommon for train crews to encounter colour light *repeaters* at red, but usually the colour light *enhancer* at the points would have cleared to the desired route before the crew sighted it. In this instance, train 2DA2 passed the colour light repeater showing red, the train crew assuming that the system was still counting down before moving the points. The data shows that at this point the system had already tried to move the points and failed, unbeknown to the train crew. This meant that the train crew would have had to rely on route knowledge, approaching train speed, and sighting of the points, points stand indicator target, or the colour light enhancer, in order to stop the train short of the points at Union Reef.

Approaching train speed relies on the judgement of individual drivers. Drivers must use their experience to judge a range of factors – in particular the sighting distance and train braking characteristics in the prevailing conditions. That judgement may also vary significantly between different drivers, depending on the level of risk perceived and accepted by that driver. While the rule says 'movements shall approach the points at a speed at which the movement can be stopped short of the points', its application is not precise and it is something that cannot be measured unless an incident, such as this, occurs. In this instance with reduced sighting distance, approach speed was critical.

Safety Critical Zones

A strategy being used by some Australian rail operators to enhance train crews' threat and error management is the identification of 'safety critical zones.'[16] A safety critical zone is generally identified as a set time or distance on approach to a known higher risk phase of the trip, such as a stopping location, or limit of authority (Figure 7). While in the safety critical zone, the crew restricts all attention, actions, and communications to safety critical functions (to the exclusion of other non-critical tasks or communications). Ideally, on entering the safety critical zone, the crew would also conduct a briefing to confirm each crew member's responsibilities during the zone transit period – thus verifying assumptions and expectations before proceeding[17].

Figure 7: Theoretical Safety Critical Zone



In this instance, had there been safety critical zone guidance for the train crew, it is likely that the crew would have been focussed on the approach task and not on ancillary activities. Similarly, approaching train speed would have been such that it could be stopped before the points, once the red enhancer was seen. If, when sighted, the point enhancer had cleared, the train could have continued and traversed the points below the defined speed limit.

---

16 See for example, Australian Transport Safety Bureau (2014) *RO 2013-019 Overrun of authority involving train 6MP5, Blamey, Western Australia 14 July 2013.* p6. Available from (http://atsb.gov.au/publications/investigation_reports/2013/rair/ro-2013-019.aspx)

17 Rail Safety Regulators' Panel (2007b). *Rail Resource Management Training Toolkit, Facilitator Guide, Module 6, Situational Awareness.*

Findings

From the evidence available, the following findings are made with respect to the derailment of train 2DA2 at Union Reef, Northern Territory, on 30 December 2013. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- The northern points at Union Reef most likely failed to fully transition for the crossing loop because of ore product build up and inadequate lubrication.
- **Union Reef was not treated as a special location as defined in the ARA Code of Practice for the Australian Rail Network. [Safety issue]**
- Even though the driver was operating the train at a speed that he considered appropriate for traversing the points, he did not expect the point enhancer to remain at red, and as such was not operating the train at a speed where it could be stopped before the open points.
- Vegetation reduced sighting distance for the point indicator/enhancer; limiting the opportunity for early identification and response to a red indication.
- **The GWA guidance does not provide clear and unambiguous information for train crews on acceptable points approach speeds where sighting distance is reduced. [Safety issue]**
- **The train crew had conflicting responsibilities distracting them from the safety critical task of driving. GWA did not have specific policies and procedures to define responsibilities of train crews approaching safety critical phases of operation. [Safety issue]**

Other factors that increased risk

- Due to its late running, the transport controller made a last minute decision to alter the routing plan for train 2DA2, presenting the train crew with conflicting responsibilities when approaching the Union Reef crossing loop.

Other findings

- The colour light point indicator system worked as designed by displaying a red indication when the points were unable to be detected and locked in a safe position.

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.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Special locations

Number:	RO-2013-028-SI-01
Issue owner:	Genesee and Wyoming Australia
Operation affected:	Rail: Infrastructure
Who it affects:	All owners and operators of track infrastructure.

Safety issue description:

Union Reef was not treated as a special location as defined in the ARA Code of Practice for the Australian Rail Network.

Proactive safety action taken by Genesee and Wyoming Australia

Action number: RO-2013-028-NSA-078

Genesee Wyoming Australia has proposed the following key actions to address this safety issue.

- Conduct line of sight inspections on approaches to yards between Alice Springs and Berrimah, with obstructions being removed.
- Review the inspection and maintenance frequency of motorised self-restoring points machines.
- Review the inspection and maintenance frequency of track/points associated with mining products and the response to the build-up of product.

The following additional commentary was provided:

> With regard to GWA treating the location as a ‘special location’, it was determined from the internal investigation that from Jan 2011 through to Dec 2013 there had been approximately 1100 + scheduled movements (approx. one train per day into the crossing loop from the northern end) through the automated points that had operated from N>R>N>R>N for each ore train. During that same three year period, GWA recorded an actual total of 3 points ‘failures’ at the northern end of Union Reef which equated to an approximate Mean Time between Unscheduled Inspections (MTBUI) figure of 0.2% for the location. GWA would regard the treatment of a special location to be based upon the level of risk exposure from track conditions impacting on train safety or by incident trending data. In this case the infrastructure, under failure condition, operated correctly and displayed a red indication. The driver failed to respond to the indicated message.
>
> With respect to the above dot points, GWA has conducted a review of the existing inspection and maintenance frequencies for points and track at loading locations as well as the efficacy of its reporting arrangements and found both to be acceptable. Having said this, GWA will continue to monitor the functioning of its infrastructure at loading locations with the intent of identifying any adverse trends and implementing preventative action.
>
> GWA has completed a line of sight inspection on the approaches to all locations between Alice Springs and Berrimah and removed any identified obstructions.

ATSB comment in response:

The ATSB acknowledges and accepts Genesee Wyoming Australia's assessment of automated points reliability at the Union Reef locations. Together with the maintenance review, line-of-sight inspections and ongoing monitoring of infrastructure at loading areas, the ATSB is satisfied that the safety issue has been adequately addressed.

Current status of the safety issue:

Issue status: Adequately addressed

Justification: The ATSB is satisfied that the actions taken by Genesee Wyoming Australia should address this safety issue.

Guidelines

Number:	RO-2013-028-SI-02
Issue owner:	Genesee and Wyoming Australia
Operation affected:	Rail: Track managers
Who it affects:	All owners and operators of freight trains.

Safety issue description:

The GWA guidance does not provide clear and unambiguous information for train crews on acceptable points approach speeds where sighting distance is reduced.

Proactive safety action taken by Genesee and Wyoming Australia

Action number: RO-2013-028-NSA-079

Genesee Wyoming Australia advises that they will be including this type of incident within their operational risk register and documentation, and will be implementing a critical safety zone behaviours workshop and program, incorporating lessons learnt from occurrence investigations.

GWA have also undertaken to provide clarification to train crews on acceptable approach speeds where there may be a requirement to stop before points with reduced sighting distance.

ATSB comment in response:

The ATSB is satisfied that, when implemented, the actions proposed by Genesee Wyoming Australia should address this safety issue.

Current status of the safety issue:

Issue status: Safety action pending

Justification: At the time of this report release, the safety action advised by GWA had not yet been fully implemented.

Train crew distraction and priorities

Number:	RO-2013-028-SI-03
Issue owner:	Genesee and Wyoming Australia
Operation affected:	Rail: Freight
Who it affects:	All owners and operators of freight trains.

Safety issue description:

The train crew had conflicting responsibilities distracting them from the safety critical task of driving. GWA did not have specific policies and procedures to define responsibilities of train crews approaching safety critical phases of operation.

Proactive safety action taken by Genesee and Wyoming Australia

Action number: RO-2013-028-NSA-080

As per safety issue RO-2013-028-SI-02, Genesee Wyoming Australia advised that they will be introducing a critical safety zone behaviours workshop and program, incorporating lessons learnt from occurrence investigations.

In addition, GWA management advised that in February 2014, a *Shared Learnings* information sheet was issued as an item of discussion for train crews at toolbox meetings across the organisation.

ATSB comment in response:

The ATSB is satisfied that, when fully implemented, the actions proposed by Genesee Wyoming Australia should address this safety issue.

Current status of the safety issue:

Issue status: Safety action pending

Justification: At the time of this report release, the safety action advised by GWA had not yet been fully implemented.

General details

Occurrence details

Date and time:	30 December 2013 – 1547 CST	
Occurrence category:	Incident	
Primary occurrence type:	Derailment	
Location:	Union Reef, Northern Territory	
	Latitude: e.g. 13° 41.003' S	Longitude: e.g. 131° 45.996' E

Train details

Train operator:	Genesee & Wyoming Australia	
Registration:	2DA2	
Type of operation:	Freight,	
Persons on board:	Crew – 4	Passengers – nil
Injuries:	Crew – nil	Passengers – nil
Damage:	Minor	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- Genesee & Wyoming Australia operational documentation and procedures
- The operating crew of train 2DA2
- Recorded data and video from train 2DA2

References

McLeod, R.W., Walker, G.H., & Moray, N. (2005). Analysing and modelling train driver performance. Applied Ergonomics, 36, 671-680.

Hancock, P.A., Mouloua, M., & Senders, J.W. (2008). On the philosophical foundations of the distracted driver and driving distraction. In M.A. Regan, J.D. Lee, & K.L. Young (Eds). Driver distraction: Theory, effects and mitigation. CRC Press: Boca Raton. pp 11-30.

Regan, M.A., Hallett, C. & Gordon, C.P. (2011). Driver distraction and driver inattention: Definition, relationship and taxonomy. Accident Analysis and Prevention, 43, 1771-1781.

Rail Safety Regulators' Panel (2007a). Guidelines for Rail Resource Management. National Rail Resource Management Project. Available from: http://www.onrsr.com.au/__data/assets/pdf_file/0003/2973/Guideline-Rail-Resource-Management-2007.pdf

Rail Safety Regulators' Panel (2007a). p54.

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 Genesee & Wyoming Australia, Office of National Rail Safety Regulation, and the train drivers.

Submissions were received from Genesee & Wyoming Australia, Office of National Rail Safety Regulation, and the co-driver of 2DA2. 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 ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within 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 factors related to the transport safety matter being investigated.

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

Developing safety action

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

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

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

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

Australian Transport Safety Bureau

Enquiries 1800 020 616
Notifications 1800 011 034
REPCON 1800 011 034
Web www.atsb. gov.au
Twitter @ATSBinfo
Email atsbinfo@atsb.gov.au

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation

Derailment of freight train 2DA2, Union Reef, Northern Territory 30 December 2013

RO-2013-028
Final – 17 February 2015