QUEENSLAND GOVERNMENT

Transport and Main Roads

# Cairns Tilt Train derailment (Ingham-Hinchinbrook)

## 19 March 2011

### Final report, rail safety investigation TMR 3947

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# Cairns Tilt Train derailment (Ingham-Hinchinbrook) 19 March 2011

## Major rail incident investigation

Final report, incident reference: TMR 3947

# Contents

# Terms of reference

As the delegate of the Rail Safety Regulator pursuant to the Transport (Rail Safety) Act 2010 I hereby require a Rail Safety Officer to conduct an investigation in accordance with Section 183 (2) of the Transport (Rail Safety) Act 2010 and report to me on the circumstances and causes of the derailment of the northbound Cairns Tilt Train between Ingham and Hinchinbrook on the 19 March 2011.

Your investigation will:

- clearly establish the factual circumstances of the incident
- conduct an analysis of the cause or causes of the incident including but not limited to track infrastructure maintenance
- assess human factors to identify any underlying matters:
    1. the interface and the actions of relevant parties which may have caused or contributed to the incident and recovery
    2. lines of communication, both formal and informal
- assess the adequacy and effectiveness of actions taken as a result of the incident paying particular attention to:
    1. response to the incident
    2. recovery operations undertaken
- if necessary, make appropriate recommendations designed to prevent a recurrence of any failures.

The investigation team will be comprised of Rail Safety Officers from the Rail Safety Regulation Branch of the Department of Transport and Main Roads and other Rail Safety Officers appointed from external consultants.

**General Manager**
**Rail Safety and Transport Security Division**
**Transport and Main Roads**

# Executive summary

**About 3.44pm on 19 March 2011, the Rail Traffic Crew (RTC) of a northbound Cairns Tilt Train observed severe track buckling on the Ingham-Hinchinbrook section of the North Coast Line. The RTC was of the belief they would be unable to stop the train prior to travelling over the buckle, and attempted to ride out the buckle without braking.**

While traversing the buckle the lead power unit of the train derailed, emergency brakes were applied with the train coming to a stop 62.3 metres post derailment. No injuries were reported, with minor damage to the train.

The Department of Transport and Main Roads conducted an independent investigation in accordance with the Terms of Reference. The investigation determined the immediate cause of the derailment was the lead power unit travelling over a severe track buckle on the Ingham-Hinchinbrook section of the North Coast Line.

The investigation found that the immediate cause of the derailment was that the lead power unit travelled over severe track buckling. The investigation found that an underlying cause of the derailment was a history of track instability and defects in the area of derailment.

The investigation recommendations include that Queensland Rail Limited (Queensland Rail):

- provides additional training for train drivers regarding the appropriate course of action when track buckling is observed
- reviews the use of steel sleepers at locations of track instability
- ensures RTC have mobile phone availability and reliability on long distance services, to the extent that telecommunication networks allow
- ensures that when an incident occurs, there is a clear delegation of an 'On Site Controller' until the arrival of the Queensland Rail Incident Commander
- reviews Standard SAF/STD/0075/CIV *Hot Weather Precautions for Track Stability*, to include a precaution regarding track buckling when there is temperature increases after a period of lower temperatures
- develops a program to establish and maintain the integrity of curve and creep monuments in compliance with sub-section 10.6.2 SAF/STD/0077/CIV *Civil Engineering Track Standards*.
- ensure complaince with clause 10.2.3.3. SAF/STD/0077/CIV *Civil Engineering Track Standards* regarding track buckling risks.

For the purpose of this report, the incident was a notifiable occurrence as defined in Schedule 3 of the *Transport (Rail Safety) Act 2010*. It is considered a notifiable occurrence for the following reasons:

- the operation or movement of rolling stock on a railway track is defined in Section 9 of the *Transport (Rail Safety) Act 2010* as railway operations
- rolling stock as defined in Schedule 3 of the *Transport (Rail Safety) Act 2010* was involved in this incident
- the operator of the rolling stock was accredited under *Transport (Rail Safety) Act 2010* at the time of the incident
- the incident was an occurrence that was required to be reported by the rolling stock operator and the rail infrastructure manager under the conditions of accreditation.

# 1 Introduction

Rail safety in Queensland is regulated by the Rail Safety Regulation Branch of the Department of Transport and Main Roads. All rail infrastructure managers and/or rolling stock operators within Queensland are required to be accredited in accordance with the *Transport (Rail Safety) Act 2010* (the Act).

The accreditation process is to ensure the safe carrying out of railway operations, and the management of risks associated with railway operations. The Rail Safety Regulation Branch is responsible for investigating incidents, collisions and other transport safety matters involving rail operations.

## Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, the Rail Safety Regulation Branch investigations determine and communicate the safety factors related to the rail safety matter being investigated.

The purpose of this investigation is to enhance rail safety by determining the sequence of events that led to the incident and to then determine why those events occurred. The investigation has endeavoured to identify the factors that contributed to the incident, with the intent of identifying risks that may have the potential to adversely affect rail safety. Where considered necessary, recommendations to this effect have been made.

# 2 Investigation methodology

The investigation was conducted by the Rail Safety Regulation Branch of the Department of Transport and Main Roads with external assistance sought as required. The investigation was conducted in accordance with the legal framework as defined in Queensland's *Transport (Rail Safety) Act 2010*.

During the investigation information was obtained and analysed from numerous sources. This included:

- interviews with persons directly and indirectly involved with the derailment
- evidence and technical information including:
    - visits to the derailment site
    - examination of train data logs
    - examination of relevant safety management system documents
    - examination of training documents
    - examination of track stability at the point of derailment
    - maintenance of the track at the point of derailment
    - the decision taken to re-open the track after extensive rainfall.

# 3 Factual information

## 3.1 Background information

At approximately 3.44pm on 19 March 2011, the Cairns Tilt Train (service VCQ5) was travelling in a northerly direction at the 1458.091km point[1] of the Ingham-Hinchinbrook section of the North Coast Line. The train was traversing a left hand bend when the Rail Traffic Crew (RTC)[2] observed track buckles. The RTC considered they would be unable to stop the train prior to traversing the buckles, and made the conscious decision to travel over the buckles without braking. The intention of not braking was an effort to reduce the applied forces on the track, which in turn reduces the tendency for the track to further buckle.

As the lead power unit traversed the track buckle, the lead wheel set on the trailing bogie of the lead power unit derailed. After derailment, full service followed by emergency braking was applied, with the train stopping 62.3 metres post derailment. There were no reported injuries to passengers or crew, and minimal damage to the train.

## 3.2 Overview

### 3.2.1 Occurrence location

The location of derailment is approximately 10 kilometres north of the township of Ingham, 118 kilometres north of Townsville and 223 kilometres south of Cairns by rail. Approximately 300 metres north of the derailment is the Hinchinbrook Bridge; 600 metres to the south is the Halifax level crossing.

For northbound rail traffic (direction of service VCQ5), and approaching the point of derailment, trains encounter a left hand curve in the track following a straight section. The derailment occurred on the curved section of the track. The area is rural in nature, with the derailment point surrounded by sugar cane plantations. The sugar cane can restrict the forward vision of train drivers when approaching bends.

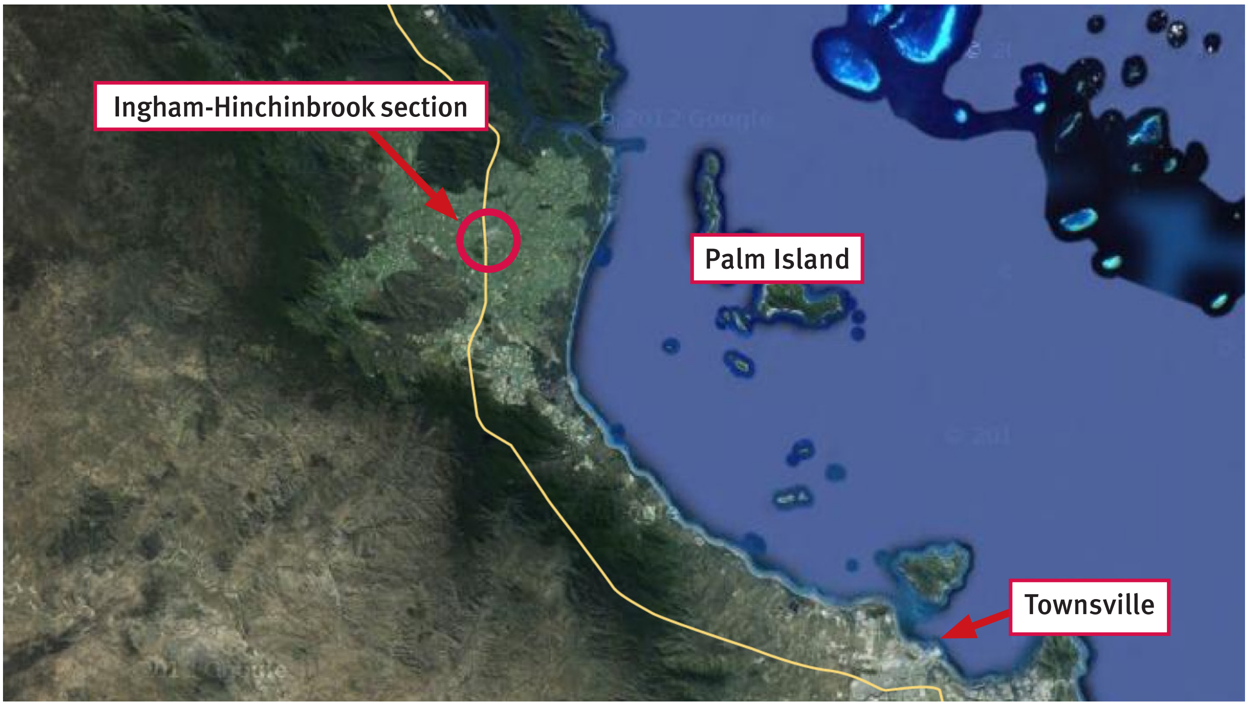


Figure 1: Location of derailment on the North Coast Line

[1] Rail kilometres measured from the Roma Street Station Brisbane.
[2] Train drivers operating the train service.

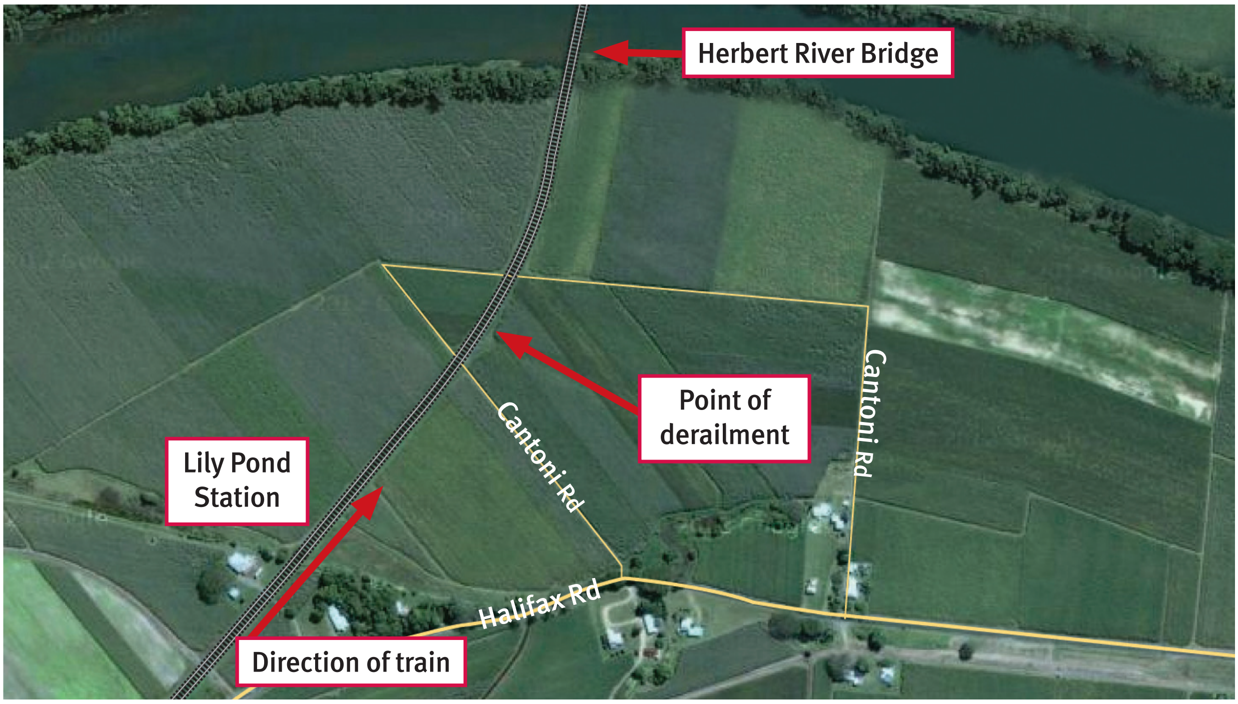


Figure 2: Rail layout and point of derailment

### 3.2.2 Rail layout

The track is bi-directional[3], with north and south bound trains using the single track. The track at the point of derailment usually has a speed limit of 80km/h in both directions. However since 2 June 2010, a temporary speed restriction (TSR) of 40 km/h has been in place. Originally the speed restriction related to painting work on the Herbert Bridge, however this was extended in recognition of an identified track defect requiring attention[4]. The track defect was rectified by tamping[5] on the 16 February 2011. The TSR was due to be lifted on 16 May 2011, however it was delayed due to competing priorities.

## 3.3 Detail of train operations

### 3.3.1 The Cairns Tilt Train

Queensland Rail is an accredited rolling stock operator in Queensland. Queensland Rail operates the Cairns Tilt Train between Brisbane and Cairns three times a week, with two identical train sets used for this service. The rail distance is 1691km, with a travel time of 23 hours and 55 minutes. The Cairns Tilt Train is a long distance passenger service train offering dining and entertainment.

The train sets were built by EDI Rail, Maryborough Queensland and began service in 2003. The trains are operated as a push-pull configuration. There is a power unit[6] at each end with seven cars in between. The train is 202.07 metres long, with a tare weight of 448.3 tonnes. The maximum allowable speed limit for the Cairns Tilt Train is 160km/h between Brisbane and Rockhampton, and 100km/h between Townsville and Cairns. On occasions speed restrictions are in place for particular reasons.

The train was fitted with a data logger, Automatic Train Protection, Vigilance Control System and Station Protection System.

[3] Track which allows trains to run in either direction.
[4] See 3.5.2 for further details on the track defect.
[5] Tamping is a term to describe compacting ballast under the sleepers to ensure the ballast distributes the loading, holds the track in line, along with the cant and affords drainage.
[6] On this train service the power units are diesel locomotives.

### 3.3.2 Driver details

The lead power unit was operated by two Queensland Rail locomotive drivers, who had driven from Townsville. Both drivers were locomotive and route qualified. The operating driver at the time of derailment had in excess of 18 years train driving experience. The co-driver had more than 10 years experience as a train driver.

The train drivers are not restricted to driving the Cairns Tilt Train, when not rostered for the Cairns Tilt Train they have other locomotive driving duties.

### 3.3.3 On-board staff

The train has a compliment of five on-board staff. Their duties include attending to customer requirements, and security and emergency response. The senior member of the on-board staff is the Passenger Services Supervisor, whose duties include the management of on-board staff.

### 3.3.4 Alcohol testing

The train drivers were not tested for the presence of alcohol.

Section 80(4) of the *Transport Operations (Road Use Management) Act 1995* legislates a three hour time limit for obtaining a breath test from train drivers following an incident. The Townsville Network Control Centre incident report indicates that Queensland Police arrived at 6.53pm. The incident occurred at 3.44 pm and was therefore outside the three hour time limit.

There was no indication that the RTC were under the influence of alcohol or drugs.

### 3.3.5 Train handling

Data downloaded from the train indicated that prior to the derailment and any application of brakes, the train was travelling at 39 km/h in the 40 km/h speed limited area. When the train derailed at 3.44.05pm, full service braking was applied, followed by emergency braking. At 3.44.15pm the train came to a stop 62.3 metres from the point of derailment.

### 3.3.6 Network control

Train movements on this section of track are controlled from Townsville Network Control using the Direct Traffic Control (DTC)[7] safeworking system. Train movements are governed by instructions issued by train controllers to the rail traffic crew.

## 3.4 Rolling stock and maintenance

### 3.4.1 Inspections and maintenance

Regular mechanical and electrical inspections of the Cairns Tilt Train were conducted. The last scheduled inspection prior to the derailment was on 17 March 2011. There were no outstanding critical maintenance issues.

[7] Direct Traffic Control (DTC) is an absolute block safeworking system used to control the movement of trains in non-signalled territory.

## 3.5 Railway infrastructure

### 3.5.1 Rail infrastructure

Queensland Rail is accredited as a Rail Infrastructure Manager.

The track infrastructure at the location consisted of 82lb continuously welded rail (CWR)[8] on steel sleepers with rail fasteners, ballast and situated on a low embankment. The derailment point was on the circular portion of a 600 metre radius horizontal curve. The curve had a cant[9] of 32mm.

### 3.5.2 Rail infrastructure inspections and maintenance

Queensland Rail records show that there had been ongoing problems with maintaining vertical and horizontal alignment of the track in the vicinity of the derailment, particularly near the culvert at the 1458.100km mark. The location of this buckle coincides with the location of a known track and formation trouble spot. Maintenance records from 2003 to 2011 indicate track workers had attended this area on numerous occasions to rectify vertical defects. The track recorder car confirms the existence of vertical (top and twist) and horizontal (versine) defects in this area in December 2010. There were no previous reports of track buckles in the area.

The track had been tamped (resurfaced) approximately twice each year to rectify top and line (vertical and horizontal) defects. The most recent resurfacing work had been completed on 16 February 2011.

The track maintenance supervisory staff advised that tamping and resurfacing work was conducted as a 'smoothing' process (the curvature of the track was evened out to minimise changes in radius) and therefore did not reference the track to the curve monuments.[10]

It was evident upon inspection that curve monuments for the 600m radius curve were not all in good condition, and may have moved since installation. One curve monument in particular was extremely loose and could be moved by up to 150mm. It was established as part of the investigation that the Rail Infrastructure Manager did not have a program in place to check or maintain curve monuments in this area.

Placing the track back to the nominal design position was not viewed as being essential by interviewed Queensland Rail maintenance staff. This was due to a lack of confidence in the curve monuments. Discrepancies in the offset to the curve monuments were also not seen as a concern.

The track between Bambaroo (~1424km) and Ingham (~1449km) was closed due to flooding for most of the period between 16 February and 19 March 2011. Only 44 trains passed through the section during the periods when the track was open, and after tamping work on 16 February 2011.

The Track Section Supervisor travelled through the Bambaroo-Ingham section of track at 9.30am on 19 March 2011 to check for any obstructions or obvious defects after the track had been closed due to extensive rainfall. Queensland Rail requires a track inspection to be conducted at maximum 96 hour intervals in compliance with SAF/STD/0077/CIV *Civil Engineering Track Standards*. No obstructions or defects were reported and the track was reopened at 11.48am.

### 3.5.3 Previous rail traffic (19 March 2011)

On the day of the derailment, train 6C49 (northbound) passed the site at 12.45pm, train 6798 (southbound) passed the site at 1.20pm, and train 6CP3 (northbound) passed the site at 2.12pm. These three trains passed through prior to the Cairns Tilt Train and did not report any track buckle or other serious defect issues.

[8] CWR: refers to the way in which rail is joined to form track. Through CWR, rails are welded together to form one uninterrupted rail that may be several miles long.

[9] 'Cant' is the name used to describe the cross level angle of track on a curve, which is used to compensate for lateral forces generated by the train as it passes through the curve. Sleepers are laid at an angle so that the outer rail on the curve is at a higher level than the inner rail.

[10] Fixed post to indicate the correct level or position of the track. Measurements are taken from monuments to check the correct position of the track (see figure 8).

## 3.6 Visual conditions

### 3.6.1 Local weather conditions

The RTC reported that there were scattered clouds with good visibility. At the time of derailment it was not raining, with less than one millimetre of rain reported on the day of derailment. In the two weeks prior to 19 March 2011 the area had received extensive rainfall.

The Bureau of Meteorology[11] website data for Bemerside weather station does not record temperatures. The nearest temperature recordings are for Ingham, approximately 10 km south of the site. The maximum temperature at Ingham on 19 March 2011 was 32.8°C, while the minimum was 23.1°C.

## 3.7 Damage and injury information

At the point of derailment, and on the right hand rail for north bound trains (the high side) flange climb[12] of the rail was located, followed by scoring on the top of the rail running for approximately three metres in length, before the wheel dropped off into the ballast. Impact marks on the ballast and steel sleepers indicated a derailed running of 62.3 metres.

Figure 3: Derailed locomotive in situ

[11] Bureau of Meteorology www.bom.gov.au.

[12] Wheel climb, in which the wheel is lifted off the track because the friction between the flange and the gauge face of the rail is too great, causing the wheel flange to climb outwards over the head of the rail.

Figure 4: Scoring on the head of the rail

Figure 5: Impact damage to steel sleepers caused by the derailed wheel

### 3.7.1 Passenger injuries

No injury to crew or passengers was reported.

### 3.7.2 Damage to rolling stock and track infrastructure

Queensland Rail reported that the Cairns Tilt Train, in particular the derailed bogie only suffered superficial damage associated with ballast scuffing. This is supported by photographic evidence. A post derailment inspection of the wheels indicated that they were in good condition, with no wear to the flanges.

There was no reported damage to track infrastructure.

Figure 7: Derailed bogie wheel in situ

Figure 6: Trailing bogie on lead locomotive

### 3.7.3 Emergency response

At approximately 3.45pm on 19 March 2011, the RTC of the Cairns Tilt Train advised Townsville Network Control Centre, that the lead power unit (5404) had derailed after travelling over a track buckle.

The Queensland Rail Incident Commander arrived on site at 7.11pm. As a consequence of the delay, activities at the site were uncoordinated and events unrecorded prior to his arrival.

Although it appears there was no early chain of command, one of the infrastructure staff on site assisted by coordinating with the on-board staff to arrange the transfer of the passengers and luggage to waiting buses.

The RTC reported there was inadequate communications during the emergency response, and they were unaware of what decisions were being made. They reported communication difficulties. The RTC mobile phone provided in the cab of the Cairns Tilt Train power unit was unreliable, with their battery rapidly running out. The RTC had to rely on personal mobile phones.

The RTC advised they were receiving limited information as to the progress of the emergency response. They were not aware of the arrival of the Incident Commander, and were not contacted by the Commander regarding handing over responsibility for the site. It appears the RTC did not attempt to take any active part in managing the recovery process until the passengers and luggage were being unloaded.

Queensland Rail Standard SAF/SPC/0022/SEC, *'Rail Emergency Response Plan'* ('the plan'), clause 1.9.1.1 *Establishing Control* states,

> *'The Train Control Manager has responsibility for arranging a QR worker to attend the emergency site and command QR resources for the response (coordinated with the train controller).'*
>
> *'In the first instance, this is actioned by the Train Control Supervisor who should nominate a QR worker to act as the On-Site Coordinator as soon as possible following the identification of the emergency situation.'*

Clause 1.9.1.2 of the plan states:

> *'Ideally the On-site Coordinator is appointed and supported appropriately, however in the absence of communications being available to enable the appointment, the most senior QR worker at the emergency site shall assume the role of the On-site Coordinator and communicate that assumption to others at the emergency site.'*

Sub-section 1.15.6 of the plan, 'Rail Emergency Procedures Summary' provides details as to the response roles of personnel at an emergency.

- The train crew has the duty to *'follow directions of Train Controller or QR Commander until relieved.'*
- The train controller has the duty to *'confirm Train Driver of (sic) First QR Worker at the scene as On-site Coordinator.'*

Queensland Rail Standard SAF/SPC/0022/SEC, *'Derailment'* provides for the duties of Train Controllers in the event of a derailment. Sub-section 6.5.3 includes a duty to *'Verify that the first QR Worker a (sic) the scene or Train Driver (depending on the condition of the Traincrew) will act as On-site Coordinator until further notice'*

Sub-section 6.5.2 of the abovementioned Standard includes duties for the RTC in the event of a derailment. This does not state they will automatically act as the On Site Coordinator.

In this instance the Train Controller did not direct anyone to take the role of On-site Coordinator pending the arrival of the Queensland Rail Incident Commander.

# 4 Analysis

## 4.1 The incident

### 4.1.1 The derailment

The immediate cause of the derailment of service VCQ5 was flange climb of the right hand (outside) lead wheel set of the trailing bogie on the lead power unit while travelling over track buckling.

When negotiating a curved track, a train exerts higher than normal lateral and vertical forces on the outside rail. The design of track geometry caters for these increased forces by raising the level of outside rail to maintain the balance of forces arising at the wheel rail interaction point.

If the lateral forces exceed a certain ratio of the vertical forces at the wheel rail interaction point, this leads to a situation when the wheel flange starts gradually climbing on the rail head and could finally derail.

A buckled track creates conditions at the wheel rail interaction point where extra lateral forces required to compensate for the curving motion are absent, and results in conditions conducive to derailment.

### 4.1.2 Track stability

#### General

A key defence against track buckling related derailments is to establish and maintain a system that ensures track stability under normal weather conditions and has safeguards to reduce risk when extreme weather conditions exist.

#### Hot weather management

Track maintenance staff advised they did not consider the predicted maximum temperature to warrant concern over potential track buckling. This was based on the guidelines provided within Standard SAF/STD/0075/CIV sub-section 4.2.5 *Hot Weather Precautions for Track Stability*. The Standard only requires special precautions after track disturbing works when the air temperature is predicted to reach or exceed 34°C. Although this standard assumes a reduced risk of buckles after prolonged periods of hot weather, it does not warn of the increased risk of buckles when the temperature increases after a period of lower temperature, as was the case approaching the day of the derailment.

The actual rail temperature is more important than the ambient temperature and this is significantly affected by direct radiation from the sun (rail temperatures significantly exceed the ambient temperature when no clouds are shading the track). The RTC reported that the sun was shining and making the apparent temperature hot. The two week period leading up to the day of the derailment had been very overcast with significant rainfall.

The rail infrastructure manager monitors rail temperatures at Conn Creek, which is approximately 22 km north of the derailment site. These records give a reasonable indication of the pattern of rail temperatures in the vicinity of the track buckle. The Conn Creek records show that the maximum rail temperature on the day when the resurfacing was conducted (16 February 2011) was comparatively low (28.5°C), and remained low for most of the intervening period. The maximum rail temperature did not exceed 35°C for 17 of the 31 days.

Frequency of track monitoring is set out in Standard SAF/STD/0075/CIV, sub-section 3.2.1, *Hot Weather Precautions for Track Stability,*

> *'The Strategic Asset Services General Manager must regularly access the information on air temperature predictions or actual measurements, and use it to assess the need to undertake hot weather patrols or advise traffic operations of the need to apply speed restrictions.'*

The weather conditions on the date of the incident were approaching extreme and had followed an extended period where lower temperatures and extensive cloud cover had existed. Nevertheless, the weather conditions at the time of the incident, when assessed against the criteria in Queensland Rail Standards, were not extreme and hence additional hot weather track monitoring was not mandated.

Track stability is addressed in SAF/STD/0077/CIV Module CETS[13] 10 – *'Track Stability'*, sub-section 10.2.3 lists two key measures for ensuring track stability:

- construct the track to a stress free condition at design neutral temperature[14]
- monitor the track for signs of instability.

There is no mention of any requirement to:

- establish and maintain a system of controls for alignment on curves
- regularly and routinely conduct stress tests to ensure a correct stress state.

Controlling the alignment of curves to the design alignment is critical to maintaining the correct stress condition. A misalignment of 50mm (over 50 metres) from the initial design/construction position on the 600 metre radius curve at the derailment site would be equivalent to about a seven degree Celsius change in temperature. This seven degree difference has a large effect on track stability. The effect is even greater on sharper radius curves.

The sensitivity of track stability to alignment change is recognised in sub-section 2.8.6 of Module CETS 2 – *Rail*. Rail stress checks are mandated when the alignment is permanently altered in excess of the 50mm limit (horizontal or vertical) alignment from the stress free alignment.

The horizontal misalignments could occur gradually over time under traffic, during periods where temperature varies from design neutral, or may be created progressively by maintenance tamping activities if curve 'smoothing' is permitted.

The design curve alignment at the derailment site was initially surveyed as part of the track restoration process. No detail was available regarding the alignment at the time of the derailment relative to the original design alignment or the transition curve monuments.

There is no evidence that a system of controls existed to ensure that the curve alignment limits were not exceeded over time, or that alternative methods were used to control the stress effects of misalignments.

Measurements taken on 7 June 2011 (after the track was repaired and significant traffic had passed over the track) found that the track varied from +13mm (outwards) to -41mm (inwards). The apparent lack of attention to maintaining curve monuments is indicative of the lack of importance placed on maintaining track to the design alignment.

## Curve monuments

Curve monuments[10] were present at the start, middle and end of each transition curve and one at the midpoint of the circular arc at the site. Upon inspection, at least one of these curve monuments was so loose in the ground as to be ineffective. Others may have also been disturbed.

SAF/STD/0077/CIV Module CETS 10 – *'Track Stability'*, sub-section 10.6.2 states,

> *'Curve monuments are to be vertical, stable and extend to a sufficient height above rail level so as to be easily visible through the viewfinder of an optical creepometer, or such that a string line or large square can be used.'*

Additionally, a system would need to be created for ensuring all curve monuments were accurately positioned and that their accurate position was maintained over time. This does not currently exist.

[13] 'CETS': Civil Engineering Track Standards.

[14] Rail temperature at which the track has no longitudinal thermal stress, neutral rail temperature in this area is 38 degrees Celsius.

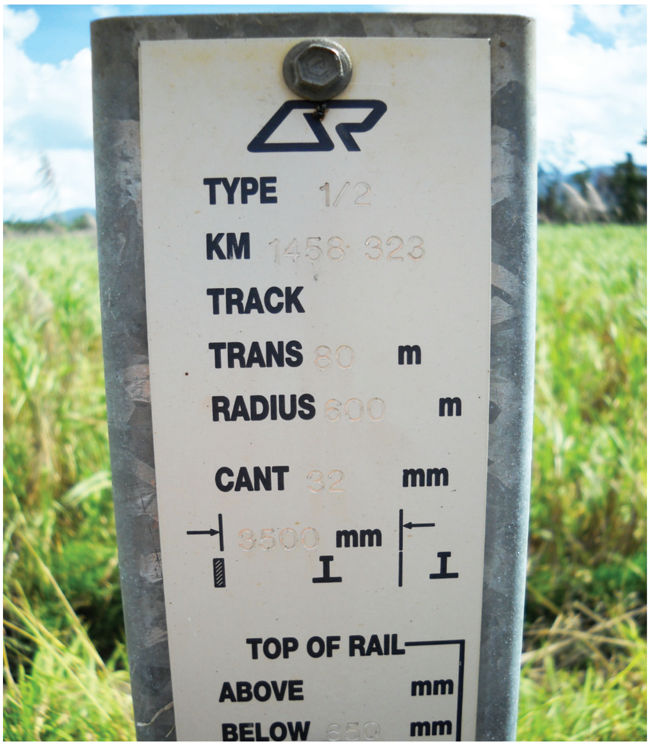


Figure 8: Curve monument situated at the scene of derailment

## Steel sleepers

The rail structure at the location of derailment consisted of 82lb continuously welded rail (CWR) on steel sleepers with 'Trak-Lok 2' fasteners. Publications such as *Steel Sleeper Introduction on NSW Class 1 Main Line Track 1996 – 2004*[15] outline a number of associated problems with steel sleepers.

Steel sleepers need to have correct installation, as they do not perform as well as timber or concrete sleepers in situations where the track infrastructure (ballast formation and track geometry) is poor. The insertion of ballast into the underside of the steel sleeper is essential to the integrity of the structural stability of the steel sleeper. Where correct insertion and tamping is not achieved, steel sleeper stability is compromised.

The tamping of newly installed sleepers needs to be carried out correctly. Unlike other sleeper types, steel sleepers depend on the ballast for their structural integrity. If the ballast is not tamped correctly, then the result can lead to an inadequately filled pod.[16] Due to the shape of the steel sleepers they tend to settle further under equivalent ballast and tamping conditions before supporting the same load as timber and concrete sleepers, both of which have flat bottoms.

A steel sleeper that has not been correctly tamped and consolidated may eventually pump.[17] The deterioration of ballast is often related to the rounding of the ballast, where the gradual rounding of the ballast occurs producing a whitening of ballast around the steel sleeper. Steel sleepers are designed to capture and retain the ballast that is moved into the pod in the underside of the sleeper, however if the ballast is rounded, then the lateral stability of the sleeper is greatly reduced. Steel sleepers rely on the ballast to provide support and to add to their effective mass.

[15] Office of Transport Safety Investigations (NSW) www.otsi.nsw.gov.au/rail/IR-SteelSleeper-final.

[16] Steel sleepers require ballast to fill the underside of the pod; unlike concrete and wooden sleepers.

[17] Track pump: A sleeper that moves vertically up and down as rail traffic passes over the sleeper. This action often results in the degradation and contamination of the ballast structure.

## Creep monitoring

Rail creep is the longitudinal movement of rails in track caused by the action of traffic on the line. Welded track must be closely monitored for creep, especially on curves.

The nearest creep monuments[18] were about five kilometres from the site and were of no assistance in assessing local creep effects. At the time of the department's inspection, there was no remaining evidence that any longitudinal movement had occurred between the rail and the sleepers under the rail clips, nor was there any obvious evidence that the sleepers had been ploughing through the ballast bed. It should be noted that this evidence was probably obliterated/corrupted by the track repair work and rail stressing that had been conducted immediately after the incident.

There was information provided from fault records that a pull apart had occurred near the Herbert River Bridge in 2005 however no further detail was available, including whether any stress checking was conducted during repairs. Stress assessment at pull-apart sites is required under sub-section 10.3.3 of CETS 10.

Sub-section 10.6.2 of CETS 10 states that *'monitoring of rail and/or track creep is an acceptable method of assessing rail stress changes with time'*.

## Annual inspection

Clause 10.2.3.3 of CETS 10 requires an annual inspection and review to be undertaken to identify track buckling risk prior to the onset of hot weather.

No evidence was available to confirm that such an inspection and review had been undertaken. A suitably detailed procedure, including recording detail for individual sites of concern is necessary for that task.

# 4.2 Post incident

## 4.2.1 Emergency response

There is no clear record of when Queensland Rail infrastructure personnel first arrived on site. The Queensland Rail Incident Commander did not arrive on site until 7.11pm. Until this time it appears one of the rail infrastructure personnel was acting as an Incident Coordinator. Records were not kept of on-site decisions or actions during the period between the derailment and arrival of the Incident Commander. The following details have been obtained from the Townsville Network Control Centre, *Incident Detail Report*, and the data logger fitted to the train.

| | |
|---|---|
| **3.44pm** | Time of derailment VCQ5 |
| **6.57pm** | Attending Queensland Police advised that it was an unsafe to walk passengers from the train position to buses at the Halifax crossing |
| **7.11pm** | Queensland Rail Incident Commander arrived at scene |
| **8.11pm** | Passengers transported from the scene by vehicles to waiting buses |
| **9.20pm** | Buses departed site with passengers. |

## 4.2.2 Evacuation

The rural location of the derailment made evacuation of passengers and luggage difficult.

The on-board passenger supervisor, together with on-site infrastructure staff and Queensland Police Service officers assisted in the transfer of the passenger and luggage by vehicles to buses at the Halifax crossing.

## 4.2.3 Site recovery

All passengers and luggage had been conveyed from the train by 8.11pm. Buses left the scene at 9.20pm.

The RTC left the site at 10.25pm, with security remaining at the scene.

On Sunday 20 March 2011, power unit 5404 was re-railed and re-joined with VCQ5. At 5.05pm the track was repaired and open for traffic with a speed restriction of 15km/h.

[18] A permanent monument on each side of the track to facilitate the accurate measurement of creep. The monuments are installed clear of the track centre-line.

## 4.3 Human factors

The evidence gathered from the RTC indicates that the buckle was first observed at a relatively close distance. No accurate distance was obtained from the train drivers. The RTC stated that when they first observed the buckle, they were almost upon it. This sighting distance was restricted due to the curvature of the track, the vegetation on the verge of the rail corridor, and the driver sitting slightly to the left of centre in the locomotive cabin. This restricted view, combined with the reaction time and braking distance, may have made stopping prior to the buckles difficult. Harsh braking by the RTC may have increased the risk of further track buckling.

In this situation, no criticism is made as to the RTC's actions in respect of travelling over the buckle. They acted in accordance with advice supplied by other drivers. However, as this report recommends, Queensland Rail should consider formal training to assist drivers in making decisions when they are confronted with track buckling.

# 5 Findings

## 5.1 Context

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

The investigation determined the immediate cause of the derailment was the lead power unit of the Cairns Tilt Train travelling over track buckling.

## 5.2 Contributing safety factors

1. Queensland Rail does not currently provide formal training to RTC regarding guidance when approaching track buckles. The RTC advised that reliance is on informal or experimental learning transferred by word of mouth.
2. The *Hot Weather Precautions for Track Stability* SAF/STD/0075/CIV does not take into consideration the increased probability of track buckling when cool weather conditions directly precede hot weather conditions, as occurred in this instance.
3. At the point of derailment, the integrity of curve monuments was not maintained, highlighting the lack of maintaining track design alignment.
4. The use of steel sleepers in areas where there is a history of track instability.

## 5.3 Other safety factors

1. A Queensland Rail 'On Site' Coordinator was not delegated by the Train Control Supervisor, as required by *Rail Emergency Response Plan* SAF/SPC/0022/SEC. The initial response was uncoordinated and not recorded until the arrival of the Queensland Rail Incident Commander.
2. Communication at the scene of the derailment was hampered by mobile phones that would not hold their charge.

## 5.4 Recommendations

The following safety recommendations were provided to Queensland Rail.

1. Queensland Rail provides formal training for RTC regarding appropriate action when confronted with track buckling.
2. Queensland Rail reviews the use and inspection process for steel sleepers at locations of track instability.
3. Queensland Rail ensures RTC have mobile phone availability and reliability on long distance train services, to the extent that telecommunication networks allow.
4. Queensland Rail ensures there is a well communicated command structure when an incident occurs, especially in the initial absence of a Queensland Rail Incident Commander.
5. Queensland Rail reviews Standard *Hot Weather Precautions for Track Stability* SAF/STD/0075/CIV to include a warning of an increased risk of buckling when the temperature increases after a period of lower temperatures.
6. Queensland Rail develops a maintenance program to ensure the integrity of creep and curve monuments, in compliance with sub-section 10.6.2 of SAF/STD/0077/CIV '*Track Stability*'.
7. Queensland Rail ensures compliance with clause 10.2.3.3 of SAF/STD/0077/CIV regarding annual track inspections to identify track buckling risks prior to the onset of hot weather.

Queensland Rail was given the opportunity to review the draft report and to provide comment prior to the release of the investigation report.

## Notes:

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