NEWSLETTER No 7/2006

Railway Technical Society of Australasia
SA Chapter
Engineering House, Bagot Street
NORTH ADELAIDE SA 5006

JULY 2006

NEXT MEETING

The next RTSA meeting will be held on

Thursday 3rd August 2006
at the Adelaide Riviera, 31-34 North Terrace Adelaide commencing at 5.30pm.

The subject of the meeting will be:

The History of Ultrasonic Rail Flaw Detection

which will be presented by Roy Nancarrow.

The detection of internal rail defects has been a major area of research and development over the past fifty years. The safety and economic benefits of this work has been enormous. The importance of the ability to accurately detect, classify and in a timely manner remove defects before they can cause a rail break and a potential derailment cannot be underestimated.

The use and development over the past 30 years of ultrasonic methods for the detection of internal rail defects has been the key that has enabled rail flaw detection to reach the level of maturity and usefulness that we have at present.

Roy Nancarrow has been closely associated with the development and use of ultrasonic rail flaw detection methods for much of this time and his presentation is based on this experience. Roy has great enthusiasm for his work and his presentations are always interesting and knowledgeable.

Following the meeting, light refreshments will be provided.

Continuous Professional Development (CPD)

IEAust members are reminded that attendance at RTSA technical meetings contribute towards CPD requirements. Each RTSA technical meeting generally has a value of 1 CPD point.

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LAST MEETING

The topic of the July meeting was a presentation by George Erdos on the investigation into the Queensland Rail Tilt Train Derailment. Details of his presentation follow.

Derailment of Cairns Tilt Train VCQ5

Preamble – Accident Investigation

Accident investigation that substantially removes the threat of sanctions against individuals and/or organisations is far more likely to tease out the root cause of any accident. These investigations are typically referred to as 'No Blame'. 'Safety Investigations' undertaken using legislative Acts like the Queensland *Transport Infrastructure Act 1994* (TI Act) and the Commonwealth *Transport Safety Investigation Act 2003* (TSI Act) have been developed with this philosophy in mind, thereby aiding the investigative process by teasing out the route cause of accidents and incidents. These Acts have very powerful legislative clauses that permit witnesses and involved parties to provide sensitive information.

In developing an accident hypothesis, investigators may be privy to information that is not generally available to the public or third parties. While reports developed under these Acts do not directly apportion blame, in developing accident scenarios indirect attribution of accountability may occur. However, it is important to appreciate that reports and information developed under these Acts cannot be used in any civil or criminal proceedings. The reports produced and information sourced by the investigator is legally protected[1]

The Occurrence

Power car 'City of Townsville', leading Tilt Train VCQ5 departed Roma Street, Brisbane at 1825 on Monday 15th November 2004 as scheduled. Two drivers operated the Brisbane to Bundaberg section. The trip was uneventful and no vehicle defects or problems were reported.

A crew changeover occurred at Bundaberg at 2258. Two drivers also operate the Bundaberg to Mackay section.

The train departed Bundaberg at 2311, two minutes early, with 150 passengers, two drivers and five passenger service staff on board. The Bundaberg to Gladstone section comprises single line with passing loops to facilitate the crossing of trains. There are passing loops at Berajondo (413.5km) and Baffle (424.2km). The track between the two passing loops is undulating with nine curve sections linked by straights. Speeds of up to 150km/h are permitted at 417.783km and 420.854km but there is a need to reduce to 60km/h at 419.410km.

VCQ5 arrived at Berajondo at 2350. At 2354, after having passed through Berajondo and eight curve speed restrictions, the co-driver left his seat and entered the adjacent vestibule area to make a 'brew' for the driver.

The night was dark, there was no moon or background lighting from external sources. At 2355 the power car passed over the 'mid-section' magnet located between Berajondo and Baffle (418.995km). The driver acknowledged the alarm. Thirteen seconds later, the throttle was moved rapidly to zero and shortly thereafter into full emergency braking. The rest is history, VCQ5 derailed 419.493km from Brisbane north of Berajondo on the Bundaberg to Gladstone line. The lead power car and all remaining seven trailer cars derailed. The trailing power car was the only unit to remain substantially upright although it was also partially derailed.

Preventing Accidents

To prevent accidents, it is essential to understand why they have occurred. The primary purpose of Accident Investigation is to discover the causal factors & identify problems/breakdown in defences that may have led to the accident. Findings need to be communicated to industry; and for quality accident investigation it is essential to have independent investigators so that risk of bias is removed.

The Investigation Team

Due to the serious nature of the derailment, the Queensland Government invited the Australian Transport Safety Bureau (ATSB) to lead a joint independent accident investigation in conjunction with Queensland Transport (QT).

The ATSB is an operationally independent agency of DOTARS. Its principal objective is safe transport. This is achieved through independent transport accident investigation, safety data research and analysis, education, etc.

Rail safety in Queensland is regulated by QT. All railway managers and/or railway operators within Queensland are required to be accredited in accordance with the *Transport Infrastructure Act 1994* . QT's role in rail safety also includes accident investigation.

Transport Infrastructure Act 1994

The investigation was conducted in accordance with the legal framework defined by Queensland's *Transport Infrastructure Act 1994* (Act). Early in the investigation it was established that the existing Act was deficient in protecting witnesses, personnel and organisations that may provide 'Restricted Information' and that this could thwart disclosure of important information that might be relevant to the investigation.

As a result the Queensland Government passed a series of amendments to the Act, these amendments were generally consistent with the *Transport Safety Investigation Act 2003* (TSI Act) and among other issues, provided protection to witnesses, personnel and organisations who provide 'Restricted Information'.

Terms of Reference

The investigation was required to:

- i) Establish factual circumstances of the accident.
- ii) Identify the direct cause(s) of the accident and contributing factors.
- iii) Assess human factors to identify underlying matters which may have caused or contributed to the accident.
- iv) Provide an estimate of direct and associated costs.
- v) Make appropriate recommendations designed to prevent recurrence.
- vi) Be a systemic style investigation - should not directly apportion blame.

Initial Response

The ATSB was contacted Tuesday morning 16th November 2004, at approximately 01.37 and was advised of the derailment and requested to assist/lead the investigation. ATSB agreed to assist.

ATSB provided immediate response with a field officer from Brisbane, this was followed up by a Team Leader and field officer from Adelaide with a further three field officers and a data specialist coming from Canberra.

QT had a Senior Manager and two field officers on site. ATSB's data specialist and Queensland Police downloaded and examined data from the Tilt Train 'Loco Log' in Brisbane on 16th November 2004.

Three days 16th to 18th November 2004 were spent onsite collecting field evidence, making contact with appropriate personnel and observing recovery operations.

Preservation of Evidence

Preservation of evidence is probably one of the most critical elements of any Accident Investigation. *"Evidence is highly volatile, once lost it cannot be retrieved".* The investigation team needed to ensure following as a minimum was recorded:

- i) Contact person & details.
- ii) Location, time, weather conditions, etc.
- iii) Brief description of the circumstances.
- iv) Person(s) directly involved and details.
- v) Toxicology testing.
- vi) Perishable evidence has to be identified & preserved. eg voice, loco & data logs, measurements.
- vii) Ensure physical evidence eg damaged track, rollingstock, signalling equipment, have appropriate protection orders, can't be removed.
- viii) Photographic & video evidence.

Early Observations

In identifying the accident mode we needed to examine the many possible causes for derailment, including:

- i) Track failure
- ii) Vehicle failure
- iii) Flange climb
- iv) Vehicle roll-over (capsizing)

First observations indicated there was limited damage to the leading wheels of the leading power car.

Early work done by the ATSB data specialist, in examining the Tilt Train 'Loco Log' showed the train speed to be 112km/h when it derailed. This was significantly in excess of the posted 60km/h curve speed. This strongly suggested derailment was a result of roll over (capsizing), suggesting over-speed.

There was some early concern regarding failure of the bogie. The second of the two diesel tilt trains, the one not involved in the accident, was withdrawn on Friday 19th November 2004 as a precautionary measure. The train was returned to service the following Monday, as no issues were identified.

Collection of Evidence

The tracking down, collection and subsequent cataloguing of evidence was a significant process. Without being limited, areas of interest included:

- i) Organisation
- ii) Operations
- iii) Human Factors
- iv) Infrastructure
- v) Environmental
- vi) Response Plan and

vii) Site Recovery

Each area was further broken down into blocks with expert analysis being made as appropriate.

Areas of specific specialisation included:
- i) Rollingstock
- ii) Track
- iii) Signalling/ATP

ATSB/QT engaged specialists, as appropriate to examine available evidence in these areas. This resulted in the development of a number of supplementary reports, the findings and recommendations of which are reflected in the final report as appropriate.

ATSB/QT co-ordinated bringing together of all evidence and undertook investigations into a range of specialist areas such as risk assessment, metallurgical, human factor, signalling/ATP, etc.

In areas of specialisation such as Human factors, ATSB/QT interviewed driver, co-driver, QR management team, etc.

ATSB/QT used a specialist medical practitioner and psychologist to examine the health/wellbeing of the driver and prepare a survey for passengers and staff on CTT.

The passenger and staff surveys were used to:
- i) Understand injury types
- ii) Assist in developing the mode of derailment
- iii) Understand robustness of CTT
- iv) Understand weaknesses in evacuation strategies

Analysis – Track & Speed Boards

The track was laid and maintained in accordance with QR standards. Pre and post-derailment site data indicated track was in good condition. The track was fit for purpose and suitable for tilt train operations.

The style and location of the speed board at 419.410km was as gazetted by QR. Trains are required to be at or below the prescribed speed limit before passing the board. QR has guidelines for placement of advance warning signs. There were none at this location.

QR custom and practice for tilt train operation, relies heavily on driver ‘Route Knowledge’ in recognising geographic position and managing speed accordingly. This is a common railway practice.

Analysis - Rollingstock

Available site evidence was collected and the CTT was then transported to the EDI Workshops (Maryborough) and impounded for further examination.
Subsequent examination included:
- i) Wheel profiles, suspension, bogies, tilt mechanism and braking systems
- ii) Metallurgical examination of bogies, focus on fracture cracking
- iii) Review of maintenance and inspection records
- iv) Assessment of the crashworthiness and structural performance

The review of pre-derailment maintenance records and post maintenance condition established that it was highly improbable that there were defective items or deficiencies that contributed to the derailment.

The train headlights were raised as a possible issue. A review of QR records established that the headlight covers were replaced prior to derailment and lighting met the prescribed industry standards.

From a crash worthiness perspective train performed well.

Analysis – Derailment Modeling

The derailment analysis was carried out using a combination of techniques comprising force-balance equation and Vampire modelling and was used to establish the feasibility of roll-over/capsizing of the CTT. Vampire modelling established that 100% wheel unloading for the lead power car through the first 60km/h curve occurred at 97km/h.

The modelling, supported by force-balance calculations and field observations, led to the conclusion that the lead power car rolled and then dragged the remaining trailer cars off the track before all units came to rest.

Analysis – Environmental

At the time of the accident, the temperature was approximately 24.5 degrees Celsius, wind speed was low and visibility was good. There was no discernible rainfall, the weather in the vicinity of Berajondo was fine.

A comprehensive analysis of available data, track, rollingstock and environmental established that it was highly improbable that there was any direct or indirect ‘causal factors’ involving infrastructure or environmental issues that may have contributed to the derailment. This excludes the influence of darkness and that the driver was reliant upon the train headlight for external vision ahead and for peripheral vision.

Ruling out these areas meant that we needed to look closely at 'Human Factors' and 'Organisational' issues that may have allowed a failure in defences and the resultant derailment.

Analysis – Passenger Questionnaire

The questionnaire developed by ATSB and QT in trying to come to an understanding of the various events as perceived by passengers in the lead-up to, during, and post accident was analysed. As a result of the questionnaire, it was concluded that the journey on VCQ5 on the night of the 15 November 2005, up until the derailment was consistent with previous journeys.

The evacuation of passengers was hampered by the failure of the various 'Emergency Evacuation Exits' but more importantly the 'Emergency Evacuation Lighting', which failed in all but car 'G'. In addition, the unknown status of the 25kV AC traction power supply system hindered escape efforts and created unnecessary anxiety for passengers.

Analysis – Organisational Factors

At the organisational level we looked at QR's 'Risk Assessment & Safety Case' for the introduction of RTT/CTT.

QR had examined track/infrastructure. The track was considered fit for tilt train operations at up to 25% over speed on curves provided with concrete sleepers, up to a maximum limit of 160km/h on suitable locations (straights, etc).

Based on its operational experience, QR also looked at human factors and while recognising ATP as the ideal and eventual strategy, considered safe operations could be achieved through a combination of:

- i) Two Driver Operation
- ii) Onboard Vigilance
- iii) Station Protection
- iv) Speed Boards
- v) Training

Investigators also looked at organisational culture and this was generally found to be 'Safety Supportive'.

Having examined the relevant 'Organisational Factors' it was concluded that that these did not directly contribute to the accident. Simply, Queensland Rail had put a number of defences in place that should have been effective in preventing this accident. However, the provision of technologies such as 'Positive Train Control' and/or ATP would have prevented this accident if installed and working correctly.

Analysis –Human Factors

Training & Qualifications - Training and qualifications for both the driver/co-driver was found to be appropriate. They both had extensive experience driving a variety of train types including the diesel tilt train. Both had recently traveled over the section concerned.

Performance - Driver had been involved in some safety performance issues, notably Signals Passed at Danger (SPAD). He had undergone re-training/re-evaluation, and successfully returned to work but subject to ongoing monitoring.

Fatigue - An examination of actual worked by driver/co-driver indicated that fatigue should not have been factor.

Medical - No issues were identified that either directly or indirectly contributed to the accident as a result of the driver's/co-driver's physical or psychological health.

Key Observations

- i) The infrastructure was fit for purpose.
- ii) Human factors – Medical, toxicology, fatigue, experience and qualifications and route knowledge, were not considered issues.
- iii) We do know that the driver did not reduce the train to a safe speed before entering the curve at 419.411km. The train was going too fast, it was travelling at 112km/h on a curve rated at speed of 60km/h for Tilt Train operations.

So what went wrong? Had the QR organisational defences failed? From a systemic point of view, you'd have to say the principal causal factor was a 'Human Performance' issue, however better organisational controls may have prevented the accident.

Some Facts

Before leaving Bundaberg, the driver placed his bag under the co-driver seat. The journey from Bundaberg to Berajondo appeared normal. After leaving Berajondo at about 23.54 after passing through a series of eight curve speed restrictions, the co-driver left his seat and entered the adjacent vestibule area to tidy-up and make a 'brew' for the driver. This meant that the co-driver was not in a position to observe the train's speed as it approached the critical curve at 419.410km and intervene as may have become possible. The primary defence of having two drivers in the cab was not there.

The Hypothesis

Shortly after the co-driver left the cab, it is hypothesised that the driver reached under his seat for his bag. The bag wasn't there and he realised it was under the co-drivers seat. He got out of his seat to access his bag about 23.54:52.

Shortly after, 23.55:10 and while out of his seat the mid-section alarm activated. The driver incorrectly interpreted this as the station protection magnet in advance of Baffle, which leads into a speed restriction of 90/110 km/h.

The driver had failed to recognise the geographic proximity of the train along the track. By making this assumption there was no need for the driver to slow the train.

The train continued at a speed of approximately 110 km/h until the driver finally recognised where he was. By this time it was too late, the derailment was inevitable.

Conclusions

The principal cause of the derailment was excessive speed. The driver did not reduce the train to a safe speed before entering the curve at 419.411km.

The safe operation of the CTT largely depended on 'two-driver' presence and sound route knowledge/driver competency.

The co-driver was absent from his seat when the accident occurred. He was not in a position to check the driver's actions or inactions thus removing an important defence against one-person error.

The driver probably became disorientated and/or distracted from his principal driving task. It is hypothesised that the driver left the driving position, either shortly before or after passing over the mid-section magnet, to get some food from his carry bag.

The external darkness may have contributed to any loss of geographical awareness by the driver.

There was no technical system on the CTT that detected very short periods of driver inactivity/distraction. The fixed time based Vigilance system as installed on VCQ5 was ineffective in preventing driver distraction and promoting driver alertness. No Automatic Train Protection system was operating to reduce the risks of human error.

Monitoring of a driver's return to full duties following an accident or disciplinary occurrence by 'tutor drivers', from the same depot could be tested by their personal knowledge of a direct colleague where judgement may be affected by hostility or friendship.

Emergency communications coverage in this locality was patchy with the existence of 'dead spots'.

CTT, passengers and the emergency response team(s) were not fully aware of the status of the 25kv AC power system and this hindered evacuation.

Recommendations

The following recommendations are made:

- i) Review use of vigilance systems - random based system.
- ii) Use of 'Advance' speed warning boards.
- iii) Conduct risk assessment into the procedures that permit a co-driver vacating cab.
- iv) Explore possibility/advisability of differentiation of individual station magnets.
- v) Review effectiveness of emergency communication strategies.
- vi) Review risks associated with train evacuation where electrical equipment may be live.
- vii) Review the effectiveness of passenger 'Safety Briefings'.
- viii) Review the crash survivability of the current 'Emergency Exit' systems including emergency lighting/communications.
- ix) Review of a passenger restraint system on tilt train services.
- x) Review its monitoring and ongoing training of drivers that have been involved in nonconforming situations.
- xi) It was noted that QR intended to expand the use of its Automatic Train Protection (ATP) for tilt train services. Note: This strategy was supported with the proviso that if the present system cannot be effectively modified/used a further review should be undertaken to determine additional mechanisms to enhance/enforce driver vigilance, including the use of alternative positive train control systems.

Proposed Railway Study Tour to Victoria

A study tour to Victoria, in conjunction with the PWI was proposed for late 2006. For various reasons it has been decided that the proposed study tour be deferred to late 2007. Further details will be sent out early next year.

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JULY 2006

IRSE TECHNICAL CONVENTION

ADELAIDE

3RD & 4TH November 2006

MATCHING TECHNOLOGY with OPERATIONAL REQUIREMENTS

OVERVIEW

The Institution of Railway Signal Engineers (IRSE) Australasian Section is holding a two-day Technical Convention in Adelaide on Friday 3rd and Saturday 4th November 2006.

The theme of the Convention will be "Matching Technology with Operational Requirements".

The Friday Technical Sessions and Conference Dinner will be held at the Holiday Inn Adelaide.

The Keynote Speaker will be Mr Peter Foley, Deputy Director, Surface Safety Investigations, Australian Transport Safety Bureau.

The program will include the following technical presentations:

i) TransAdelaide CTC Upgrade Project – Operational Benefits – TransAdelaide

ii) TransAdelaide CTC Upgrade Project – Project Technical – United Rail Group

iii) ARTC 3G850 Train Communications System – ARTC & Telstra

iv) ARTC ATMS Train Control System – ARTC & Lockheed Martin

v) ICAPS In Cab Activated Points System – ARTC & Westinghouse Rail Systems

vi) Darwin Train Control System – Westinghouse Rail Systems

vii) Signalling the Adelaide Yard – Connell Wagner

A Panel Session will follow the technical sessions with senior representatives from ATSB, ARTC, Pacific National and TransAdelaide.

The Saturday program will include an inspection at TransAdelaide of the recently commissioned Centralised Traffic Control (CTC) system for the Adelaide Metropolitan area. This will be followed by a technical inspection at the GWA Train Control Centre at Dry Creek, where delegates will see the control and monitoring of the trains operating to Darwin. The Saturday program will conclude with lunch and a networking session.

Registration details for the convention will be distributed to all IRSE Australasian Members and RTSA South Australian Members in mid August 2006. Full registration or Partial registration is available.

For further details, please contact:

Malcolm Menadue, FIRSE, FIEAust

Chairman, Local Organising Committee

Phone: 0418 827 126

Fax: 08 8370 7004

Email: mmenadue@ozemail.com.au

MEETINGS FOR 2006

Future Speakers/Dates/Topics

Date	Speaker	Organisation	Topic	Venue
3/8/2006	R Nancarrow		History of Ultrasonic Rail Flaw Detection/ Current Practices	Adelaide Riviera – North Terrace Adelaide – Joint with PWI
7/9/2006	Graham Cook and Rod Brimble	Department for Transport, Energy and Infrastructure	ALCAM "Australian Level Crossing Assessment Model"	Joint with IRSE – Adelaide Riviera, North Terrace Adelaide
5/10/2006	Mike Sowden	ARTC	Wayside Detection and Wheel Profile Measurement	Joint with PWI - IEAust Building – Bagot Street
2/11/2006	TBA	Bombardier	The Vlocity Train	IEAust Building – Bagot Street
28/11/2006				RTSA AGM

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KEY RTSA CHAPTER COMMITTEE CONTACTS

Chairman	Rob Schweiger	03 9610 2948
Treasurer	Duncan McLeod	8338 1081
Secretary	Tom Hampton	
N/L Despatch	Malcolm Menadue	8270 2873
N/L Editor	Stephen Townsend	0400 135 481

Articles or editorial comment for Newsletter are very welcome. We have over 100 members locally some of whom will have stories, events or developments of interest that could be reported in Newsletter.

Part of the function of RTSA is to keep members in touch with what is going on in the industry and with each other and to that end we are only too happy to publish items of interest.

Send copy to the Editor, Stephen Townsend at st771048@bigpond.net.au or fax to 08 8297 0992.

Electronic despatch of Newsletter is undertaken by Malcolm Menadue – contact Malcolm on mmenadue@ozemail.com.au if you have any problems receiving Newsletter electronically or in hard copy. Note that electronic subscribers will get their Newsletters and flyers as soon as the editorial stuff is done, while the hard copy mail will of course be some days slower.

For all other matters relating to RTSA SA Chapter contact Robert Schweiger (Chairman) at e-mail robert.schweiger@jhg.com.au, or by phone on 0413 128 775.