05-123	**empty passenger Train 4356, overrun of conditional stop board without authority, following an automatic air brake valve irregularity, Meadowbank**	**6 October 2005**

Report 05-123

empty passenger Train 4356

overrun of conditional stop board without authority

following an automatic air brake valve irregularity

Meadowbank

6 October 2005

Abstract

On Thursday 6 October 2005 at 1451, the locomotive engineer of empty passenger Train 4356 was unable to operate fully the automatic air brake valve to stop the train at a conditional stop board erected at the entrance to an infrastructure work area near Meadowbank. The locomotive engineer operated an emergency brake button instead, but the train overran a conditional stop board by about 170 metres.

There was no damage or injuries.

Safety issues identified included:

- the procurement, inspection and maintenance of safety-critical components
- the control of standards for locally manufactured safety-critical components
- the continued operation of a train before establishing why a critical system had failed
- an independent overview of the construction and commissioning of a new passenger train concept
- the extent of regulatory oversight of the rail transport industry in New Zealand.

Safety actions taken and safety recommendations made to the Director of Land Transport New Zealand address these issues.

Contents

Figures

Abbreviations

ARTA	Auckland Regional Transport Authority
auto brake valve	26-C automatic air brake valve
Connex	Connex Auckland Limited
EPP	emergency protection person
km	kilometre(s)
km/h	kilometre(s) per hour
kPa	kilopascal(s)
Land Transport NZ	Land Transport New Zealand
LTSA	Land Transport Safety Authority
m	metre(s)
NRSS	National Rail System Standards
NYAB	New York Air Brake Company
PIC	person in charge
RSSM	Rail Safety System Manual
Toll Rail	Toll NZ Consolidated Limited
United	United Group Limited
UTC	co-ordinated universal time
Veolia	Veolia Transport Auckland Limited

Data Summary

Train type and number:	empty passenger Train 4356
Classification:	SD5811 driving trailer
Year of manufacture:	1972 by British Rail as a Mk 2 passenger carriage
Year of rebuilding:	2005 in Toll Rail NZ Consolidated Limited's (Toll Rail's) Hillside workshops
Date and time:	6 October 2005 at 1451[1]
Location:	Meadowbank
Persons on board:	crew: 2
Injuries:	nil
Damage:	nil
Operator:	Connex Auckland Limited (Connex)
Investigator-in-charge:	Vernon Hoey

[1] Times in this report are New Zealand Daylight Time (UTC + 13 hours) and are expressed in the 24-hour mode.

Auckland rail passenger system: roles and relationships

Rail Services
Auckland Regional Transport Authority

- Specifier and purchaser of rail passenger services
- Specification and preliminary planning of infrastructure upgrades
- Rolling stock owner
- Management of stakeholder relations

Connex Auckland Limited (succeeded by Veolia Transport Auckland Limited)

- Rail operator
- On-train staff
- Marketing/ Communications
- Fare collection

ONTRACK

- Access
- Train control
- Track maintenance
- Track development

Auckland Regional Transport Network Limited

- Britomart access
- Station access
- Station facilities management
- Station development

Toll NZ Consolidated Limited

- Locomotive lease
- Maintenance facilities access
- Stabling
- Maintenance/Fuelling
- Locomotive engineer hire
- Locomotive engineer training
- Silver Fern charter
- Rolling stock refurbishment

1 Factual Information

1.1 Narrative

1.1.1 On Thursday 6 October 2005, Train 4356 was an empty passenger service being positioned from Otahuhu to Britomart to begin passenger operations for the afternoon.

1.1.2 The service was operated by Connex Auckland Limited (Connex) and was crewed by a Toll NZ Consolidated Limited (Toll Rail) locomotive engineer[2] and a Connex train manager.

1.1.3 Train 4356 consisted of SD5811 driving trailer equipped with a driving cab, 3 SA class passenger carriages and a DC class diesel-electric locomotive that provided motive power (see Figure 1).

Figure 1
SA/SD consist

1.1.4 The train departed Otahuhu at 1441 in the push mode. Shortly afterwards, the locomotive engineer made a normal brake application to slow the train to 40 kilometres per hour (km/h) to travel through the junction points at Westfield, then accelerated the train up to normal speed.

1.1.5 At about 1450, and after the train had passed an advanced warning board located between Glen Innes and Meadowbank, the locomotive engineer made a minimum application on the 26-C automatic air brake valve (auto brake valve) and let the brakes settle. At about this time, the train manager went through to the cab of SD5811 to check that an air conditioning fault had been recorded in the 54D book. The 54D book was where staff recorded details of faults or problems that were occurring on trains they were operating.

1.1.6 Shortly afterwards, and in preparation to stop the train at the conditional stop board, the locomotive engineer motioned the auto brake valve handle to the service position, but it would not move. He then repeatedly attempted to move the handle in a series of punches with the open palm of his hand. While in the cab, the train manager saw the locomotive engineer forcibly "bang" the handle a few times.

1.1.7 The locomotive engineer became concerned at not being able to brake the train, so he let the brake off momentarily and gave more thrust to get the handle past the minimum position, but again it would not move. He then pressed the emergency brake button located opposite the auto brake valve (see Figure 2) and the train stopped about 170 metres (m) past the conditional stop board, about 330 m short of the actual boundary of the worksite.

[2] Toll Rail provided the locomotive engineer in accordance with contractual arrangements with Connex.

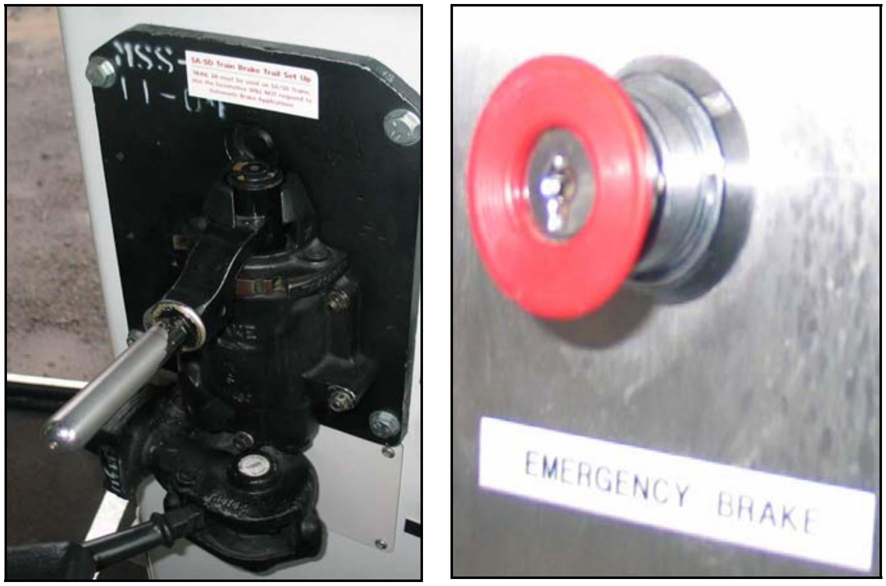

Figure 2
Air brake controls in the driving cab of SD5811

1.1.8 Soon after, a supervisor and a manager from Connex arrived, and together with the locomotive engineer they motioned the brake handle and were able to free it up a little, but it took some effort to move the handle past the minimum position. The air brakes were tested and the manager authorised the supervisor to drive the train to Britomart, because by then several following passenger trains were being delayed by the stationary Train 4356.

1.1.9 After the train arrived at Britomart and the doors were opened, passengers boarded the train before anyone could stop them. Because the braking problem appeared to be with SD5811 and the train would now be driven from DC4375 in the pull mode, it was decided that the train could convey the passengers to Papakura. The journey was uneventful and the train was taken out of service at Papakura.

1.2 Similar occurrence involving the continuing operation of a train with defective safety critical equipment

1.2.1 On Monday 31 October 2005, a set of bi-parting doors on Train 3056, a Connex diesel multiple unit passenger service, closed on a passenger boarding at Papatoetoe. A passenger became trapped, but was freed when the doors were subsequently prised open. The onboard train staff were dealing with a worsening door control problem while continuing to run the train in service.

1.2.2 As a result of this incident, on 12 September 2006 the Commission, in report 05-128, recommended to the General Manager of Veolia Transport Auckland Limited[3] (Veolia) that he provide clearer guidelines to operating staff on the actions to be taken when safety-critical components of a train consist became defective while in operation. It recommended that the guidelines include when advice was to be sought, the position of the person from whom it was to be sought, and the action to be taken if that person could not be contacted.

1.2.3 In response to the recommendation, Veolia appointed 2 service delivery managers and predicted to have their instructions for onboard train staff updated by 1 January 2007.

[3] Connex rebranded its Auckland rail operation to Veolia Transport Auckland Limited on 1 March 2006.

1.3 Train operating information

Locomotive engineer

1.3.1 The locomotive engineer had been employed by Toll Rail and its predecessors for about 24 years. He had been a grade 1 locomotive engineer for about 17 years and held current certification.

1.3.2 The locomotive engineer's roster contained a high proportion of driving the SA/SD consists and he had received special training to drive the push/pull sets that included special operating procedures for the 26-C brake valve with its graduated release function[4].

1.3.3 Throughout his career, the locomotive engineer had applied oil to the brake valve quadrant and the spring retaining hole on the brake handle when he experienced more resistance than normal in operating a handle. This was a practice that had been passed on to him by experienced locomotive engineers, early in his career.

Event recorder

1.3.4 Data downloaded from the event recorder on SD5811 in the 10-minute period leading up to the incident showed the following:

- at 1450:15, a 70-kilopascal (kPa) reduction was made with the auto brake valve that reduced the speed of Train 4356 from 87 km/h to 57 km/h
- at 1450:50, the auto brake valve was returned to the Release position and the equalising reservoir and brake pipe began recharging and the brakes released in proportion to the amount of recharge
- at 1451:10, a minimum reduction was initiated on the auto brake valve
- between 1451:15 and 1451:45, there appeared to be some movement of the auto brake valve between the Release and minimum Reduction positions
- at 1451:50, the auto brake valve handle appeared to have been moved beyond the minimum Reduction position
- at 1451:55, the emergency brake was initiated from the auto brake valve.

1.3.5 The data also showed that in the 10-minute period leading up to the incident, the locomotive engineer's response to the vigilance system[5] was between one and 11 seconds.

54D book entries on SD5811

1.3.6 In the 5½ weeks between the commissioning of SD5811 and the incident, there were no records in the 54D book regarding any braking-related issues.

[4] An additional feature of the air braking system that provided a smoother application/release of the brakes for passenger comfort.
[5] The vigilance system was an automated device that monitored the alertness of the locomotive engineer.

1.4 Site and infrastructure information

Site information

1.4.1 The North Island Main Trunk between Otahuhu and Britomart was double track. Trains ran on the left-hand track in the direction of travel, with northbound trains travelling to Britomart on the Up Main line and southbound trains travelling from Britomart on the Down Main line.

1.4.2 The authorised maximum speed for passenger trains travelling between Otahuhu and Britomart was 100 km/h.

1.4.3 Train 4356 stopped at about 676.67 kilometres (km) between Meadowbank and Orakei (see Figure 3).

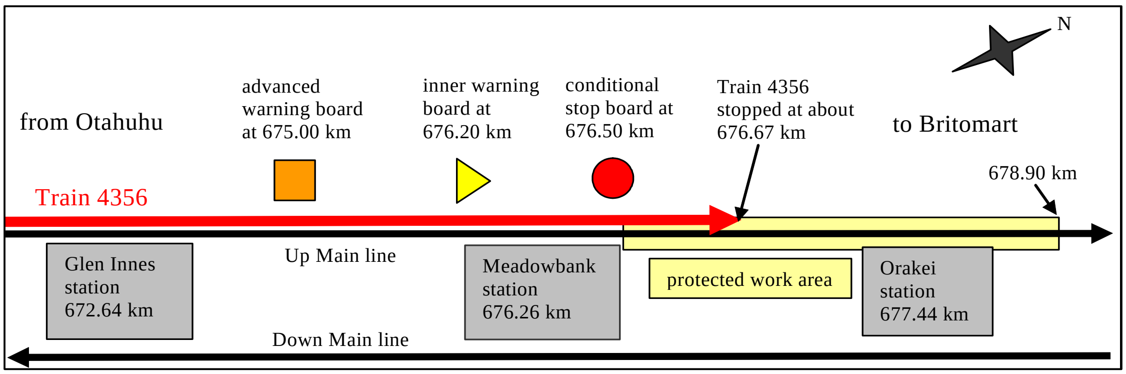

Figure 3
Plan of North Island Main Trunk between Otahuhu and Britomart (not to scale)

Signalling information

1.4.4 Double-line automatic signalling was the signalling system in use and the movement of trains was controlled from the national train control centre in Wellington.

Conditional stop protection

1.4.5 A protected infrastructure work area had been authorised by Ontrack for the Up Main line only between 676.50 km, 240 m north of Meadowbank, and 678.90 km between Orakei and Britomart to allow contractors to install a communication cable. The work area was protected by conditional stop protection arrangements in accordance with amended Engineering Rule 905.

1.4.6 Ontrack's semi-permanent bulletin No.687 dated 28 September 2005, which amended the conditions of Rule 905, stated in part:

> Following recent incidents involving Conditional Stop Protection it will now be necessary for Locomotive Engineers to STOP trains at Conditional Stop Boards and then observe the following procedures:-
>
> - Once the train is stopped the Locomotive Engineer will initiate contact with the Site Protector using the radio call sign allocated for the work on the Information Bulletin.
> - The Locomotive Engineer will obtain from the Site Protector
>   - authority to pass the Conditional Stop Board
>   - any associated instructions regarding speed through the work site.
>
> This procedure aligns with that used for authorising passing of Signals at "Stop" where the train must be stopped at the Signal concerned.

1.4.7 In addition to the requirements of Rule 905, Ontrack had appointed an additional resource in the form of an emergency protection person (EPP), who was located at the conditional stop board.

1.4.8 Ontrack's semi-permanent bulletin No.686 dated 28 September 2005 for worksites within the Auckland suburban area stated in part:

Auckland Suburban Area
All lines between Papakura, Auckland and Waitakere

CONDITIONAL STOP PROTECTION ARRANGEMENTS

Emergency Protection Persons (EPP) will be positioned at Conditional Stop Boards at all CSP [Conditional stop Protection] sites in the above area.

Purpose:

- To provide additional warning at Conditional Stop Boards

Duties:

- Attempt to gain the attention of the Locomotive Engineer of any train travelling at such a speed that [it] is unlikely to stop at the Conditional Stop Board.
- Warn track crews when an approaching train has over run the Conditional Stop Board without stopping.

Equipment required:

- Hand-held warning horn x 2
- Red flag

Note: The EPP will have no involvement with trains that stop at CSP Boards that comply with Rule 905 procedures.

Person in charge (PIC)

1.4.9 The person in charge (PIC) was an independent protection contractor to Ontrack. He had been employed in the rail industry as a signalling technician until 2002 and held current certification that allowed him to protect infrastructure worksites in the Auckland area. The PIC had selected the EPP, who was trained to the level of individual train detection. This was the minimum qualification to work on the rail corridor.

1.4.10 On the day of the incident, the PIC positioned the EPP about 20 m from the conditional stop board. He also provided the EPP with a portable radio and cell phone in addition to the air horn because of the prescribed 500 m distance between the conditional stop board and the worksite. The PIC also provided a motor vehicle to shelter the EPP because of inclement weather in the area. From the front passenger's seat, the EPP could see the inner warning board, located about 300 m away (see Figure 3).

1.4.11 The PIC instructed the EPP to walk to the conditional stop board with the air horn and red flag and carry out the assigned duties when he heard a train whistle. The PIC then travelled to the worksite some distance away and started work for the day.

1.4.12 The EPP vacated the motor vehicle and started to walk towards the conditional stop board when Train 4356 first appeared about 200 m away. The train did not appear to be travelling fast and the EPP expected it to stop at the board. The EPP waved his hand to attract the attention of the locomotive engineer because he had left his red flag and air horn in the motor vehicle.

1.4.13 The EPP was standing about 20 m from the conditional stop board when Train 4356 passed by.

1.4.14 After Train 4356 had passed the conditional stop board, the EPP saw that the train was stopping, so instead of using his radio, he telephoned the PIC to inform him of what had happened. The PIC radioed the locomotive engineer of Train 4356, who replied that he was experiencing engine problems. The PIC subsequently received a telephone call from a person from Connex who advised him that Train 4356 had run the boards.

1.5 Train 4356 information

Development and arrangements of the SA/SD consists

1.5.1 Growth in rail patronage in Auckland had seen annual passenger trip numbers increase from about one million in 1992 to between 3 million and 4 million in 2005. To cater for this and predicted growth, the Auckland Regional Transport Authority (ARTA) had contracted Tranz Rail, the predecessor to Toll Rail[6], to convert a fleet of surplus British Rail Mk 2 carriages into SA/SD consists with a design lifespan of 25 years. The initial contract was signed in June 2003. Further contracts have since been signed for the construction of additional consists, with ARTA planning to have 35 consists in service by 2011.

1.5.2 ARTA owned the SA/SD consists, but leased the locomotives from Toll Rail.

1.5.3 Connex's asset list recorded the consist as set No.7 and it was made up of the requisite vehicles and remained coupled together (see Figure 4). DC4375 was not permanently allocated to the consist because locomotives were regularly exchanged for servicing and maintenance.

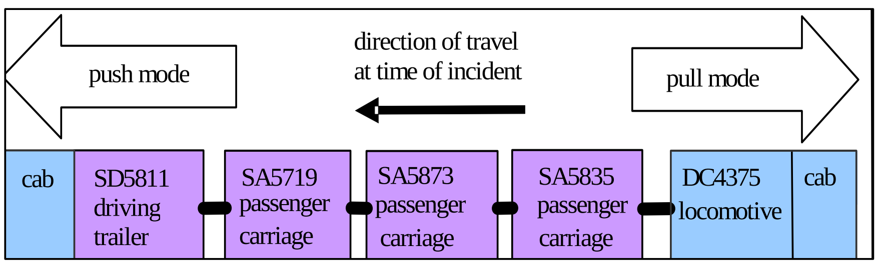

Figure 4
Plan of Train 4356 (not to scale)

1.5.4 The consist was passed out[7] from Toll Rail's Hillside workshops in early August 2005 and was commissioned for passenger operations in Auckland by Toll Rail engineers on 29 August 2005.

SD5811

1.5.5 The cab in SD5811 was equipped with a standard DX class locomotive controller that allowed a locomotive engineer to control DC4375 in the same way as controlling multiple locomotives working in unison. The locomotive engineer controlled the direction, throttle and dynamic brake applications via the controller to accelerate and moderate the speed of the train.

1.5.6 A 26-C auto brake valve was installed in the cab of SD5811 and enabled the locomotive engineer to control the air brakes throughout the consist to slow and stop the train. While driving from SD5811, the locomotive engineer could also control the air brakes on DC4375, independent from the air brake system on the rest of the train.

1.5.7 The locomotive engineer operated a cut-out switch in the driving cab being vacated, then cut in the brake operation in the cab he was to drive from when transferring the air brake control of an SA/SD consist at terminating stations, such as Britomart.

---

[6] Toll Rail took control of the rail business on 5 May 2004.
[7] The formal handing over to operational use of a rail vehicle after construction or heavy repair conducted in a mechanical depot or workshop.

1.6 26-C auto brake valve system

Operation

1.6.1 The 26-C auto brake valve was the primary device in a train's air brake arrangement. It provided the manual means for initiating and releasing air brake applications. The valve had 2 operating portions and handles. One handle controlled the automatic brake operation and the other handle controlled the independent brake operation (see Figure 5).

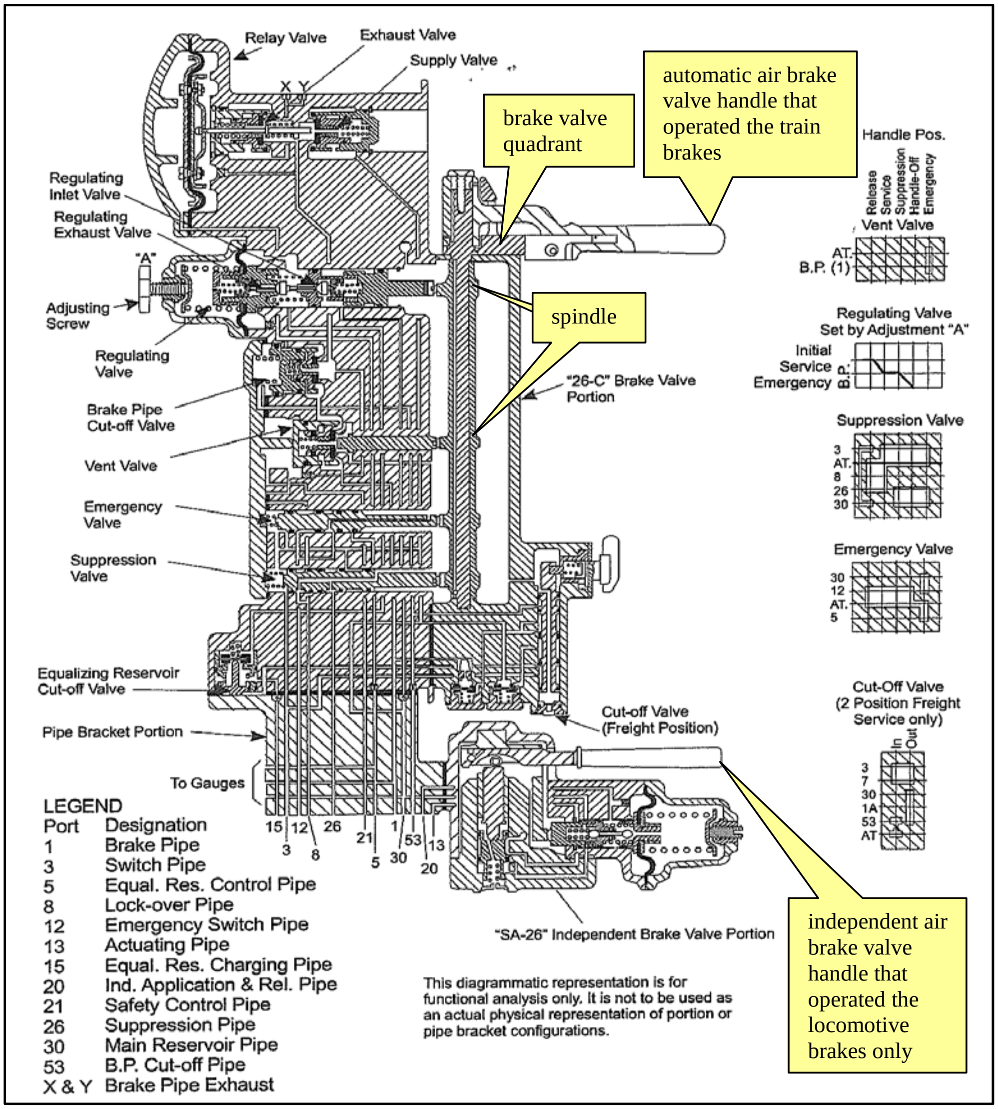

Figure 5
Detailed internal elevation of 26-C auto brake valve

1.6.2 The auto brake valve handle rotated a spindle that directed air pressure to actuate a series of control valves, which in turn directed air flow through the brake pipe to the brake cylinders throughout all the coupled vehicles.

1.6.3 The train brake operation was activated by the locomotive engineer manually moving the auto brake valve handle into one of 6 externally detented quadrant positions: Release, Initial Reduction, Service, Suppression, Handle Off and Emergency (see Figure 6).

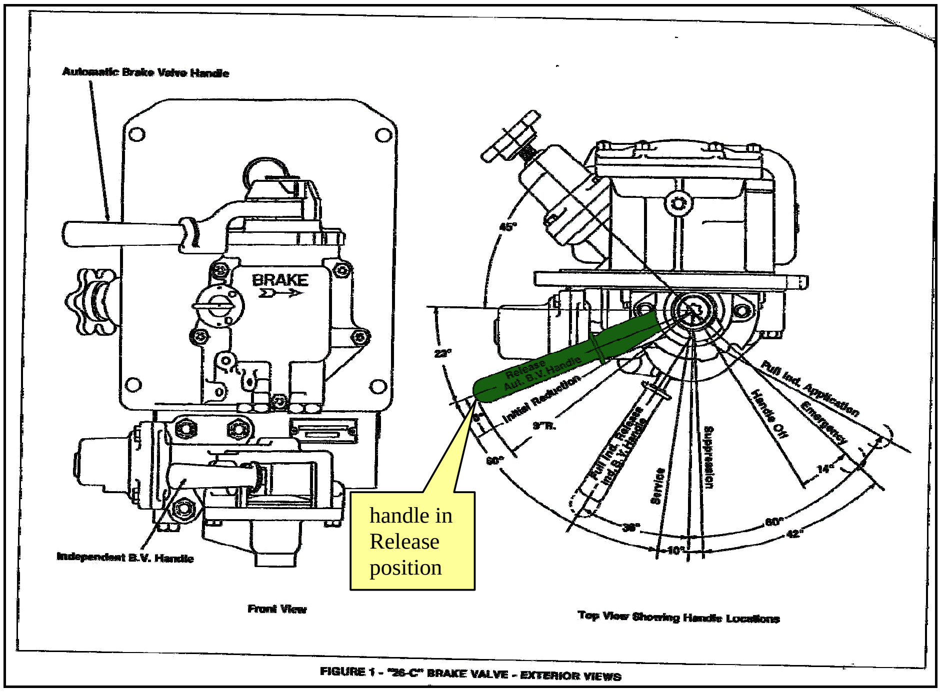

Figure 6
Exterior elevation and plan of 26-C auto brake valve

1.6.4 The Release position was used to:

- charge air pressure to a maximum of 550 kPa in the brake system when a locomotive was started up, and when a locomotive was attached to rail vehicles containing no air pressure
- recharge air pressure to 550 kPa and subsequently release brake cylinder air pressure after a brake application.

1.6.5 The Service sector consisted of an Initial Reduction position, a quadrant zone between the Initial Reduction and Service positions, a Suppression position and a quadrant zone between Suppression and a Handle Off position. A reduction of brake pipe pressure was gradually increased as the auto brake valve handle was moved through these sectors, until the handle was in the Service position where a total brake pipe reduction could be obtained.

1.6.6 The independent brake valve handle controlled the locomotive brake cylinder pressure on DC4375, regardless of the auto brake valve handle position or the state of the automatic air brake throughout the consist. The independent brake cylinder pressure operation on DC4375 could be controlled from either DC4375 or SD5811, whichever was cut in at the time. Although SD5811 was fitted with an independent brake valve handle, this only controlled the locomotive's brake cylinder pressure. There was no independent brake cylinder operation on SD5811.

1.6.7 The arrangement of the auto brake valve provided for a compact installation that occupied a minimum amount of space and eliminated much of the air piping in the open part of the locomotive and in the driving cabs of DC4375 and SD5811. The entire valvular section of the auto brake valve portion was mounted behind a panel, with only the auto brake valve handle and independent brake valve handle appearing on the front of the panel.

Fitting out in SD driving trailers

1.6.8 Toll Rail's Professional Services Group was responsible for the design and project management of the SD driving trailer construction. Because new auto brake valves could not be sourced in time, second-hand auto brake valves were sourced from the American Railroad Equipment Corporation, a spare parts company supplying railroads in the United States of America.

1.6.9 Some of the auto brake valves, such as the one installed in SD5811, were manufactured by the New York Air Brake Company (NYAB). The valves were made to a Wabtec (formerly Westinghouse Air Brake Company) pattern. There were minor differences between the NYAB and Wabtec auto brake valves.

1.6.10 The second-hand auto brake valves were delivered to Toll Rail as follows:

- on 20 July 2004, five un-refurbished valves without brake handles arrived
- on 7 January 2005, three refurbished valves with plastic brake handles arrived
- on 14 July 2005, four refurbished valves without brake handles arrived.

1.6.11 The 5 un-refurbished valves that arrived on 20 July 2004, together with some of the refurbished valves that arrived on 14 July 2005, were subsequently reconditioned at United Group Limited's[8] (United's) air brake group at Hutt workshops after this incident, and prior to being installed in SD driving carriages.

1.6.12 The auto brake valve fitted in SD5811 was not reconditioned in New Zealand prior to installation. Subsequent to the incident, the auto brake valve in SD5811 was changed out[9] on 4 July 2006 following the detection of a fault with the carriage door alarms when a minimum reduction had not delivered enough air pressure to achieve the required level of suppression.

Brake handles

1.6.13 The order for the auto brake valves did not specify the supply of brake handles because Toll Rail had assumed that handles would be supplied. When the auto brake valves arrived, only 3 were supplied with handles.

1.6.14 To address this situation, replacement brake handles were manufactured at a Dunedin engineering firm that performed work under contract to Toll Rail. Technical drawings were drawn up using an existing serviceable handle as a template. There was no type verification or any other similar control tests done on the locally manufactured handles. After the locally manufactured handles had been fitted, the functioning of the auto brake valve was tested statically, during test runs and during the final pass-out from Hillside workshops over a period of time.

1.6.15 The 3 plastic handles were fitted to the SD driving trailers, but because the Auckland-based locomotive engineers did not like the feel of them, they were subsequently replaced with locally manufactured handles.

1.6.16 Incorporated into brake handles was a detent plunger (part 5B in Figure 7) that was spring loaded to force it into detented impressions on the brake valve quadrant (part 7 in Figure 7). The detent impressions were located between each brake sector to signal to the locomotive engineer that he was moving into another type of brake application. The detent plunger on the handle fitted to SD5811 at the time of the incident was made from mild steel, similar to the material used on a Wabtec-manufactured handle.

---

[8] United was contracted to undertake the inspection and maintenance of rolling stock to standards set by Toll Rail.
[9] A term to describe the removal of rotable equipment from locomotives.

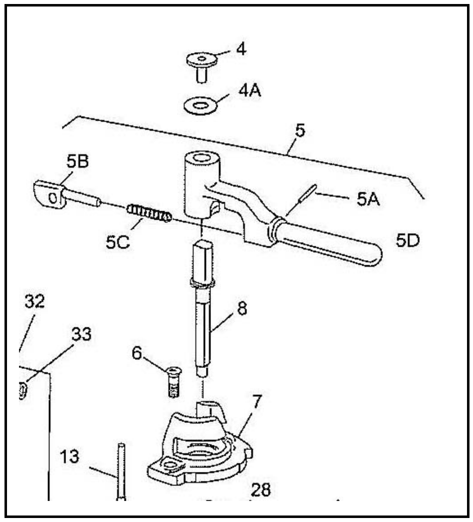

Figure 7
Exploded view of auto brake valve handle

1.7 Maintenance and examination of 26-C auto brake valve system

Inspection and test procedures

1.7.1 Toll Rail's Mechanical Code M 9352 inspection and test procedure for SA/SD car air brakes was the document that detailed the brake test procedures. The document stated in part that:

> This Full Code Test is required to be carried out during larger maintenance checks, vehicle commissioning and when any work is carried out on the air brake system.
>
> 5. Automatic Brake Valve Test:
>
> Check that the cut out valve is at "N", "Open" or "FRT" position.
> The brake handle must operate freely and must not be slack on the spindle.
>
> i) Move brake valve to minimum reduction position and note that brake pipe pressure drops at least 40 kPa [kilopascal] but not more that 50 kPa and that brakes apply. Brake pressure (SD cylinders) should be between 70 kPa and 100 kPa.
>
> ii) Move brake valve in steps towards full service and note that brake pipe pressure decreases and brake cylinder pressure increases incrementally at each step. In full service ensure that brake pipe pressure settles at 390 + 10 kPa and brake cylinder pressure settles at 390 – 410 kPa. Replace the defective components if the settled pressures are outside the specified range.

Post-incident examination

1.7.2 After the consist was taken out of service at Papakura, it returned empty to Toll Rail's passenger vehicle depot at Westfield where the auto brake valve in SD5811 was examined.

1.7.3 The front of the auto brake valve was removed and, with the original handle still attached, the main spindle, cams and shuttle valves were seen to move freely throughout their full range with no signs of interference between any of the moving parts. The front cover was replaced and the auto brake valve underwent a full automatic brake code test, again with the original handle, but the fault could not be replicated. There were some signs of wear on the detent plunger of the brake handle (see Figure 8).

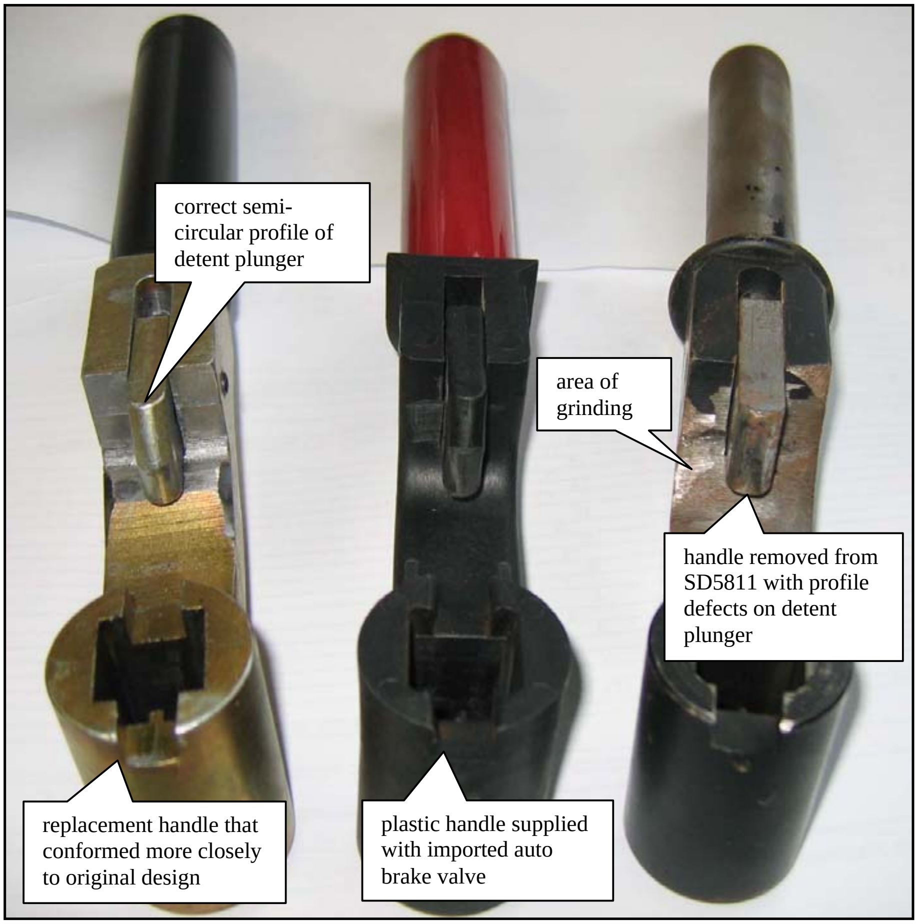

Figure 8
Brake handles (end view)

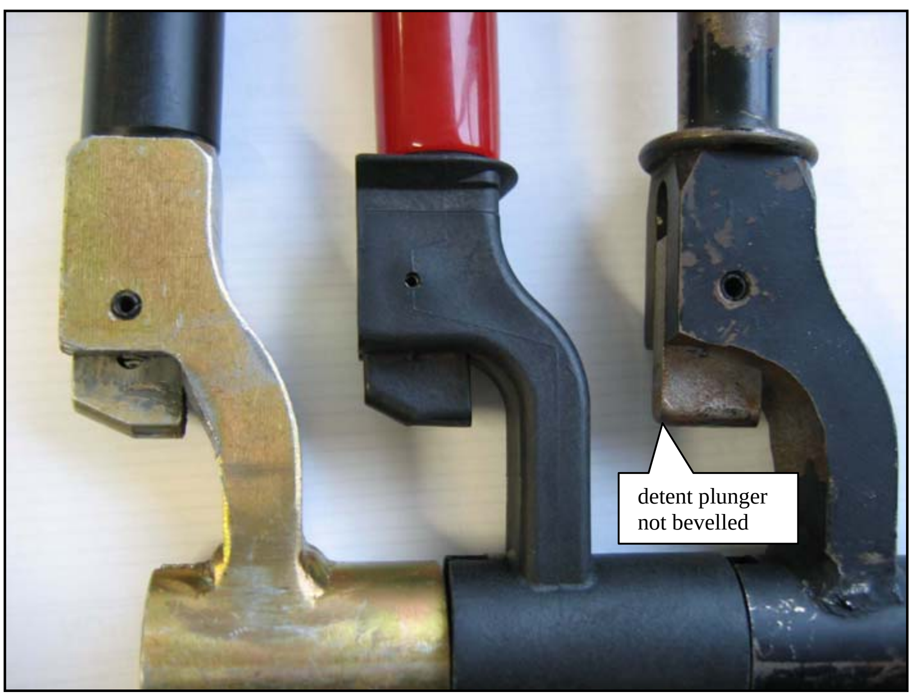

Figure 9
Brake handles (side view)

1.7.4 It was noticed that the profile of the detent plunger was out of phase with the detents on the quadrant and there were a few worn/flat spots on the head of the plunger. Instead of being of semi-circular profile, it was irregular in shape and had a non-conforming radius on one side, making the plunger jam rather than ride over the quadrant as it was designed to.

1.7.5 The brake handle looked well used and was not made of cast steel like the original handles. There were 2 areas of mechanical grinding on the underside of the shank near the detent plunger and where the shank joined the spindle. Why these were there could not be readily explained but Toll Rail thought they might have been done to allow the handle to be moved to the full Release position.

1.7.6 In addition to the irregular profile, the bottom of the detent plunger was not bevelled like the original handles (see Figure 9). The handle was removed from SD5811 as a precaution.

1.7.7 SD5811, now equipped with a replacement brake handle, underwent and passed an auto brake valve test component of the SD brake code test check on 7 October 2005, the day after the incident. The consist then returned to service.

Frequency of brake handle usage on SA/SD consist

1.7.8 In order to ascertain the number of times that SA/SD consists were scheduled to stop at stations during a Monday-to-Friday period, a review of Veolia's rolling stock plan dated 3 December 2006 was carried out. It showed the following:

Diagram no	Daily timetabled stops	Weekly total
1	120	600
2	103	515
3	107	535
4	106	530
5	157	785
6	146	730
7	115	575
8	117	585
9	66	330
10	144	720
11	113	565

Note: A diagram referred to a series of planned train movements throughout a day. Sets were assigned to a diagram on a daily basis.

1.7.9 The figures did not include any random stops or decelerations requiring brake applications that could occur for operational reasons. Each timetabled stop required the auto brake valve handle to be moved to the Service zone, and when the train was ready to restart the handle was moved to the Release position.

1.7.10 As at 3 December 2006, Veolia had 13 operational SA/SD consists available to fill the 11 diagrams. The 2 consists not utilised would normally be scheduled for maintenance or stabled as spare.

Subsequent similar braking incident not investigated by the Commission

1.7.11 On Friday 3 November 2006, the locomotive engineer driving DC4254 on SA/SD Train 2151 reported that the train had lost time due to the brake handle jamming and causing erratic brake applications while he was trying to reduce speed en route. On arrival at Britomart, the set was taken out of service.

1.7.12 On Monday 6 November 2006, Veolia advised that the fleet maintenance protocol log that recorded details of the incident had been closed out with comments that the driver's sticking brake valve was lubricated and the brake handle slide face (detent plunger) was lubricated.

1.8 Rail regulatory framework in New Zealand

Recent rail history

1.8.1 Government policy in the 1980s changed the status of all transport sectors (maritime and air as well as road and rail) through deregulation. The Government-owned integrated railway system incorporating all infrastructure and rolling stock assets was changed from a government department into a state-owned corporation in 1982. Subsequently, in 1991, the corporation was transformed into a public limited liability company, retaining all assets except surplus land for the running of the railway system.

Licensing of the rail industry by Land Transport New Zealand

1.8.2 In 1993, New Zealand Railways Corporation was privatised when the Government sold the railway system incorporating both infrastructure and rolling stock to Wisconsin Central Railroad from the United States of America, with financial backing from a consortium of merchant bankers. Concurrent with that event, the Land Transport Safety Authority (LTSA, the predecessor to Land Transport New Zealand [Land Transport NZ]) was mandated by the Government to administer railway safety legislation, oversee its application to railway operations and monitor ongoing compliance and performance.

1.8.3 A document called the Rail Safety Licensing and Safety Assessment Guidelines (the guidelines), first published in 2000, was updated in April 2006 by Land Transport NZ following the passing into law of the Railways Act 2005. The 2006 guidelines (from which the following information was extracted) related to the safety management of railways in New Zealand and set out requirements of the Government with respect to safety. The guidelines placed the onus on each rail participant to take all practicable steps to ensure that none of the rail activities for which it was responsible caused, or was likely to cause, death or serious injury to individuals.

1.8.4 In defining its policy and designing the applicable legislation, the Government adopted a co-regulatory approach, meaning that the technical and operating standards that formed a rail participant's safety system were the responsibility of the rail industry. To gain a licence, each applicant had to show, through the submission of a safety case, that it had taken all practicable steps to ensure that all rail activities were safe. Reference needed to be made to the safety system and, in particular, comprehensive risk assessments. The risk creators (the rail participants and licence holders) carried the responsibility for managing their operations safely.

1.8.5 Land Transport NZ, as the Government's nominated rail safety monitoring agency, administered the legislation that required the application of an integrated safety management systems/safety assessment (audit) approach. This placed Land Transport NZ in a regulatory role that included approving the minimum requirements for the scope and contents of a safety case and underlying safety system. Land Transport NZ did not set technical or operating standards.

1.8.6 Land Transport NZ maintained its responsibility by monitoring railway participant performance in the achievement of its safety objectives. This was achieved through the monitoring of key performance indicators and accident and incident occurrence data and the application of a safety assessment regime. Land Transport NZ, through the Government, had the power to intervene and make rules regarding technical and operating standards to ensure safety was maintained across the rail industry. In doing so the Minister would rely on Land Transport NZ for technical expertise in drafting rules and consulting with the industry. No rules had been made for regulating the rail industry.

1.8.7 Land Transport NZ was able to tailor the safety assessment[10] programme to match the nature and extent of rail participants' rail activities, taking into account their safety records, but initially it was expected that annual safety assessment programmes would apply. The scope of safety assessments could vary so that annual safety assessments looked at one part of the business (in a cycle), with the whole business being covered every 2 years.

Safety case

1.8.8 All licence holders were required to have an overarching safety case that covered all of the rail activities of all rail participants with which they had contractual relationships (for which they were responsible). Inter-operability arrangements with other rail participants were required to be covered.

1.8.9 Land Transport NZ was required to approve the safety case of each licence holder. The safety case was a method of providing an assurance to Land Transport NZ that the rail participant was able to operate safely, that all key risks had been identified and assessed and that control measures were in place to ensure the safety of people and property with a view to continuous improvements in safety performance. Underpinning a safety case was the licence holder's safety system.

Safety system

1.8.10 A rail safety system was a more detailed description on how the rail participant was going to conform to its safety case; in other words, it was a system containing safety and quality management manuals that underpinned the rail participant's operations. The key idea behind such a system was to state how compliance was going to be achieved and show that it was being followed in practice.

1.8.11 Such systems defined standards and procedures consistent with accepted good railway operating practices for the activities being undertaken by rail participants' organisations, and required assurance of compliance with those standards, practices and procedures to ensure safe consequences. Rail participants operating on the national rail system were expected to refer to and adopt the National Rail System Standards (NRSS) administered by Ontrack. These Standards were designed to provide policy guidelines for the high-level safety system elements and ensure consistency with the operation practices of Ontrack and other network users.

1.8.12 The Rail Safety System Manual (RSSM), dated 19 August 2004, was the principal document defining Toll Rail's rail safety system and was designed to meet the requirements set out in the guidelines document (first published in 2000).

1.8.13 Toll Rail had implemented a multi-level approach to safety management. The separation into the strategic and operation levels together with the linkages between the various system elements are illustrated, together with Veolia's and Ontrack's safety management systems for comparison, in Figure 10.

1.8.14 At Toll Rail's operational level, standards and procedures for design, construction, inspection and maintenance were detailed in various mechanical codes. The codes, together with supplements and supporting documents numbered in the M9000 series, embodied the principles for the safe operation and working of equipment on the national rail system. The codes also provided construction and maintenance standards, and provided parameters for inspection and testing.

---

[10] Safety assessments confirmed whether or not rail licence holders were operating in accordance with their approved safety cases and supporting safety systems.

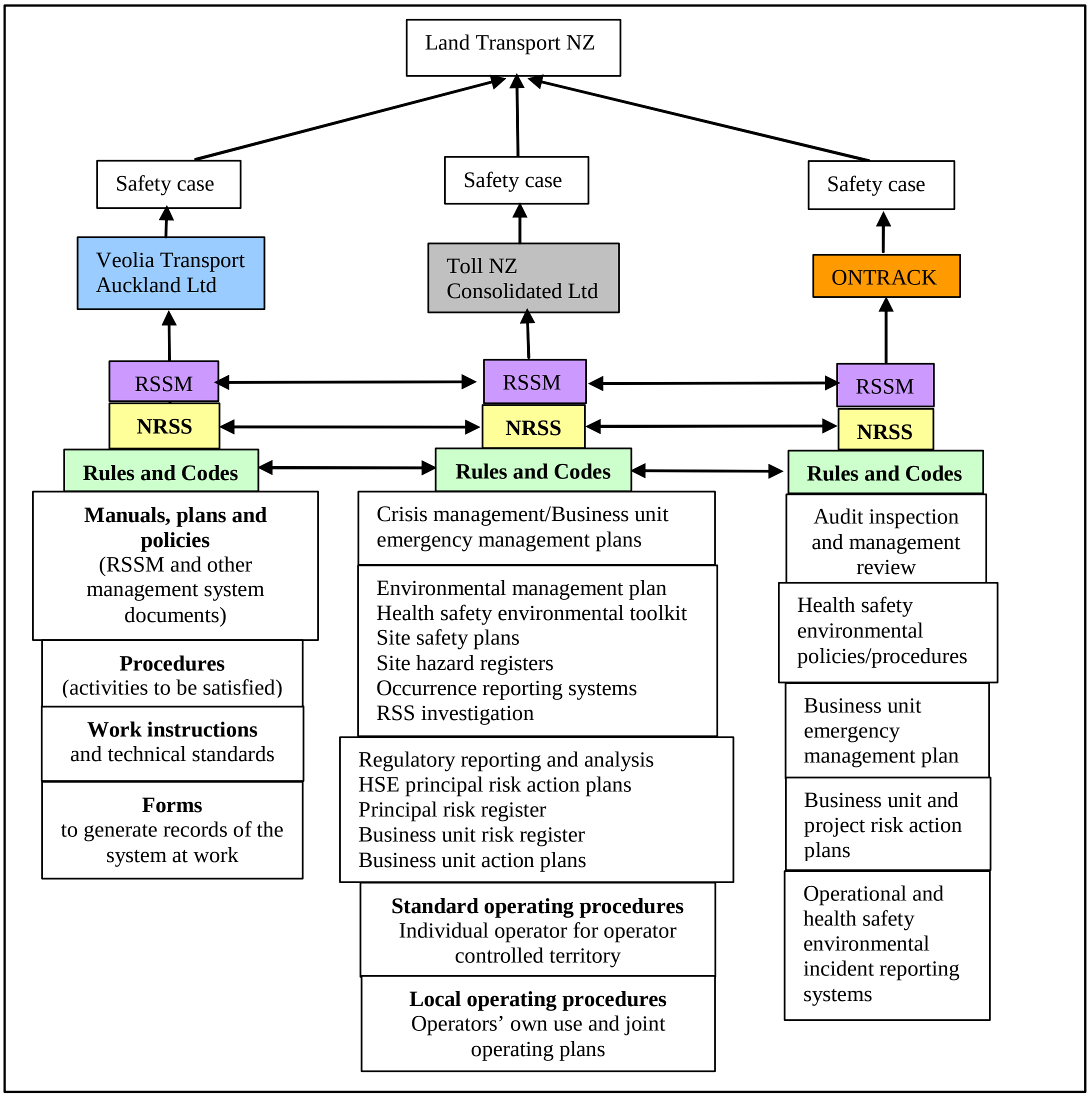

Figure 10
Current rail safety case/system structure

1.9 Previous recent Auckland passenger vehicle occurrence reports

Occurrence report 06-101, passenger Train 3334, fire, Manurewa, 15 March 2006

1.9.1 On 15 March 2006, the auxiliary motor installed under DMU trailer car ADC857 in the consist of Train 3334 caught fire when lubricating oil sprayed from a loose connection onto the hot surface of the turbocharger. The train was stopped at Manurewa where the passengers were evacuated and the fire was extinguished by the New Zealand Fire Service.

1.9.2 The safety issues identified during this investigation were:

- the process for fitting the oil inlet hose to the turbocharger
- the accessibility of the auxiliary engine
- the cleanliness of the auxiliary engine surround
- the monitoring and recording of maintenance and spare parts
- the lack of a fire detection and suppression system.

1.9.3 On 19 June 2007 and as a result of this investigation, the Commission issued a safety recommendation to the Director of Land Transport NZ that, because of prospective anticipated growth in the rail passenger traffic in the Auckland region in the foreseeable future, and the ageing current rail fleet, he require all rail participants to operate a maintenance system where:

- engineering standards consistent with world standard practice were identified and adhered to
- manufacturers' inspection, repair and maintenance instructions were documented and followed
- safety-critical components were identified and documented
- work instructions were issued for maintaining safety-critical equipment and work on safety-critical components was signed off by someone other than the maintainer
- all maintenance was recorded.

1.9.4 On 26 September 2007, Land Transport NZ responded to the safety recommendation as follows:

> Land Transport NZ will continue to seek assurance, through its annual safety assessment process, that licence holders have robust and appropriate maintenance systems as outlined in approved safety cases and safety systems. Furthermore, Land Transport NZ will continue to instruct its safety auditors during their annual safety assessment of operators to pay special attention to specific safety issues identified by TAIC investigations.

Occurrence report 06-102, passenger Train 4306, braking irregularity between Westfield and Otahuhu, 31 March 2006

1.9.5 On 31 March 2006, the locomotive engineer of empty passenger Train 4306 noticed the air brake system operating below normal performance while driving the train between Westfield and Otahuhu at the start of operations for the day. After the train had reached Otahuhu, the locomotive engineer examined the brake system and decided to return to Westfield rather than continue passenger operations.

1.9.6 Safety issues identified included:

- purging of contaminants from a locomotive's air brake piping
- scheduling the reconditioning of brake control valves
- standards for tracking and monitoring safety-critical components.

1.9.7 Because of safety actions taken by Toll NZ Consolidated Limited, no safety recommendations were made. The safety recommendation directed to the Director of Land Transport NZ as a result of rail occurrence report 06-101 was equally applicable to this occurrence and no new safety recommendation was made to address this issue.

1.10 Strategic-level policy for the construction of SA/SD consists

1.10.1 The design and construction of the prototype SA/SD consist predated the promulgation of the NRSS. On 28 March 2007, Toll Rail advised the following in part:

> **Certifying Engineer**
>
> The SA/SD design process predates Ontrack and NRSS being in force. The design/verification phase of the project was delivered by an integrated railway, not the current separate operator and access provider structure, which requires interface standards such as NRSS. Only the last approval of commercial push-pull operation occurred during the first six weeks of Ontrack existence and no approvals were required or sought from Ontrack.
>
> Nevertheless, this development followed the formal processes of the Tranz Rail Design Manual M3000 and the requirements of Land Transport NZ, following their policy of the time "Land Transport policy concerning the introduction of rail vehicles".
>
> In the case of the SA/SD Tranz Rail's Professional Services Group Manager (and later National Manager HSQE or Professional Services Group Manager's advice) wrote to Land Transport NZ and requested a Variation to our Safety System for the vehicle/operating mode concerned. For subsequent designs the Professional Services Group Manager has written to Ontrack and certified that the design meets the requirements of NRSS and has requested running rights for the design concerned.
>
> Prior to this letter being written the Manager Professional Services Group had satisfied himself that the vehicle design was of a suitable standard for the defined service, ascertained by means of:
>
> - design and analysis by suitable qualified staff (nearly all professional services group staff were employed at some point of the project on some aspect of the design or testing)
> - supervision of construction
> - extensive testing
> - liaison with operating staff and Rail and Maritime Transport Union
> - risk assessment
> - inspection and test procedures signed off
>
> The quality of the individual SD cars is controlled by means of specially prepared inspection and test procedures. These are 'controlled issued' in the M9xxx series and include "M9370 SD COMMISSIONING CHECK LIST & TOLL RAIL ACCEPTANCE OF SD CARS".
>
> As can be seen from the attached sample, these are comprehensive documents and even cover operating staff (union) checks and implications. It calls up the SA/SD brakes test code M9353. Section 5 of the SD brakes test requires the tester to thoroughly exercise the driver's control valve while checking it delivers the correct outputs.
>
> One of these is completed for each car prior to workshop pass out and this is witnessed by professional services group or Toll Auckland metro maintenance substitute during pass out audit. Before the car enters service the inspection and test procedures must be complete and the senior Toll Auckland Metro Maintenance Engineer is usually responsible for this.
>
> Only (four) selected people have been allowed to check and sign off these inspection and test procedures as having been correctly completed and these individuals fulfil the role of "certifying engineer" (even though this role did not exist at the time the first three SA./SD sets entered service).
>
> **In summary the design was "certified" by the Professional Services Group Manager and his authorised representatives "certify" each individual vehicle as compliant, fulfilling the requirement for a "certifying engineer".**
>
> **General**

It is important to note that the design decisions at the concept phase were heavily influenced by the need to eliminate any unnecessary new features on what was already an extremely novel and demanding design (first push-pull operation in NZ) from the Professional Services Group's perspective and resources. The most significant decision was that control systems would duplicate standard (to New Zealand) locomotive practice, greatly reducing the amount of new work required and resulting opportunity for design error. This included the brake system, which it was decided would duplicate an existing NZ General Electric or Electric Motive Division locomotive cab and use the same proprietary brake components (valves), including the driver's control valve.

While extensive brake testing to verify the overall performance of the design was carried out by the designers during type testing of the SD design, it was quite reasonably assumed that proprietary products such as brake valves, railway roller bearings and the like were as specified and required no testing aside from verifying they did their job while the vehicle was type tested. Neither was special inspection (stripping, measuring or so on) of such proprietary components during production acceptance specified, correct performance of their function when installed as being adequate.

In summary:

- a deliberate design decision was made to employ a standard and proven brake control system using proprietary components
- there is a formal requirement for full testing of each and every installation by workshop, Dunedin drivers and Auckland drivers before final acceptance
- it is required the "certifying engineer" confirm that these tests have been carried out and signed off before certifying the train for service
- there is a thorough process in place for detecting any material non compliance.

All production vehicles were subjected to the inspection and test procedures (ITP) process and each SD would have been brake tested to the SD code in Hillside (ITP 3.13), mainline operated in the Dunedin (ITP 4) area and tested by Auckland drivers (ITP 6). Even though a non original equipment manufactured brake handle had been substituted for the correct one at some point of the build process, it would have had to get through all these checks suggesting its deficiencies were minor enough to pass un-noticed at these points.

Subsequent to Train set 10, tighter requirements were introduced for the re-use of second hand brake valves due to in service problems resulting from these valves being at or close to acceptable tolerances shortly after entering service. Prior to this point they were being verified by being tested in situ, all used control valves must now be subjected to a full bench test using original equipment manufactured approved test equipment before installation. On that basis this handle passed all of the above tests it is a moot point whether this process would have detected and removed it. Nevertheless tighter test requirements will now be specified for any overseas sourced used equipment being used in or refurbished for Toll projects. M3000 will be updated to incorporate this requirement.

NRSS/6 change required

As a final comment, NRSS/6 is largely based on Tranz Rail document Q910, which applied entirely to enthusiast operated "heritage vehicles" and where it was required (based on experience) that each individual vehicle be specially verified as being compliant. Toll believe Clause 2.2 has not been properly developed to reflect the universal role of this new document and as such it does not differentiate clearly enough the requirements for "Type Acceptance", where the design and compliance of a first of kind is verified (requiring extensive activity) and the more routine verification of production examples of a series design. Currently Toll certifies to Ontrack that new designs are compliant but Ontrack quite rightly relies on Toll's Land Transport approved systems to ensure that each subsequent production vessel also complies. Toll will raise this matter at the Joint Technical Committee – Engineering Interoperability with a view to having the situation recognised in the wording of 2.2.

The NRSS

1.10.2 The NRSS, dated 12 July 2004, was the manual that documented standards in use by ONTRACK (referred to as the Access Provider) and all operators such as Toll Rail using ONTRACK's controlled network and Toll Rail's own controlled territory. The object of the NRSS was to provide a generic framework for the management of the critical elements within Toll Rail's rail safety system and the systems of other rail participants (Access Providers and Operators). Section 6, Engineering Interoperability, of the NRSS stated in part that:

> **2 RAIL VEHICLE QUALIFICATION**
>
> **2.1 General**
>
> Operators must ensure that their vehicles are designed, constructed, maintained and operated in accordance with good sound railway engineering practice, and the requirements of the Rail Service Licence and all National Rail System Standards.
>
> In absence of sound alternatives contained in the Operator's Rail Safety System approved as part of their Rail Service Licence issued by LTSA[11] and agreed to by the Access Provider, Tranz Rail/Toll NZ codes, standards and practices effective at 30 June 2004, with subsequent amendments acceptable to the Access Provider will apply in respect to all aspects of design, construction (including body strength, longitudinal strength and crashworthiness), inspection and maintenance. Note that these Tranz Rail/Toll NZ standards are currently generally accepted NZ rail industry practice applicable to the National Rail System.
>
> Nation-wide standards specifying minimum rail vehicle construction standards applicable to new and existing rail vehicles may be subsequently developed.
>
> **2.2 Certification**
>
> Before any rail vehicle will be allowed onto the National Rail System for the first time, or after modifications that alter vehicle axle loads, weight distribution and/or physical profile, the Operator must have a competent railway mechanical engineer (the Certifying Engineer) certify that it is fit for service on the National Rail System. The Certifying Engineer must be suitably qualified and acceptable to the Access Provider. The Certifying Engineer must subject the rail vehicle to a formal acceptance process to demonstrate compliance with this standard and the operator's engineering standards applicable as a part of their Rail Safety System.
>
> In certifying the rail vehicle the Certifying Engineer must give due weight or consideration to, but not limited to:
>
> - The nature of the service in which the vehicle will be employed
> - The operating environment it will be used in
> - Its condition and its maintenance history (existing vehicles)
> - Proposed maintenance environment
> - Its crashworthiness and other safety features
> - The original construction standards and its compliance with these (where applicable)
> - Any heritage status
> - Other factors pertinent with respect to sound engineering practice.
>
> **2.4 Maintenance**
>
> Operators shall maintain their vehicles in a safe operating conditional in accordance with the requirements covered by their Rail Service Licence, sound railway engineering practice and requirements of the standard, and also ensure that they are fit to operate (in all respects) for use in carrying out rail operations.

[11] Now Land Transport New Zealand

9.4 Rail Vehicle Braking Performance

9.4.1 The braking system must achieve the following stopping distances from 80 km/h or line speed, whichever is greater:

(a) the train within 885 m
(b) a single vehicle (in a break-away test) within 650 m
(c) passenger rolling stock must stop from 100 km/h within 600 m as per 9.4.2, individually or as a train, and in wet and dry conditions
(d) EMU's within the Wellington suburban area must stop within 460 m from 100 km/h or be subject to Working Timetable speed restrictions.

9.4.2 This performance must be achieved under the following conditions:

(a) at all combinations of block or wheel wear and block material variation;
(b) on straight and level track;
(c) in any load condition;
(d) under normal climatic conditions;
(e) with individual car brakes cut out in accordance with Rules and Regulations;
(f) no tractive power applied to the locomotive;
(g) a full service brake application;
(h) brake system fully charged before application.

9.7 Air Brake System Type

The braking system fitted to rail vehicles are to be compatible with the single pipe direct release "Westinghouse" type automatic continuous brake system which has been traditionally used on the National Rail System.

The air brake system has the following parameters:

- Passenger and scheduled unit freight trains may operate on either "direct release" or "graduated release".

9.8 Compliance with Braking Standards

In general, the simplest way of meeting this brake standard is to provide a braking system that is compatible with the "Westinghouse" system with brake pipe pressure set at 550 kPa.

1.10.3 In reference to the Access Provider requirements in the NRSS, Ontrack said that it considered Toll Rail to be competent to provide certification of the SA/SD consists.

1.10.4 Toll Rail advised that the original brake performance test consisted of single car breakaway testing, which it considered was all that was required by the NRSS and other processes. Subsequent testing has been carried out on complete SA/SD trains that were in service to confirm stopping distances, which were shown to be satisfactory.

Significant variation criteria

1.10.5 Material changes to safety cases required the licence holder to seek approval of the changes under the auspices of a safety case variation. A memorandum of understanding existed between the LTSA and Toll Rail that required each organisation to advise the other of any significant variation. The significant variations were changes that could significantly increase Toll Rail's risk profile, or were changes necessary in the interest of avoiding a significant risk or serious injury.

1.10.6 The RSSM identified that potential significant variations could arise in the following areas:

- the introduction of new locomotives and electric and diesel units (including second hand) that required additions and/or changes to existing standards and/or operating procedures
- the introduction of new or substantially changed rolling stock (including second hand) that required additions and/or changes to existing standards and/or operating procedures.

Safety system approval for construction of SA/SD consists

1.10.7 The following exchanges of documents summarise the approval process that occurred for the development of the prototype SA/SD consist:

- 11 June 2003, Toll Rail requested the acceptability in principle of a push-pull passenger train operation in New Zealand from the LTSA
- 29 September 2003, the LTSA granted interim type approval to Toll Rail
- 8 October 2004, Toll Rail requested type approval from the LTSA as a variation to its safety system
- 11 October 2004, Connex advised the LTSA that initial testing had occurred
- 13 October 2004, the LTSA provided type approval to Toll Rail and Connex to undergo operational commissioning with some minor conditions
- 9 November 2004, Interfleet Technology, an international rail technology consultancy, provided Toll Rail with an independent review of push-pull trains' operation. Toll Rail had commissioned Interfleet to provide advice on and approval of the proposed push-pull operation using the SA/SD consists propelled by DC locomotives on the Auckland suburban network using infrastructure data supplied by Toll Rail
- 10 November 2004, Toll Rail requested operational approval-mechanical from the LTSA
- 11 November 2004, the LTSA provided operational approval-mechanical to Toll Rail and Connex
- 12 November 2004, Toll Rail issued a statement of compliance with the NRSS that said in part:

> **Background**
> The SA/SD train is the first application of the internationally well-proven operating concept of push-pull operation in New Zealand.
>
> These trains will be operated in DC-SA-SA-SA-SD configuration, with the DC hauling conventionally in one direction (pull) but pushing and controlled from the SD cab (push) in the other.
>
> These trains will operate commuter passenger services over the full extent of the Toll Tranz Metro [subsequently Connex and Veolia] Auckland Rail Network, possibly extending to Hamilton and Helensville in the future.
>
> **Vehicle description**
> The SD was a driving-generator-trailer, a major development of the S [first generation of ex BR carriage rebuilds] car, and is in effect an SA with a driving cab and diesel generator set to supply on board power.
>
> Interfleet (an ex British Rail railway engineering and operations consultancy spin off) had specific knowledge of push-pull operation in the UK environment and has provided objective and independent confirmation of the Toll Rail design and approval process.
>
> NRSS/6 and M3000 do not currently cover push-pull operation. Specific issues relating to push-pull operation of these vehicles have been addressed and were assessed during Interfleet's review.
>
> To conclude, I am satisfied these trains are ready for service and suitable for push-pull operation. Therefore, please be advised these vehicles have been released by Toll Rail for passenger service and that this letter is a statement of compliance with NRSS. Special items relating to push-pull operation but outside the scope of NRSS have been identified and adequately addressed as evidenced by Interfleet's letter.

- 23 December 2004, Connex requested full operation approval, removing minor conditions set on 13 October 2004
- 23 December 2004, Land Transport NZ provided full operational approval-mechanical to Toll Rail and Connex.

1.11 Comparative policy for design and certification of new transport equipment

New Zealand maritime transport industry

1.11.1 Maritime Rules laid down requirements for, among other things, the construction, life-saving, fire-fighting appliances, stability and subdivision of restricted limit passenger vessels.

1.11.2 Maritime Rules required that design approval be given by a surveyor authorised by the Director of Maritime New Zealand, and stated in part that:

> the ship's design is approved[2] by a surveyor recognised by the Director for that purpose under rule 46.29 as -
>
> (i) fit for its intended service and intended operating limits; and
>
> (ii) complying with all the applicable maritime and marine protection rules
>
> [2] Approval of the ship's design does not guarantee any performance of the ship's design other than in respect of the sufficiency and compliance with maritime and marine protection rules of those elements included in the definition of ship design in rule 40C.2. ["Ship's design" includes the ship's structural integrity, watertightness and weathertightness, safe means of egress and access, intact stability and reserve of buoyancy, the ship's compliance with any damage stability and buoyancy requirements, and the provision of machinery and other installed systems and equipment necessary for the safe working of the ship]

Authorised surveyors for design approval were required to be experienced naval architects. They inspected the submitted detailed plans of vessels, and ensured that they met all the requirements of the Maritime Rules for hull strength, machinery, electrical installation and other ancillary parts.

New Zealand road transport industry

1.11.3 Land Transport NZ specified the legal requirements for the design and construction of all passenger service vehicles in New Zealand in Rule 31001, which became law on 1 September 1999. Passenger service vehicles must comply with the requirements in the Rule so that the public will be assured that any vehicles offering a passenger service in New Zealand are safely designed and constructed.

1.11.4 Passenger service vehicles must be certified for compliance with this Rule. A person authorised by the Director of Land Transport NZ to certify a passenger service vehicle for compliance with the Rule must not do so if the person has reason to believe that the vehicle does not comply with the Rule.

Australian standard for railway safety management of rolling stock

1.11.5 The following are extracts (in part) from an Australian standard for railway safety management of rolling stock that specified the standards for rolling stock operating on railway systems in that country:

SCOPE AND GENERAL

1.8 Hazard identification and risk analysis

Determination of the matters to be included in standards and procedures for each phase of the life cycle should include identification of hazards which might affect the following:

- Integrity of rolling stock and trains.
- Provision for passenger and worker protection.
- Provision of reliable vehicle couplings, brake systems, and brake and other connections between vehicles.

DESIGN

3.3 Rolling stock items

Standards and procedures shall be established and maintained for the selection and design of rolling stock including, where relevant, those listed as follows:

- Braking systems.

3.4 Verification and Validation

Standards and procedures shall be established for the verification and validation of all stages of the design of rolling stock. These standards and procedures shall include at least the following:

- Verification of design specification and test plan in terms of accuracy and conformance to client requests, safety requirements, standards and regulatory requirements.
- Verification of detailed design in terms of accuracy and conformance to client requests, safety requirements, standards and regulatory requirements.
- Validation that the detailed design conforms to the required safety standards and client requirements.

These verification and validation processes shall be performed at an appropriate level of independence from the design process to be verified and validated. The degree and nature of the independence shall be determined by taking into account at least the following factors:

- The risk of errors being perpetuated during the verification and validation process due to there being too close an association between the persons performing the verification and validation and those involved in the design process.

- The risk imposed on the existing system both by the introduction of the system to be verified and validated and by faults or inconsistencies in that system.

CONTRUCTION AND IMPLEMENTATION

3.3 Rolling stock requirements

Standards and procedures shall be established and maintained for the construction of rolling stock in respect of the items listed in 3.3 for the design of the rolling stock.

Standards and procedures should include the following items:

- Use of appropriate construction and installation practices and specifications.
- Procedures to ensure the use of approved and current plans.

4.3 Verification and Validation

Standards and procedures shall be established for the verification and validation of all stages of construction and implementation of rolling stock builds. These standards and procedures shall include at least the following:

- Verification that the construction conforms to the detailed design and to client requests, safety requirements, standards and regulatory requirements.
- Validation that the rolling stock construction conforms to the required specifications, safety standards and client requirements.

These verification and validation processes shall be performed at an appropriate level of independence from the construction process to be verified and validated. The degree and nature of the independence shall be determined by taking into account at least the following factors:

- The risk of errors being perpetuated during the verification and validation process due to there being too close an association between the persons performing the verification and validation and those involved in the construction process.
- The risk imposed on the existing system both by the introduction of the system to be verified and validated and by faults or inconsistencies in that system.

1.11.6 Copyright permission was obtained from SAI global to include this information.

Australian regulatory oversight of new rolling stock

1.11.7 An Australian state regulatory body informed the Commission that it maintained a cooperative approach with rail industry entities. When a new concept of rail vehicle was proposed, such as a push-pull passenger train, the regulator worked alongside the designers, manufacturers and eventual owners in a cooperative approach. This allowed the regulator to monitor that certifications on the prototype rail vehicle were being conducted at critical stages in compliance with the respective safety cases. This regulator was one of several throughout Australia.

1.12 LTSA's sponsored review of Tranz Rail's outsourced infrastructure maintenance contract

1.12.1 On 18 March 2002, the LTSA contracted an overseas consultancy group to review the change in infrastructure maintenance completed by Tranz Rail. Transfield Services Limited had become the alliance contractor on 1 March 2002. The requirement for the review was based on the LTSA's schedule of services dated 2 March 2002, which specifically raised the following issues:

- ministerial, parliamentary and employee group concerns brought to the attention of the LTSA
- implications of Tranz Rail outsourcing infrastructure maintenance. Tranz Rail had recently announced the outsourcing of infrastructure maintenance to Transfield Services Limited
- a series of recent occurrences on the Tranz Rail network especially [a] the continuing incidence of heat buckle derailments and [b] derailments due to washouts/slips
- recent LTSA field observations of infrastructure non-compliance incidents, especially in relation to continuous welded rail
- the effectiveness of:
    - infrastructure asset management
    - audit processes (the audit processes are as set out in the Transport Services Licensing Act 1989, and as further described in the LTSA publication Rail Safety Licensing and Audit Guidelines).

1.12.2 Some of the key conclusions in the review report relevant to the rail regulatory system are included below:

- the various documents that comprised the codes and standards were a mixture of standards, work procedures, work instructions, quality control and background information
- changes to codes and standards were managed through a number of technical committees. The process of incorporating changes to infrastructure assets did not appear to comply fully with the procedures outlined in Tranz Rail's Q360 Change and Risk Manual. There was no process for monitoring the effectiveness of changes
- there were now a number of different operators and maintainers on the Tranz Rail network. Codes and standards were therefore required to support a range of business objectives. As one of these operators, Tranz Rail may not been seen to be sufficiently independent to maintain the codes and standards.

1.12.3 Land Transport NZ was not able to say what action it had taken in response to the review. The review did not include the outsourcing of the mechanical maintenance contract for Tranz Rail's locomotives and rolling stock assets that was occurring at the same time.

2 Analysis

The incident

2.1 Train 4356 did not stop at the conditional stop board because the locomotive engineer could not advance the auto brake valve beyond the minimum application position. The event recorder confirmed that during a 30-second period the brake handle had been moved between Release and the limit of the minimum position several times, which was consistent with the actions later recalled by the locomotive engineer and the train manager. The event recorder also showed that the locomotive engineer was responding to the vigilance system within acceptable tolerances, indicating that he had situational awareness in the period leading up to the incident.

2.2 While a temporary fault within the auto brake valve could not be ruled out, the evidence pointed to the fault lying in the construction and wear and tear noted with the auto brake valve handle. The brake handle displayed signs of heavy wear and looked like it was not an originally manufactured handle. The handle was made from mild steel as opposed to cast steel, its detent plunger was constructed differently in that it did not have a lower bevelled profile, and it was retained with a roll pin as opposed to a screw. The 2 areas of grinding seen near the shank were probably required at some time to allow full movement around the auto brake valve quadrant prior to installation on SD5811.

2.3 The wear exhibited by the handle suggested that it had seen more usage than the 5½ weeks that it had been in service on SD5811. This suggested that brake handles could have been locally manufactured in New Zealand prior to the batch manufactured to cover the supply shortfall that had been discovered on the imported second-hand auto brake valves. Wear of the detent plunger could have caused it to stick in the indent on the quadrant, or could have caused the detent plunger to jam in its housing, preventing it compressing against the spring pressure and ramp over the indent on the quadrant. Any one or a combination of these 2 scenarios, or an unknown and ultimately undetected fault within the auto brake valve, could have prevented a service brake application, as happened on the day of the incident.

2.4 Time constraints were the most likely factor in choosing the local manufacturing option of the brake handles to cover the supply shortfall. Instead of using an existing brake handle as a template, Toll Rail should have either ordered proprietary handles from an overseas supplier or obtained proper technical drawings from which the new handles could have been manufactured, followed by a quality assurance process to ensure they were fit for purpose.

2.5 Toll Rail arranged the manufacture of brake handles that were not subjected to a proper design, examination and certification process. Although the detent plunger's main role was to provide resistance on the brake valve quadrant, it also had to be free enough for it to travel axially within the handle grip so it would climb over the impressions on the brake valve quadrant during brake applications. It was therefore critical that the correct semi-circular profile was created and maintained on the detent plunger so it could operate effectively.

2.6 The SA/SD consists were required to make frequent stops on Auckland's suburban rail system and therefore auto brake valves and associated handles were subjected to high usage during a working day. However, unlike the auto brake valve, the brake handles were not considered a separate maintenance item requiring periodic checks. The current air brake check procedures only required the handle to move freely while still attached to the spindle. These checks were more for the operation of the auto brake valve than an independent check of the handle, so the contact area on the detent plunger and its movement within the handle grip were not independently assessed and tested.

2.7 To ensure continuing correct operation, brake handles, even though they were a relatively simple mechanism with only a few moving parts, should have been checked against a code standard to ensure the correct profile on the plunger. Any defect or abnormal wear issues could have been addressed and corrected under controlled conditions at that time. A safety recommendation has been made to the Director of Land Transport NZ to have rail licence holders operating the 26-C auto brake valve include a specific examination of brake handles to address this issue.

2.8 A second-hand auto brake valve had been installed in SD5811, of which Toll Rail had no maintenance history, and a non-standard locally manufactured brake handle was used to operate it; consequently the chances of the brake system failing in some way were greater. These matters should have been documented to the regulator as variations to the safety case, but it was apparent that there was no record of this occurring. The brake system was signed off as having been put through a successful full code test. Finally, and when the SA/SD consist had been constructed, the NRSS was unclear as to what factor drove the choice of either testing an individual car or testing a complete train consist to comply with the rail vehicle braking performance requirement, or for that matter, if both tests were required. A robust design, maintenance and testing system would not have followed the practices adopted during the construction and commissioning of these SD driving trailers in respect of the braking system.

2.9 The braking system on any transport vehicle is critical to its safe operation. The maintaining and tracking of components in critical systems are vital for safe operation, and the modification or replacement of components with non-standard parts should not be done without at least consulting the manufacturer. In light of these events and knowing that there is a continuing development plan of SA/SD consists through to 2011, a safety recommendation has been made to the Director of Land Transport NZ to ensure the appropriateness of Toll Rail's safety case for the procurement, installation, examination and passing out of auto brake valves and handles and other safety-related equipment installed on SD driving trailers.

2.10 The locomotive engineer was able to stop his train on this occasion without damage or injury, but if the situation had developed while driving in the pull mode, the outcome could have been different. Although the supervisor and manager from Connex made a successful test of the brakes subsequent to the incident, they had no way of knowing the real cause of the braking failure. To continue the service to Britomart without an examination by an air brake fitter, then subsequently operate the train with passengers on board to Papakura was, under the circumstances, unwise. As a result of rail occurrence report 05-128, the Commission recommended to the General Manager of Veolia that he define clearer guidelines for staff dealing with a train becoming defective while in service. The recommendation is equally applicable to this incident and therefore no new safety recommendation has been made.

The EPP

2.11 The EPP concept was restricted to the Auckland suburban area only. Operating rules and procedures had been changed to require locomotive engineers to stop their trains at conditional stop boards. These changes had been introduced shortly before this incident to improve procedures following a series of operating incidents across the network, a number of which had been investigated by the Commission. A prerequisite of the approval process for the use of conditional stop protection arrangements anywhere on the network was that local radio coverage had to be proved across the worksite.

2.12 Existing engineering rules required a manned protector to hold a licence to operate and to be equipped with a multi-channel portable radio (or if convenient, a vehicle radio) together with other safety equipment. In this event, it was pointless the EPP flagging down the train because the locomotive engineer could not stop his train. The locomotive engineer was aware of the conditional stop board, but was preoccupied with trying to stop his train. Some value the EPP could have provided was advance warning to the PIC that a train had passed the boards without stopping, but on this occasion he did not use the quickest means, the radio. This was later explained because the EPP saw the train stopping. Notwithstanding this, a radio call would have been prudent to alert all those listening to a potential risk.

The SA/SD project

2.13 The project to design and construct the SA/SD consists was a large and complex undertaking for Toll Rail's mechanical engineering section. There was little institutionalised knowledge within the business of the dynamic forces inherent in consists with heavy locomotives propelling comparatively lightweight passenger vehicles at speeds up to 100 km/h. Historically, passenger trains in New Zealand made up of un-motorised passenger vehicles were pulled in the direction of travel.

2.14 It was understandable that Toll Rail decided to standardise control systems in the cabs of SD driving trailers with air braking equipment and control systems similar to those already in use. The fitting out of the cabs with auto brake valves that replicated a general locomotive cab layout was logical and was recommended in the NRSS as being the preferred system for use in New Zealand. Although the Auckland diesel multiple unit fleet was equipped with an electro-pneumatic braking system to operate the brakes, the decision to use only a pneumatic system on the SA/SD trains meant a simpler fit-out in SD driving cabs and little modification to the leased locomotives.

2.15 However, the statements made in the NRSS sections 9.7 and 9.8 (see paragraph 1.9.2 of this report) regarding the standards of braking system indicate that performance and mechanical standards in New Zealand may have been to a certain degree "locked in time" and not promoted the use of more modern systems. This was supported by Toll Rail's description of the certification process, where it referred to keeping the system simple with as few changes as possible. The braking system chosen was adequate for the intended purpose had it been maintained and installed in line with sound engineering practice.

2.16 Typically, standards set by a national regulator should specify the minimum performance standards with which systems should comply, rather than be built around a particular system. The NRSS had been designed around the historical and current operating regime in New Zealand rather than what is current or best practice for suburban commuter trains by modern standards. Also, the NRSS evolved from a self-regulated system where one entity virtually controlled the entire railway system. Comment from Toll Rail in paragraph 1.10.1 of this report that one part of the NRSS was based around standards for enthusiast operated 'heritage vehicles' supports the Commission's suggestion that the standards were not appropriate for today's rail system.

2.17 A robust set of standards should cover, for example, provisions for redundancy of critical systems that might not be "failsafe" in generic terms, so that any system chosen by an operator could be measured against those standards. The higher-level standards belong under the control of the regulator, or at least the regulator should have some control over the setting and review of the standards in partnership with the stakeholders. Operators' safety systems then have to at least ensure compliance with those standards over which they do not have sole control.

2.18 The SA/SD project framework that Tranz Rail then Toll Rail initially followed was detailed in operational level documentation, but without the overarching strategic NRSS document being applicable. This meant that without a documented explanation of the role of the certifying engineer, the responsibility fell by default to the engineer in charge of the design team who signed off the stages of production and issued the final statement of compliance.

Regulatory framework and independent overview

2.19 The rail transport business in Auckland was relatively complex with 5 separate agencies, each having separate responsibilities in equipment ownership, operational resourcing, maintenance, station maintenance and network maintenance and access control. Only 3 of these 5 agencies held rail safety licences. These agencies all needed to merge their efforts and provide a fluent transport alternative for the city's commuters. Overseeing all this change was a co-regulatory system that tended toward a "hands-off policy" by the regulator, but which required the businesses to cooperate safely in compliance with NRSS interoperability policies. These interoperability arrangements were still a relatively new concept to some of these entities and it was possible there was some uncertainty in interpreting this policy.

2.20 One of the fundamental principles of Land Transport NZ's guidelines was that participants in the rail industry had to demonstrate continuous safety improvement. The understanding behind this principle was that rail participants were in the best position to identify safety initiatives and improvements in safety. While the concept of push-pull trains was essentially safe, they were new to New Zealand and should have been introduced with an independent certification process at important stages during the project.

2.21 By adopting essentially a "hands-off" approach, the regulator was reliant on the rail participants' business cultures fostering and initiating safety improvement from within the organisations. However, the introduction of the push-pull passenger train concept was driven by commercial and financial influences rather than a generic example of an overall improvement in safety. The SA/SD sets were seen as a cost-effective and relatively speedy solution to meet the current and future demand for passenger-carrying capacity in Auckland. The leased diesel locomotives, designed originally to mostly haul freight trains at speeds of 55 km/h and 80 km/h, offered an expedient solution in the absence of an already established alternative such as electric traction that required the installation of overhead catenary and an electricity reticulation system.

2.22 There were examples in other countries where push-pull passenger trains had provided a safe and efficient passenger transport option, albeit on different track gauges, with different motive power and over different terrain.

2.23 It was under the auspices of Tranz Rail's M3000 design manual that the design and construction of the SA/SD consists started. However, this document and the NRSS that followed had no allowance for any independent overview to ensure that standards were being complied with at critical stages of design and construction. In comparison, if this had been a New Zealand-based project to build a new design of bus, passenger ship or aircraft, an independent certification would have been required under the auspices of the respective mode regulator to ensure that standards were being met and that safety-critical components were properly fitted and were fit for purpose. Comments made in the LTSA-sponsored review supported the Commission's view that there should have been some independent review of the design and construction of the SA/SD consists.

2.24 The self- or co-regulatory policy applicable to the rail industry in New Zealand differed from that in Australia, for example, where regulators, if they chose to follow the Australian standard, could perform independent verifications and validations at critical stages throughout a project. In the case of the prototype SA/SD consist, Toll Rail issued its own statement of compliance after it had sought approval from Land Transport NZ. The statement of compliance acknowledged outside specialised assistance in recognition of Toll Rail's limited knowledge of the dynamics of push-pull trains and their effects on track infrastructure. The statement claimed that Interfleet had confirmed acceptance of Toll Rail's "approval process", yet on inspection it was apparent that Interfleet's involvement was more to do with the concept.

2.25 The rail vehicle braking performance tests conducted on some individual carriages did not meet the standards set out in the NRSS. For completeness, it would have been advisable for Toll Rail to conduct certification brake performance testing on whole SA/SD consists as they were to be configured in service. The Commission's interpretation was that this was a requirement, or at least the intent, of the NRSS, even though Toll Rail did not agree. Second-hand auto brake valves that had not been thoroughly examined and sub-standard manufacture of the replacement brake handles were examples of safety-critical equipment that was passed out as being fit for purpose.

2.26 Currently as the rail system sits, the NRSS is kept and administered by Ontrack, which is one of several main participants in the rail system. The NRSS refers to the Toll Rail standards and practices as the default in the absence of other "sound alternative" standards included in another operator's rail safety system. Ontrack, as the Access Provider, considered Toll Rail competent to provide certification for the SA/SD consists. While not doubting Toll Rail had the technical knowledge to provide this service, having the project leader, with time and resource constraints to deal with, have the final sign-off for compliance added another level of risk that could have been mitigated by the regulator having or requiring an independent overview of the construction and commissioning project.

2.27 Having national rail standards under the state control of the participants in the rail system adds another level of risk. The rail industry in New Zealand has and continues to undergo some rapid change. Ownership of the infrastructure is now with the state and there are 4 major operators, as well as 71 minor operators. The industry is becoming more aligned to the other modes of transport in New Zealand. The self-regulatory system of the past served the rail industry well in earlier years. The co-regulatory approach explained by Land Transport NZ in its guidelines document could have worked depending on the level at which the regulator decided to get involved, which was dependent on its resources and ability to do so.

2.28 Figure 11 shows an example of the generic principle where the regulator is actively involved in industry oversight where vested commercial interest is potentially in conflict with public vested interest in having a safe transport system. The maritime and aviation industries in New Zealand and the rail industry in Australia are examples of where that generic principle has been applied. The Commission supports a similar approach for the rail industry in New Zealand.

2.29 While the single failure of a brake mechanism as described in this report might not at first appear to be serious, the Commission's investigation into the building and commissioning process for the SD/SA sets revealed systemic issues with the level of regulatory oversight of the rail system. The recommendation made to the Director of Land Transport NZ, common to the Commission's published reports 06-101 and 06-102 (see section 1.9 of this report), indicates that there are other issues surrounding repair and maintenance that require the regulator to adopt a more strategic approach to risk management of the rail industry.

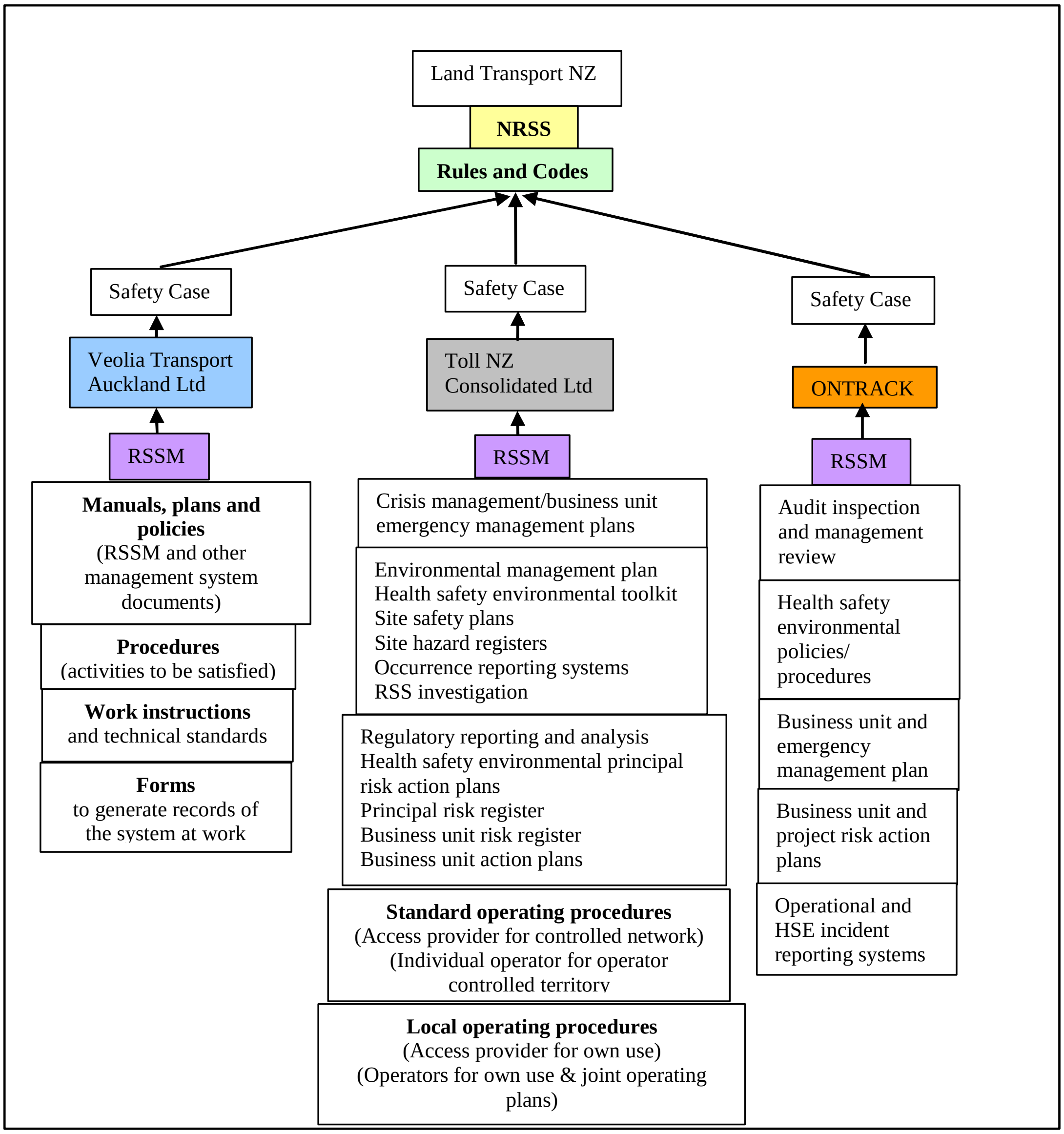

Figure 11
Example of generic rail safety system with appropriate regulatory oversight

2.30 The Commission is of the opinion that the level of regulatory oversight and intervention of the rail industry has not kept pace with the rapid change that has occurred within the industry in recent years. A consequence of a transport regulatory system not being compatible with the level and type of activity being regulated can be to raise the risk profile of that activity. The Commission has made a safety recommendation to the Director of Land Transport NZ to address this issue.

3 Findings

Findings are listed in order of development and not in order of priority.

3.1 The locomotive engineer of Train 4356 had his train under control and at an appropriate speed to stop before reaching the conditional stop board marking the southern limit of the work area.

3.2 Train 4356 was unable to stop at the conditional stop board due to a malfunction in the train braking system. The malfunction could have been within the 26-C auto brake valve, but the evidence points to it being caused by the brake handle that controlled the auto brake valve, jamming on the valve quadrant due to poor design, construction and maintenance.

3.3 The EPP assigned to a backup level of protection for the work gang was not effective because he had not been provided with a radio to communicate with the person in charge of the work gang and warn them of the train overrun, nor did he use the other means of communication he had been given.

3.4 More detailed control measures, incorporating an examination of Train 4356 by an air brake fitter before it departed Meadowbank and diverting the train away from Britomart, should have been followed to prevent passengers being conveyed on a defective service.

3.5 A number of decisions made during the building and commissioning of the SA/SD concept increased the risk of the safety-critical brake system failing:

- to fit a second-hand auto brake valve of unknown history without examination or overhaul
- to fit a non-standard auto brake valve handle
- to not conduct a full dynamic brake test of the complete consist prior to signing off the concept.

3.6 An appropriate level of regulatory oversight and intervention would have resulted in a more robust programme for commissioning the new concept of push-pull suburban passenger train operations in New Zealand.

3.7 The rail regulatory system in New Zealand, where the rail participants set, own and measure their own compliance with minimal intervention from the regulator, poses a risk to public safety because vested commercial interests are potentially in conflict with the public's right to a safe rail system.

4 Safety Actions

4.1 On 25 July 2006, Toll Rail advised in part that:

> Subsequent investigations found some brake valves for the SD trains had been supplied without brake handles. As a result handles were manufactured through Hillside Workshops but have been found to have had profile deficiencies that had potential to inhibit fluent operation of the air brake.
>
> These brake handles are being replaced and workshops personnel have been made aware of the need to ensure compliant equipment is installed.

4.2 On 20 September 2006, Toll Rail advised in part that:

> The procedural failure [the non examination of the 26 C brake valve in SD5811] has now been rectified and all non original equipment manufactured imported brake valves are fully tested at United Rail Hutt (Brake Group) before being installed.
>
> The practice [of manufacturing handles by copying other handles] has been stopped and only original handles are now used.

5 Safety Recommendations

Safety recommendations are listed in order of development, not in order of priority.

5.1 On 14 March 2007 the Commission recommended to the Director of Land Transport NZ that he:

5.1.1 Ensure that Toll Rail's safety case covers procedures for the procurement, installation, examination and passing out of auto brake valves and handles and other safety related equipment installed on SD driving trailers are appropriate to confirm that such equipment was fit for purpose. (002/07)

5.2 On 28 March 2007 the Director of Land Transport NZ replied in part:

> As discussed with Commission staff we included the review of Toll Rail procedures for the installation of certification of SD car brake and other safety related equipment in the ordinary safety assessment of Toll Rail.
>
> An assessment was carried out in the Wellington Professional Services Group Office on 14 & 15 March 2007 and a further assessment will be carried out in Hillsides Workshops on 4 & 5 April. At this point the safety assessment report has yet to be received by Land Transport NZ.

5.3 On 26 September 2007 the Commission recommended to the Director of Land Transport NZ that he require rail participants to:

5.3.1 Schedule planned maintenance programmes for the examination of automatic air brake valve handles to ensure correct operation. (005/07)

5.4 On 27 September 2007 the Director of Land Transport New Zealand replied in part:

> Land Transport NZ accepts this recommendation.

5.5 On 26 September 2007 the Commission recommended to the Director of Land Transport New Zealand that he:

Note the failures of the regulatory system to detect shortcomings in the maintenance of infrastructure (as presented in the Commission's report 05-116: collapse of the Nuhaka Bridge under a work train) and shortcomings in the construction and commissioning process for newly modified rolling stock
(as presented in this report), and;

Take a more strategic approach to risk management of the rail industry, and in particular take more of a leadership role in setting, changing and monitoring compliance with national standards for rail infrastructure and rolling stock, and the interaction between these components of the rail system. (035/07)

5.6 On 26 September 2007 the Director of Land Transport New Zealand replied in part:

> Land Transport NZ has recently reviewed its regulatory activities within the co-regulatory New Zealand rail system and plans to take a more strategic, proactive and risk based approach in its monitoring of, and involvement with, the rail industry. Land Transport NZ notes the failure of the maintenance system that led to the collapse of the Nuhaka Bridge and in the commissioning and construction process associated with the construction of SD passenger cars, as outlined in the TAIC reports.

Approved on 20 September 2007 for publication

Hon W P Jeffries
Chief Commissioner

Recent railway occurrence reports published by the Transport Accident Investigation Commission (most recent at top of list)

05-124	express freight Trains 834 and 841, collision, Cora Lynn, 20 October 2005
06-112	loss of airbrakes and collision, Tram 244, Christchurch, 21 November 2006
06-102	SA/SD passenger Train 4306, braking irregularity, between Westfield and Otahuhu, 31 March 2006
06-101	diesel multiple unit passenger Train 3163, fire in diesel auxiliary engine, Manurewa, 15 March 2006
05-127	Mainline shunting service M52, track occupation irregularity, Te Rapa, 27 October 2005
05-120	Express freight Train 142, runaway wagons, Mercer, 1 September 2005
05-128	Diesel multiple unit Train 3056, passenger injury, Papatoetoe, 31 October 2005.
05-125	Taieri Gorge Railway passenger Train 1910, train parting, Dunedin, 28 October 2005
05-118	Express freight Train 245, derailment, Ohingaiti, 27 July 2005
05-115	Empty passenger Train 2100, train parting and improper door opening, Ranui, 1 April 2005
05-108	Diesel multiple unit passenger Train 3334, fire, Auckland, 23 February 2005
05-126	Express freight Train 246, derailment, South Junction, 30 October 2005
05-103	Express freight Train 237, derailment, 206.246km Hunterville, 20 January 2005
05-121	Express freight Train 354, near collision with school bus, Caverhill Road level crossing, Awakaponga, 2 September 2005
05-112	Hi-rail vehicle passenger express Train 200, track occupancy incident, near Taumarunui, 7 March 2005
05-111	Express freight Train 312, school bus struck by descending barrier arm, Norton Road level crossing, Hamilton, 16 February 2005
05-109	Passenger Train "Linx" and "Snake", derailments, Driving Creek Railway, Coromandel, 20 February 2005 - 3 March 2005

Price $ 32.00 ISSN 1172-8280