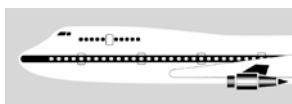


## RAILWAY OCCURRENCE REPORT

06-102

SA/SD passenger Train 4306, braking irregularity, between Westfield and Otahuhu

31 March 2006



**TRANSPORT ACCIDENT INVESTIGATION COMMISSION  
NEW ZEALAND**

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

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## **Report 06-102**

### **empty passenger Train 4306 automatic air brake irregularity**

#### **Westfield-Otahuhu**

**31 March 2006**

### **Abstract**

On Friday 31 March 2006 at about 0520, 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.

There was no damage or injuries.

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.

Because of safety actions taken by Toll NZ Consolidated Limited, no safety recommendations have been made. The Commission made a safety recommendation to the Director of Land Transport New Zealand as a result of Rail Occurrence Report 06-101, relating to the tracking and monitoring of safety-critical components. This recommendation is equally applicable to this occurrence, so no new safety recommendation has been made to address this issue.



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## Abbreviations

ARTA	Auckland Regional Transport Authority
CPR	Canadian Pacific Railroad
FRA	Federation of American Railroads
km	kilometre(s)
km/h	kilometre(s) per hour
kPa	kilopascal(s)
Toll Rail	Toll NZ Consolidated Limited
United	United Group Limited
USA	United States of America
UTC	co-ordinated universal time
Veolia	Veolia Transport Auckland Limited

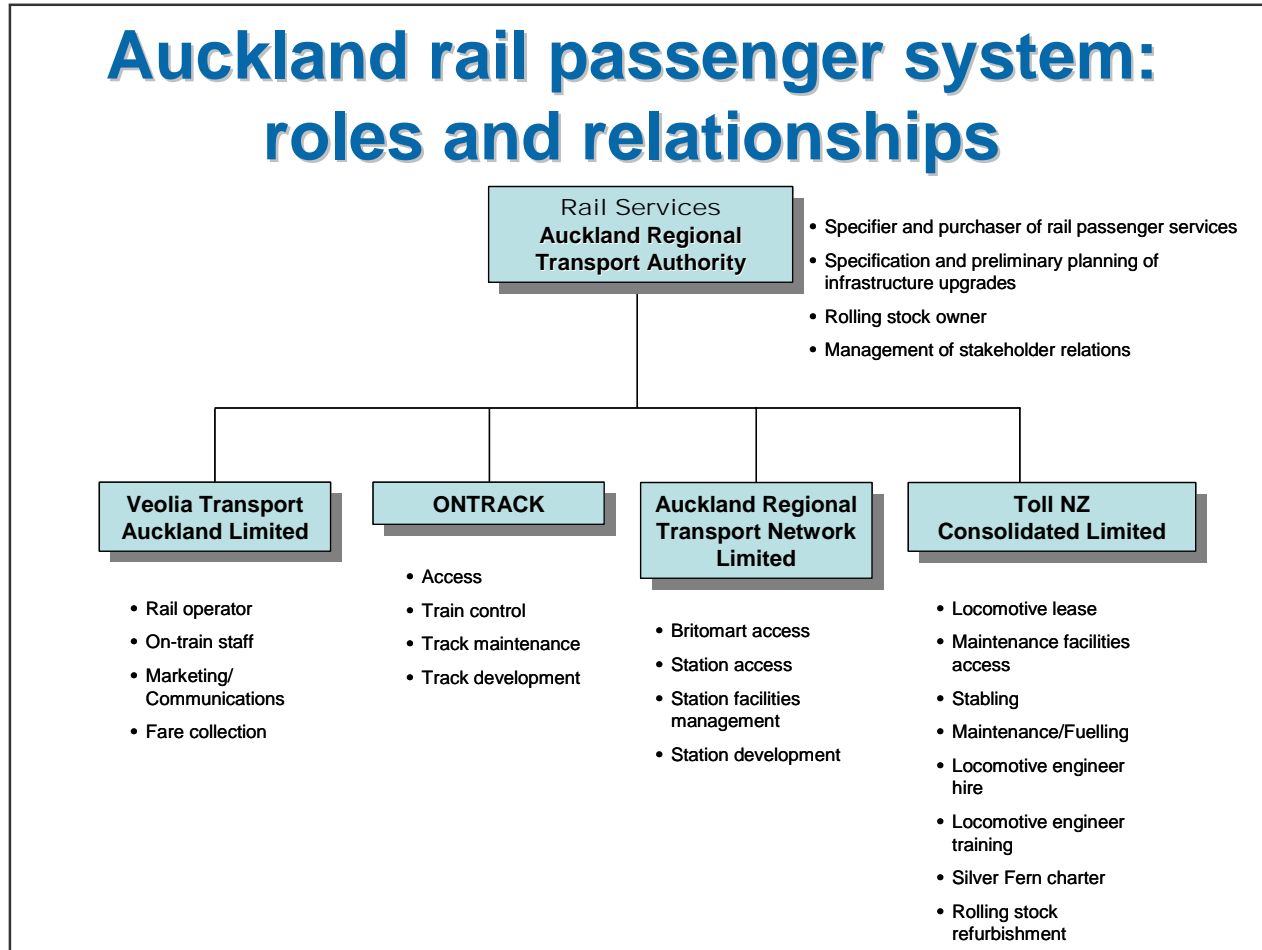
## Data Summary

<b>Train type and number:</b>	empty passenger Train 4306
<b>Locomotive:</b>	DC4375
<b>Year of locomotive's manufacture:</b>	1955 by General Motors of Canada
<b>Year of locomotive's rebuild:</b>	1978 by Clyde Engineering of Australia
<b>Date and time:</b>	Friday 31 March 2006 at about 0520 <sup>1</sup>
<b>Location:</b>	Westfield-Otahuhu
<b>Persons on board:</b>	crew: 2 passengers: nil
<b>Injuries:</b>	nil
<b>Damage:</b>	nil
<b>Operator:</b>	Veolia Transport Auckland Limited
<b>Investigator-in-charge:</b>	Vernon Hoey

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<sup>1</sup> Times in this report are New Zealand Daylight Time (UTC +13) and are quoted in the 24-hour mode.

# Auckland rail passenger system: roles and relationships





# 1 Factual Information

## 1.1 Narrative

- 1.1.1 On Friday 31 March 2006, Train 4306 was a scheduled Veolia Transport Auckland Limited (Veolia) diesel electric locomotive-operated passenger service being positioned from Westfield to Britomart via Otahuhu to begin passenger operations for the day.
- 1.1.2 The service was crewed by a Toll NZ Consolidated Limited (Toll Rail) locomotive engineer<sup>2</sup> and a Veolia train manager.
- 1.1.3 Train 4306 consisted of a driving trailer equipped with a driving cab; 3 passenger carriages; and a locomotive that provided motive power (see Figure 1).



**Figure 1**  
**SA/SD consist**

- 1.1.4 The train left Westfield at about 0510 in the push mode. During the short journey to Otahuhu, the locomotive engineer noticed the braking effect to be “extremely poor” when he applied the air brakes from driving trailer SD3199 to slow and stop the train.
- 1.1.5 After the train had stopped at Otahuhu, the locomotive engineer cut out<sup>3</sup> the brakes on SD3199 and walked to DC4375 at the rear, checking the carriage brakes on the way. When he reached DC4375, the locomotive engineer saw the brake blocks on the locomotive were released from the wheel treads, whereas he knew that they should have been in contact.
- 1.1.6 The locomotive engineer entered the locomotive cab and cut in<sup>4</sup> the brakes on DC4375. After the air pressure had been fully recharged, he applied the brakes but saw that the brake cylinder gauge registered zero pressure. He then increased the brake reduction to full service, which raised the brake cylinder gauge reading to 200 kilopascals (kPa). He repeated the brake applications with differing results, but noted that a minimum brake application consistently registered zero pressure on the brake cylinder gauge.
- 1.1.7 From these results, the locomotive engineer concluded that the air brakes were not functioning correctly. The locomotive engineer returned the consist at slow speed to the maintenance depot at Westfield, using the locomotive’s independent<sup>5</sup> air brake.
- 1.1.8 DC4375 was removed from the consist for examination.

<sup>2</sup> Toll Rail provided the locomotive engineer in accordance with contractual arrangements with Veolia.

<sup>3</sup> The action required to shut down control of the air brake operation on an auto brake valve.

<sup>4</sup> The action required to start up control of the air brake valve on an auto brake valve.

<sup>5</sup> The part of a locomotive’s air braking system that can operate the brakes on the locomotive(s) only without affecting the brakes on any coupled vehicle(s).

## 1.2 Site information

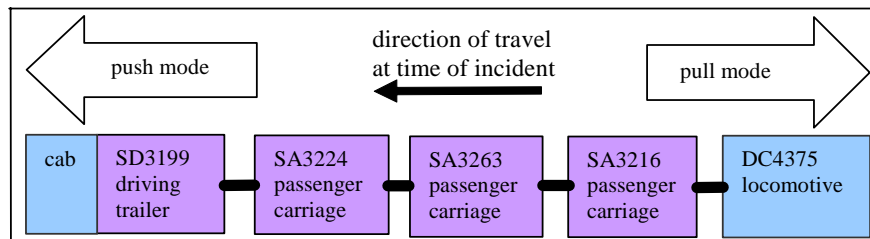
1.2.1 The movement travelled via Toll Rail's controlled area at Westfield to ONTRACK's controlled network at Otahuhu. The maximum authorised speed was 25 kilometres per hour (km/h).

## 1.3 Train 4306

### Consist

1.3.1 In June 2003, the Auckland Regional Transport Authority (ARTA) contracted Toll Rail to convert a fleet of ex British Rail Mk 2 carriages into 4-car push/pull consists for suburban passenger operation in Auckland.

1.3.2 ARTA's asset list recorded the consist as set No.4, made up of passenger vehicles permanently coupled together (see Figure 2). Set No.4 entered service on 26 January 2005.



**Figure 2**  
**Plan of Train 4306 (not to scale)**

1.3.3 DC4375 was not permanently allocated to the consist because locomotives were regularly exchanged between consists for servicing and maintenance.

1.3.4 The tare weight of Train 4306, including DC4375, was about 210 tonne.

### DC4375

1.3.5 The history of DC4375 was:

- 1955: built by General Motors Limited of Canada and classified as DA1450
- 1978: sent to Clyde Engineering in Australia for rebuilding and reclassified as DC4375
- 2000: withdrawn from service and stored.

Toll Rail advised that during the rebuild in 1978 the air brake piping on DC4375 was scheduled to be replaced but some of the original piping could have been retained.

1.3.6 On 29 May 2004, Tranz Rail, the predecessor to Toll Rail<sup>6</sup> issued Specification No.347 to Alstom Transport New Zealand Limited<sup>7</sup> to reinstate and refurbish four DC class locomotives to operate SA/SD<sup>8</sup> trains under a lease arrangement with ARTA.

<sup>6</sup> Toll Rail took control of the rail business on 5 May 2004.

<sup>7</sup> Alstom Transport New Zealand Limited was contracted to provide inspection and maintenance services for rolling stock to standards set by Tranz Rail and subsequently Toll Rail.

<sup>8</sup> SA/SD were the classifications given to the vehicles and was the term used to describe the coupled consist.

1.3.7 DC4375 was one of the 4 locomotives selected from storage and was refurbished at Hutt workshops near Wellington during 2004 to provide a 10-year service span. As part of the refurbishment, the following work on the air brake equipment was scheduled to be done:

**8 Brake and Air**

- Refurbish compressor in accordance with MI 1110
- Purchase replacement 26C automatic brake valves (used)
- Refurbish brake suite:
  - 26C automatic brake valve
  - MU-2A valve
  - SA26 independent brake valve
  - 26D brake control valve [incorporating the 26-F valve]
  - J1 relay valve
  - flow meter valve
  - sanding valves
- All refurbishments in accordance with Westinghouse Brake Refurbishment Instructions
- Convert 26C valve to support graduated release function<sup>9</sup> if not already so equipped
- Carry out double check valve inspection as per FMI 1043

**12 Test and acceptance**

- Perform full brake code test and safety inspection (pass out)

1.3.8 Toll Rail advised that the air brake piping was inspected and tested for leakage during the refurbishment.

1.3.9 At the end of its refurbishment on 22 June 2004, DC4375 underwent and passed an air brake test at Hutt workshops and was re-commissioned for service. Between its re-commissioning and the date of the incident, DC4375 passed the following scheduled air brake code checks:

<b>Date</b>	<b>Check</b>	<b>Type of air brake test</b>
31 October 2004	A	Operating efficiency test
26 February 2005	B	Operating efficiency test
16 July 2005	A	Operating efficiency test
15 October 2005	C	Full brake test
23 January 2006	A	Operating efficiency test

---

<sup>9</sup> An additional feature of the air braking system that provided a smoother application/release of the brakes for passenger comfort.

### **Locomotive event recorder**

- 1.3.10 Data downloaded from the event recorder on DC4375 for the journey from Westfield to Otahuhu and return showed the following:
- the speed of the train did not exceed 24 km/h
  - the train stopped several times when travelling in both directions
  - the locomotive was not responding consistently to brake pipe reductions
  - the fault occurred irrespective of which end of the consist the brake pipe reductions were made
  - the locomotive was responding correctly to independent brake applications
  - the J1 relay valve appeared to be working correctly as evidenced by a consistent response when the independent brake was used.
- 1.3.11 The event recorder from DC4375 was also interrogated for evidence of previous similar braking incidents, but nothing was found.

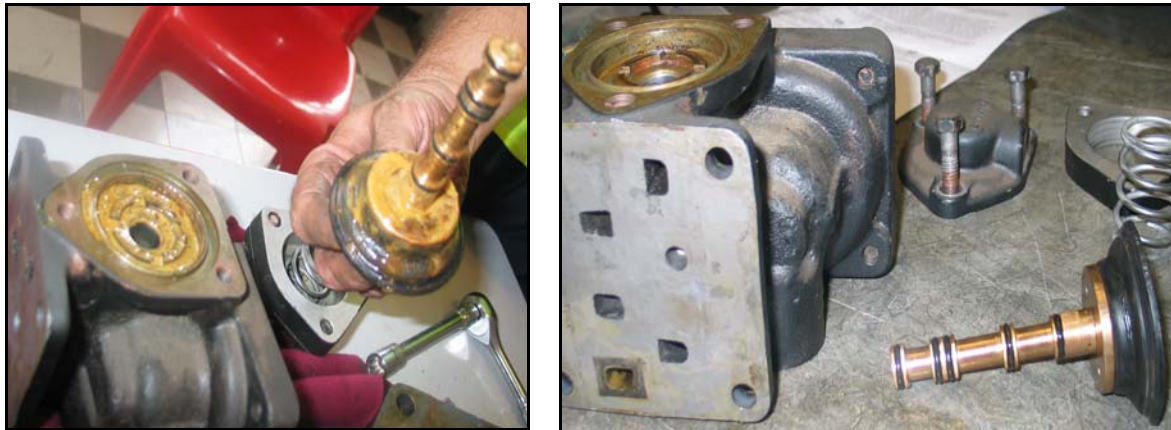
### **Post-incident examination of DC4375**

- 1.3.12 After withdrawal from service on 31 March 2006, DC4375 was initially examined at Westfield by Toll Rail in an attempt to replicate the fault as reported by the locomotive engineer. This was a procedural response to this type of fault, and following the examination DC4375 was impounded pending the Commission's investigation.
- 1.3.13 On 4 April 2006, with the Commission's investigator in attendance, DC4375 underwent an air brake test incorporating the operation of the automatic air brake valve and independent air brake valve. The test was successfully completed with no fault found and the results were recorded on an air brake code test sheet.
- 1.3.14 The examination then focused on the operating condition of the brake control valves located in the brake control valve cabinet in the short hood of DC4375 (see Figure 3). The brake control valves were removed and disassembled for inspection.



**Figure 3**  
**Brake control valve cabinet of DC4375**

- 1.3.15 When the 26-F quick-release brake control valve (26-F valve) was disassembled, it was found that the spindle actuating the small diaphragm in the quick-release portion was sticking intermittently in response to manual pushes. The spindle was removed from its bore and an emulsion of oil and water was found in the area below the diaphragm and along the spindle (see Figure 4).



**Figure 4**

**Contaminated valve spindle/diaphragm, left, with clean spindle/diaphragm for comparison on right**

- 1.3.16 The space between the housing and the diaphragm would normally be dry, with only residues of lubricant present. However, the oil-water emulsion had found its way into the quick-release portion of the valve body, causing the intermittent sticking of the spindle.
- 1.3.17 A replacement 26-F valve was sourced from inventory and fitted to DC4375 and the locomotive was returned to service.

**54D book entries from DC4375**

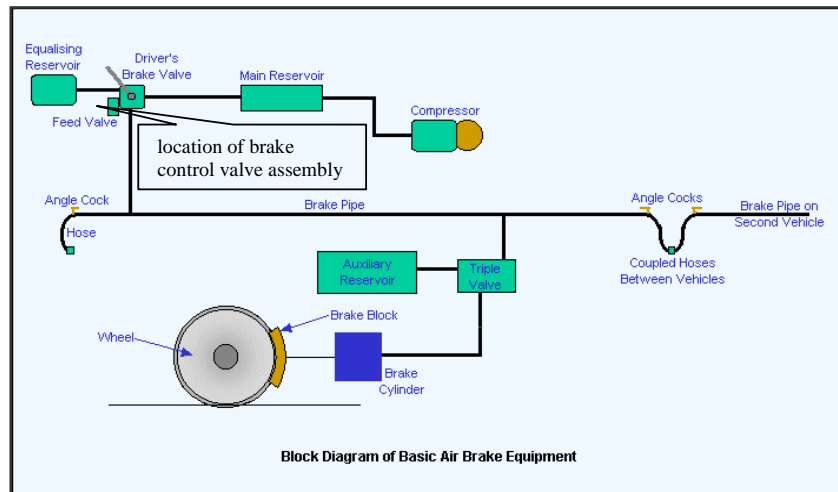
- 1.3.18 Locomotive engineers were required to record in the 54D book details of faults or problems encountered on locomotives that they were driving. In the 20 months leading up to the incident, braking faults were recorded in the 54D book on DC4375 as follows:

<b>Fault date</b>	<b>Nature of fault</b>	<b>Date repaired</b>	<b>Nature and comment on repair</b>
9 Dec 2004	Independent brake not applying when using the automatic brake	9 Dec 2004	Brake continuity test carried out and engine brakes applied
10 Mar 2005	Brakes a tad poor on this set, to adjust/replace please	11 Mar 2005	Blocks changed and adjusted where required
8 Sep 2005	Braking on this set is not very good	8 Sep 2005	Loco blocks changed

## 1.4 Westinghouse air brake system

### On a train

- 1.4.1 The Westinghouse air brake system was a standard, failsafe train brake used by railways all over the world. It was based on the simple physical properties of compressed air. The braking system used compressed air as the force to push the blocks onto the wheel treads. The compressed air was transmitted through a brake pipe along the length of the train. Changing the level of air pressure in the pipe caused a change in the state of the brake on each vehicle. It could apply the brake, release it or hold it on after a partial application (see Figure 5).



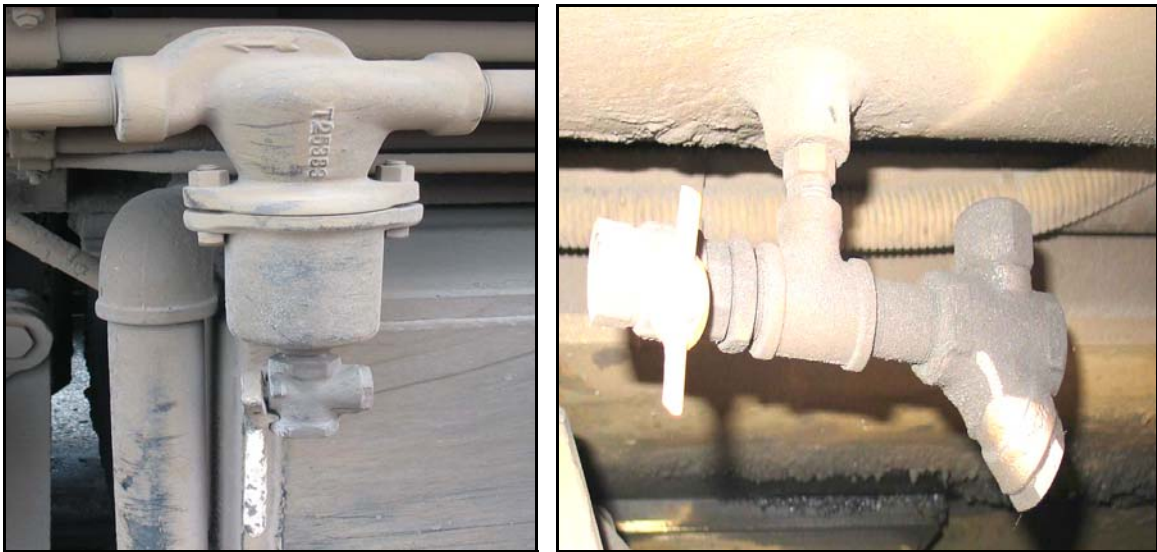
**Figure 5**  
**Diagram of basic air brake equipment**

- 1.4.2 When a locomotive engineer applied the brake, air pressure in the brake pipe escaped. The loss of pressure was detected in the triple valve on each coupled vehicle. When the pressure on the brake pipe side of the triple valve fell, the auxiliary reservoir pressure on the other side pushed a slide valve over, opening a connection between the auxiliary reservoir and the brake cylinder. Auxiliary reservoir air was then fed into the brake cylinder, forcing the piston to move against the spring pressure and causing the brake blocks to be applied to the wheels. Air would continue to pass from the auxiliary reservoir to the brake cylinder until the pressure in both was equal.

### On a locomotive

- 1.4.3 Air pressure in a locomotive was created by an air compressor. Compressors were changed out<sup>10</sup> at about 12-yearly intervals or after a locomotive had travelled about 1.5 million kilometres (km).
- 1.4.4 There were drain valves and dirt collectors installed on the air brake piping system within a locomotive. The drain valves allowed oil and water to be drained from reservoirs where they naturally collected. Drain valves were mostly automatic of the Spirax Sarco type and “spat” every few seconds to expel the oil and water. Some of the drain valves were manually operated (see Figure 6).

<sup>10</sup> The removal for reconditioning of rotatable equipment from rolling stock.



**Figure 6**  
**Manual dirt collector, left, and combined manual/automatic drain valve on right**

- 1.4.5 There was one dirt collector, 3 automatic (spitter) drain valves and 4 manual drain valves installed on DC4375. One of the drain valves was installed on the dirt collector.
- 1.4.6 The dirt collectors were designed to capture scale flaking from inside the air brake piping system and soot particles caused by carbonising from the heat generated by the air compressor. There were some variations in the number of dirt collectors installed on individual locomotives and on different classes of locomotive, but all locomotives had at least one dirt collector installed. The dirt collectors consisted of a horse-hair filter and a centrifugal dirt collector and were fitted with either drain cocks for automatic purging or a bung that allowed them to be purged manually.
- 1.4.7 At the time of the incident, the responsibility for draining the non-automatic drain valves and dirt collectors was not clearly defined in procedures. In an attempt to reduce the amount of water condensate in locomotives' brake piping, the Servicing task instruction was in the process of being amended. It was intended that whenever a locomotive was serviced, the instruction would require dirt collectors to be drained where a manual drain cock was fitted, headstock cocks to be vented briefly to expel water, and any other manual drain cocks to be operated (see Figure 7).



**Figure 7**  
**Headstock cocks, left, and condensation being expelled from a valve on right**

- 1.4.8 Toll Rail said that the North Island Main Trunk class 30 electric locomotives were fitted with Knorr-Bremse air dryers to counteract condensation. The air dryers were additional to the suite of drain valves and dirt collectors fitted to this class of locomotive. Toll Rail said that despite the dryers, the air brake systems on these locomotives were as prone to faults as on any other locomotive, possibly more so. The dryers on these did not appear to function well when excess lubricating oil was passed from the air compressor.
- 1.4.9 Work was underway to clean out the oil-fouled air dryers and to compare their performance with a different air dryer/filter recommended by Compressed Air Controls Limited. No diesel locomotives had been fitted with air dryers, although the matter had been discussed during the outsourcing of the mechanical maintenance some years previously.

### **Emergency braking**

- 1.4.10 Toll Rail's Operating Code stated in part that:

#### **1.3.5 Emergency**

When there is danger, the brake valve handle must be placed in this position immediately. Brake pipe pressure is reduced to zero and brakes apply fully. The brake valve handle MUST be left in this position until the train has stopped. At the same time sand is fed to the rails to give maximum adhesion to prevent wheelslip. This position prevents the vigilance device from cycling and on certain locomotives will put the engine speed to idle. On others, the engine may stop if the throttle is left in notch 5 or 6.

- 1.4.11 An emergency air brake button, separate from the 26-C automatic brake valve, was provided in the cab of SD3199, but not in the cab of DC4375.

### **Testing and servicing of air brake system on a locomotive**

- 1.4.12 Toll Rail's mechanical code M9103, effective 1 September 2005, required that the air brakes on DC class diesel locomotives be subjected, in part, to the following standard tests and servicing schedule:

#### **1. Servicing**

Each time the locomotive is serviced, carry out servicing test as per M9103, Section B.

#### **2. A check**

Test operating efficiency of brakes, M9103, Section B.

#### **3. B check**

Change compressor air filter. Check all brake rigging, piping, hoses and fittings for leakage and fouling. Test operating efficiency of brakes, M9103, Section B.

#### **4. C check**

Clean compressor air suction strainer. Check all brake rigging, piping, hoses and fittings for leakage and fouling. Full Air Brake Code Test to the relevant section of the Air Brake Code M9103.

#### **5. D & E check**

Clean compressor air suction strainer. Change compressor oil and test oil pressure. Clean out all dirt collectors and drain valves. Check all brake rigging, piping, hoses and fittings for leakage and fouling. Full Air Brake Code Test to the relevant section of the Air Brake Code M9103.

#### **6. Air brake check**

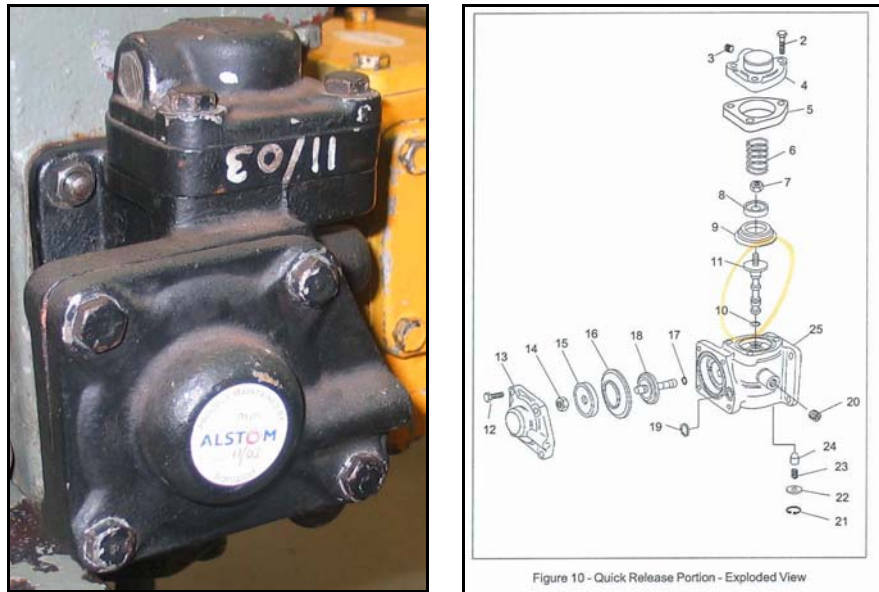
- Every 4 years
- Remove the following brake equipment and replace with refurbished units:  
26-F brake valve  
Full Air Brake Code Test to the relevant section of the Air Brake Code M9103.



- 1.4.13 The servicing test was an elementary test that occurred every time a locomotive was serviced, nominally about every 24 hours. The A and B checks were simpler brake efficiency tests and occurred at about 18 000 km, or 2 months in service.
- 1.4.14 The C check incorporated the exercise of every brake function and occurred at about 72 000 km, or 8 months in service. The results of all of the tests were recorded in the locomotive check sheet. If a valve was failed during a check, it was removed and forwarded to United Group Limited's<sup>11</sup> (United's) air brake group at Hutt workshops for repair. If a valve passed the check it was retained on the locomotive. Information relating to brake control valve change-outs on individual locomotives was retained on Toll Rail's Maximo system, which detailed maintenance and inspection activity for each locomotive.

**1.5 26-F valve**

- 1.5.1 The 26-F valve formed part of the 26-D brake control valve arrangement installed in the short hood end of DC4375. The 26-D control valve arrangement was a pneumatic device designed for use in locomotives where the air pressure did not exceed 150 pounds per square inch.
- 1.5.2 The 26-F valve responded to service and/or emergency brake pressure reductions made on the 26-C automatic brake valve handles by locomotive engineers in the cab. The reductions then developed brake cylinder pressures, by way of a relay valve, in accordance with a control reservoir pressure reference (refer Appendix).
- 1.5.3 The 26-F valve also responded to increases in brake pipe pressure to release brake cylinder pressure in a manner either consistent with a preset mode of operation or as affected by the pressure/volume relationship of the control reservoir and the selector volume reservoir.
- 1.5.4 The 26-F valve consisted of a quick-release portion and a service portion mounted on a pipe bracket portion (see Figure 8).



**Figure 8**  
**26-F valve, left, and exploded diagrammatic view of quick-release portion on right**

<sup>11</sup> United Group Limited was contracted to provide inspection and maintenance services for rolling stock to standards set up by Toll Rail. United had replaced Alstom for this contract.

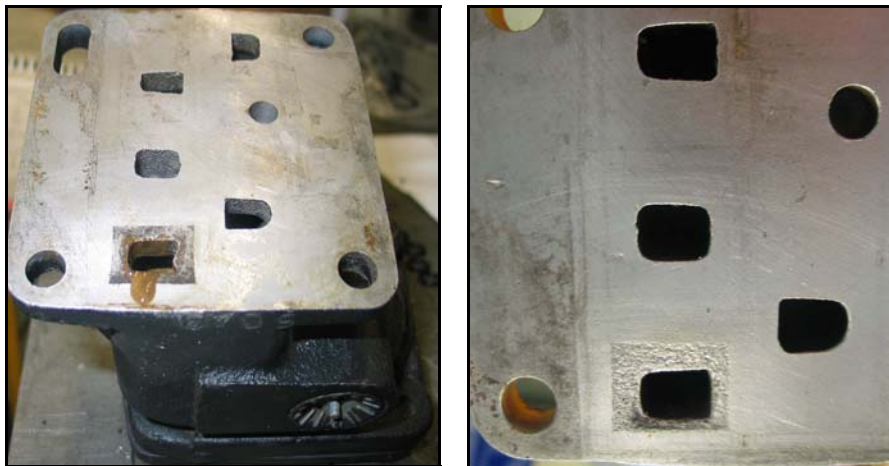
- 1.5.5 The quick-release portion of the 26-F valve was designed to permit a fast, independent release of an automatic brake application. When the locomotive engineer operated the independent brake valve handle, air pressure developed at the control brake valve would flow into the 26-F valve to operate the small diaphragm and stem assembly in the quick-release portion (parts 2 to 11 inclusive in the right-hand view of Figure 8).
- 1.5.6 The movement of the small diaphragm and stem assembly interrupted and vented to atmosphere the air pressure developed in the pipe connected to the brake cylinder and relay control valve. The operation of the small diaphragm and stem assembly also initiated the operation of the larger diaphragm and stem assembly of the quick-release portion. This action vented a sufficient amount of control reservoir air to atmosphere in order to equalise the control reservoir pressure with the brake pipe pressure.
- 1.5.7 With the control reservoir and brake pipe pressures equal, the 26-F valve restricted a reapplication of the automatic brake, even if the independent brake valve handle was released. The independent brake valve handle controlled the locomotive brake cylinder pressure on DC4375, regardless of the automatic brake valve handle positions or the state of the automatic brake throughout the train.

### Reconditioning

- 1.5.8 United's air brake group in Hutt workshops repaired and reconditioned all the brake control valves removed from locomotives following a failed test or during a scheduled change-out. The valves were stripped, inspected and cleaned, and defective parts were replaced. The valve parts were lubricated and then reassembled. The valves were tested and placed in inventory from where they could be sent to any depot for fitting on any locomotive, depending on demand.
- 1.5.9 A 4-yearly cycle for the change-out of reconditioned brake control valves was introduced in 2003. Prior to this date, there was no scheduled change-out policy and valves remained in service until they failed. Toll Rail advised that this previous policy, applied by its predecessors, had been seen as safe and cost effective but had resulted in a high number of in-service failures of locomotives, which ultimately led to the introduction of the 4-yearly change-out frequency.

### Detailed examination of the failed 26-F valve

- 1.5.10 The 26-F valve from DC4375 was sent to the air brake group for a detailed examination. A residue of oil-water emulsion was seen emanating from a port on the mounting plate at the rear of the valve (see the left-hand picture in Figure 9). After cleaning, there was a rectangular area of pitting around the same port (see the right-hand picture in Figure 9).



**Figure 9**  
**Mounting plate of 26-F valve**

- 1.5.11 The valve was stripped down to its individual components and examined. Some wear on the “O rings” and in the “O ring” seats on the spindle was observed. The spindle shaft was rolled on a flat plate and was observed to be straight.
- 1.5.12 Records showed the valve had last been reconditioned on 7 November 2003.
- 1.5.13 The valve was reassembled and later passed an air brake code test.

## **1.6 Comparative international policy**

- 1.6.1 In order to ascertain what air drying equipment a major overseas railroad company had installed on its locomotive fleet, the Commission approached the Canadian Pacific Railroad (CPR), which was based in Calgary, Alberta, Canada. The Railroad provided freight transport over a network of 13 800 miles (22 080 km) in Canada and the United States of America (USA). The network, although much larger than New Zealand’s, had similar operating characteristics.
- 1.6.2 CPR advised that about 20% of its lower-horsepower locomotive units came equipped with air dryers, mainly split between 2 manufacturers, Wabtec and Salem. The dryers were never maintained and the Wabtec parts were no longer available. The remaining 80% of the fleet were not equipped with air dryers. CPR was not aware of any performance differences between units equipped and not equipped with air dryers.
- 1.6.3 CPR added that the Federation of American Railroads (FRA) believed that requiring locomotives to be equipped with air dryers would provide minimal safety benefits and would impose an enormous and unwarranted cost burden on the railroad companies.
- 1.6.4 At the same time, the FRA mandated the incorporation of a 2-way radio system between air brake controls on lead locomotives and air brake equipment on the rear of trains. This system was imposed on companies operating trains faster than 50 km/h over heavily graded lines. It enabled locomotive engineers to initiate an emergency brake application that commenced at the rear of the train in the event of a blockage or separation in the brake pipe that would prevent the pneumatic transmission of the emergency brake application from the front of the train.

## **1.7 Wabtec**

- 1.7.1 Wabtec (formerly Westinghouse Brake Company) was a USA-based company that manufactured a range of air braking equipment for use on locomotives. Wabtec had recommended that the 26-C auto brake valve and the 26-D control valve arrangement be changed out at 2-yearly intervals for metro (suburban passenger) train operations and 4-yearly intervals for freight train operations. The company explained that the differences in the change-out sequencing for locomotives operating in metro and freight were due to different wear rates on the brake control valves brought about by the different operating environments.

## 1.8 Frequency of air brake system usage on SA/SD sets

- 1.8.1 In order to ascertain the number of scheduled stops at stations for SA/SD consists 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:

<b>Diagram no.</b>	<b>Daily timetabled stops</b>	<b>Weekly total</b>
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.

- 1.8.2 The figures did not include any random stops or decelerations requiring brake applications that could occur for other operational reasons. Each timetabled stop required a sufficient pressure reduction in the air brake system to bring the train to a stop at a station. When the train was ready to restart, the pressure was recharged to 550 kPa to release the brakes.
- 1.8.3 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.

## 1.9 Personnel

### Locomotive engineer

- 1.9.1 The locomotive engineer had been employed by Toll Rail and its predecessors for about 30 years. He had been a grade 1 locomotive engineer since 1995 and held a current operating certificate.
- 1.9.2 The locomotive engineer booked on at Westfield, boarded SD3199 and, after receiving permission from the signal box controller, drove the train to the south-west backshunt at Otahuhu.

### Hutt workshops' air brake maintenance staff

- 1.9.3 A number of managerial and fitting staff related to maintenance operations in the air brake group at Hutt workshops were spoken to.
- 1.9.4 The air brake group was responsible for the reconditioning of all air brake components used on Toll Rail locomotives, passenger vehicles and freight wagons. The group received changed-out and failed components that had been removed from rail vehicles following scheduled checks or failures. After refurbishment, components were tested before being returned to inventory. The results of all the tests were manually recorded and filed in the group's office.

- 1.9.5 In regard to locomotive braking components, the output of the air brake group was determined by demand that fluctuated with the number of locomotives that were progressing through maintenance checks in the depots. The peaks in demand were managed by maintaining a minimal supply of reconditioned brake valves in inventory.
- 1.9.6 Work orders were issued specifying the number and type of locomotive brake control valves required to be refurbished within a specified time. From this plan, work was allocated to a team of air brake fitters. The refurbishment work then followed detailed maintenance instructions and code tests approved by Toll Rail.
- 1.9.7 Because of the different nature of Toll Rail's passenger vehicles, some of the air brake components originated from different manufacturers. There was a standard amount of time allocated to the refurbishment of the different components. The valves were stripped, cleaned, inspected, reassembled and tested against code on a test rack (see Figure 10). During the refurbishment, any item could be condemned if it did not meet the maintenance manual's standard.



**Figure 10**  
**Air brake group's test rack**

- 1.9.8 After a component had been reassembled, it was painted and a quality sticker attached. Because the air brake group did not have its own maintenance instructions, the manufacturers' instructions were mostly used. Where procedural gaps occurred, staff had written up some instructions that were certified through internal channels.
- 1.9.9 Some of the maintenance instructions had been unchanged from those issued by New Zealand Government Railways. Maintenance instructions that had been written up had taken some time to be approved and on one occasion never approved, but the situation had improved recently.
- 1.9.10 The details of the refurbishments carried out on individual components were not recorded on a database. The only information recorded and filed under each valve's identity number was the date and results of the test after the valve had been reassembled. In conclusion, the 2 most common locomotive brake control valves found with the worst contamination were the 26-F valve and the 26-C brake valve.
- 1.9.11 The contamination seen on the valve from DC4375 was primarily water condensation and oil passed from the air compressor because of wear or scoring in the bore and wear in the rings in the compressor. Because the 26-F valve was the first component in that circuit, it tended to be affected first. Condensation was inherent with the design of any pneumatic braking system.

- 1.9.12 Discussions had been held with Toll Rail to introduce some additional checks for servicing staff to “blow down” the condensation from DC class locomotives. It was planned that headstock cocks and dirt collectors would be manually opened to expel the condensation, which could alleviate the level of condensation being experienced.
- 1.9.13 There was an increasing awareness of braking and pneumatic problems on diesel locomotives because of the contamination levels in brake control valves. Because the locomotives were getting older, the level of corrosion and rust in the brake pipes was worsening and, when combined with condensation and oil passed from the compressors, problems were attracting attention more frequently.
- 1.9.14 Contamination in locomotive brake valves was mostly the cause of the brake valve failing with water seeming to accumulate there for some reason. Often brake valves were brought in for reconditioning long before the 4 years were up, for one reason or another. Rust from the inside of the locomotives’ air brake pipes was a common problem. Questions had been raised on why brake valves were being returned for reconditioning after only 6 to 12 months in service.
- 1.9.15 There was no system in the air brake group where the repair history of each valve could be recorded, unlike the system in the traction motor shop where sheets were available for comments. It would have helped if it was known that brake valves being installed in one locomotive were lasting 6 months, while in other locomotives they were lasting quite well. It would have been worthwhile to have a procedure that found the cause of the contamination in brake control valves, which could have provided an opportunity to fix the problem.
- 1.9.16 A rack test of six 26-C brake control valves that had recently arrived from overseas had failed 2 of the valves, while another 2 imported valves had been returned for repair after failing in locomotives. Consequently, more of the imported 26-C valves were being tested before being handed over to inventory.

## **2 Analysis**

- 2.1 The loss of braking effect that occurred towards the end of the short journey from Westfield to Otahuhu was caused by the 26-F quick-release valve spindle sticking in its bore. Because the lightweight train was travelling at slow speed, the locomotive engineer was able to control the train safely to a stop on the backshunt at Otahuhu. When the locomotive engineer subsequently saw that the brake blocks on DC4375 had not applied as they should have, he concluded that some sort of failure had occurred in the train’s braking system and decided the train was therefore not in a safe condition to convey passengers.
- 2.2 It was fortunate that Train 4306 was an empty service travelling at slow speed at the time of the incident. After its arrival at Britomart, it was timetabled to run a series of services scheduled to convey passengers at speeds of up to 100 km/h; if the valve had failed while running one of these services in the pull mode, a serious accident would have been possible. On the other hand, in the event of a failure in the push mode, the locomotive engineer could have used the emergency stop button.
- 2.3 Because the air brakes on DC4375 had not responded correctly to the locomotive engineer’s brake pipe reductions, the fault was most likely located in either:
- a direct control reservoir leakage, or
  - a defective 26-F quick-release valve.
- A direct control reservoir leakage could be discounted because there would be evidence of a fault occurring every time an automatic brake application was made. There was no evidence on the event recorder data, or from any other source, to support this notion.

- 2.4 Analysis of the event recorder data, together with reference to the schematic brake pipe diagram (refer Appendix) indicated that a defective 26-F quick-release valve was therefore the more likely cause of the reduced braking effect that the locomotive engineer experienced on this occasion.
- 2.5 The brake code test that DC4375 underwent 4 days after the incident was a full air brake code test scheduled to occur at 8-monthly intervals. However, the post-incident test could not replicate the fault experienced on the day of the incident. The air brakes on DC4375 had last been tested 2½ months previously and there had been no faults recorded on the 54D book relating to any braking issues since that test.
- 2.6 Why the 26-F valve had recovered sufficient capacity only 4 days after the incident was not apparent, but it was possible that the initial tests affected the operation of the valve. However, it was clear that the contamination had caused the spindle to stick intermittently, rather than causing it to stick fast in the bore, and it showed the intermittent nature of the fault because the valve had recovered sufficient capacity in only 4 days. Intermittent faults were difficult to replicate and also locate.
- 2.7 Because the SA/SD consists only operated between Monday and Friday, it was likely that the fault pattern that occurred in the 4-day period between the incident and the examination was prevalent in the weeks leading up to the incident. However, such a contamination seen on DC4375 would typically accumulate over an extended period of time. From this it was also concluded there had been a gradual, but unnoticed, loss of effectiveness before the contamination was serious enough to manifest itself in the failure that occurred on the day of the incident.
- 2.8 It was apparent that the leaking of what was initially an unknown thick liquid from a port at the back of the 26-F valve was not normal. The liquid had likely impeded the valve's normal operation. This was evident because some manual force was needed to extract the small diaphragm spindle from its bore when it should have moved more freely. In comparison, the removal of other much larger spindles from other valves did not require the same amount of effort during the Commission's examination.
- 2.9 Because no other liquefied materials are present in a locomotive's air brake piping, it was concluded the thick liquid seen in the valve could only be an oil-water emulsion. The air braking system installed on locomotives in New Zealand was similar to those installed on other locomotive fleets around the world. Lubricating oil from the compressor passed into the air brake piping because of normal wear and tear and mixed with the water particles, forming an emulsion. This emulsion eventually worked its way through the system, and in this case to the 26-F valve.
- 2.10 To mitigate this problem, drains, valves and dirt collectors had been installed in areas where the contamination naturally gathered, such as in the bottoms of the various air reservoir cylinders. However, these valves and collectors needed to be purged regularly to clear the contamination before it could pose a threat to any of the critical brake control valves. It was apparent that a process to conduct this purging was not included in locomotives' daily servicing requirements. However, Toll Rail's subsequent safety action to require a manual purge in addition to the automatic purging that already occurred on all locomotives, including those leased to ARTA, should assist in addressing the problem. In view of this action, the Commission has not made a safety recommendation covering this issue.

- 2.11 The introduction of the 4-yearly change-out cycle for the brake control valves was an improvement in bringing a measure of control over the mechanical condition of the components. This improvement benefited both the maintenance cycling of the brake valve components and operating personnel, who had probably seen a reduction in en-route failures attributable to defective air brake components. However, the 4-yearly policy applied across the whole of Toll Rail's locomotive fleet, including the SA/SD consists with their fleet of dedicated leased locomotives. These leased locomotives were assigned exclusively to suburban passenger train operations with the inherent repetitive and frequent stops at closely spaced suburban stations.
- 2.12 The figures gathered from Veolia's rolling stock plan showed the SA/SD trains were making a high number of timetabled stops over a 5-day period. Although the leased locomotives had retained their dynamic braking capability, it was unlikely that this braking capability was used because of the need to maintain schedule and decelerate trains quickly with an air brake application when approaching stations.
- 2.13 The age of the diesel locomotive fleet in New Zealand meant that there was no air-drying or air-cleaning equipment installed. Retrofitting such equipment on locomotives in New Zealand would be costly and would be difficult to justify. It was concluded from CPR's comments that air-cleaning equipment systems had not proven to be the complete solution to the problem and therefore they were also difficult to justify on safety grounds. The climatic conditions in which CPR operated in Canada were harsher than those in New Zealand, adding more weight to the reason for the non-fitting of such equipment to locomotives here.
- 2.14 Although the 26-F valve still had 27 months before its next scheduled change-out from DC4375, it was clear that it would have never lasted that long. For locomotives that operated exclusively in a passenger operation, a relatively new concept for the rail industry in New Zealand, a tighter change-out policy was considered necessary. However, in view of Toll Rail's agreed action to reschedule the frequency of brake control valve change-outs from a 4-yearly to a 2-yearly cycle, and schedule an annual clean of the 26-F valve on the locomotives leased to ARTA, no safety recommendation covering this issue has been made.
- 2.15 By defining brake control valves and other brake components as rotatable equipment, Toll Rail and its predecessors had categorised these critical items of equipment as changeable components that did not have lifetime associations with locomotives. Each 4 years the equipment was changed out, and after reconditioning could be installed in a locomotive operating in a different part of the country under different operating environments. Such a policy made systematic tracking or monitoring of the performance of brake valves, which were safety-critical components, difficult.
- 2.16 The specialised work performed in the air brake group at Hutt workshops meant that staff employed in this facility were more aware of contamination issues in brake control valves than most others in the rail business. They saw first hand the different levels of contamination in brake components, but without an audit trail where pertinent information could be recorded, much of what they saw and contended with could only be related anecdotally when opportunities arose.
- 2.17 Although the air brake group kept records of the reconditioning of the brake components, these records were not integrated with Toll Rail's Maximo system so the full life cycle of brake components could be tracked and monitored. A system that recorded the life cycles of brake components as part of a quality management system would have been useful. This information could have highlighted areas or activities where contamination was more common than others. In Rail Occurrence Report 06-101, the Commission made a safety recommendation to the Director of Land Transport New Zealand to ensure that Toll Rail implemented quality systems to manage the standards for the monitoring and tracking of safety-critical components.



### **3 Findings**

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

- 3.1 The braking performance of Train 4306 was reduced when the quick-release portion of the 26-F brake control valve intermittently failed to operate properly.
- 3.2 The valve was serviceable and within wear limits, but its operation had been affected by the ingress of an oil-water emulsion formed from lubricating oil from the compressor and water condensation normally associated with compressed air systems.
- 3.3 Oil, water and other contaminants would normally be expelled from the brake system through a combination of automatic and manual drains and filters, but there was no documented system to ensure this was carried out during routine maintenance prior to this incident.
- 3.4 The manufacturer's recommendation for locomotives used in suburban passenger operations was to change out brake control valves and auto brake valves every 2 years instead of the usual 4 years for long-haul freight operations. Although the physical condition of the 26-F valve in this case was within limits, failure to take heed of the manufacturer's recommended practice increased the risk of brake irregularities on suburban passenger trains.
- 3.5 The workshop knowledge of previous premature failures in brake components was not being analysed and used to improve the maintenance system. A coordinated approach to designing, performing, recording and analysing system maintenance, including the tracking of safety-critical components, would improve operational safety and efficiency.

### **4 Safety Actions**

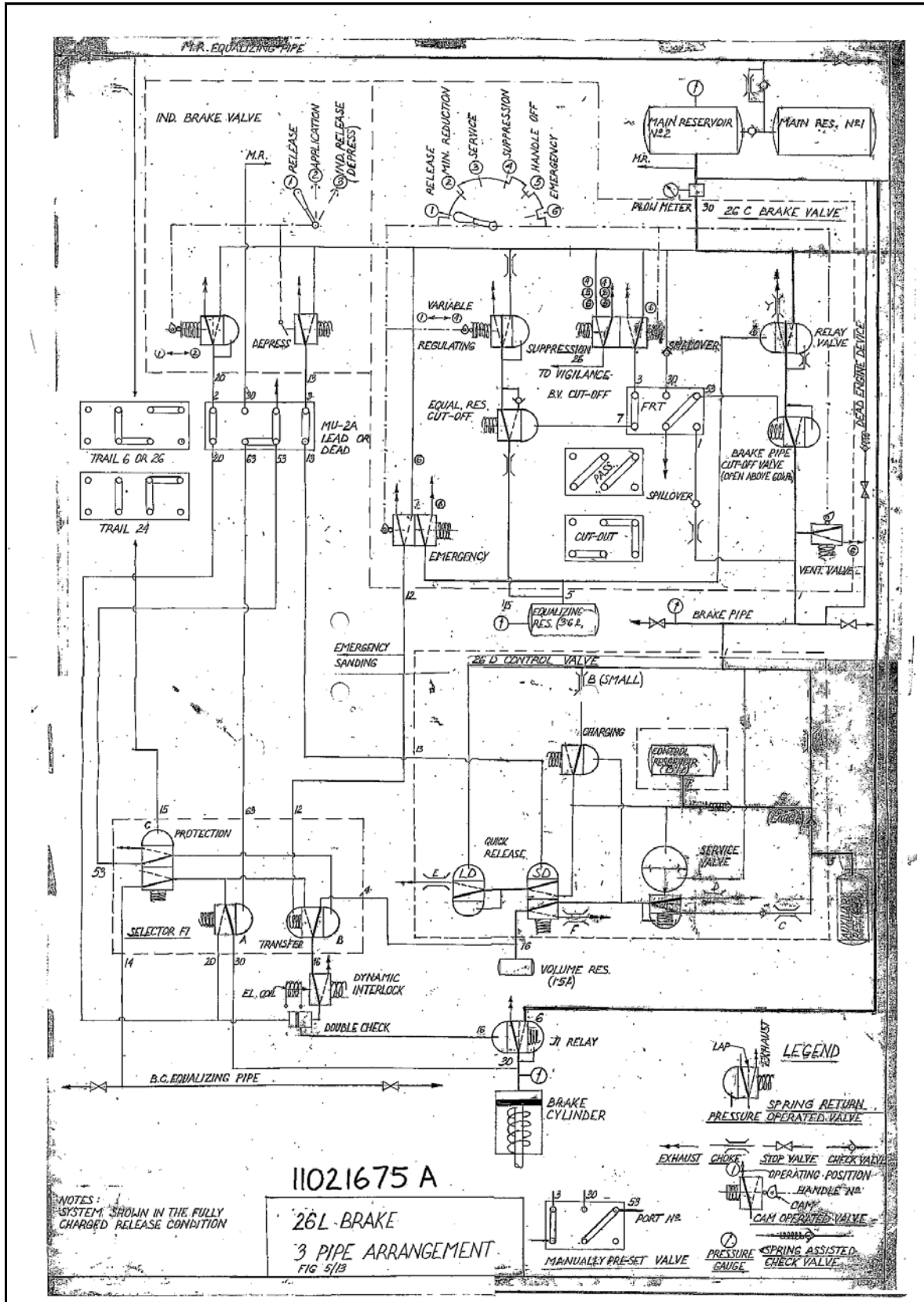
- 4.1 On 1 February 2007, Toll Rail advised that the following safety action had been taken following this incident:

The M9122 Locomotive Servicing Task Instruction document No.4 had been promulgated and required servicing staff to drain the air system of condensate. This task was achieved by opening the headstock cocks, and No.1 and 2 main reservoir drain cocks briefly to expel any condensate and also purge dirt collector where manual drain cocks are fitted to these.

- 4.2 On 5 June 2007, Toll Rail advised in part that the following safety action had been taken:

Toll Rail's Locomotive Technical Committee has reviewed this incident and has determined the present Code requirement for ARTA locomotives will be changed to a bi-annual change out of the 26-C and 26-D locomotive brake valves. The code change will also include a requirement to clean the 26-F brake valve on a yearly basis.

# Appendix





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- 05-107 Diesel multiple unit passenger Train 3037, wrong routing, signal passed at danger and unauthorised wrong line travel, Westfield, 14 February 2005
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