Report 08-113, empty push/pull passenger Train 5250, collision with platform-end stop block, Britomart station, Auckland, 19 December 2008

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empty push/pull passenger Train 5250

collision with platform-end stop block

Britomart station, Auckland

19 December 2008

Figure 1
Location of incident

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Abbreviations

BK contactor	braking contactor
km/h	kilometre(s) per hour
kPa	kilopascal(s)
m	metre(s)
TAIC	Transport Accident Investigation Commission
Toll Rail	Toll Rail NZ Consolidated Limited
UTC	universal coordinated time
Veolia	Veolia Transport Auckland Limited

Data Summary

Date and time:	19 December 2008 at 1616[1]
Location:	Britomart station, Auckland
Train type and number:	empty push/pull passenger Train 5250
Vehicle classes:	SA passenger carriages and SD driving trailer
Year of manufacture:	1972 by British Rail as Mk 2 passenger carriages
Year of conversion for NZ operations:	between 2004 and 2006 in Toll Rail NZ Consolidated Limited's (Toll Rail's) Hillside workshops in Dunedin
Motive power:	DC class diesel-electric locomotives rebuilt between 1978 and 1980 by Clyde Engineering of Australia from DA class locomotives originally built in late 1950s/early 1960s by General Motors of Canada
Licensed train operator:	Veolia Transport Auckland Limited (Veolia)
Persons on board Train 5250:	Toll Rail: one Veolia: one passengers: nil
Injuries:	nil
Damage:	minor to coupler on SD5794 and moderate to the stop block at end of platform 2 in Britomart station
Investigator-in-charge:	Vernon Hoey

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

Executive Summary

On 19 December 2008, Train 5250 was an empty push/pull service being repositioned to start passenger operations when it collided with the stop block at Britomart station, Auckland. Some damage occurred to the coupler on the front of the train and the stop block, but neither the locomotive engineer (driver) nor the train manager was injured.

The primary factor contributing to the collision was the failure of an electrical contactor within the locomotive brake system that prevented the locomotive brakes applying. Safety issues discussed include the speed of the train during the approach to Britomart station and the use of a power braking technique during emergency stop applications.

1 Factual Information

1.1 Narrative

1.1.1 On Friday 19 December 2008, Train 5250 was an empty push/pull passenger service relocating from Westfield to Britomart in the push mode. The train left Westfield on time at 1554. From Britomart, it was timetabled to operate a series of evening peak-hour services across the Auckland suburban rail network. The train was crewed by a KiwiRail driver and a Veolia train manager, both of whom were correctly certified for their roles.

1.1.2 Train 5250 was made up of driving trailer SD5794, passenger carriages SA5801, SA5746 and SA5887, and locomotive DC4035, which provided motive power from the rear (see Figure 2). This train was identified as set No.16 and had been commissioned to service in September 2008, about 3 months before the incident.

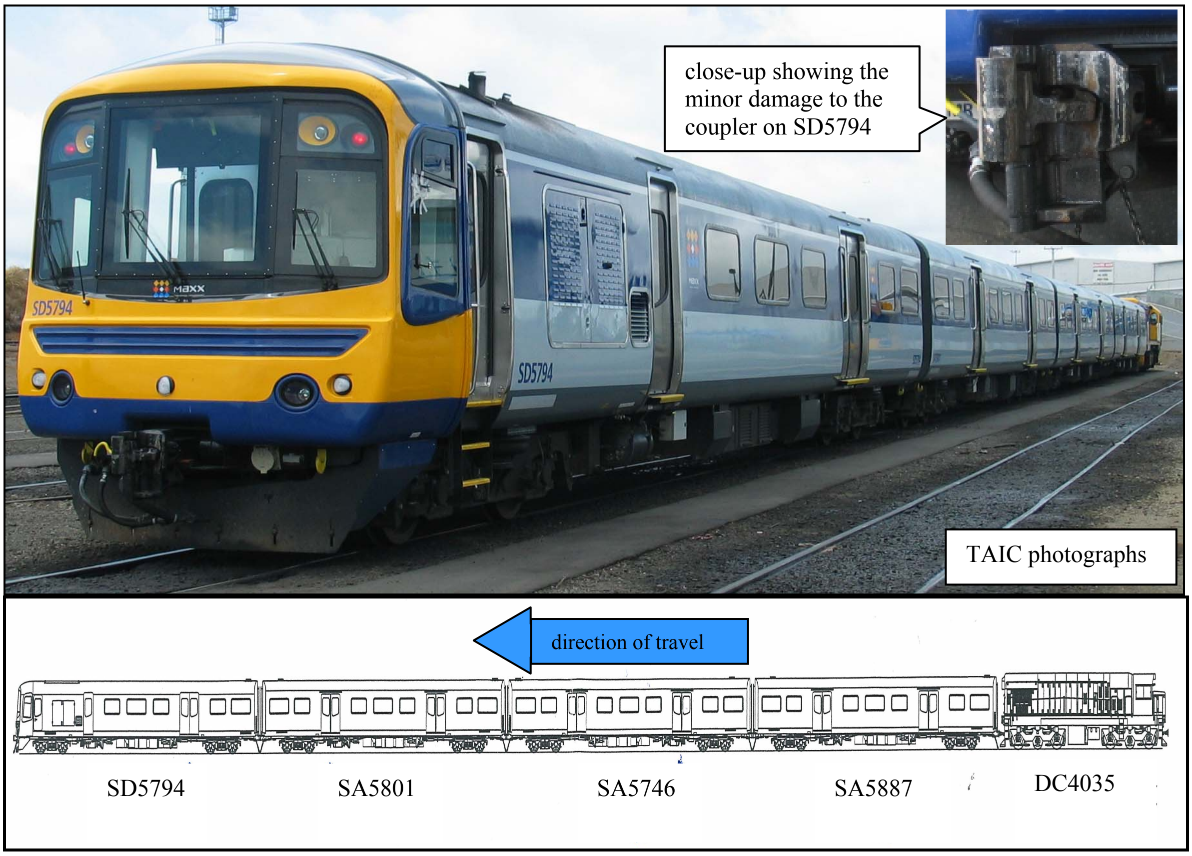

Figure 2
Image and drawing of Train 5250

1.1.3 Train scheduling required Train 5250 to run behind a passenger service that was stopping at all stations between Westfield and Britomart. This meant that the train was required to slow or stop for adverse signals to maintain separation from the stopping service ahead.

1.1.4 Under normal circumstances, when the driver applied the automatic air brakes (train brakes) on a push/pull set from either the SD driving trailer or the DC locomotive, the brakes would apply on all the vehicles on the train, including the locomotive. Data downloaded from the event recorder on DC4035 showed that on 2 separate occasions during the first part of the journey, the locomotive brakes did not apply when the driver applied the train brakes from SD5794.

1.1.5 The driver said that he did not notice that the locomotive brakes had not applied. He said that he thought the train was experiencing a little bit of brake fade[2] during that part of the journey but didn't think it was any worse than usual.

1.1.6 At about 1612, the driver applied the train brakes and stopped Train 5250 at the first of 6 controlled signals that authorised entry into Britomart station. The event recorder showed that the brakes on DC4035 did not apply during this braking cycle. After stopping for about 30 seconds, the train moved off.

1.1.7 During the next 3 minutes, the driver applied the train brakes on 2 further occasions from speeds between 28 and 36 kilometres per hour (km/h) and the train was slowed to less than 10 km/h. These brake applications were in response to adverse signal aspects.

1.1.8 Signal 42, the last of the 6 controlled signals, was located about 325 metres (m) back from the Britomart station stop blocks. A permanent speed restriction of 25 km/h was in place from Signal 42 to the stop blocks and included 2 sets of points numbered 35 and 37 that routed the train to platform 2. The event recorder showed that Train 5250 was travelling at between 27 and 34 km/h when it passed the signal and travelled through the 2 sets of points.

1.1.9 The driver applied the train brakes as Train 5250 approached the platform. The driver later said that he thought he had reduced the throttle to idle, as he normally did. However, the event recorder data showed the throttle had reduced to notch one instead. This meant the locomotive was operating under power braking, a documented technique designed to keep couplings throughout a train stretched while in the pull mode, a procedure adapted by drivers of the push/pull sets to keep the couplings compressed while operating in the push mode. To explain further, power braking is where a train is braked while the locomotive's power throttle is left open so that the locomotive maintains forward power. This braking technique smoothes the ride for passengers by minimising any backlash created by play in the coupling systems.

1.1.10 In this instance and when the driver felt the train was not slowing sufficiently, he made a full service brake application followed by an emergency brake application, but Train 5250 collided with the stop block at the end of platform 2 at a speed of about 2 km/h. The coupler on SD5794 sustained minor damage. The stop block was also damaged.

1.1.11 The driver said it felt as though the train went into a complete wheel-slide along platform 2 after the full service brake application was made. The driver, and the train manager who was riding in one of the SA carriages, were not injured.

1.2 Post-incident inspection of Train 5250

1.2.1 Train 5250 was examined at Britomart by KiwiRail maintenance staff, who found that the brake controls had been set up correctly in both SD5794 and DC4035 for push mode operation. The train set was taken out of service and returned to Westfield empty.

1.2.2 The following day a further examination was made. A KiwiRail brake efficiency test procedure showed that brake-block-to-wheel contact on vehicles throughout the train was within tolerance. All brake blocks were found to be in good condition.

1.2.3 A test of the park brake and full service brake application made from SD5794 showed no faults. A re-examination of the brake cylinders on all the vehicles showed that they all applied correctly.

[2] A phenomenon where brake effectiveness is reduced when the brake blocks heat up owing to frequent and hard braking.

1.2.4 When data downloaded from the tranzlog event recorders on SD5794 and DC4035 were compared, the fault with the locomotive brakes not applying was revealed. The data from SD5794 showed that the brakes on the SD/SA vehicles were engaging correctly, but the brakes on DC4035 had not engaged when the driver applied the train brake from SD5794 throughout the journey of Train 5250 from Westfield to Britomart. DC4035 was uncoupled and set aside for further testing.

1.2.5 The following table shows some of the output from the tranzlogs for the 59 seconds before the collision. Throughout the last 43 seconds, the driver unintentionally left the throttle setting in notch one. The event recorder showed that the brakes on DC4035 did not apply during this 43-second period before the impact.

Time	Distance in metres (m) from stop block	Speed (km/h)	Driver's air brake/power actions
1615:27	400	11	brakes released
1615:29	396	12	power setting increased from notch 3 to 6
1615:30	393	13	power setting decreased to notch 5
1615:34	377	19	power setting increased to notch 7
1615:38	355	27	power setting decreased to idle then increased to notch 2
1615:43	310	34	power setting decreased to notch one
1615:55	198	33	brake reduction of 60 kilopascals (kPa)
1615:59	160	35	further reduction of 40 kPa
1616:06	96	29	further reduction of 30 kPa
1616:09	73	26	release of 40 kPa
1616:14	40	19	full service brake application
1616:18	20	15	emergency brake selected
1616:26	0	2	Collision

1.2.6 At the time of the incident, the tranzlog system was noted as working correctly, and it recorded that the speedometer speed was reading 1.2% fast against true speed. This meant that there was a 0.3 km/h difference when Train 5250 was travelling at 33 km/h.

1.2.7 On 23 December 2008, KiwiRail mechanical engineers found that the train brake application in the locomotive had been disabled by an incorrect operation of an auxiliary contact fitted to a "braking contactor" (BK contactor) within the electrical circuitry/air brake system of DC4035. The auxiliary contact had an interlock function that under normal operation would have prevented the automatic air brakes applying on the locomotive when dynamic braking was selected. This would have been achieved by the auxiliary contact activating an air dump valve on the locomotive's brake system.

1.2.8 Dynamic braking is where the locomotive traction motors are used as generators to create a braking force, and is a function that can be selected by drivers to assist in slowing trains while descending gradients. Operating procedures stated that the locomotive throttle was to be placed in idle in order to engage dynamic braking. Once engaged, the locomotive's air brakes were automatically disengaged.

1.2.9 Two auxiliary contacts were physically connected to the BK contactor so that the normal movement of the BK contactor closing would actuate 2 micro switches. The micro switches were enclosed devices screwed to a mounting plate on the body of the BK contactor. The micro switch actuating plungers passed through the mounting plate and made physical contact with a lever arm on the moving part of the BK contactor (see Figure 3).

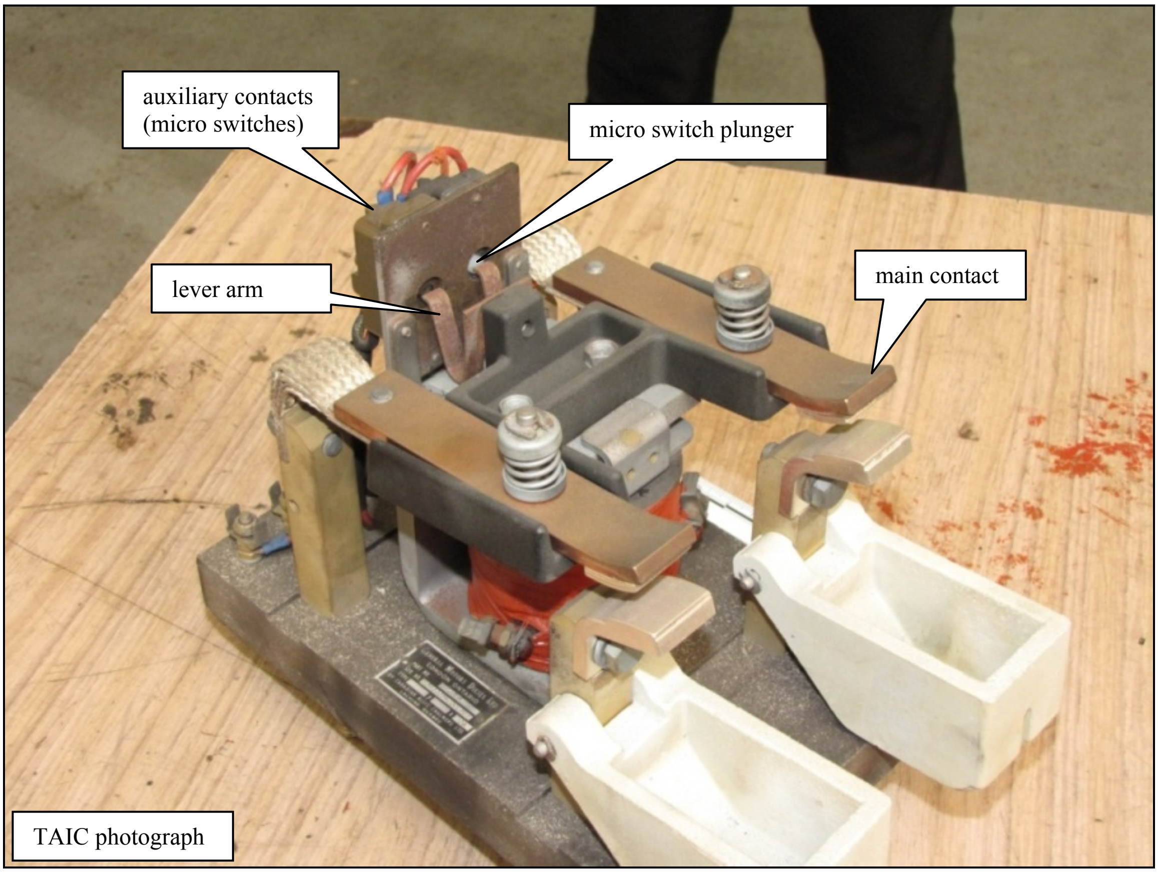

Figure 3
BK contactor

1.2.10 The nature of the fault was a mechanical clearance error that resulted in one auxiliary contact jamming in the "closed" position instead of opening when the BK contactor de-energised. This had the effect of "tricking" the system into thinking the dynamic braking had been engaged when the locomotive throttle was advanced to notch one or above, activating the air dump valve through an electrical back-feed that prevented the locomotive's air brakes applying.

2 Analysis

2.1.1 When Train 5250 approached Britomart station the track was dry and the train was empty, so the braking performance of the train should have been good. Post-accident inspections showed that the components within the brake system were within tolerance, which was consistent with the train being relatively new in service.

2.1.2 The failure of the locomotive's air brakes to apply during the final stop would have significantly reduced the brake performance of the train, because the 4 passenger carriages would have had to share the braking load of an 82-tonne locomotive between them (an average of 20.5 tonnes for each carriage).

2.1.3 This failure of the locomotive's air brake was a major factor contributing to the collision with the stop block, but other contributing factors were also apparent.

2.1.4 The speed of the train reached a maximum 35 km/h and was above the 25 km/h speed limit for a distance of around 280 m over 32 seconds as the train entered Britomart station. The speed was still 33 km/h and the train was 198 m from the stop block when the driver made his first brake application to stop the train at the platform, and the speed had reduced to 26 km/h when 73 m from the stop block.

2.1.5 Copies of recent train stopping distance tests conducted by KiwiRail show that the push/pull sets will struggle to stop within the National Rail System Standard of 600 m under a full service brake application from 100 km/h. Simply extrapolating out a compliant train braking system, Train 5250, travelling at 33 km/h with about 200 m to go, would require a 198 m stopping distance. However, the speed at which Train 5250 approached Britomart station increased the risk of it not being able to be stopped owing to an error in judgement or mechanical malfunction.

2.1.6 Conditions favourable for good stopping performance were that there were no passengers on board the train, the dry track, and the general good condition of the train brake system (not including the locomotive). Unfavourable conditions were the fault in the locomotive brake system and the fact that power braking was being used and continued to be used even after an emergency brake application had been made.

2.1.7 Power braking was condoned by KiwiRail, and was referred to in its train operating instructions as a method for creating a smoother ride for passengers. Power braking will, however, increase the stopping distance because the locomotive continues to power against the braking train, although only at low throttle settings. The removal of power braking when maximum stopping is required (when emergency brake applications are made) is covered in the instructions, but the effect of power braking on stopping distance is not covered in the operating instructions for locomotive-running personnel driving passenger trains. There is reference made to not needing power braking with short trains, such as passenger trains, but this is buried in a section dealing with preventing run-ins on long freight trains when emergency braking is required. A safety recommendation has been made to the Chief Executive of the NZ Transport Agency to address this safety issue.

2.1.8 Ironically, the fault condition that was preventing the locomotive brakes applying would only occur when the throttle was in notch one or above. Had the throttle been reduced to idle in this instance, the BK contactor fault would not have manifested itself and the locomotive would not have been opposing the train's braking effort. The locomotive brakes would then have applied and the collision would probably not have occurred because the train was only travelling at 2 km/h when it struck the stop block.

2.1.9 The post-accident inspection of the entire locomotive fleet showed that the component failure was an isolated case rather than a widespread problem. The component failure was, however, a single point of failure within a critical system. This safety issue has been addressed by the modification described in the safety actions section of this report.

3 Findings

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

3.1 Train 5250 collided with the stop block at Britomart station primarily owing to a misaligned auxiliary contactor within the locomotive brake system that prevented the locomotive brakes applying when the throttle was in notch one or above.

3.2 The speed of the train as it approached platform 2 at Britomart station exceeded the allowable speed limit for the area, which reduced the margin due to an error in judgement, or failure, or reduced performance of equipment.

3.3 Train operating instructions do not adequately cover the effect of power braking on train stopping performance, and also do not adequately cover when not to use it, for example in emergency brake applications.

4 Safety Actions

4.1 KiwiRail immediately started an inspection programme for all DC and DBR class locomotives in its fleet to check the condition of the BK contactor, including a functionality test to ensure the dynamic brake interlock was not being energised when the power setting was in notch one or above.

4.2 On 22 December 2008, KiwiRail issued nationally a special bulletin titled "Hazard Warning, DC and DBR locomotives". The bulletin asked locomotive engineers to monitor train braking performance on push/pull trains and other trains, and should a fault occur, they were to modify their train speed, report the fault and record details in accordance with standard procedures.

4.3 On 24 December 2008, KiwiRail issued an urgent safety notice L-024 (functionality test of BK Contactor) and on the same date it said that the DC locomotive fleet dedicated to operating the push/pull sets in Auckland had been checked. Checks of the remaining DC and DBR locomotives throughout the country were completed by the end of January 2009.

4.4 Because the failure of an auxiliary contactor was a single point of failure affecting a safety-critical system, the circuit was redesigned to include a blocking diode that would prevent a back-feed in the event of failure. This will considerably lower the risk (2 components would need to fail) of this failure adversely affecting the braking system.

4.5 The brake code was amended to include a test for this failure. An "engineering change request" was submitted to the KiwiRail locomotive technical committee in January 2009. On 27 April 2009, the request had been reviewed and approved by the technical committee and on 30 June 2009, a "field modification instruction" was issued to implement the change.

4.6 By October 2009, all DC and DBR class locomotives on the network had been modified. During this process, 2 other BK contactors were found to be slightly misaligned, but they were still functioning correctly.

4.7 Formal amendments to KiwiRail's brake code manual incorporating procedural changes for scheduled checks on the BK contactor were approved in January 2010, and these are expected to be published during February 2010.

5 Safety Recommendation

5.1 On 25 February 2010, it was recommended to the Chief Executive of the NZ Transport Agency that he address the safety issue whereby locomotive operating instructions do not address the effects of power braking on train stopping distances, particularly in situations requiring emergency brake applications. (006/10)

5.2 On 18 December 2009 and in response to the safety recommendation in its preliminary stage, the Chief Executive of the NZ Transport Agency replied as follows:

> The NZ Transport Agency accepts this recommendation and will be working closely with KiwiRail in an effort to facilitate satisfactory resolution of this recommendation in a timely manner.

Approved on 25 February 2010 for publication

Hon.W P Jeffries
Chief Commissioner

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