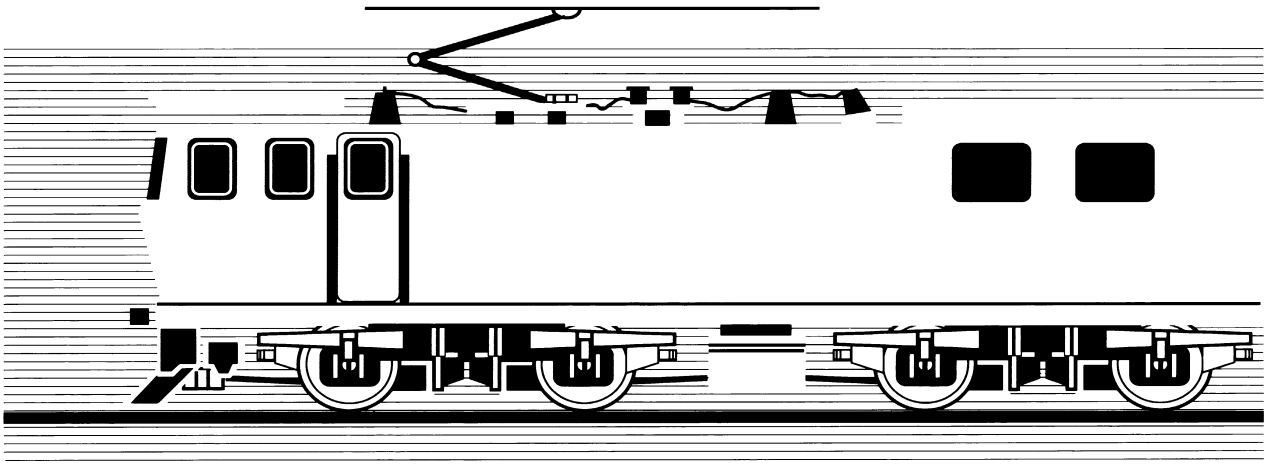
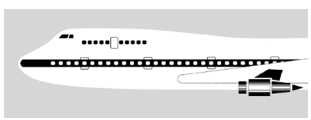
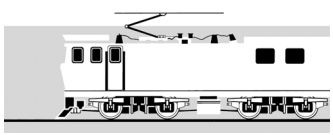


RAILWAY OCCURRENCE REPORT

04-116 passenger express Train 1605, fire in generator car, Carterton, 28 June 2004


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.

Report 04-116

passenger express Train 1605

fire in generator car

Carterton

28 June 2004

Abstract

On Monday 28 June 2004, at about 0710, the power generator unit at the rear of passenger express Train 1605 caught fire as the train berthed at Carterton Station. The train manager expended one of 3 fire extinguishers carried on board the train to extinguish the fire.

There were no injuries to passengers or crew.

Safety issues identified included:

- the layout of the generator enclosure
- the installation of the fire detection and suppression system.

Three safety recommendations were made to the Chief Executive of Toll NZ Consolidated Limited to address these issues.

Contents

Figures

Abbreviations

DC	direct current
FMI	field modification instruction
km	kilometre(s)
kVA	kilovoltampere(s)
kW	kilowatt(s)
LED	light emitting diode
m	metre(s)
mA	milliamps
mm	millimetre(s)
Toll Rail	Toll NZ Consolidated Limited
UTC	coordinated universal time

Data Summary

Train type and number:	passenger express Train 1605
Date and time:	28 June 2004 at about 0710[1]
Location:	Carterton
Persons on board:	crew: 3 passengers: 40
Injuries:	nil
Damage:	moderate damage to the power generator unit in passenger carriage AL2073
Operator:	Toll NZ Consolidated Limited (Toll Rail)
Investigator-in-charge:	P G Miskell

[1] Times in this report are New Zealand Standard Time (UTC + 12) and are expressed in the 24-hour mode.

1 Factual Information

1.1 Narrative

1.1.1 On Monday 28 June 2004, Train 1605 was the scheduled 0653 Tranz Metro,[2] passenger express service from Masterton to Wellington. It consisted of locomotive DC4110 and passenger cars A2277, A2333 and AL2073.

1.1.2 Train 1605 was crewed by a locomotive engineer, a train manager and a passenger operator. There were 40 passengers on the train when it berthed at Carterton, en route to Wellington.

1.1.3 The train manager was travelling in the guard's compartment of AL2073 when the train approached Carterton and said that he had smelt fumes, so he entered the generator compartment to investigate (see Figure 1). He did not identify the source of the fumes but satisfied himself that the generator was still producing power and otherwise operating normally.

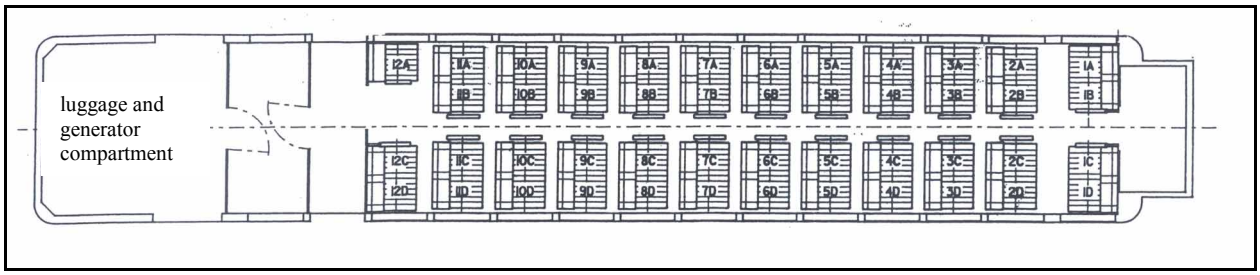


Figure 1
Layout of passenger car AL2073

1.1.4 As the train came to a stop, one of the passengers waiting on the platform told the train manager that flames were coming from the rear passenger car.

1.1.5 The train manager shut down the power generator unit before he opened the side cover of the generator enclosure and was confronted by flames. He used a dry-powder fire extinguisher to suppress the fire.

1.1.6 The train manager asked the station attendant to call the Fire Service. The attending fire officer confirmed that the fire had been extinguished and that it was safe for passenger car AL2073 to continue on to Wellington for repairs. However, the train manager and his Wellington-based manager had already decided to terminate the train at Carterton and transfer the passengers to buses.

1.1.7 The train manager travelled to Wellington on the empty service and sat near the generator with a fire extinguisher at the ready in case the fire should re-ignite.

1.2 Site evidence

1.2.1 Carterton was the third passenger stop for Train 1605 after departing Masterton. All passenger cars were alongside the 100 m long station platform when the train berthed at Carterton.

[2] Tranz Metro was the group within Toll Rail responsible for the operation of electric multiple unit suburban passenger services in Wellington and the express passenger services between Wellington and Masterton.

1.3 Passenger carriage AL2073

1.3.1 Passenger carriage AL 2073 entered service in 1986 after being converted from a standard A Class passenger car. The conversion reduced the seating capacity by making way for a separate guard's compartment and a luggage compartment, which was subsequently converted to house a power generator set.

1.4 AL2073 power generator unit

1.4.1 The diesel-powered generator was a 50 kVA, 3-phase FG Wilson model P50E, mounted in the generator compartment at the rear of the AL2073 in a removable soundproofed enclosure (see Figure 2). The generator provided lighting and heating for up to 6 carriages.

Figure 2
Generator enclosure with the side and front-end covers removed

1.4.2 Engine aspiration and cooling air was drawn in from the roof intake vent and ducted to the generator enclosure. The axial radiator fan mounted at the rear of the generator housing, forced the enclosure cooling air out into the atmosphere at the rear of the passenger car. The air intake on the roof had provision for an air filter but was not fitted.

1.4.3 On 28 July 2005, Toll Rail advised that the air intake filters had been permanently removed in late 2000 after an investigation into an earlier fire in the other Wairarapa generator car, AL 2067, and following an investigation into hot-engine shut-downs on both Wairarapa AL generator sets in the Rimutaka tunnel. The investigations found that when the AL generator cars were in the tunnel the air intake filter and fan assembly was too restrictive and resulted in temperatures of up to 95ºC around the generator set, leading to overheating and shutdown. The generator overheating problems and the vulnerability to fire in the intake filter were resolved by permanently removing both the filter and its companion fan.

1.4.4 The alternator was directly coupled to the front end of the diesel engine drive shaft. The engine and alternator were completely enclosed within a metal clad enclosure with egg carton style plastic foam soundproof lining. The alternator cooling air was drawn from the air within the generator unit enclosure, entered the alternator at the front and was forced out at the rear near the diesel engine (see Figure 3).

1.4.5 The electrical load at the time of the fire was estimated to be one air-conditioning unit, operating in air circulation mode only, and 5 kW of heating per passenger car.

1.5 Fire detection and suppression system

1.5.1 The generator unit enclosure was fitted with a fire suppression system, and in the event of a fire it could be extinguished by:

- automatic activation of the fire suppression system
- manual activation of the fire suppression system
- discharge of hand-held fire extinguishers.

Figure 3
Alternator air intake and exhaust grill

1.5.2 A Lifeline 2000 Fire Extinguisher System (SAP No. 816634) was fitted to AL2073. Toll NZ Consolidated Limited (Toll Rail) advised that the system was fitted in accordance with Field Modification Instruction (FMI) No. P2053TK dated 21 December 2000. This document specified the method of installation, commissioning and regular testing procedure.

1.5.3 Fire detection was achieved using an insulated, flexible double link wire fitted in the generator enclosure. Heat generated by a fire would melt the insulation and allow the 2 conductors to make contact, triggering the control unit to activate an explosive charge on a pressurised fire extinguisher bottle. The foam suppressant was ducted to discharge nozzles within the generator enclosure via plastic-coated aluminium tubing. The FMI specified the fusible link wire route as along the top of the alternator and near the fuel injectors of the diesel engine. Inspection after the fire indicated that the fusible link wire was run along the top of the generator enclosure and had remained intact.

1.5.4 The supplier specified that the tubing to the fire suppression discharge nozzles should be plastic-coated aluminium, whereas Toll Rail's FMI P2053TK specified nylon tubing.

1.5.5 Lifeline fire suppression systems had been designed for use in rally cars and vehicles participating in motor sport events. It was controlled by a power pack which had a 3-position manual switch that enabled the operator to "Test", "Isolate" or "Arm" the system as required (see Figure 4). The control module was fitted with a Light Emitting Diode (LED) to indicate that the system was operating.

Figure 4
Power pack and control module

1.5.6 The power pack was fitted with a PP3 9-volt alkaline battery, commonly used in domestic smoke alarm detectors and capable of about 200 mA hour capacity. The system supplier recommended selecting the "Isolate" position when the generator was not in use to extend the battery life. Because of the variability of battery life, the battery was checked weekly and replaced, regardless of condition, every 2 months. The battery was checked on Monday 21 June 2004 and was due to be checked on the day of the fire, after Train 1605 arrived in Wellington. Toll Rail advised that the battery was flat on the day of the fire.

1.5.7 A manual switch, located by the door leading into the generator room, was connected in parallel to a common control module (see Figure 5). Thus, with a flat battery the manual switch would not operate.

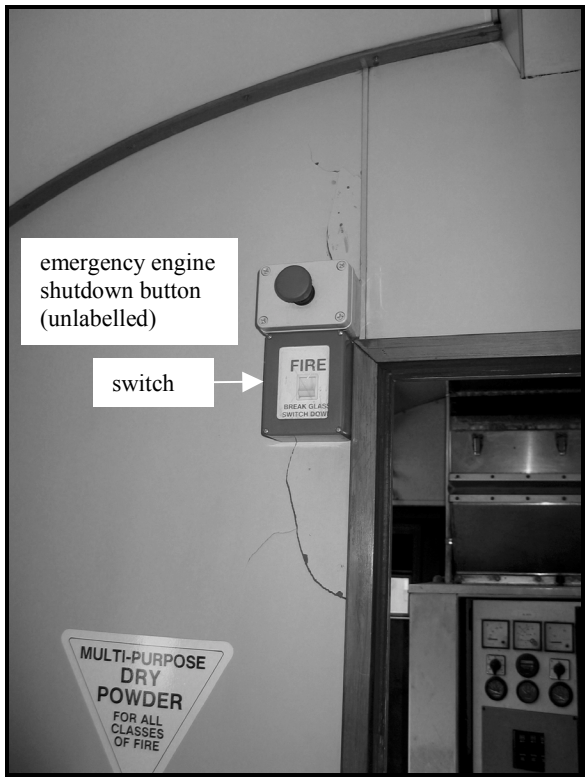


Figure 5
Switch for manual activation of fire suppression system

1.6 Fire damage to the generator unit

1.6.1 Fire damage was contained within the generator enclosure. There appeared to be an initial fire seat near the alternator grill, with the flames then travelling vertically up the soundproof insulation material and spreading along the inside ceiling of the enclosure. Insulation on some cables and flexible conduit within the enclosure had melted but the cables were generally intact. The most significant damage was soot, extinguisher deposits and burnt soundproofing material along the front wall and ceiling.

1.6.2 The front-end panel of the generator enclosure had a compression mark where the alternator end plate had been pressing hard against insulation material (see Figure 6). A sample of the soundproof material was cut off and attempts made to ignite it. The material did not ignite but smouldered.

1.6.3 The diesel fuel for the generator was contained within a tank under the engine and had not been affected by the fire. Fuel pipes within the engine enclosure remained intact.

1.6.4 The fusible link wire appeared to be intact. Other melted items looked like the remains of the plastic-coated tubing, but the extinguisher discharge nozzles were not found. However, Toll Rail advised that nozzles were still intact.

1.6.5 There was no evidence of electrical failure in the alternator windings that could have initiated the fire.

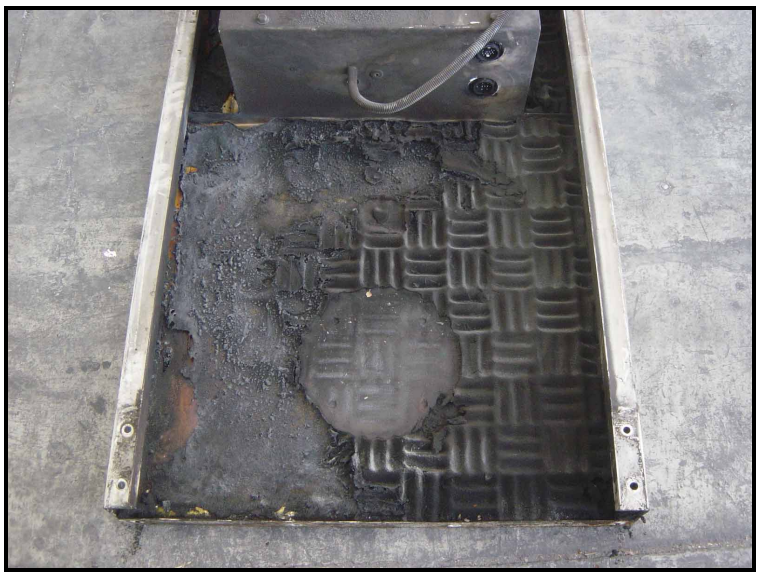


Figure 6
Burn marks to the soundproofing material

1.7 Inspection and maintenance

1.7.1 Toll Rail's Mechanical Code M2000 determined that the scheduled maintenance inspection of locomotive-hauled passenger rolling stock was to be carried out by the service manager or team leader at the following intervals:

- pre-departure check — daily inspection with no time extension permitted
- A check — every 6 000 km with an upper limit at 7 000 km
- B check — every 24 000 km or 6 months whichever comes first, upper limit of 26 000 km or 7 months whichever comes first
- C check — every 12 months with an upper limit of 14 months
- power generator set — every 500 operating hours with an upper limit of 600.

On 22 July 2005, Toll Rail advised that the pre-departure checks on the Wairarapa passenger services were carried out at Wellington only. Because the passenger cars had "over-nighted" at Masterton, a pre-departure check had not been carried out before Train 1605 departed Masterton.

1.7.2 The 500-hour check on the power generator set required the following work to be carried out:

- air filters — clean or change
- engine oil — change
- oil filters — change
- fuel lift pump — clean strainer and sediment bowl
- fuel filters — change
- water filter — change
- vee belts — check tension and condition
- oil leaks — rectify
- test run — check idle speed, check intake fans operate OK.

1.7.3 The most recent 500-hour generator service check on AL2073 was carried out within the prescribed timeframe on 12 May 2004, when the hour meter had registered 22 500 operating hours. During the service check, two fuel filters, an oil filter and an air filter were replaced and the oil changed. There was no requirement in the generator service check to record running temperature or cooling airflow. The 500-hour checks were occurring at about 2-monthly intervals.

1.7.4 The most recent A, B and C checks were undertaken within specified timeframes. These maintenance checks did not identify any major work to be carried out to either the wheels, braking system, electrical components or the passenger car coupling system. There was no requirement to inspect the generator during the A, B or C checks.

1.8 Train emergency procedures

1.8.1 Toll Rail's Operating Code Supplement CSR 3.2 stated in part:

> If a fire is seen, or smoke is smelt, or if a passenger reports a fire, the following steps must be taken:
>
> - If provided, first turn off the carriage air conditioning to prevent the spread of smoke to other parts of the service. Evacuate the carriage.
> - Notify other on-board staff that a serious problem exists.
> - Relocate the passengers to the adjacent carriage.
> - The Train Manager should proceed immediately to the affected carriage to co-ordinate activities.
> - If the fire appears controllable, use the nearest appropriate fire extinguisher to extinguish the fire.

1.9 Personnel

The train manager

1.9.1 The train manager had worked for Toll Rail and its predecessors since 1975. He had more than 20 years' experience as train manager on passenger trains operating between Wellington and Masterton. His certification was current for passenger train inspections, stationary shunting, on board service for both carriage trains and electric multiple units and DC electrification awareness. His training had included fighting oil and electrical fires.

1.9.2 The train manager said that the generator had already been switched on and was running when the train was placed at the Masterton platform, and he had checked the oil, water and fuel levels for the generator before the train departed.

1.9.3 The train manager said that he had been into the generator compartment 2 or 3 times while the train was travelling between Masterton and Carterton because there had been a strong smell of fumes. He said that there was no burning smell, just more fumes than usual. He was aware that the air filters on the generator had been replaced earlier in the month and knew that the fumes should not have been present but he could not identify the source.

1.9.4 When alerted to the fire by a passenger waiting at Carterton, the train manager immediately shut down the generator. Because he was not totally convinced that there was a fire, he re-entered the generator room and, with the assistance of the passenger operator, opened the side panel of the generator enclosure. When confronted by flames he discharged a dry-powder fire extinguisher that was located outside the generator room. There were a few passengers only in AL2073 at the time, and the train manager said he felt it was not necessary to evacuate the carriage before extinguishing the fire. However, most of the passengers had already alighted from the passenger car while the on-board staff extinguished the fire. After the fire was suppressed, the train manager instructed the passenger operator to inform those passengers still on the train that there would be a service delay. He then arranged for the Fire Service to attend and asked the Wellington platform manager to have buses on standby.

The passenger operator

1.9.5 The passenger operator started work with Tranz Metro in December 2003. He had completed safety induction and train emergency procedures training, and his certification for DC electrification awareness was current.

1.9.6 The passenger operator had returned to the leading carriage, A2277, by the time Train 1605 berthed at Carterton. He said that he had walked to the guard's compartment in the rear carriage and had spoken to the train manager when the train was about 2 or 3 minutes away from Carterton. He did not detect anything untoward at that time.

1.9.7 When he alighted from the front carriage and turned to look back along the train, he saw what he thought was smoke coming from the rear of the train, so he went to investigate. He assisted the train manager open the side panel of the generator enclosure.

1.9.8 The passenger operator had more than 30 years Fire Service experience that included station officer level. He said the train manager was aware of that experience and had taken notice of the advice he had given when suppressing the fire.

2 Analysis

2.1 The initial fire seat appeared to be near the alternator grill but it was not possible to determine the exact cause of the fire. It was possible, but unlikely, that a hot cinder emitted from the locomotive exhaust would have travelled the length of 3 passenger cars to be ingested into the generator enclosure and lodged in a collection of dust and diesel oil, and remained hot enough to provide an ignition source. The locomotive exhaust may have been a contributing factor had generator car AL 2073 been marshalled directly behind the locomotive and the train was travelling through the Rimutaka tunnel.

2.2 However, it was probable that airborne particles of dust within the alternator were heated and deposited on the soundproof material near the alternator exhaust grill. The accumulation of heated particles may have combined with oil deposits left by fumes from the diesel engine and eventually ignited the soundproof insulation material. Other airborne particles may have also been heated by the engine exhaust pipe work and found their way down to the alternator area. The poor air circulation and lack of cooling in the alternator area allowed the temperature to rise to ignition temperature.

2.3 There were a number of factors including the absence of a generator enclosure air intake filter that contributed to the final set of conditions that allowed the fire to start. Had the fabric filter been in place, it would have limited the amount of airborne dust and debris drawn into the generator enclosure that could become source material for a fire. A safety recommendation has been made to the Chief Executive of Toll NZ Consolidated Limited to address this issue.

2.4 The generator enclosure was poorly designed in that it allowed the cooling air to bypass the alternator. The alternator was positioned in a dead air space where the ambient temperature was likely to rise significantly above that in other parts of the enclosure. The air circulation around the alternator was so restricted that hot alternator exhaust air could be recycled through the alternator intake grill. A safety recommendation has been made to the Chief Executive of Toll NZ Consolidated Limited to address this issue.

2.5 There was no requirement to check the power generator set to ensure that air was freely flowing through the generator enclosure and that the engine compartment operating temperature after sustained running with all panels fitted was within acceptable limits. Regular testing at 12-monthly intervals would ensure that the automatic over-temperature detection and alarm system was operating as designed and that the airflow was adequate in the restricted areas within the generator enclosure. So long as the risk of an over-temperature situation exists within the generator enclosure, it should be checked regularly to confirm that:

- the airflow is adequate
- the radiator and cooling fan are working efficiently
- the alternator cooling airflow is adequate
- the fan belt is in place and tight
- dust and oil deposits have not collected in at risk locations
- the design of the enclosure is suitable
- the generator continues to operate correctly at operational temperatures
- the muffler and exhaust system is functioning correctly
- the over-temperature alarm is working correctly.

A safety recommendation has been made to the Chief Executive of Toll NZ Consolidated Limited to address this issue.

2.6 A constant current drain on current from an illuminated LED fitted to the control module of the fire suppression system meant that the expected life of a PP3 battery was probably a few weeks only and was therefore likely to fail between weekly checks and before the scheduled replacement. Because the battery in the control module had failed sometime during the week before this incident, both the automatic and manually operated fire extinguisher system was inoperative at the time of the fire.

2.7 FMI P2053 TK specified nylon tubing from the extinguisher bottle to the discharge nozzles, rather than plastic-coated aluminium tubing as specified by the supplier. The instruction within the FMI was in error, rather than incorrect tubing having been fitted.

2.8 The power generator unit on AL2073 had the capacity to provide lighting and heating for a 6-passenger car train. At the time of the fire, the train was made up of only 3 carriages and was therefore operating at less than 50% of full load. Examination of the armature windings after the fire confirmed that the fire had not started from an electrical ignition source.

2.9 The actions of the train manager in monitoring the build-up of fumes in the generator room and attending to the fire were prompt and proper. Although opening a space suspected of containing a fire would normally be discouraged, the train manager had been into the generator compartment several times in a short space of time and the fire was likely to have been small, as it proved to be. Before entering the generator room he could have tried to activate the manual switch to suppress the fire but it would have been ineffective because the battery in the control module was flat. However, he probably thought that he was not putting himself at risk by using the hand-held fire extinguisher to extinguish the fire before considering the manual switch alternative. The passenger operator used his considerable fire-fighting experience to provide support and to assist the train manager locate the seat of the fire.

3. Findings

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

2.10 The fire probably resulted from the ignition of accumulated heated debris in the alternator area of the generator enclosure.

2.11 The accumulated debris around the alternator air exhaust was probably due to the absence of a generator enclosure air intake filter.

2.12 The generator enclosure was constructed in such a manner that allowed the cooling air to by-pass the alternator.

2.13 The automatic fire suppression system installation described in Toll Rail's FMI No. P2053TK appeared to be in conflict with the supplier's recommendations.

2.14 The automatic fire suppression system fitted to the generator enclosure on AL2073 was likely to have operated had the battery not been flat at the time of the incident.

2.15 The programmed maintenance checks on the power generator unit had been carried out within the prescribed timeframes.

2.16 The fire was not caused by an electrical failure in the alternator windings.

2.17 The actions of the on-board staff were appropriate and did not contribute to the fire.

3 Safety Actions

3.1 On 26 April 2005, Toll Rail advised in part:

> Following the fire the control module on AL2073 was replaced with an older style module. The older style does **not** have the LED light that blinks to indicate that the battery is operating, that the newer style has.
>
> The batteries on the newer style module require replacing approximately every two months due to the drain from the LED, whereas the older style requires battery replacement yearly and is replaced at the same time as the electrical warrant inspection.

5. Safety Recommendations

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

5.1 On 15 August 2005 the Commission recommended to the Chief Executive of Toll NZ Consolidated Ltd that he:

5.1.1 take steps to minimise the quantity of airborne dust particles being circulated in the generator enclosure of similar AL passenger cars (068/05)

5.1.2 check all generator units similar to AL2073 to ensure that the cooling airflow is adequate and unrestricted within the generator enclosure around all parts of the diesel engine and the alternator housing and that there is no build up of diesel oil or dust particles. (069/05)

5.1.3 include in the 12-monthly C-check an additional test to establish that adequate cooling has been achieved within all areas of the generator enclosure with all covers in place after the generator has run under load continuously for about 45 minutes. (070/05)

5.2 On 29 August 2005 the Chief Executive of Toll NZ Consolidated Ltd replied that:

> Toll NZ have considered re-installing filters on the cooling air intake however experience has shown that while filtering the dust particles entering the generator enclosure this also restricted air intake to the point that the sets ran hot and shut down in the Rimutaka Tunnel.
>
> Investigations carried out have shown that with the air intake filter removed the cooling airflow in the generator enclosure is sufficient. Regular cleaning takes place every 24,000 km (approximately every three months) and whenever the oil is changed.
>
> Toll NZ considers that the most likely root cause of the fire was a hot cinder from the locomotive exhaust being pulled in through the air intake and sitting on an oil impregnated part of the DA set sound insulation causing it to eventually ignite.
>
> Covering the existing insulation with Flamestop insulation to prevent oil impregnation and contact with hot cinders will prevent a repeat of this incident. We intend to have this installed in all AL generator cars by the end of 2005. (068/05) and (069/05)

5.3 On 29 August 2005 the Chief Executive of Toll NZ Consolidated Ltd replied that:

> We do not accept this recommendation. Overheating investigations carried out have shown that with the air intake filter and fan removed, the AL generator sets get sufficient cooling air flow under all conditions and that generator enclosure temperatures remained well within reasonable limits. Additionally the engines are protected with an overheat detector that shuts down the DA set and brings up an annunciator LED on the control panel if overheat conditions are occurring. Therefore we do not intend to implement this recommendation. (070/05)

Approved on 18 August 2005 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)

04-103	shunting service Train P40, derailment, 43.55 km near Oringi, 16 February 2004
04-116	passenger express Train 1605, fire in generator car, Carterton, 28 June 2004
04-127	express freight Train 952 and stock truck and trailer, collision, Browns Road level crossing, Dunsandel, 19 October 2004
04-125	Collision between an over-dimensioned road load and rail over road bridge No.98 on Opaki-Kaiparoro Road, between Eketahuna and Mangamahoe, 2 October 2004.
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04-118	Express freight Train 725, track occupation irregularity leading to a near collision, Tormore-Scargill, 20 July 2004
04-112	Diesel multiple unit passenger Train 2146, fire in auxiliary engine, Boston road, 16 April 2004
04-111	Express freight Train 736, track occupation irregularity involving a near collision, Christchurch, 14 April 2004
04-110	Shunt L9, run away wagon, Owen's Siding Onehunga, 5 April 2004
03-114	Express freight Train 220, derailment, Shannon, 21 November 2003
04-113	Express freight Train 220, and empty truck and trailer, collision, farm access level crossing, 162.56 km between Maewa and Rangitawa, 27 April 2004
03-113	Diesel multiple unit, passenger Train 3366, passed conditional stop board without authority, Glen Innes, 30 October 2003

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