



Australian Government

Australian Transport Safety Bureau

Fire in Locomotive NR8

Cardiff, New South Wales, 4 April 2016

ATSB Transport Safety Report
Rail Occurrence Investigation
RO-2016-003
Final – 18 January 2018

Cover photo: Sydney Trains CCTV

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Addendum

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Fire in locomotive NR8

What happened

On 4 April 2016 at approximately 0505 Australian Eastern Time (EST),¹ lead locomotive NR8 on train 7YN2 caught fire near the southern side of Cardiff railway station, New South Wales (NSW). The crew stopped the train 250 metres north of Cardiff station after they were alerted to the fire by flames emanating from the locomotive's engine cab. The crew informed Network Control² they could not contain the fire and requested the assistance from NSW Fire and Rescue (NSWFR). At 0510, the crew applied the locomotive park brake and both crew members evacuated without injury. The crew further secured the train by applying the hand brakes on the first 10 wagons and isolated the other two locomotives. NSWFR attended at 0525 but could not commence extinguishing the fire due to the overhead electrical wiring remaining energised. At 0535 an engine explosion displaced a number of engine crank case inspection covers. At 0543 passenger service N116 was stopped from passing the burning locomotive and passengers were detrained to alternative transport. At 0635 the overhead wiring was de-energised and by 0830 NSWFR had extinguished the fire.

The ATSB found that two of the 10 oil filter tank cover bolts had failed beneath the retaining nut due to fatigue and overload fractures. There was evidence of fretting damage on the tank cover at the failed bolt positions. This was consistent with a loose bolted joint associated with in service movement of the assembly. The fire ignited when the displaced tank cover enabled high pressure oil to escape and come in contact with hot engine components (Figure 1).

Figure 1: Fire in lead locomotive NR8 passing through Cardiff Station



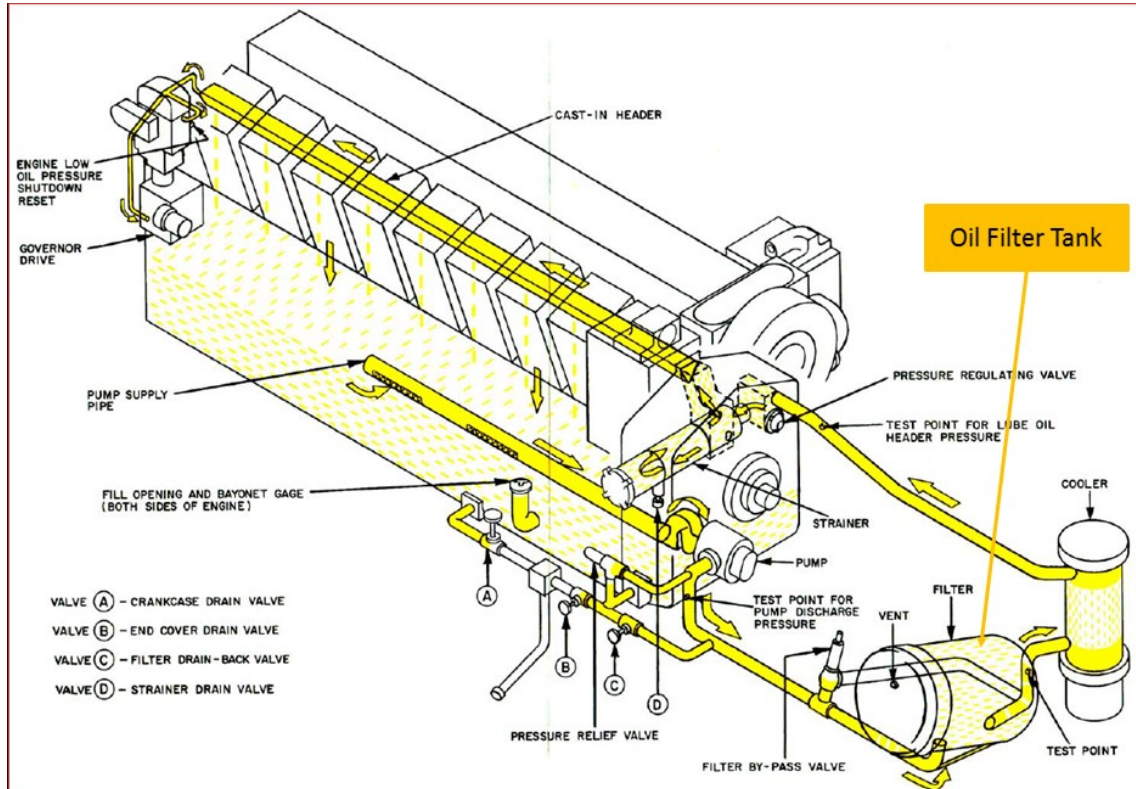
Source: Sydney Trains CCTV

¹ Australian Eastern Time (EST): Coordinated Universal Times (UTC) + 10 hours.

² Network Control oversees the movement of train services on the network. They control the signals and points to direct train services and ensure their safe passage.

The oil filter tank is a part of the locomotive engine's lubricating oil system (Figure 2 and 3). The lubricating oil system capacity is approximately 1500 l. There was approximately 800 l of lubricating oil left in the system after the incident.

Figure 2: Schematic of engine oil lubricating system



Source: GE annotated by ATSB

Figure 3: NR8 engine removed from bay (L) and oil filter tank in situ (R)



Source: ATSB

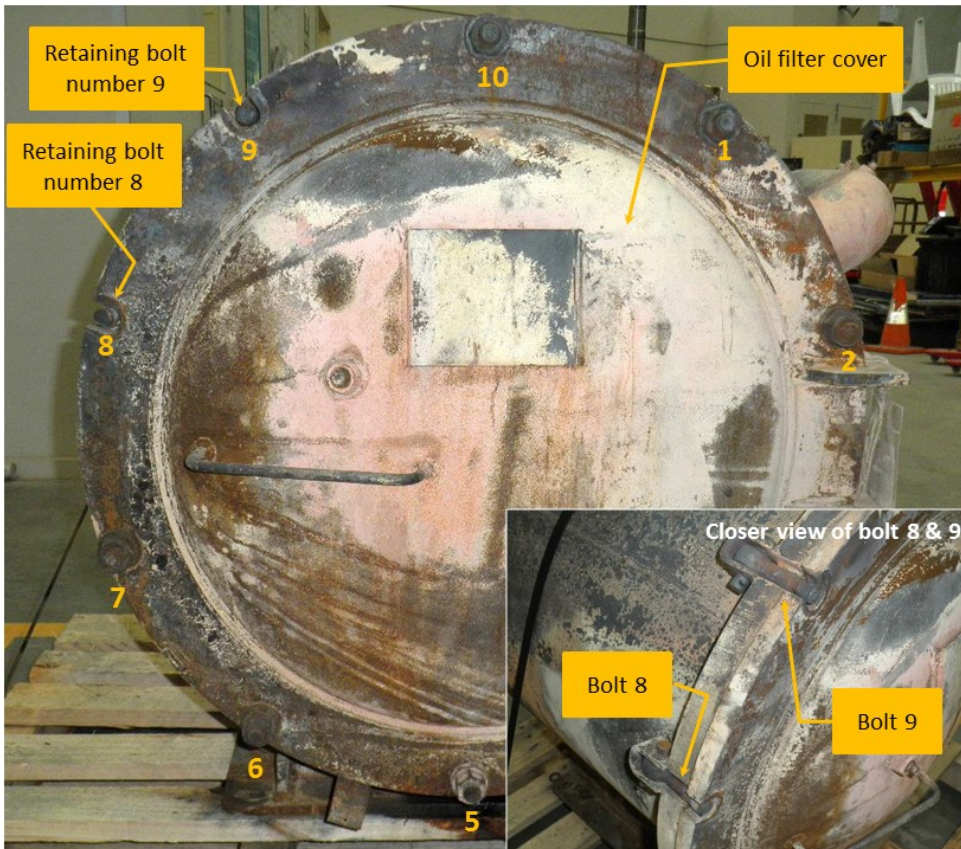
Safety analysis

Fires can be unique in their ignition and progress, however, organisations need to prepare their staff to deal with the early stages of the fire so they can minimise escalation of the fire.

Failed components

An independent metallurgist established that the 19 mm diameter oil filter cover bolts (Figure 4) had suffered unidirectional fatigue failure through the root diameter of the thread. The fractures occurred directly below the nut adjacent to the cover's nut seat. The nut seat exhibited fretting damage, which suggested there was movement across the bolted joint and most likely attributed to excessive torquing of the bolts.

Figure 4: NR8 oil filter tank and cover



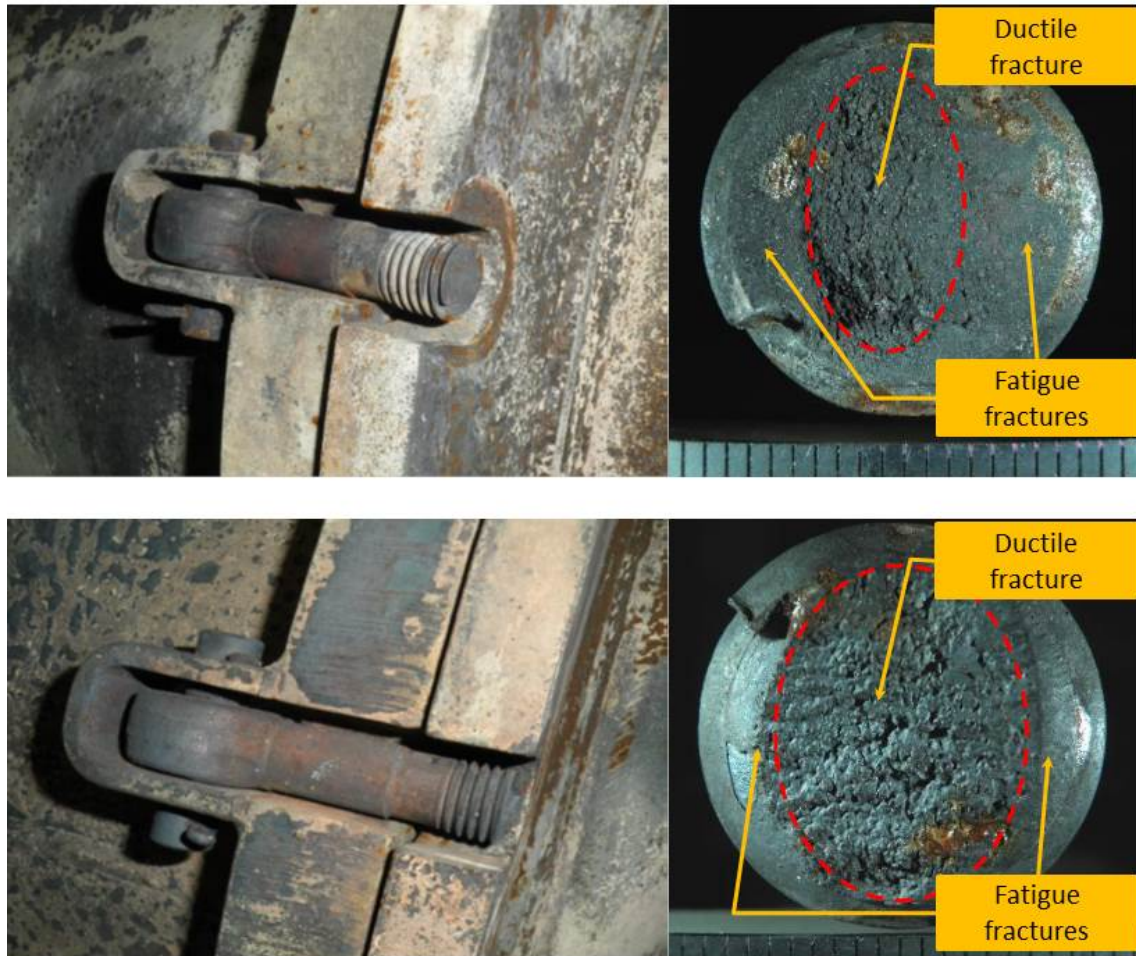
Source: ALS annotated by ATSB

The fracture surfaces of the broken bolts suggested the bolts had been moving transversely to the plane of the cover causing micro fractures at the root of the thread adjacent to the nut seat. Each movement of the bolt would have increased the size of the fatigue fractures and progressively reduce the bolt's tensile strength.

Bolt eight exhibited a small central region ductile fracture surrounded by fatigue fractures emanating from the root of the thread. Bolt nine had a larger ductile fracture surrounded by a smaller area of fatigue fractures. The central region ductile fractures corresponded with the final failure of the bolts (Figure 5 and 6).

The area of the ductile fracture on bolt number eight was smaller than on bolt number nine suggesting bolt eight had fatigued more and failed first. Bolt nine most likely failed after bolt eight.

Figure 5: Bolt number 8 (Top) and 9 (Bottom) with cross sections



Source: ALS annotated by ATSB

Evaluation of the other eight bolts indicated similar fatigue fracturing in similar locations.

There was four engine crank case inspection covers displaced during the occurrence. This was likely due to a secondary fire and subsequent minor explosion in the crankcase.

Postfire response

The crew had on board one 4.5 kg fire extinguisher located in the cab of the locomotive and two larger 9 kg fire extinguishers located in the radiator compartment. All fire extinguishers were dry powder suitable for fuel, oil and electrical fires.

When the driver noticed the fire he immediately applied the emergency shutdown of the locomotives and called train control. Whilst on the radio to train control he made an assessment of the fire to determine if he was able to put it out but confirmed NSWFR would be needed. The driver then applied the park brake before exiting the locomotive with the second person and stood in a safe place away from the burning locomotive.

Approximately 15 minutes later NSWFR arrived at the nearby overhead bridge (Newcastle Street). Whilst the driver discussed the situation with NSWFR the second person applied hand brakes to 10 wagons to ensure the train was stabilized. The driver and second person then isolated the remaining two locomotives (NR90 and NR103). NSWFR commenced set up but could not start due to the live overhead lines.

The isolation of the overhead lines was confirmed at 0548 approximately 23 minutes after notification. It took a further 47 minutes before residual current was confirmed out of the overhead lines. NSWFR then commenced putting out the locomotive fire. All parties had ensured they could approach the burning locomotive only when it was safe to do so.

Network Control informed scheduled passenger service N116 of the locomotive fire at Cardiff at 0531 he informed the driver to approach at caution and provide advice on the situation on arrival. At 0543 N116 was on approach to the incident site when the site incident commander stopped the train and informed the driver of N116 that the train would need to be detrained as passing the site was not possible at that stage.

Findings

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

- Oil filter cover retaining bolts eight and nine had failed through the first thread beneath the nut by a unidirectional fatigue failure mechanism.
- The pattern of fretting damage on the cover nut seat suggested relative movement was evident between bolts eight and nine and the oil filter cover.

Safety action

In response to the retaining bolt failures, Pacific National has advised the ATSB that they have completed the following actions:

- Developed and implemented a bolt tightening and removal procedure
- Reduced the bolt replacement frequency from 732 days to 366 days
- Retrofitted a guard in NR locomotives to minimise the risk of oil escaping from the filter tank and contacting hot engine components.

Other finding

The postfire response from all parties was managed in accordance with procedures.

Safety message

Correct tensioning of bolts can be a critical aspect of ensuring equipment functions as designed. Operators should ensure their safety management systems provide appropriate procedures for bolt inspection and tensioning where there is a risk of equipment failure, especially when the consequence can escalate to fire.

The ATSB *SafetyWatch* highlights the broad safety concerns that come out of our investigation findings and from the occurrence data reported to us by industry.



General details

Fire in Locomotive

Date and time:	4 April 2016 – 0505 AEST	
Occurrence category:	Incident	
Primary occurrence type:	Fire on Train Rolling stock	
Location:	Cardiff Railway Station	
	Latitude: 32° 56'30.7"S	Longitude: 151° 39'43.3"E

Locomotive NR8

Manufacturer and model:	United Goninan, NR class	
Registration:	NR8	
Operator:	Pacific National	
Type of operation:	Freight Haulage	
Persons on board:	Crew – 2	Passengers – n/a
Injuries:	Crew – nil	Passengers – n/a
Locomotive damage:	Substantial	

About the ATSB

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; and fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.