Australian Government
Australian Transport Safety Bureau

# Locomotive fire

Awaba, New South Wales | 5 June 2014


Investigation

**ATSB Transport Safety Report**
Rail Occurrence Investigation
RO-2014-010
Final – 31 October 2014

**Cover photo: Source OTSI**

This investigation was conducted under the Transport Safety Investigation Act 2003 (Cth) by the Office of Transport Safety Investigations (NSW) on behalf of the Australian Transport Safety Bureau in accordance with the Collaboration Agreement entered into on 18 January 2013.

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

**Publishing information**

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**Addendum**

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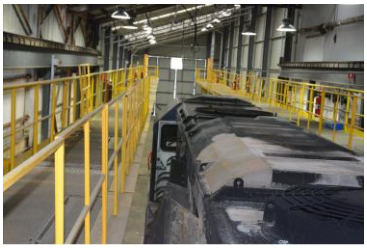
# Safety summary

## What happened

At 2245 on 5 June 2014, the crew on Pacific National (PN) coal service ER64 reported that flames were emanating from the top of the fourth locomotive, 8221, on their train. At the time, ER64 was near Awaba in New South Wales enroute to unload at the Eraring power station. The crew stopped the train and assessed the extent of the fire while also calling for fire brigade assistance. The fire was declared extinguished at 0139 on 6 June 2014. It caused substantial damage to the locomotive.

There were no reported injuries as a result of the incident.

**8221 Fire damage pattern**



Source: OTSI

## What the ATSB found

The ATSB found that the fire was most likely caused when the clevis clamping one of the fuel sight glasses to the fuel filter assembly disengaged, allowing fuel under pressure to spray throughout the engine bay and ignite probably on either the hot exhaust manifold or from within the main generator. The sight glass assembly disengaged because its clevis had compressed, bending inwards, and allowing sufficient lateral movement for it to release from the clevis bolts in the sight glass aperture. The procedures for locomotive inspection and maintenance were not effective at identifying and addressing continuing fuel leakage problems on this type of fuel filter assembly.

## What's been done as a result

Pacific National informed the ATSB that an immediate inspection of all locomotives fitted with the sight glass arrangement was conducted to ensure clevis assemblies conform to original equipment manufacturer specifications and requirements. It also informed the ATSB that an amendment was made to current maintenance procedures increasing the inspection requirements for the sight glass assembly including the clevis and clevis bolts.

## Safety message

This incident illustrates the importance for locomotive maintainers to maintain vigilance and ensure adherence to current maintenance procedures when conducting maintenance on locomotive fuel systems to minimise the risk of fuel leakage and consequent potential for fire.

# Contents

# The occurrence

At 2245 on 5 June 2014, the crew on Pacific National (PN) coal service ER64 reported to the signaller at Fassifern that flames were emanating from the top of the fourth locomotive, 8221, on the train. ER64 was a diesel electric hauled service travelling on the Up Main line between Fassifern and Awaba on the Sydney Trains electrified network at the time. It was enroute to unload at the Eraring power station.

The crew stopped the train and attempted to shut down the four locomotives. However, the engine on 8221 failed to stop and continued running. The driver then called the signaller to request fire brigade assistance while the second person assessed the fire. However, due to its extent, both crew members immediately cleared to a safe place; deeming it unsafe to attempt to fight the fire or separate the burning locomotive from the rest of the train. A crew from the local Rural Fire Services arrived on site at 2345.

The fire was declared extinguished at 0139 on 6 June 2014. While the fire was contained to 8221, it caused substantial damage to the equipment inside and underneath the engine bay, including the main generator.

There were no reported injuries as a result of the incident.

8221 was then hauled to Awaba and stowed in a siding while the overhead wiring at the incident site was inspected for damage. The line was reopened at 0415 and, at 0417, ER64 recommenced its journey to the power station with the remaining three locomotives.

8221 was subsequently recovered to heavy maintenance facilities at Cardiff in Newcastle where it was inspected on 10 June 2014.

The inspection determined that the fire was most likely caused when one of the fuel sight glasses situated on the fuel filter assembly disengaged and sprayed fuel under pressure throughout the engine bay.

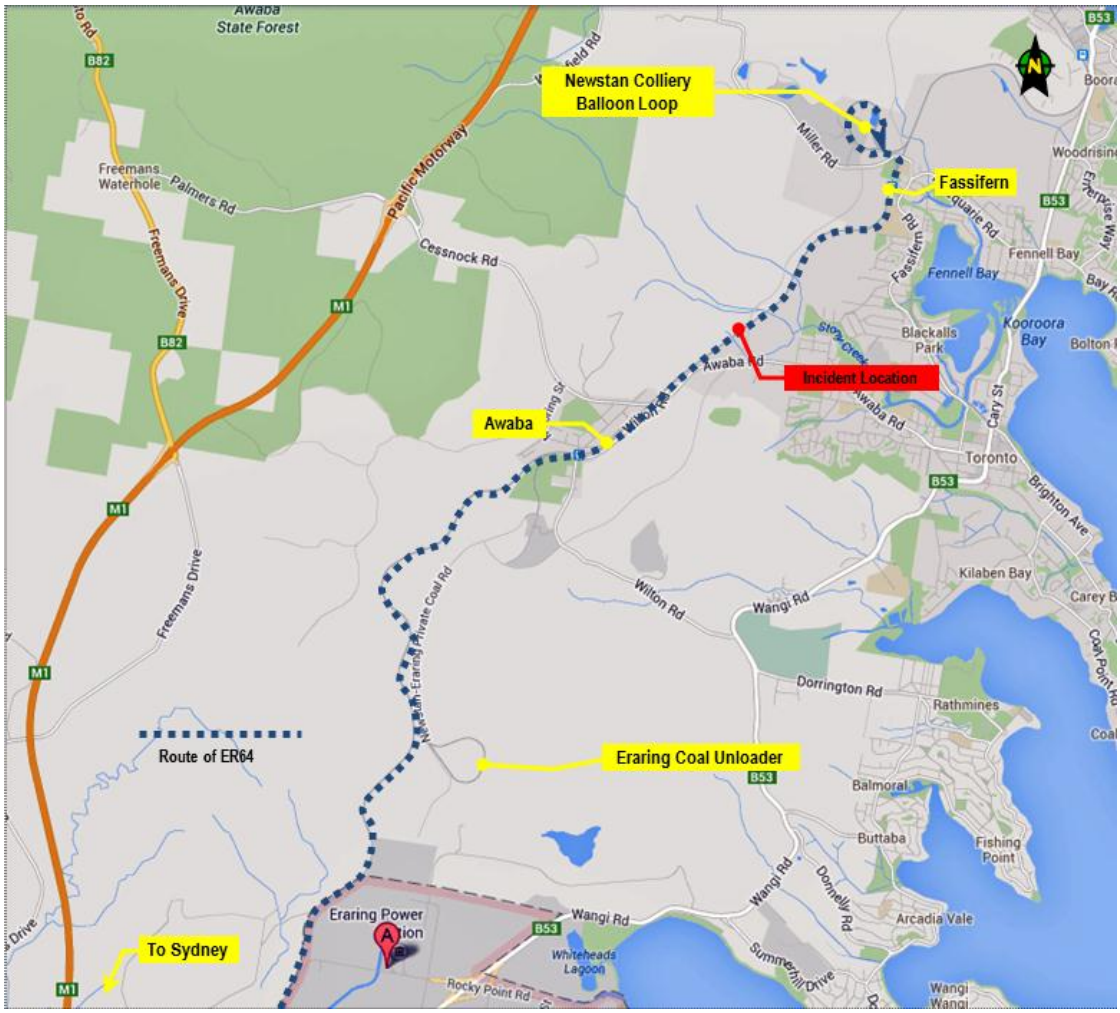
# Context

## Incident location and weather

ER64 came to a stand at 139.972 km in the section between Fassifern (142.179 km) and Awaba (137.240 km) after turning in the Newstan Colliery balloon loop (Figure 1). It had travelled via the Newstan Colliery balloon loop in order to turn for entry onto a branch line leading into the coal unloading station at Eraring power station. The branch line junction is located at 132.590 km.

Bureau of Meteorology records indicated that the minimum overnight temperature was 14.1°C and 8.8 mm of rain had fallen throughout the 24 hr period to 0900 on 6 June 2014. The crew reported that it was drizzling rain at the time of the incident.

**Figure 1: Incident location**




**Source: Geoscience Australia annotated by the ATSB**

## Train/locomotive information

### *Consist*

After undergoing scheduled maintenance at Port Kembla, ER64 was travelling from Lidsdale, near Lithgow, to Eraring via Fassifern. It comprised of four 82 class locomotives and 39 loaded coal wagons measuring 744 metres in length and hauling 3,900 tonnes.

## *Fire detection on 82 class locomotives*

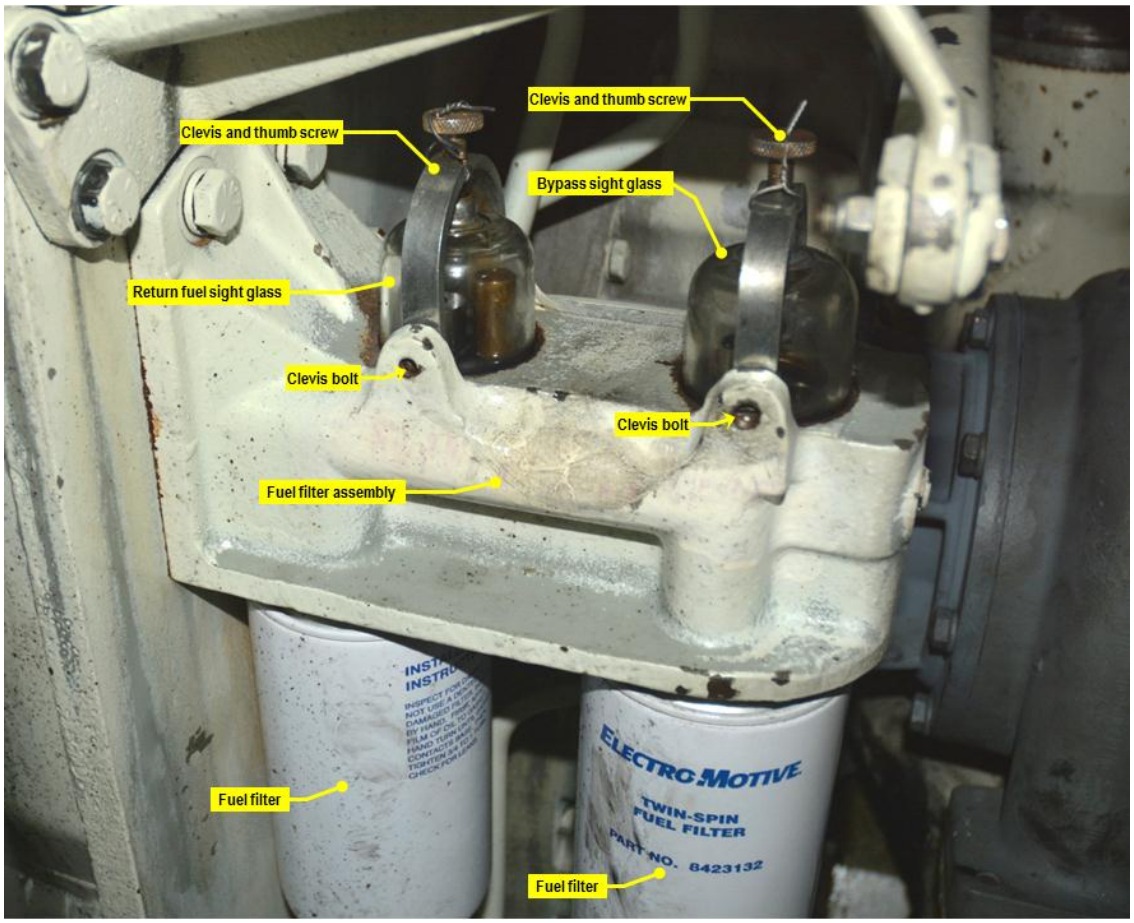
82 class locomotives are not fitted with any fire detection, alarm or suppression system to alert the crew in the event of a fire. In this incident, the fire on 8221 was detected through the vigilance of the crew. The only firefighting equipment carried on board was the portable dry chemical extinguishers located in each driver's cab. However, the extinguishers were inadequate given the extent of the fire and its location. The extent of the fire also prevented the crew from separating the burning locomotive from the rest of the train, a contingency for which PN has no documented guidelines.

## *Locomotive fuel system*

82 class locomotives have a diesel fuel capacity of 10,000 litres.

To maintain engine power, fuel is circulated throughout the engine at the rate of approximately 1500 litres per hour (25 litres per minute) by a conventional diesel fuel injection system. Operating pressures in the system vary up to 410 kPa (60 psi). The fuel is filtered by dual filters located on an assembly inside the engine bay at the front of the engine (Figure 2). Two sight glasses that indicate blockage of the fuel filters to maintenance staff form part of the assembly. After the fuel is filtered, it flows via the fuel rails to the injectors where it is metered into the combustion chamber. Once metered by the injectors all excess fuel is returned to the fuel tank.

**Figure 2: Exemplary fuel filter assembly**




**Source: OTSI**

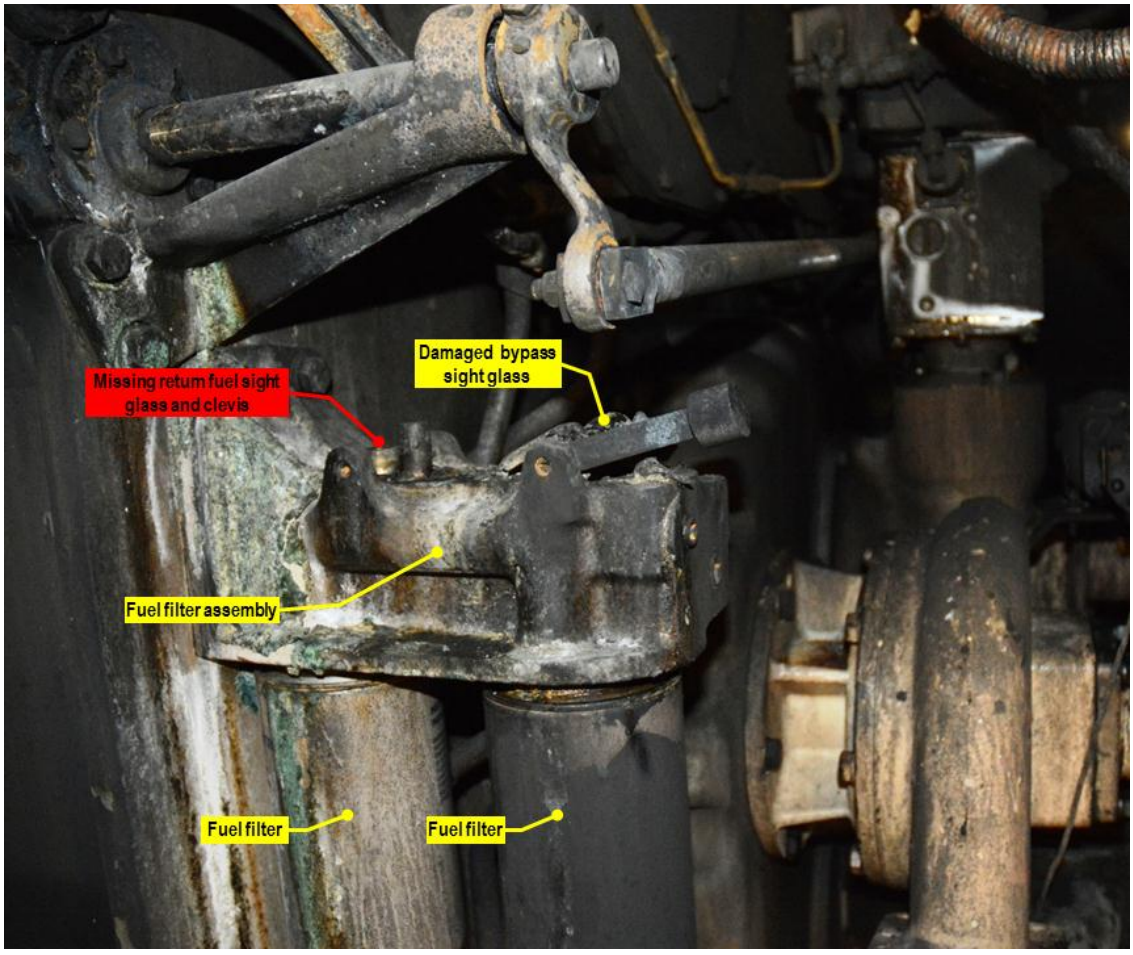
## Post incident inspection

### *Fire origin*

Inspection of 8221 observed that the main fire area had emanated from the locomotive sump[1] inside the engine bay while damaged areas outside the engine bay were generally heat rather than flame affected.

The inspection further determined that the fire had most likely originated at the return fuel sight glass which was missing from the top of the fuel filter assembly (Figure 3). Remnants of the return fuel sight glass, a sight glass seal and the sight glass clevis, which clamps the sight glass onto the filter assembly, were recovered from the sump floor unaffected by the fire (Figure 4). The clevis and remnants of the second (bypass) sight glass were observed still in position albeit fire affected.

**Figure 3: Damaged fuel filter assembly including missing return fuel sight glass and clevis**




**Source: OTSI**

[1] A bunded (containment) area under the engine to store fluid leaks from the engine and prevent spillage onto the track.

**Figure 4: Recovered items**


**Source: OTSI**

The absence of fire damage on the recovered items indicated that they had disengaged and fallen from the filter assembly prior to the fire igniting. This disengagement would have caused diesel fuel under pressure to leak and eventually spray throughout the engine bay starving the engine of fuel and causing it to lose power. The crew reported that the train had experienced a power loss as it passed through Newstan Colliery.

Locomotive fuel management system logs from 8221 indicated that, at 2216, the same time the train was standing stationary in the colliery awaiting a path back onto the Up Main line, its fuel return flow rate suddenly reduced from 1454 litres per hour to approximately 4 litres per hour. The change in the return rate and the loss of power indicated that a major fuel leak had developed on the locomotive. An increasingly large fluid trail, indicative of such a leak, was evident in CCTV footage taken from Fassifern station when 8221 passed through at 2237, approximately five minutes before the fire (Figure 5).

**Figure 5: 8221 passing through Fassifern Station**


**Source: Sydney Trains**

By the time the fuel ignited, an estimated 700 litres had been pumped out through the sight glass, spraying over the engine and accumulating in the locomotive sump. Although not definitive, two likely sources of ignition were considered; these being either the hot exhaust manifold of the running engine immediately above the fuel filter assembly or from within the main generator which is positioned low in the sump at the other end of the engine. The main generator was considered as its rotating machinery had become immersed in the fuel that had accumulated in the sump, potentially causing it to flash over or short-circuit while in operation.

## *Examination of the clevis and sight glass*

Initial inspection of the items recovered from the sump revealed the following:

- The clevis thumb screw was still tie-wired in position complete with clamp seat intact but not in accordance with current maintenance procedures. However, the second (bypass) sight glass was a Durox® ratching type which is currently being removed from service as its thumb screw cannot be tie-wired in accordance with these procedures
- The overall width of the clevis had compressed and bent inwards from 170 mm to 164.5 mm. This caused an excessive total gap of 5.5 mm when the clevis was fitted into position in the mating (170 mm) aperture on the fuel filter assembly
- The protrusion of the two clevis bolts, which measured 6 mm and 2.5 mm respectively, was not set correctly in the fuel filter aperture
- The thumb screw hole was not centrally located width-wise in the clevis
- The thread on the thumb screw exhibited considerable wear
- There were no part number or equipment manufacturer details marked on the clevis.

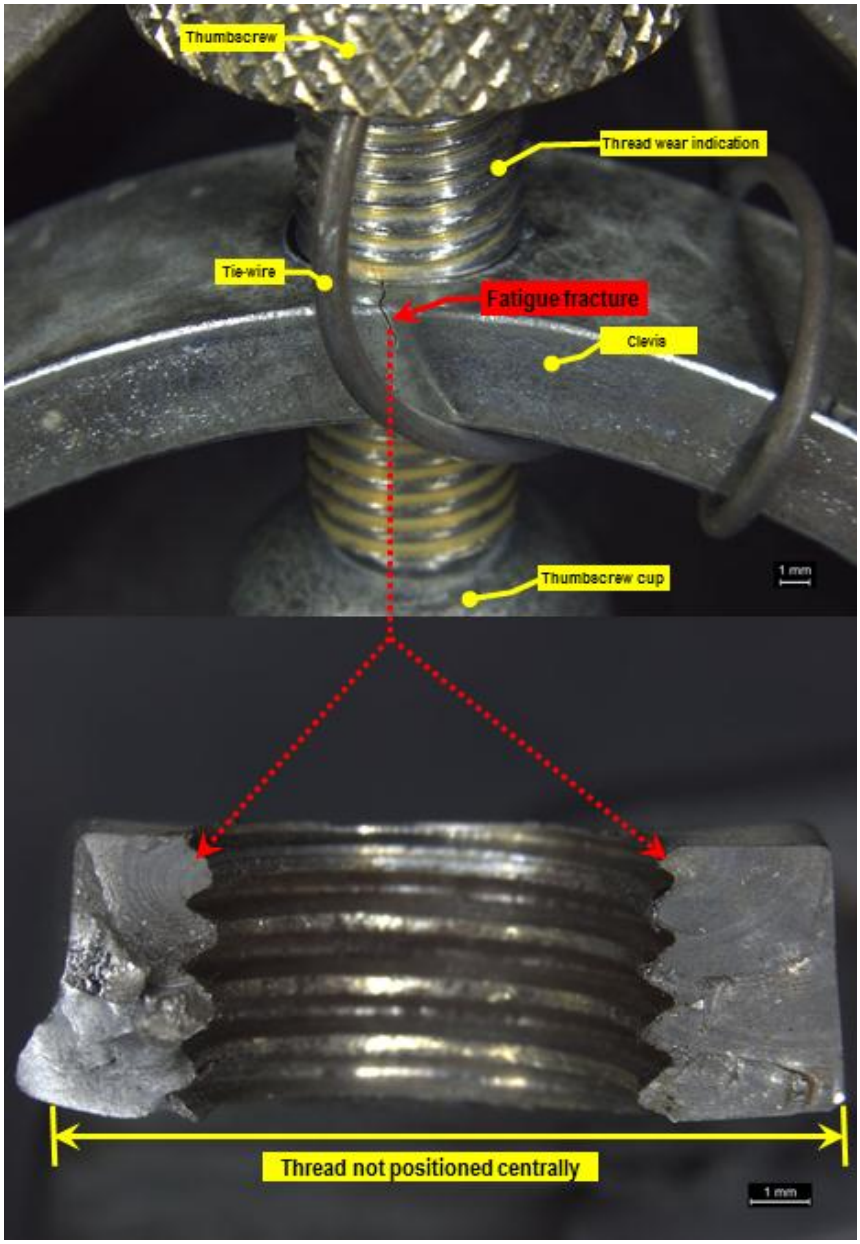
The clevis, sight glass remnants and seal were sent to the ATSB Technical Analysis section in Canberra for detailed examination. This examination revealed the following:

- The presence of a fatigue fracture that had progressed through 75% of the cross sectional area at the thumb screw hole of the clevis (Figure 6)
- There were gas inclusions (bubbles) within the sight glass material
- The seal recovered was not made of the current specified material.

PN subsequently advised that the seal found in the sump was not of the current type used and probably had been dropped during previous maintenance. Remnants of a seal had also been found still in position on the fuel filter assembly.

On 16 September 2014 PN further advised that one of the clevis bolts had been identified as a third party, non-Original Equipment Manufacturer (OEM), part which had suffered deformation after being installed incorrectly.

**Figure 6: Fatigue fracture**




**Source: ATSB**

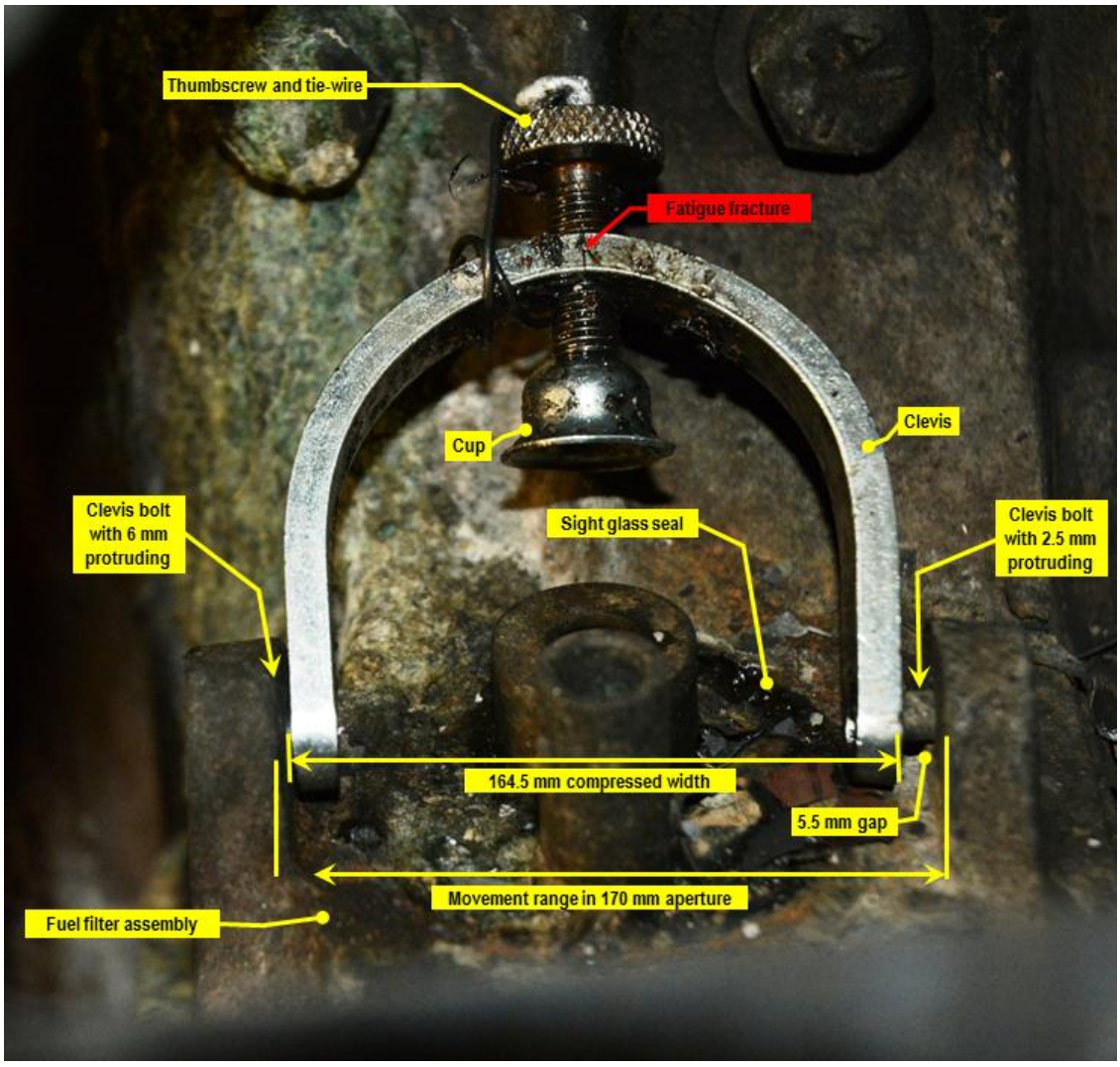
### *Clevis disengagement*

The clevis disengaged for two reasons:

- The overall width of the clevis had compressed from a nominal width of 170 mm to 164.5 mm. This created a total gap of 5.5 mm for lateral movement between the clevis and the faces of the aperture in the fuel filter assembly (Figure 7)
- One of the clevis bolts protruded only 2.5 mm into the aperture. With the 5.5 mm gap in the aperture, the clevis only had to move laterally the length of the protruding pin (2.5 mm) before one side disengaged. Once disengaged, all clamping on the sight glass was released allowing fuel under pressure to escape into the engine bay.

In addition, subsequent dismantling of the fuel filter assembly by PN, in conjunction with Downer EDI Rail (DEDIR), identified that the short protruding clevis bolt was a non-OEM part with a differing thread which had misaligned upwards during replacement of the clevis on 27 April 2014.

**Figure 7: Clevis on fuel filter assembly**




**Source: OTSI**

The compressing of the clevis was most likely the result of continual over-tightening. The continual over-tightening was evidenced by the wear on the upper surface of the thumb screw thread and the fatigue fracture which initiated at a stress point relative to the thread in the clevis.

The subsequent movement of the clevis was most likely caused by engine vibration under normal operating conditions.

# Safety analysis

## Locomotive maintenance

Maintenance of the 82 class locomotives was conducted under contractual arrangements between PN and DEDIR, the locomotive manufacturers' Australian representative.

The locomotives were examined by DEDIR as part of a 28 day 'Trip Inspection' cycle and at major inspections conducted every 140 days. Examination of the sight glasses, which indicate blockage of the fuel filters on the locomotive, formed part of these detailed inspections by locomotive maintainers. Outside these scheduled inspections, PN train crews conducted visual examinations for fuel leaks as part of locomotive preparations.

Maintenance records for 8221 from the previous two years indicated the following:

- The locomotive had been inspected at the specified time intervals with no missed or outstanding trip or major inspections
- A 'Trip Inspection', including examination of the fuel system for leaks, had been conducted at Port Kembla on 2 June 2014, three days prior to the fire
- The clevis on the return fuel sight glass had been replaced on 27 April 2014 after the thumb screw securing cup had collapsed causing the sight glass to leak. The records furthermore indicated that an original equipment manufacturer replacement part had been used. However, the presence of the fatigue fracture and excessive thread wear suggested that the clevis was not a new replacement part
- Six reported sight glass fuel leaks had been repaired on the locomotive in the 24 months prior.

The continual repair of leaks, and the previous collapse of the thumb screw securing cup, indicated that locomotive maintainers were either not adhering to the maintenance requirements or dealing with a reliability issue.

### *Sight glass reliability*

Pacific National has 100 locomotives in its fleet fitted with this sight glass arrangement including 55 x 82 Class locomotives which have been operating since 1994.

Documentation provided by PN indicated that the fuel sight glass arrangement had been beset by leaks since before 1997. However, this incident is the only fire attributed to fuel leakage at the sight glasses. The leaks were usually caused by the thumb screw on the clevis either vibrating loose or being over-tightened by maintenance staff. As a result, maintenance procedures for the sight glass arrangement were modified on three occasions. The modifications related to lock-wiring of the thumb screw in 1997 and two changes to the sight glass material in 2011.

Despite these modifications, sight glass related issues still caused significant delay or cancellation of trains in service. Between 2009 and 2013, nine incidents that were deemed contractual failures[2] were recorded. Another three were also recorded during the previous 12 months although not deemed as contractual failures.

The continuation of the leaks at the sight glasses indicated that inherent reliability issues existed with the sight glass assembly. Despite this, neither the maintenance procedures nor their application by locomotive maintainers were properly mitigating the continuing risk. Evidencing this was the following:

- The incorrect fitting and adjustment of the clevis bolts after the clevis was changed on 27 April 2014

[2] A contractual failure is defined as one where a train is significantly delayed or cancelled due to locomotive defects attributed to Downer EDI Rail as the contracted maintenance agency.

- The lack of replacement parts monitoring, particularly of the clevis and clevis bolts, at installation
- The use of the Durox sight glass on the fuel filter assembly which could not be tie-wired in accordance with current procedures
- The generalised modification procedures which did not detail critical information regarding the dimensions or setting of the clevis
- The ongoing leaks and over-tightening of thumbscrews.

# Findings

From the evidence available, the following findings are made with respect to the fire in the fourth locomotive (8221) of Pacific National (PN) coal service ER64. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

**Safety issues, or system problems, are highlighted in bold to emphasise their importance.** A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

## Contributing factors

- The fire was most likely caused when one of the fuel sight glasses situated on the fuel filter assembly disengaged, allowing fuel under pressure to spray throughout the engine bay and ignite probably on either the hot exhaust manifold or from within the main generator.
- The sight glass assembly disengaged because the sight glass clevis had compressed and allowed sufficient lateral movement to release from inside the sight glass aperture.
- **The procedures for locomotive inspection and maintenance were not effective at identifying and addressing continuing fuel leakage problems on this type of fuel filter assembly. [Safety issue]**

# Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

Depending on the level of risk of the safety issue, the extent of corrective action taken by the relevant organisation, or the desirability of directing a broad safety message to the [aviation, marine, rail - as applicable] industry, the ATSB may issue safety recommendations or safety advisory notices as part of the final report.

## Maintenance procedures

| | |
|---|---|
| Number: | RO-2014-010-SI-01 |
| Issue owner: | Pacific National and Downer EDI Rail |
| Operation affected: | Rail: Freight |
| Who it affects: | All owners and operators of locomotives |

### *Effectiveness of maintenance procedures:*

The procedures for locomotive inspection and maintenance were not effective at identifying and addressing continuing fuel leakage problems on this type of fuel filter assembly.

#### *Proactive safety actions taken by Pacific National and Downer EDI Rail*

Action number: RO-2014-010-NSA-002

As a result of this occurrence, Pacific National, in conjunction with Downer EDI Rail advised that the following safety actions have been implemented:

- An immediate inspection of all locomotives fitted with the sight glass arrangement to ensure clevis assemblies conform with OEM specifications and requirements
- A best practice review and various amendments to the current maintenance procedures which have increased the inspection requirements for the clevis and clevis bolts. Included are additional requirements to inspect for the following:
  - Bending in at the base of the sight glass clevis
  - Worn clevis bolts
  - Elongation of clevis bolt locating holes
  - Fracture of sight glass clevis
  - Worn thread on the sight glass thumb screw
  - Correct alignment of the clevis bolts in the aperture of the fuel filter assembly
- An audit of its current stock of clevis bolts to ensure conformance to OEM specifications
- Improved sight glass clevis tightening procedures

#### *ATSB comment in response*

The Australian Transport Safety Bureau is satisfied that the actions taken by PN and DEDIR address this safety issue.

Action status: Closed

# General details

## Occurrence details

| | | |
|---|---|---|
| Date and time: | 5 June 2014 – 2245 EST | |
| Occurrence category: | Incident | |
| Primary occurrence type: | Fire | |
| Location: | 139.972 km on Up Main Line, Awaba, New South Wales | |
| | Latitude: e.g. 33° 0.74' S | Longitude: e.g. 151° 32.569' E |

## Locomotive details

| | | |
|---|---|---|
| Locomotive Class. | 82 Class | |
| Locomotive No.: | 8221 | |
| Operator: | Pacific National | |
| Type of operation: | Freight - Coal | |
| Persons on board: | Crew – 2 | Passengers – Nil |
| Injuries: | Crew – 0 | Passengers – 0 |
| Damage: | Substantial | |

# Sources and submissions

## Sources of information

The sources of information during the investigation included:

- Downer EDI Rail
- Pacific National
- Sydney Trains
- The Bureau of Meteorology
- The Pacific National Train Crew

## Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to:

- Downer EDI Rail
- Office of the National Rail Safety Regulator
- Pacific National
- Sydney Trains

Submissions were received from Downer EDI Rail, Electro-Motive Diesel (engine manufacturer via Downer EDI Rail), Office of the National Rail Safety Regulator and Pacific National. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

# Australian Transport Safety Bureau

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; 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 fare-paying passenger operations.

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.

## Purpose of safety investigations

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

## Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

**Australian Transport Safety Bureau**

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Investigation

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