Rail Accident Investigation Branch

RAIB Bulletin 09/2009

Passenger train derailed

Description of the accident

1 In June 2009 the rear coach of a two car passenger train derailed as it was running at speed along a double track railway. The train was a class 142 'Pacer' and was carrying 36 passengers and two crew members at the time. The rear axle of the train derailed towards, and the train partially obstructed, the other line.

2 Evidence from the train's data recorder showed that the train was travelling at 57 mph (91 km/h) at the time of the derailment and was accelerating on full power away from the previous station stop. The engine mounted under the floor of the second coach became detached and fell to the track, derailing the rear axle as it passed over (Figure 1). The detachment of the engine severed control wires and damaged the braking system causing the brakes to be applied automatically, stopping the train. The engine was still running when it detached from the vehicle.

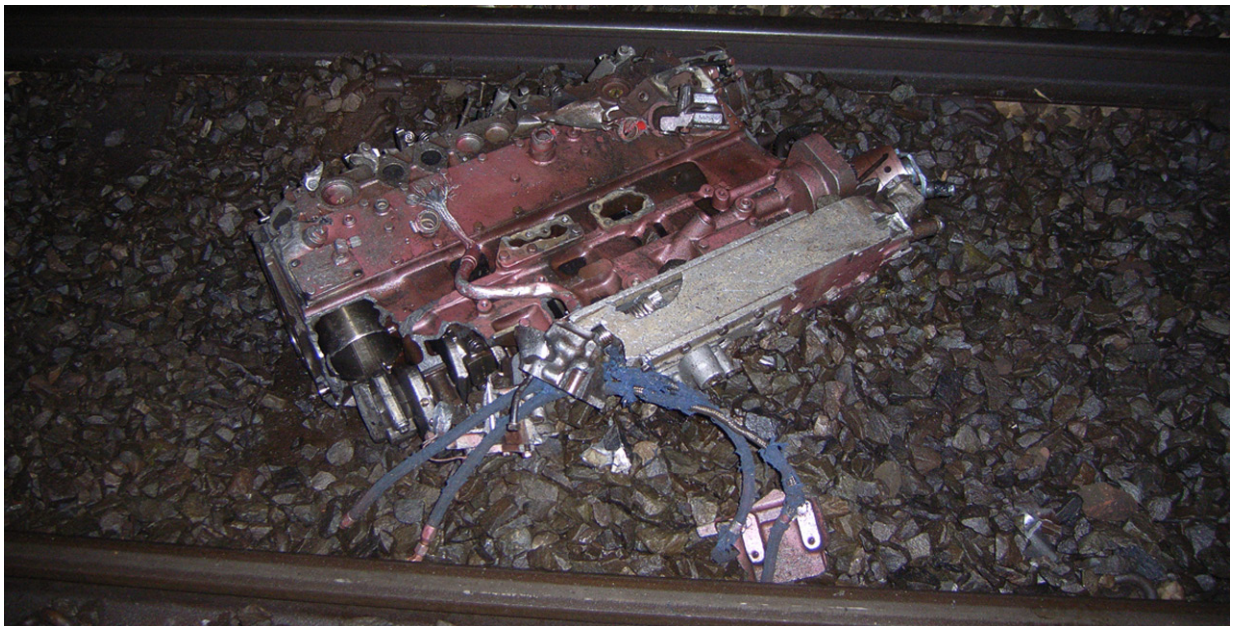

Figure 1: Detached engine

3 The rear coach of the train suffered extensive damage to underfloor equipment and the diesel fuel in its tank was lost to the environment. The track was damaged over a distance of 330 m, causing the railway to be closed to traffic for 22 hours while repairs were made. Three passengers and one member of the train crew sustained minor injuries.

Findings of the RAIB

4 The engine became detached following the failure of its attachment to the flywheel housing. Two of the three engine mounting points are on the flywheel housing which remained attached to the vehicle (Figure 2).

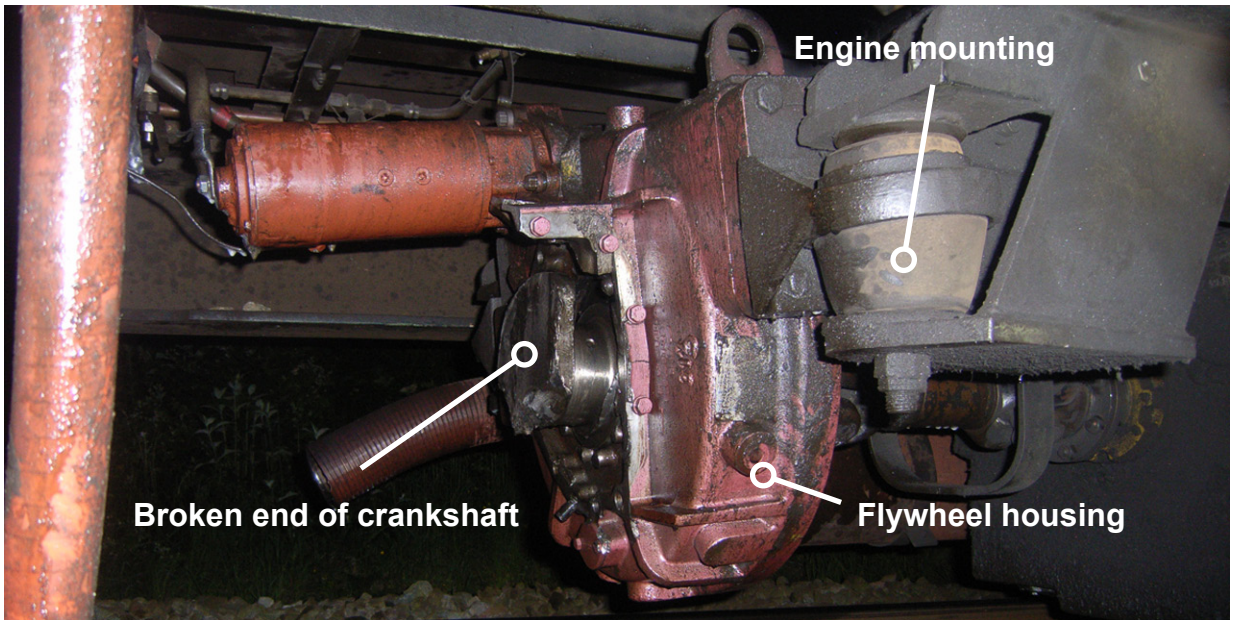

Figure 2: Flywheel housing and engine mounting points

5 The engine parts were recovered and taken to the engine overhauler's workshops for supervised examination and dismantling. The bearings and other internal engine parts were found to be well lubricated and there were no signs of overheating or seizure. The engine crankshaft had broken between the big end bearing of the 6th cylinder and the main bearing in the engine casing at the flywheel end. This break exhibited 'beach' marks characteristic of a fatigue failure (Figure 3). The torque load on the crankshaft of an engine on full power is at its maximum between the last cylinder and the flywheel, the location of the fracture.

Figure 3: Crankshaft fracture face

6 The crankshaft fracture faces were not perpendicular to the longitudinal axis of the crankshaft and this led to repeated elongation of the crankshaft as the two faces rode over one another with each rotation of the engine (Figure 4). There was bruising on the fracture faces from this overriding.

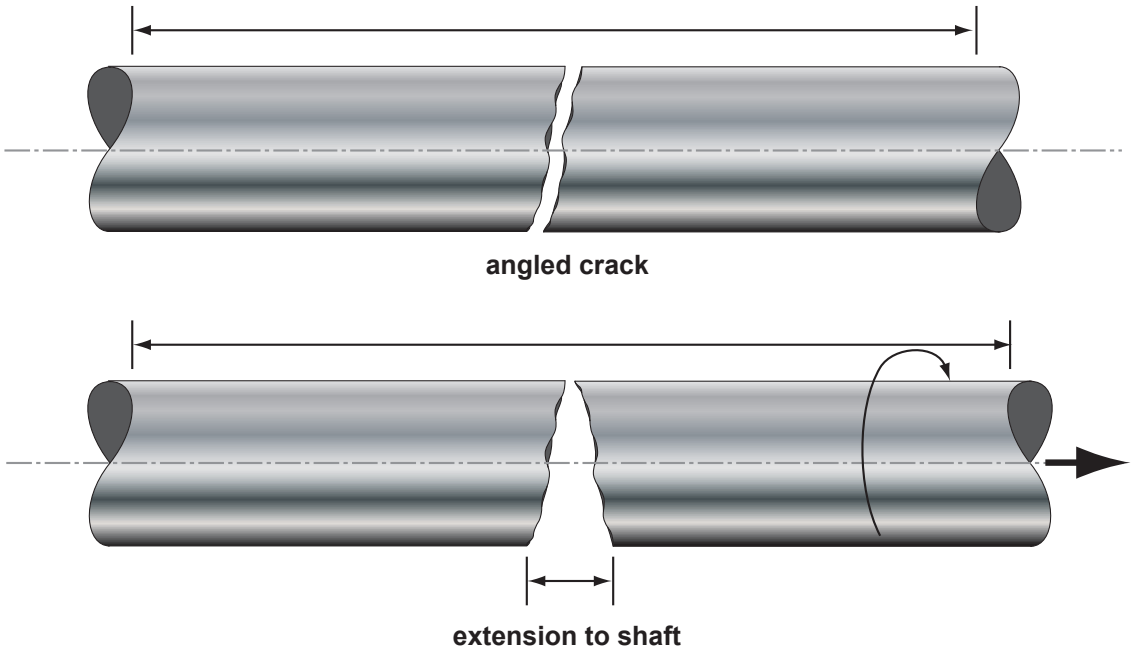

Figure 4: Diagram showing how fracture lengthened crankshaft

7 The longitudinal force generated by the failed crankshaft overriding itself broke the engine casing around the main bearing at the flywheel end and parts of this bearing were found on the track leading up to the point of derailment. A piece of main bearing and its fixing bolt were the first items found in the debris trail towards the derailed train and were found 453 m back from where the train stopped. The engine block was 205 m back from the stopped train.

8 The engine had been overhauled, and was fitted to the train, in March 2008. The train had covered 114,577 miles (183,323 km) since then. The engine has an interval of 400,000 miles (640,000 km) between overhauls. The crankshaft had been used in two other engines prior to being fitted to this engine. It had been reground and subjected to magnetic particle inspection (MPI) to check for flaws before it was fitted to this engine.

9 The MPI process used on this crankshaft was manual and, shortly after this crankshaft was tested, the maintainer had introduced an MPI testing machine, which was able to find smaller flaws.

10 The type of engine involved in this incident is a 10 litre 6-cylinder unit that is only fitted to 'Pacer' type trains (classes 142, 143 and 144). The similar, but larger, 14 litre engine fitted to trains of classes 150 - 158 is mounted on the train in such a way that failure of the engine casing is less likely to cause loss of support for the engine. The RAIB is aware of two failures of engine casings on 14 litre engines, neither of which lead to engine detachment. Although there are, on average, two or three cases of crankshaft fracture each year in 10 litre engines, the RAIB is not aware of any previous cases of crankshaft failure causing engine detachment.

Actions taken by the duty holder following the incident

11 The train operating company involved undertook an investigation after the derailment, sharing the results with the other owners and operators of 'Pacer' trains.

12 The train operating company involved has issued a National Incident Report which makes other organisations in the railway industry aware of the details and the mitigation measures they consider prudent. These measures include extra vigilance of the engine to detect oil leaks or unusual noises or vibration and, when a pit is available, visual examination of the engine casing and mounts. It has also agreed to issue a further National Incident Report on the final findings when the investigation has been finalised.

Conclusion

13 The RAIB has decided not to conduct a full investigation. This is because the RAIB does not believe that such an investigation would lead to the identification of any further significant lessons that would improve the safety of the railways or prevent railway accidents and incidents beyond that which an industry formal investigation identifies.

Learning points

14 The RAIB believes that the learning points from this incident are that owners, operators and maintainers of 'Pacer' trains should:

- review whether the current system of crankshaft flaw detection can adequately detect precursors of failure with sufficient confidence to assure an engine for a 400,000 mile interval between overhauls;
- consider if any measures need to be taken to deal with the risks posed by engines of this type already in service; and
- investigate what precautions can reasonably be taken to mitigate the consequences of catastrophic failure of the engine support.

The RAIB has written to the owners, operators and maintainers of these trains advising them of these points.

The events described took place at Broad Green, Liverpool on 11 June 2009

Addendum

Following publication of this bulletin, details have come to light of an incident in 2000 involving detachment of a 14 litre engine from a class 159 train at Winchfield, in Hampshire. The train was derailed and then rerailed itself on reaching a crossover. The engine mounting on the class 159 is the same as on the class 158. The incident was cuased by the bolted connection between the crankshaft and flywheel failing, destroying the flywheel housing. Following this incident, the maintenance procedures for the engine were changed and new bolts were fitted to this connection at overhaul. The RAIB is not aware of any similar incidents since that time. The RAIB does not consider that this event alters the conclusion drawn in paragraph 13.

This bulletin is published by the Rail Accident Investigation Branch, Department for Transport.

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