RAIB
Rail Accident Investigation Branch

# Rail Accident Investigation: Explanation of discontinuation

## Derailment of the jib runner of Crane ADRC96702 at Greenford East Curve 20 November 2006

Department for Transport

April 2007

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.



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## The Incident

1 On 20 November 2006, breakdown train 2Z99 was travelling from Brighton to Old Oak Common depot in West London when the leading wheelset of the jib runner vehicle of crane ADRC96702 (Figure 1) derailed at 15:40 hrs on Greenford East Curve, near Greenford in West London. The derailment occurred at a speed of 13 mph (21 km/h).

2 The train, which was formed by the hauling Class 67 locomotive, three Mk1 coach type breakdown vans and rail crane ADRC96702, had left Brighton at 12:51 hrs, following a re-railing operation, and was on its return journey to Old Oak Common depot. Following the derailment, the train ran on for approximately 150 m before coming to rest, causing some damage to the jib runner vehicle and the track. There were no injuries.

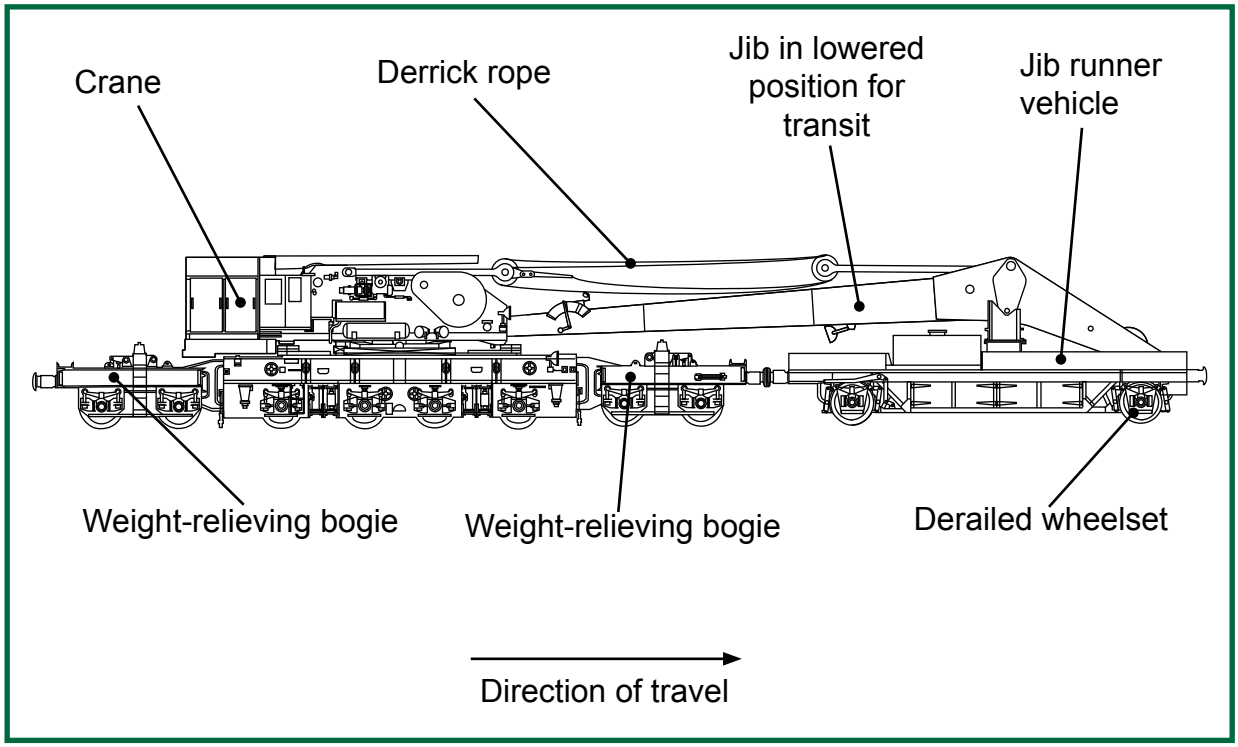


*Figure 1: Crane ADRC96702 and jib runner vehicle*

## The parties involved

3 Network Rail own and operate the infrastructure on which the derailment occurred. They are also the owners of the crane and its associated vehicles and bogies.

4 The train was operated by English, Welsh and Scottish Railways (EWS), who are also responsible for the maintenance and operation of the crane on behalf of Network Rail.

## Post incident actions

5 The crane was re-railed on the night of the incident and taken to Old Oak Common depot.

6 Initial investigations on site did not reveal any evidence that the condition of the rail crane, the track or the train's operation caused the derailment.

## The investigation

7 Network Rail staff conducted a post-incident track survey, witnessed by the RAIB, on 21 November 2006, to measure the vertical, lateral and twist alignment of the track, its curvature and the extent of voiding below the sleepers and ballast.

8 Wheel load measurements were undertaken by EWS on 22 November 2006 and by Network Rail on 27 November 2006. Both measurements were witnessed by the RAIB. These indicated an issue with the distribution of wheel loads on the jib runner, but due to the vertical alignment of the track available at that time, the results were not conclusive. A further set of wheel load measurements, at another location and using a different configuration of wheel weighing equipment, was arranged by the RAIB on 23 January 2007 and witnessed by Network Rail and EWS.

9 Network Rail carried out inspections of the crane, jib runner and associated weight relieving bogies at Old Oak Common depot on 27 November and 12 December 2006 to check if there was any fault with the vehicle, its running gear or the way the crane's jib was fitted to the jib runner, which could explain the derailment. Some faults, which may have been consequential to the derailment, were found; however, none of these could have led to the derailment.

10 CCTV images of train 2Z99 on its journey from Brighton were provided by Southern Railway to establish whether the derrick ropes (Figure 1), which are used to raise and lower the jib, had been correctly slackened prior to the journey.

## Findings

### The track

11 Greenford East curve is a right hand curve, in the direction of travel of train 2Z99, which varies in curvature from 154 m to 892 m along its length. There are no timetabled services operating over the curve and traffic volumes are low.

12 Examination of the track marks on site indicated that the derailment occurred because the flange of the left leading wheel of the jib runner climbed up over the rail head and pulled the leading wheelset into derailment to the outside of the curve.

13 The radius of curvature of the track on the approach to the point of derailment (POD), was measured at 186 m approximately four sleepers before the POD, increasing to 305 m radius at four sleepers after the POD.

14 The value of track twist over the 6.8 m wheelbase of the jib runner, based on the track survey and including void measurements to give dynamic values, was at a maximum one sleeper before the POD with a value of 1 in 139. The direction of the twist at that location acts to unload the leading left wheel with an equivalent wheel drop of 49 mm.

15 At the same location, the dynamic track twist value measured over a 3 m base, the standard measurement used by Network Rail, was 1 in 167. This is less than the 1 in 90 twist level at which the line must be blocked immediately, in accordance with Network Rail standard NR/SP/TRK/001. For curves below 400 m radius, this standard requires track twists of between 1 in 126 and 1 in 200 to be rectified within 7 working days of discovery.

## The train and its operation

16 Analysis of the On Train Monitoring Recorder (OTMR) showed that the train was travelling at 13 mph (21 km/h) at the time of the derailment. The maximum line speed through the curve is 15 mph (24 km/h).

17 The minimum curve radius that the jib runner is designed to negotiate is 100 m.

18 CCTV footage of the crane, captured at various locations from South Croydon to Balham during its journey, showed clearly that the derrick ropes on the crane were slack, as required for transit moves. Had they been tight, contrary to procedure, they could have adversely affected the curving performance of the jib runner.

## Jib runner wheel weight distribution

19 On 23 January 2007, the jib runner was re-weighed on two portable train weighers spaced 6.8 m part (equivalent to the vehicle's wheelbase) and adjusted so that all four wheels of the jib runner could be measured simultaneously, under true level track conditions.

20 The results obtained showed that the left leading wheel, which derailed at Greenford, was loaded to 6.07 tonnes, which was about 27 per cent lighter than the 8.39 tonnes which would be expected if the leading axle load had been equally distributed between its wheels. Although these values were measured post derailment, the damage sustained by the jib runner during the derailment was relatively minor and was not considered to have significantly changed the wheel load distribution. Additionally, it was found that one pair of diagonally opposite wheels were low in static load compared to the other diagonally opposite pair. This indicated that the frame of the jib runner was twisted along its length.

21 Further testing was undertaken with 16 mm of track twist introduced across the vehicle by appropriate packing of the wheel weighing equipment. This twist was arranged so that the leading left wheel was off loaded, in the manner that occurred at Greenford due to the track twist. The results showed that the static loading of the left leading wheel dropped from 6.07 tonnes (average on level track) to 3.60 tonnes (average with 16 mm of track twist).

22 Inspection of the heights of the jib runner's buffers relative to the rail head revealed that there was a twist on the vehicle's underframe of approximately 20 mm, end to end (ie one pair of diagonally opposite buffers were higher than the other pair). When and how this happened is not known.

# Analysis

23 Results of the wheel weighing (paragraph 20) showed that the jib runner had an uneven wheel load distribution, with the left leading wheel running light. This was caused by a permanent twist of the underframe which appears to have sustained damage at some point in its history.

24 At the point of derailment the track survey results revealed a track twist of 1 in 139, which although within the permissible twist level to Network Rail standard NR/SP/TRK/001, would have resulted in an equivalent wheel drop of approximately 49 mm over the jib runner wheelbase of 6.8 m.

25 The amount of wheel off-loading that such a level of wheel drop would have caused at the POD can be estimated by linear extrapolation from the wheel weighing results with 16 mm of twist (paragraph 21). It indicates that there would have been very little vertical load on the left leading wheel, if any at all. For a flange climb derailment to occur, there must be an increase in the ratio of lateral load to vertical load above a certain critical value, which is dependant on the friction and contact geometry between the wheel and the rail. With the left leading wheel almost totally unloaded, the ratio of vertical to lateral load exceeded the critical values and the flange of the left wheel climbed into derailment.

26 Therefore, the permanent twist on the jib runner, which resulted in an uneven wheel load distribution, was a causal factor. The level of track twist at the POD, which was within tolerance, was also a causal factor. The local sharpening of the curve just before the POD (paragraph 13) would have increased the lateral curving forces and was a contributory factor.

27 The RAIB has not sought to find out why the jib runner was in this twisted state. The wagon is over thirty years old and has been regularly lifted from the track when the cranes were used to carry out re-railing operations, being placed at the side of the track on ground that may be very uneven. In these circumstances the distortion could have been present for some time.

## Conclusion and discontinuation of investigation

28 There are only two fixed jib breakdown cranes of this design in service on the Network Rail system, the crane involved in this incident which is based at Old Oak Common depot and another based at Thornaby depot. Network Rail have now withdrawn the Old Oak Common crane from service. The date for the withdrawal of the Thornaby crane has yet to be decided; Network Rail have undertaken to check it for twist and uneven wheel load distribution before it is used again.

29 The Heritage Rail Association have been informed of this derailment and of the RAIB's findings and have been requested to disseminate the information to its members, who may be currently operating similar fixed jib cranes with jib runners.

30 In view of the limited life of the single remaining crane of this type on the Network Rail system and the steps that Network Rail have undertaken to carry out to prevent a recurrence of this incident, the Chief Inspector of the RAIB considers that no further safety benefit would arise from continuing this investigation. In accordance with Regulation 5.13 of The Railways (Accident Investigation and Reporting) Regulations 2005, this investigation has been discontinued.

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