RAIB
Rail Accident Investigation Branch

Rail Accident Report

Locomotive runaway near East Didsbury
27 August 2006

Department for Transport

Report 13/2007
May 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.

Any enquiries about this publication should be sent to:

RAIB
The Wharf
Stores Road
Derby UK
DE21 4BA

Email: enquiries@raib.gov.uk
Telephone: 01332 253300
Fax: 01332 253301
Website: www.raib.gov.uk

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

Locomotive runaway near East Didsbury 27 August 2006

Contents

Introduction

1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.

2 The RAIB does not establish blame, liability or carry out prosecutions.

3 Access was freely given by English, Welsh and Scottish Railway (EWS), and Network Rail to their staff, data and records in connection with the investigation.

4 Appendices at the rear of this report contain Glossaries explaining the following:

- acronyms and abbreviations are explained in Appendix A;
- technical terms (shown in *italics* the first time they appear in the report) are explained in the Appendix B; and
- a simplified explanation of the class 66 locomotive brake system is provided in Appendix C.

Summary of the report

Key facts about the incident

5 At around 01:58 hrs on 27 August 2006, unmanned locomotive 66 084 became uncoupled from the rear of train 6L22 as it approached Heald Green Station. The locomotive then ran back northwards towards Manchester in the direction from which the train had come for around 3 miles (4.8 km), through a *worksite* set up between Gatley and Mauldeth Road stations. The location of the incident is shown in Figure 1.

6 Staff working on the track within the worksite at East Didsbury station were not positioned on the same line as the runaway locomotive and consequently no one was injured.

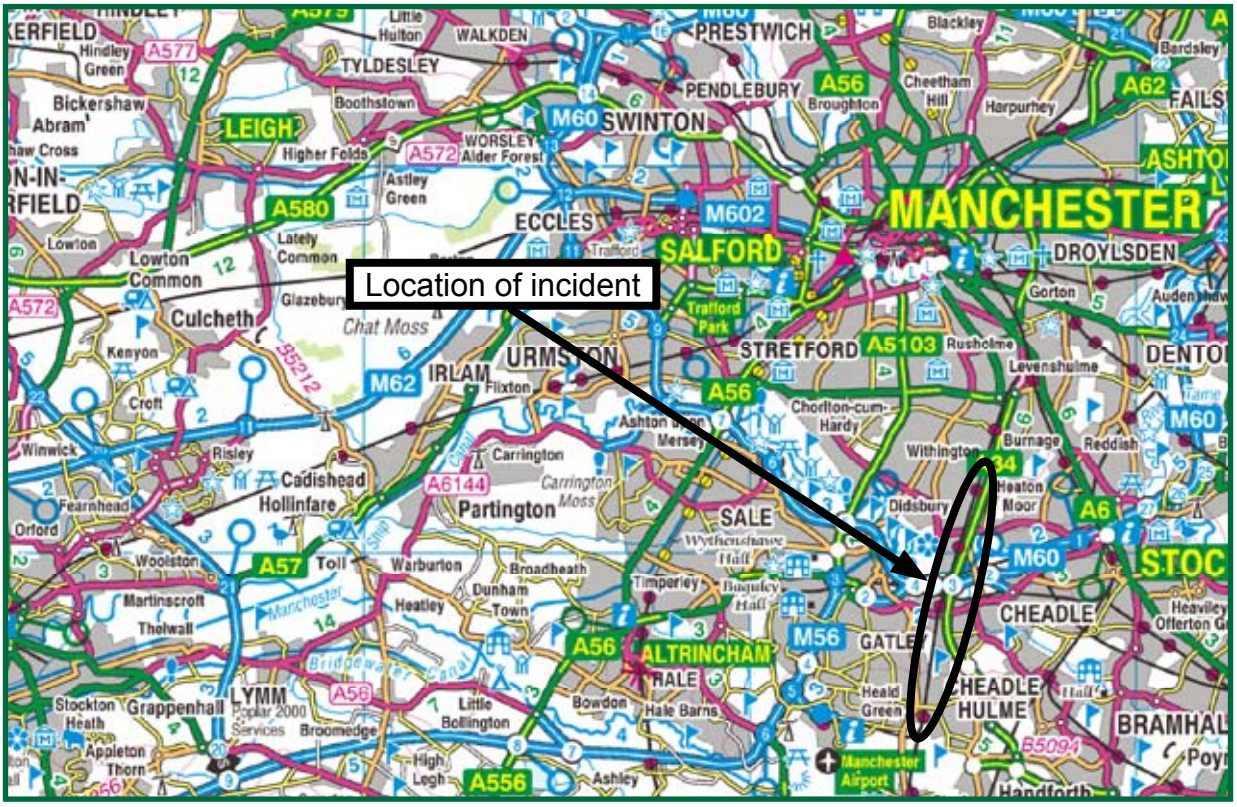


Figure 1: Extract from Ordnance Survey map showing location of incident

Immediate cause, causal and contributory factors, underlying causes

7 The immediate cause of the incident was that the rearmost wagon drawhook broke at a time when the train was on an upward gradient and when the trailing locomotive had no air supply available in its *air reservoirs* to apply the brakes.

8 The following causal factors were identified:

- a sudden, larger than recently experienced tensile load was applied to the drawhook;
- the drawhook had a pre-existing *fatigue crack* below the *gedge slot*;
- the *Assist Failed Train* (AFT) *cock* on the trailing class 66 locomotive was not opened when train 6L22 left Crewe;

- residual air within the trailing locomotive's reservoirs was used up on the journey between Crewe and the incident location; and
- the class 66 locomotive design requires the AFT cock to be manually opened to allow the locomotive to be safely *dead-hauled* on the back of a *single piped* train.

9 The following contributory factors were identified:

- the *Magnetic Particle Inspection* (MPI) of the wagon drawhook stipulated in EWS maintenance procedures, had not been carried out at Bescot depot as scheduled in January 2006;
- the only MPI operative at Bescot was out of MPI competency certification during January 2006;
- the completed maintenance documentation indicated that the MPI had been carried out;
- the driver of train 6L22 did not understand the need to open the trailing locomotive's AFT cock prior to *top and tail* working;
- routine periodic assessment of the driver's competency had not detected and remedied this lack of understanding;
- written information and briefings provided to EWS drivers when top and tail working was introduced did not ensure and confirm drivers' understanding of the necessary associated AFT cock operation;
- the widely and officially used terms 'Assist Failed Train' and 'AFT' cock are not helpful insofar as they suggest the function is primarily associated with failed trains. Under current working arrangements, the function is primarily associated with top and tail working; and
- the AFT cock was labelled 'DEAD ENGINE' and the labelling did not indicate the open and closed positions. Had the labelling been clearer, the driver's long term misunderstanding may well have been corrected.

10 The following underlying causes were identified:

- the passing of the same critical information to different EWS drivers can be by training, which includes formal assessment, or briefing, which does not. This can be dependent upon factors other than the criticality of the information; in this case, the time the driver started in EWS employment; and
- when top and tail working was started by EWS, the hazard associated with runaway trailing locomotives that it introduced was not analysed in sufficient detail to fully understand the risk and adequately mitigate against it.

Severity of consequences

11 No one was injured as a result of this incident. Minor damage to trackside installations was caused as a result of efforts to bring the locomotive to a stop.

12 Had the people working at East Didsbury station been on the same line as the locomotive, as they were scheduled to be later that night, it is likely that the incident would have had far more serious consequences.

Recommendations

13 Recommendations can be found in paragraph 108. They relate to the following areas:

- the redesign of AFT cocks;
- the modification of maintenance procedures;
- the re-training of drivers in relation to AFT cock use;
- the modification of driver assessment procedures;
- a unified description for the AFT cock within EWS;
- the labelling of AFT cocks;
- a review of how critical information is passed to drivers and their understanding of it assessed; and
- a review of processes to identify and mitigate hazards introduced by technical or operational change.

The Incident

Summary of the incident

14 At around 01:58 hrs on 27 August 2006, unmanned locomotive 66 084 became uncoupled from the rear of train 6L22 as it approached Heald Green Station as a result of a broken coupling. The train, the 22:45 hrs Crewe Basford Hall to Heald Green, was approaching its destination worksite and running in the *up* direction on the *down* line.

15 The locomotive then ran back northwards for around 3 miles (4.8 km), in the direction from which the train had come, through a worksite set up between Gatley and Mauldeth Road stations. It stopped momentarily at Burnage station before running southwards.

16 Staff on the track within the worksite at East Didsbury station were working on the up line as the runaway locomotive made its first, northward passage through the site and were clear of the line when the locomotive made its second, southward passage.

17 The locomotive then ran back and forth through a trough in the alignment to the south of East Didsbury station and was brought to a stand as a result of the gradient profile and workers wedging a wooden post in front of one of the locomotive's wheels. The station locations and the track gradient profile of the area are shown in Figure 2.

18 No one was injured as a result of this incident. Minor damage to trackside installations was caused as a result of efforts to bring the locomotive to a stop.

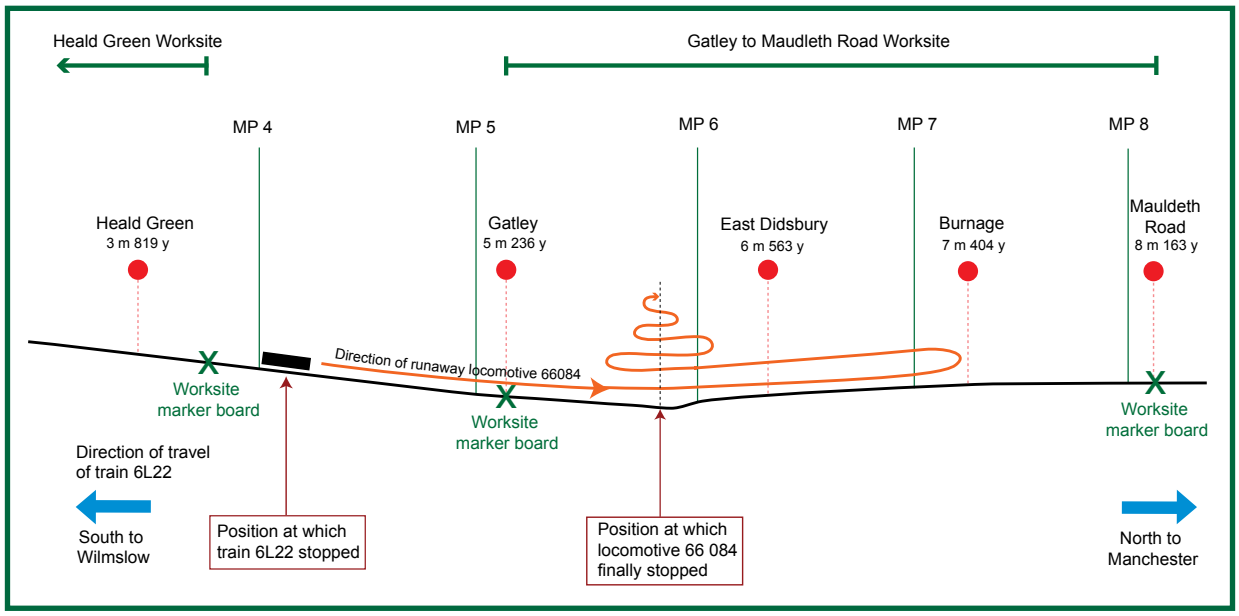


Figure 2: Locations and track gradients associated with the incident

The parties involved

19 Network Rail is the owner and infrastructure controller of the Styal Line on which the incident occurred.

20 EWS is the owner, maintainer and operator of locomotive 66 084 and wagon MHA 394620, the operator of train 6L22 and the employer of driver A.

21 Driver A joined British Railways in 1974 as a Traction Trainee and progressed through the line of promotion until being appointed as a full driver at Warrington in 1983. When class 66 locomotives were introduced into service with EWS between 1998 and 2000, driver A was one of the first drivers to be trained to drive them. At the time of the incident, driver A was based at Warrington.

22 Driver A has no medical restrictions and his driving is well regarded by his Operations Manager. EWS's last practical assessment of the driver's competence prior to the incident took place on 8 August 2006, at which the driver was assessed as 'good with excellent route and rules knowledge'.

Location

23 Figure 2 shows the location of the incident. The front (south end) of locomotive 66 084 was 384 m north of milepost 4 on the Styal line when the runaway started. At this location, the locomotive was on a 1 in 141 gradient, falling to the north.

24 The locomotive ran northwards to Burnage station, stopped, ran southwards and then oscillated about the low point just to the south of East Didsbury station. It was finally stopped 150 m south of milepost 6, by a combination of the gradient profile and workers pushing a wooden post in front of a wheel.

25 The total distance covered by the runaway locomotive was around 5 miles (8 km).

The train

26 Train 6L22, the 22:45 hrs Crewe Basford Hall to Heald Green, comprised locomotive 66 185, 37 laden *ballast* carrying wagons and locomotive 66 084. Locomotive 66 185 was hauling the train and 66 084 was being dead-hauled at the rear. The train was being operated with a single piped brake. This configuration is colloquially known as 'top and tail'.

27 The rearmost wagon, to which locomotive 66 084 was coupled, was MHA 394620. The coupling between the two was an *instanter link* coupling.

Events preceding the incident

28 Preceding the incident, driver A had been on rest days on 18, 19 and 20 August, night shifts on 21, 22, 23 and 24 August and not worked the night commencing 25 August. On 26 August, driver A booked on at 20:05 hrs.

29 Driver A then boarded train 0L21, the 20:45 hrs Warrington Arpley – Crewe Basford Hall, comprising locomotives 66 185, 66 084 and 66 062. All the locomotives were already coupled with *twin pipe* brakes, and had engines running.

30 After completing pre-departure checks, driver A drove the train to Crewe. It departed Warrington at 20:41 hrs with locomotive 66 185 leading and hauling the other two locomotives. En route, the train stopped to pick up a second driver near Salop Goods signal box in Crewe. The train arrived at Basford Hall at 21:26 hrs.

31 The two drivers assisted by two shunters, performed pre-planned shunt moves and marshalled trains 6L21 and 6L22 at Basford Hall. The second driver was assigned to train 6L21 with locomotive 66 062, and driver A to 6L22 with locomotive 66 185 leading and 66 084 at the tail.

32 As part of forming up train 6L22, driver A shut down locomotive 66 084, isolated the battery and hung a *hand tail light* on the back. Driver A did not alter any controls on the *brake rack* at this time.

33 Once train 6L22 had been marshalled into the formation described in paragraph 26, driver A and one of the shunters successfully carried out a brake test on the complete, single piped train. This included checking that the brake shoes applied on trailing locomotive 66 084 when the train brake pipe pressure fell. The shunter also confirmed that the train was carrying a working hand tail light at the rear. Both these checks are mandated by the Group Standard GO/RT3056/C, Principles of Safe Freight Train Operation.

34 Train 6L22 left Basford Hall around 22:20 hrs and was routed north on the West Coast Main Line then via Winwick Junction, Eccles, Manchester Piccadilly, Slade Lane Junction and onto the Styal Line. Driver A carried out a running brake test, as required by Group Standard GE/RT8000/TW1, whilst on the West Coast Main Line, and observed no problems with the train's braking throughout the run.

35 The entire Styal line was under *possession* on the night of 26 to 27 August 2006 to allow station renovation and other works to take place. Train 6L22 reached the possession protecting signal, MP57 at Longsight, and permission was given to pass it at danger by the signaller. The train moved off at 00:54 hrs.

36 The train crossed over at Slade Lane junction to work *wrong road* on the Styal Line (ie running southbound on the northbound/down line). It proceeded to the *worksite marker boards* at Mauldeth Road station, passed through the worksite and left it at Gatley station.

37 Within the worksite, staff were working on the up line at East Didsbury station.

Events during the incident

38 Having left the Mauldeth Road station - Gatley station worksite, train 6L22 proceeded towards its destination worksite at Heald Green. On approach to the Heald Green worksite, driver A applied the *auto brake* to stop the train at the marker board at 01:58 hrs.

39 As the train approached the marker board, driver A released the brake and an unsolicited brake application occurred, bringing the train to a stop from around 5 mph (8 km/h) despite driver A opening the throttle to counter the retardation. After around a minute of attempting to restart the train, with the brake pipe pressure falling, driver A applied the *straight air brake*, left the auto brake off and got out of the cab to investigate what he thought would be a brake pipe air leak. A simplified explanation of the class 66 locomotive's brake system is provided in Appendix C.

40 Driver A walked back along the train listening for air leaks. The driver reached the rear of the train around eight minutes after train 6L22 had stopped, heard escaping air and found the drawhook broken and the rear locomotive, 66 084, gone. The locomotive could not be seen in the darkness. After shutting the brake pipe cock on the rearmost wagon. Driver A walked back to the leading locomotive.

41 Having broken away from the train, locomotive 66 084 ran back northwards for around 3 miles (4.8 km), in the direction from which the train had come, passing through the dip at the bottom of the gradient and then climbing and entering the worksite between Gatley and Mauldeth Road stations. It stopped momentarily at Burnage station before running back downhill southwards.

42 Four people were working on the up line at East Didsbury station as the runaway locomotive made its first, northward passage through the site on the down line. Eyewitness estimates and calculations indicate that the northward pass through East Didsbury was made at around 25 mph (40 km/h) and occurred around six and a half minutes after locomotive 66 084 broke away. Those working were unaware of the locomotive until it came past them.

43 By the time the locomotive made its second southward pass through East Didsbury station all those working in the area were clear of the track. Workers had placed sleepers across the line at East Didsbury but these did not stop the locomotive.

44 Once south of East Didsbury, the locomotive ran back and forth around the trough in the alignment to the south of East Didsbury station and was eventually brought to a stand as a result of the gradient profile and workers wedging a wooden post in front of one of the locomotive's wheels. The locomotive is shown in its final position with the wooden post protruding in Figure 3.

Figure 3: Locomotive 66 084 in its final position looking northwards towards East Didsbury

Consequences of the incident

45 No one was injured as a result of this incident. Minor damage to trackside installations was caused as a result of efforts to bring the locomotive to a stop.

Events following the incident

46 Driver A walked from the back of train 6L22 towards the leading locomotive and was met by a worker from the Heald Green worksite who had walked out to attend to the worksite marker board to allow train 6L22 to enter the worksite. This person used his mobile phone to ascertain that no one had been hurt at East Didsbury and later, to ascertain the stopped position of locomotive 66 084.

47 Driver A walked to Gatley station from where he was given a lift to East Didsbury. By the time he had reached locomotive 66 084, EWS control at Doncaster had called and requested that the locomotive be secured. Driver A noted that someone had already turned the locomotive tail lights on, and applied the parking brake.

48 Sometime during this period the hand tail light was moved from the north to the south end of the locomotive.

49 Driver A was then met by an EWS operations manager who downloaded the On Train Monitoring Recorder (OTMR) on locomotive 66 084. The two then moved to train 6L22 and downloaded the OTMR on locomotive 66 185. Driver A applied the handbrake on locomotive 66 185, shut the locomotive down and applied a number of wagon handbrakes before leaving to write his report and be tested for the presence of drugs and alcohol as required by Group Standard GE/RT8070. The results of the tests proved negative.

50 On the evening of 27 August 2006 train 6L22 was recovered to Crewe by another driver, with locomotive 66 185 dead-hauled at the rear. On arrival at Crewe, it was found that the rear locomotive had been running unbraked, because the AFT cock had not been opened before the train left Heald Green.

51 On 28 August 2006 EWS issued an Urgent Operating Advice (UOA) regarding the use of the AFT cock to the rest of the industry via the National Industry Report (NIR) system, and issued an internal Urgent Safety Advice (USA) to cover their own operations. RAIB forwarded the UOA and USA to the European Rail Agency (ERA), as class 66 locomotives operate on the Continent.

The Investigation

Investigation process

52 As part of the investigation, the RAIB:

- examined the *Accredited Agent's* site logs and photographs;
- examined locomotive 66 084 on site and at Toton Motive Power depot;
- surveyed the incident location;
- examined the On Train Monitoring Recorder (OTMR) data from locomotives 66 084 and 66 185;
- conducted witness interviews;
- examined EWS briefing, training and safety management documentation;
- reviewed the metallurgical examination report into the fractured drawhook by Serco Assurance Railtest; and
- reviewed the EWS and Industry *Formal Investigation* reports into this incident.

Factual Information

53 Examinations and tests at the incident site indicate that:

- the broken coupling was found in the *four foot*, 9 m from the back of wagon MHA 394620 indicating the approximate position at which the coupling broke (Figure 4 refers);
- the drawhook on wagon MHA 394620 had fractured below the gedge slot (Figure 5 refers);
- after the incident with both 6L22 locomotives shut down, the runaway locomotive, 66 084, showed zero readings on all cab air gauges and the leading locomotive, 66 185, had its main air reservoir charged at 9.5 bar (951 kPa);
- the brake rack of locomotive 66 084 was found with the *Brake Pipe Pressure Control Unit Isolating Cock* (BPPCUIC), labelled 'BRAKE PIPE', closed, and the AFT cock, labelled 'DEAD ENGINE', closed (Figure 6 refers);
- the *buckeye coupler* adjacent to the broken coupling on locomotive 66 084 was not stowed and latched in the out-of-use position, and was free to swing on its hinge;
- on re-coupling train 6L22's brake pipe to locomotive 66 084 with the pipe fully charged, locomotive 66 084's main reservoir did not charge with the AFT cock closed. Consequently the locomotive's brakes did not apply when the brake pipe pressure was reduced; and
- when the AFT cock was opened on locomotive 66 084, the main reservoir charged from the brake pipe and the brakes could be applied by reducing brake pipe pressure.

Figure 4: Wagon MHA 394620 and broken coupling as found after the runaway

Figure 5: Wagon drawhook fracture face

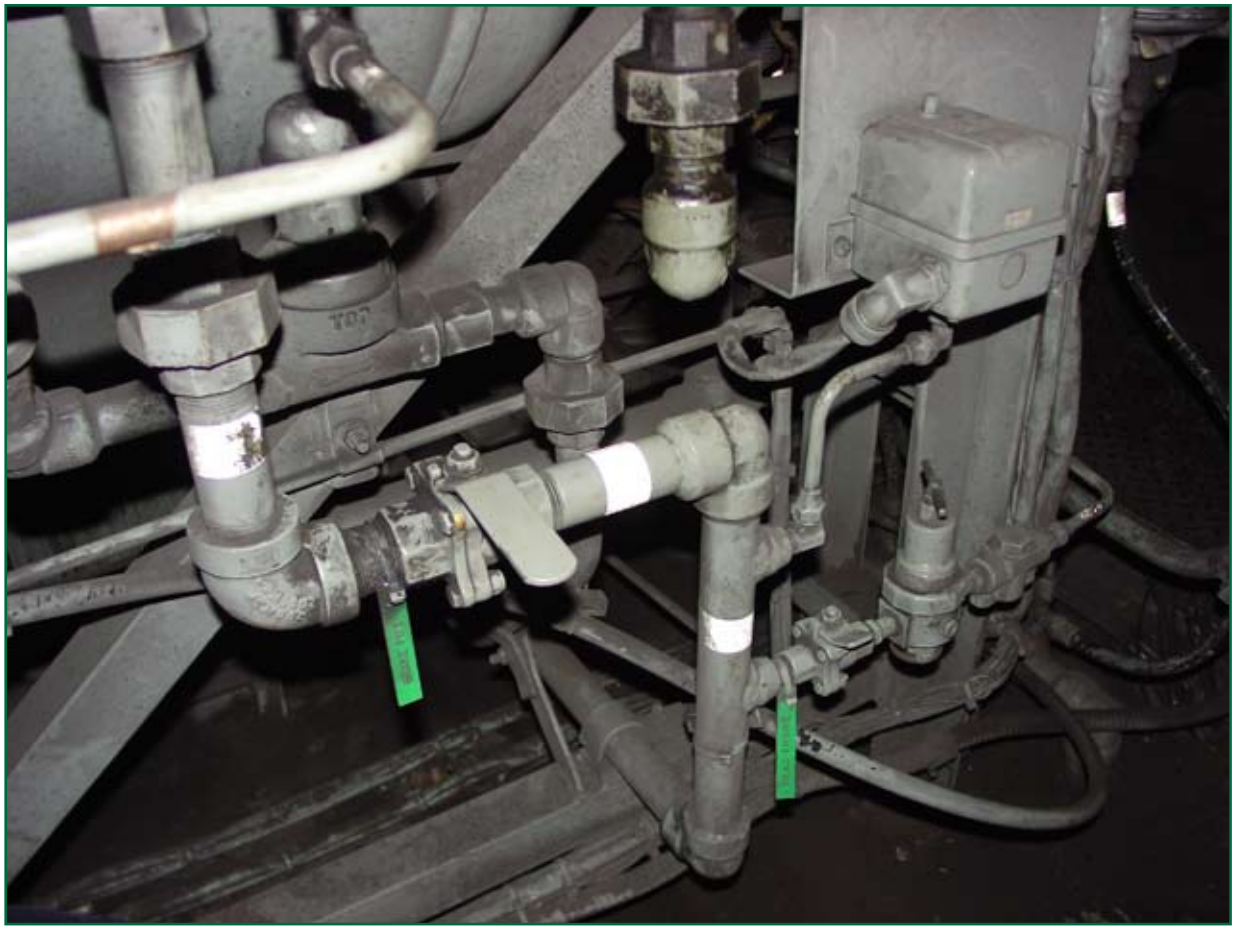


Figure 6: Locomotive 66 084 brake rack as found after the runaway

54 Metallurgical examination of samples indicates that:

- the drawhook had fractured as a result of a fatigue crack having grown to a depth of 16 mm just to the rear of centre of the gedge slot. A sudden, larger than recently experienced tensile load then fractured the remainder of the cross section (Figure 7 refers);
- the drawhook material satisfied the requirements of former British Railways specification for freight vehicle drawhook steel, 104B grade 10 (subsequently designated BS970 grade 945M38). It had been hardened and tempered to give a tensile strength at the bottom of the required range;
- the size of the fatigue crack was larger than those generally found in other broken drawhooks;
- the extent of oxidation of the fatigue crack indicated that it had been very slow growing and had been present, likely at a detectable size, for a year or more; and
- there was another significant crack in the main hook throat and several smaller cracks throughout the drawhook.

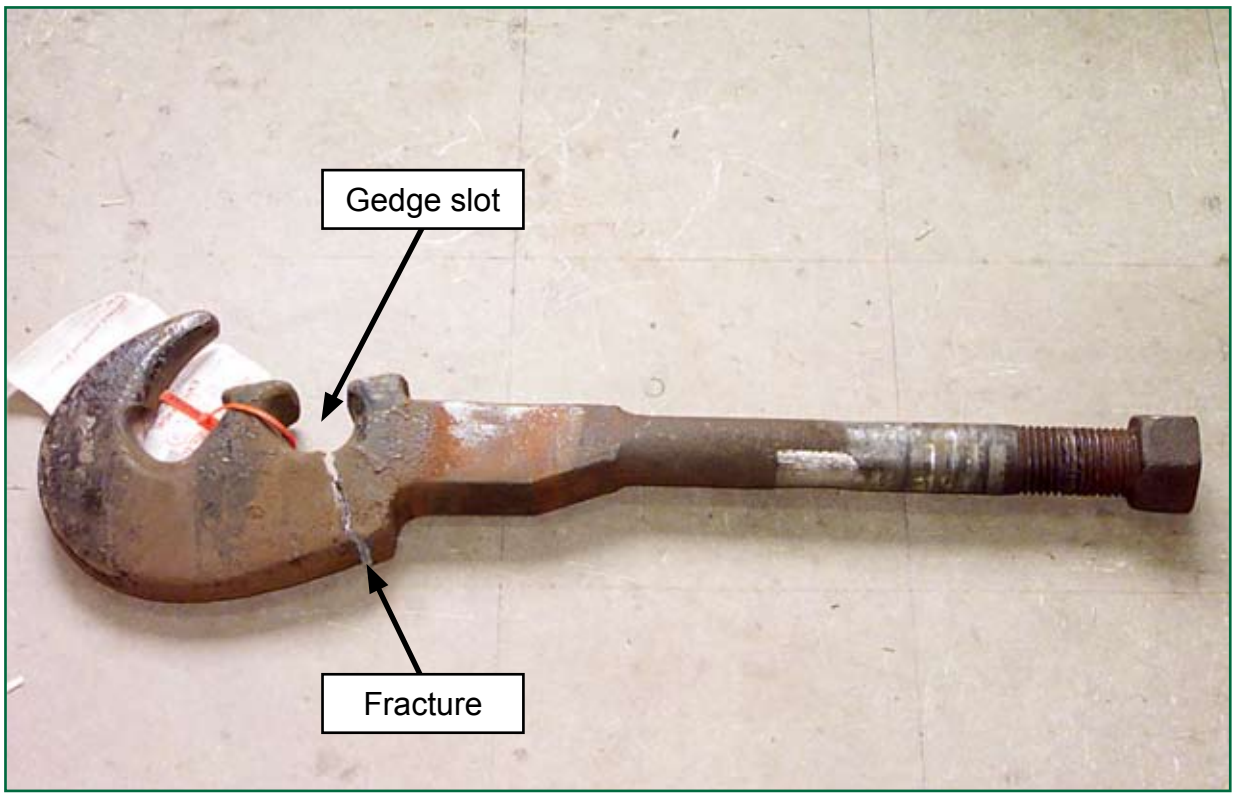


Figure 7: View of loosely reassembled drawhook (photograph courtesy of Serco Assurance Railtest)

55 Information provided by EWS and examination of wagon maintenance documentation indicates that:

- from February 2005, EWS maintenance procedures required drawhooks to undergo MPI as part of Vehicle Inspection and Brake Test (VIBT);
- prior to the incident, the last scheduled VIBT for wagon MHA 394620 had taken place on 4 January 2006. This was undertaken by EWS at Bescot depot;
- the records associated with that VIBT show that no faults were found with, or repairs made to, wagon MHA 394620;

- MPI was not undertaken as part of the 4 January 2006 VIBT because the one person at Bescot certified to do it, was not within certification dates during the month of January 2006; and
- until the MPI operative became re-certified, there was no MPI undertaken on this type of wagon at Bescot throughout January 06.

56 Witness interviews, the locomotives' OTMR data, a review of the locomotive air schematic and information provided by EWS indicate that:

- driver A did not open the AFT cock on locomotive 66 084 before it departed from Crewe Basford Hall as the dead-hauled, trailing locomotive of train 6L22;
- driver A and a Basford Hall shunter successfully conducted a brake test prior to the train leaving Crewe;
- the locomotive underwent a brake test as part of a 'C' examination on 8 August 2006 that confirmed that the brake system performed to specification shortly before the incident;
- when undergoing standard post incident brake testing, the locomotive showed no related defects; and
- static tests were carried out on 66 084 after the incident to determine at what point there would be insufficient air available in the air reservoirs to apply the brakes, assuming that the locomotive was fully charged at Crewe and that the AFT cock was left closed. By simulating brake applications in accordance with the OTMR data for the journey from Crewe to Heald Green, it was shown that the locomotive would have run out of air and become *unbraked* at Eccles as a result of air usage during the intervening journey.

57 Witness interviews and a review of EWS and *Railtrack* documents indicate the following with regard to the introduction of top and tail working:

- in 1999, EWS wished to avoid the need for large numbers of *propelling* moves within worksites for safety and operational reasons. Dead-hauling a locomotive on the rear of works trains would allow them to do this;
- at the time, the Railtrack Safety and Standards Directorate *Rule Book* required that within *class 6, 7 and 8 trains*, any dead locomotives be formed immediately behind the hauling locomotive. This meant that in order to haul a locomotive at the rear of the train, a driver would have to be stationed on the trailing locomotive for all movements - a situation EWS wished to avoid;
- EWS therefore applied for, and were granted, a *Temporary Non-Compliance* to this rule by Railtrack Safety and Standards Directorate, to apply during works on the Settle and Carlisle Line in the autumn of 1999. The provisos were that the train must be continuously braked throughout and the rear locomotive must have an AFT cock;
- during this time, EWS successfully worked trains in top and tail mode in accordance with the Temporary Non-Compliance;
- subsequently, EWS applied to the Railtrack Safety and Standards Directorate for the Rule Book to be amended to allow top and tail operation to be used on works trains on a nationwide basis;
- EWS commenced top and tail working nationally in the summer of 2001 again using a Temporary Non-Compliance until the Rule Book change permitting this mode of operation came into force in December 2001;

- top and tail working was felt to have introduced safety benefits by reducing the need for propelling within worksites. The main associated risk areas considered prior to the workings on the Settle and Carlisle Line whilst considering train division, did not consider the runaway of the tail locomotive. Subsequently when national top and tail working was being considered, EWS carried out a risk assessment in April 2001, which includes the entry shown in Figure 8; and
- as top and tail working was introduced within EWS, Staff Safety Representatives raised an issue relating to the safety of drivers getting down alongside locomotives to isolate the battery switch, as required by the EWS top and tail instructions, with trains running on adjacent lines. This lead to a revision of the applicable EWS *Traction Digest* (paragraph 58 refers);

Tasks or components of activity with associated HAZARDS	**MAIN EXISTING CONTROLS** (Next column measures effectiveness of these)	**L x S = R**	**POSSIBLE NEW OR IMPROVED CONTROLS**	**RESIDUAL RISK (L x S = R)**
1. Train Division Rear portion running away through incorrect brake isolation	Train to be fully braked. Brake continuity test to be carried out prior to movement.	2 x 5 = 10	AFT valve must be fitted on rear locomotive. Briefing/instruction and training on correct method of rear locomotive isolation and air brake requirements	1 x 5 = 5

Likelihood (L)	1 = Very unlikely (Once in 100 years)
	2 = Unlikely (Once in 10 years)
Severity (S)	5 = Fatality (Long term absence, fatality or total loss)
Risk (R)	5 = Further reduction at minimum cost should be considered (£0 - £1000)
	10 = Tolerable if cost of reduction outweighs improvement gained (£10,000 - £100,000)

Figure 8: Extract from EWS Risk Assessment

58 Witness interviews and a review of documents indicate the following with regard to training and briefing of top and tail working and the AFT cock's role:

- drivers trained and passed out on class 66 locomotives prior to the introduction of top and tail working were taught that the AFT cock is for use when assisting a failed train;
- drivers trained on class 66 locomotives since top and tail working was introduced are taught that the AFT cock is for use when assisting a failed train, and for top and tail working;
- when top and tail working was introduced, instructions, including those on the use of the AFT cock on the dead locomotive, were issued as Traction Digest Advice Number 61. This was placed in the drivers' *Notice Cases*.

- between September 2001 and January 2002, the Traction Digest was issued five times. The main reasons for updates being required were the correction of a technical error, references to a Temporary Non-Compliance with the Rule Book needing removal post December 2001 and the personal safety issue for drivers (paragraph 57 refers). None of these changes related to the use of the AFT cock on class 66 locomotives;
- in view of the possibility of confusion arising from five slightly differing issues of Traction Digest Advice Number 61 and the personal safety issues involved, it was decided that all EWS drivers would be briefed on top and tail working;
- briefing slides, including details of the correct use of the AFT cock, were drawn up and the EWS Operations Standards Manager met with the regionally based Rules and Safety Awareness Officers who would give the briefings as part of the late 2002/early 2003 *safety briefing cycle*. In discussing the slides and how the briefing should be given, the personal safety issue was stressed but correct use of the AFT cock was not;
- the briefing of all drivers took place and driver A attended on 16 December 2002 (paragraph 59 refers);
- due to the critical nature of Traction Digest Advice Number 61, it was incorporated into the EWS *Supplementary Operating Instructions* (SOI) when they were issued in their current format in December 2003. Drivers are expected to carry SOI when on duty;
- there were differences of understanding amongst the EWS staff that RAIB interviewed as to which publications it is mandatory for a driver to carry and as to the nature and use of the *Traction and Traincrew Advice*; and
- in the context of EWS's systems, training includes some form of formal assessment to confirm understanding, briefing does not.

59 Whilst recollections vary, witness interviews and documents indicate the following with reference to driver A's understanding of the role of the AFT cock in top and tail working:

- driver A was initially trained on class 66 locomotives prior to the introduction of top and tail working;
- as part of the standard EWS safety briefing and assessment cycle driver A attended a briefing and Rule Book assessment on 16 December 2002. As part of that, the top and tail briefing was delivered (paragraph 58 fifth bullet refers);
- the person conducting the briefing emphasised the need to evacuate all the air out of the brake pipe prior to topping and tailing and correct use of the BPPCUIC cock. This was a result of a desire to avoid a repeat of the Lawrence Hill accident (paragraph 62 refers);
- it is unlikely that the AFT cock was discussed at the briefing, if it was, the subject was not given any emphasis;
- it is likely that the briefing notes were handed to drivers, although whether they took them away is not known;
- no formal assessment of drivers' understanding of top and tail working was carried out;
- the paperwork in driver A's file was not complete, indicating poor record keeping, scheduled assessments not being carried out, or both;
- driver A stated that he did not understand the role of the AFT cock in top and tail working prior to this incident;

- prior to the incident, a number of other drivers within EWS did not understand the role of the AFT cock in top and tail working. For example, anecdotal evidence suggests that this could amount to 50 per cent of drivers at Warrington Train Crew depot. Confusion also existed about the position of the cock when open, closed, normal or isolated and what these terms meant in relation to locomotive operations;
- it is highly likely that driver A and other drivers never opened the AFT cock on the trailing locomotive in top and tail trains over a period of years. If this is the case, the EWS ongoing assessment process did not detect and remedy this lack of understanding; and
- witness evidence also suggests that a number of rear locomotives in top and tail trains have been found to have run unbraked.

Previous occurrences of a similar character

60 The RAIB are not aware of a previous incident of the same type. However, certain aspects of this incident have occurred previously.

61 Recent examples of unmanned vehicles running into worksites have occurred at Notting Hill Gate (24 May 2006, RAIB report reference 12/2007), Larkhall, (2 November 2005, RAIB report reference 20/2006), Alrewas (7 August 2005) and Tebay (15 February 2004). However, it is important to note that these incidents were a result of differing immediate causes to each other and to the incident at East Didsbury.

62 The misunderstanding and incorrect use of the BPPCUIC cock on an EWS class 67 locomotive led to a serious accident at Lawrence Hill near Bristol (1 November 2000). This resulted in serious injury to a driver and significant damage to equipment.

63 There are examples (paragraph 50 and 59 last bullet refer) of other EWS top and tailed trains operating with the rear locomotive AFT cock isolated and resulting in the rear locomotive being unbraked. In these instances, there was no coincident rear wagon/rear locomotive coupling failure and therefore no runaway resulted. These incidents usually became apparent when shunters tried to uncouple the rear locomotive from the train. If there was no air in the rear locomotive, the driver of the front locomotive would have been unable to compress the buffers against the braked rear locomotive to allow the coupler to be removed. Informal witness evidence and the fact that two such incidents occurred within 24 hours of each other on 27 August 2006, suggest that this type of incident is not uncommon. However, EWS management were only aware of one such incident prior to the East Didsbury runaway.

Analysis

Identification of the immediate cause

64 The breakage of the drawhook on wagon MHA 394620 led to locomotive 66 084 becoming detached from train 6L22. The consequent splitting of the brake pipe led to the train braking to a halt as designed, however locomotive 66 084 ran away as the drawhook breakage occurred whilst the train was travelling uphill and the locomotive brakes did not apply.

65 The fact that the locomotive brakes did not apply was a result of there being insufficient air to apply the brakes in the locomotive's air reservoirs. This is evidenced by the fact that by around 3 hours after the incident there was no air in locomotive 66 084's main air reservoir or brake cylinders as indicated by the cab gauges (paragraph 53 third bullet refers), post incident tests determined that the locomotive had no related faults, and the causal factors in paragraph 76 fully support this conclusion.

66 The immediate cause is therefore a combination of the rear wagon drawhook breaking, the gradient up which the train was running at the time and the fact that the trailing locomotive's brakes did not apply because there was insufficient air in the locomotive's air reservoirs to apply them.

Identification of causal and contributory factors

67 Whilst the gradient forms part of the immediate cause, it is a normal condition. There are no causal factors or contributory factors associated with it.

Causal and Contributory Factors associated with the broken drawhook

68 On-site observation and subsequent metallurgical examination (paragraphs 53 second bullet and 54 refer) indicate that the drawhook included a large, pre-existing, slow growing fatigue crack below the gedge slot reducing the effective cross section. This combined with the application of a sudden tensile load caused the drawhook to break. As the crack was slow growing, the magnitude of the tensile load must have been larger than any that the drawhook had experienced in the recent past. There is no evidence that side impacts on the coupling from an unlatched buckeye coupler occurred or contributed in any way.

69 The presence of the pre-existing fatigue crack and the application of a sudden, larger than recently experienced tensile load, are therefore causal factors.

70 EWS had procedures in place specifically designed to detect and mitigate the effects of this type of crack by using MPI and grinding the cracks or scrapping the drawhooks. The most recent maintenance activity that should have included MPI of this drawhook took place on 4 January 2006.

71 Metallurgical examination of the drawhook concluded the fatigue crack was likely to have existed in a detectable condition for a year or more. Thus it was very likely to have been detectable by 4 January 2006 and had the EWS maintenance procedure been correctly applied, the drawhook would almost certainly not have broken as it did. The MPI was not carried out because the MPI operative at Bescot depot was not within certification in January 2006. The omission of MPI and the reason for it are both contributory factors.

72 The records associated with the maintenance activities indicated that the maintenance procedure had been correctly applied and that no fault had been found. As a result the wagon was put back into service with a significant crack in the drawhook. This is therefore a further contributory factor.

73 Drawhooks are designed to withstand tensile loads although that ability had been diminished by the fatigue crack. In this case the magnitude of the load may have been increased by the trailing locomotive being unbraked or by control actions of the driver. However, whether either or both of these factors contributed significantly at the moment the drawhook broke is not possible to tell. The two issues are not considered further as to do so would add nothing to the investigation.

Causal and Contributory Factors associated with the locomotive brakes not applying

74 Locomotive 66 084 had no air in its reservoirs to apply the brakes when the coupling broke and the brake pipe split. This is because the AFT cock was left closed at the start of the journey from Crewe and because all the residual air had been expended by brake applications on the intervening journey. Such air usage is a normal part of train operation.

75 The class 66 and some other locomotive designs require an AFT cock to be opened when being dead-hauled in a single piped train, to allow the main air reservoir to be charged from the train brake pipe. Not all locomotives are designed this way and with some, the function is achieved automatically.

76 Therefore the locomotive design, that the AFT cock was not opened at Crewe and the residual air being used up are all causal factors.

77 Driver A did not open the AFT cock on locomotive 66 084 at Crewe when preparing the train. There are two differing explanations for this. One is that the driver understood the correct course of action but for some reason failed to open the cock. The alternative explanation is that driver A did not understand that the AFT cock had to be opened when operating the locomotive in this way.

78 Evidence in paragraph 59 strongly suggests that driver A did not understand the use of the AFT cock when top and tail working and that it is most likely that the driver understood that it was only for use in assisting failed trains, as the name suggests, and as he had been originally taught.

79 The possibility that the driver did understand that the AFT cock should have been opened before train 6L22 left Crewe but made an error is further discounted by the more obvious reasons for error in this case, time pressure and fatigue not being considered significant. The driver being unaware of the need to open the AFT cock at Crewe is therefore considered a contributory factor.

80 From the evidence in paragraphs 58 and 59 the following are considered to be the reasons why driver A was unaware of the need to open the AFT cock at Crewe:

- written information and briefing of drivers when top and tail working was introduced did not ensure and confirm understanding;
- ongoing driver assessments did not detect and remedy the lack of understanding;
- Assist Failed Train and AFT cock are not helpful descriptions for an item with a primary purpose now related to top and tail working. In fact the 'DEAD ENGINE' label found within the locomotive is a more accurate, if incomplete description; and
- the AFT cock was labelled 'DEAD ENGINE', with no indication of the open and closed positions.

These factors are therefore contributory.

Identification of underlying causes

Imparting of critical information and assessment of understanding

81 Paragraph 80, first and second bullets indicate that the briefing process in place at the time, and the ongoing driver assessment process then or since, did not ensure driver A's understanding of this issue or detect and remedy the lack of it.

82 Evidence in paragraph 59 indicates that driver A was not alone in his lack of understanding and the unsafe practice perpetuated as a result.

83 Newer drivers are trained on the full and correct use of the AFT cock as initial training on class 66 locomotives. The fact that it is part of initial training means that it comes within the initial assessment process. However, drivers who were already trained on class 66 locomotives when top and tail working was started, were briefed on the correct use of the AFT cock. Briefing is a less controlled process than training and does not include a formal assessment of understanding. Two differing methods were therefore used to impart the same critical information.

84 It is an underlying cause that the passing of the same critical information to different EWS drivers can be by training, which includes formal assessment or briefing, which does not. This can be dependent upon factors other than the criticality of the information; in this case, the time drivers started in EWS employment.

Assessment of hazards and risk when implementing top and tail working

85 There is no evidence that the runaway of the tail locomotive was specifically considered as a hazard prior to the introduction of top and tail working on the Settle and Carlisle Line (paragraph 57 refers).

86 A basic risk assessment was carried out prior to national top and tail working (paragraph 57 refers). The risk assessment was based upon the experience of those carrying out the work and not on quantified historical data. Whilst the assessment accounted for the hazard of the rear locomotive running away, it assumed that a brake test would reveal an unbraked rear portion of a train before the start of a journey. This incident has shown that this assumption does not always hold and suggests that the predicted 'existing' frequency of once in every ten years may have been optimistic.

87 The risk assessment assigns a ten fold decrease in frequency as a result of improved controls, 'AFT valve must be fitted on rear locomotive. Briefing/instruction and training on correct method of rear locomotive isolation and air brake requirements'. From the evidence available, it has not been possible to tell whether that reduction in frequency reduction is justified. However, the risk assessors would likely have assumed that all those who were briefed would have at least understood the correct operation of the AFT cock when they left the briefing. This is now known not to have been the case.

88 The residual hazard frequency is once every hundred years. The fact that the hazard has manifested itself after five years whilst not proving this incorrect, suggests that it is likely to be so. This suggests that the actual residual risk is greater than the risk assessment predicted.

89 Further, no methods of risk mitigation other than briefing and training appear to have been considered, such as a design change, improved labelling of the AFT etc. The combination of this and the fact that the predicted residual risk is likely to be lower than the actual residual risk meant that the hazard was not mitigated to a degree that resulted in the residual risk being in the '(low), broadly acceptable region' as EWS believed.

90 Whilst the hazard was eventually identified after top and tail working had started, it is an underlying cause that the nature of the risk was not understood to a degree that led to adequate mitigation.

Severity of consequences

91 No one was injured as a result of this incident. Minor damage to trackside installations was caused as a result of efforts to bring the locomotive to a stop.

92 Had the people working at East Didsbury station been on the same line as the runaway locomotive, as they were scheduled to be later that night, it is likely that the incident would have resulted in deaths or serious injuries.

Summary of the event chain

93 The diagram shown in Figure 9 illustrates the causal, contributory and underlying factors graphically.

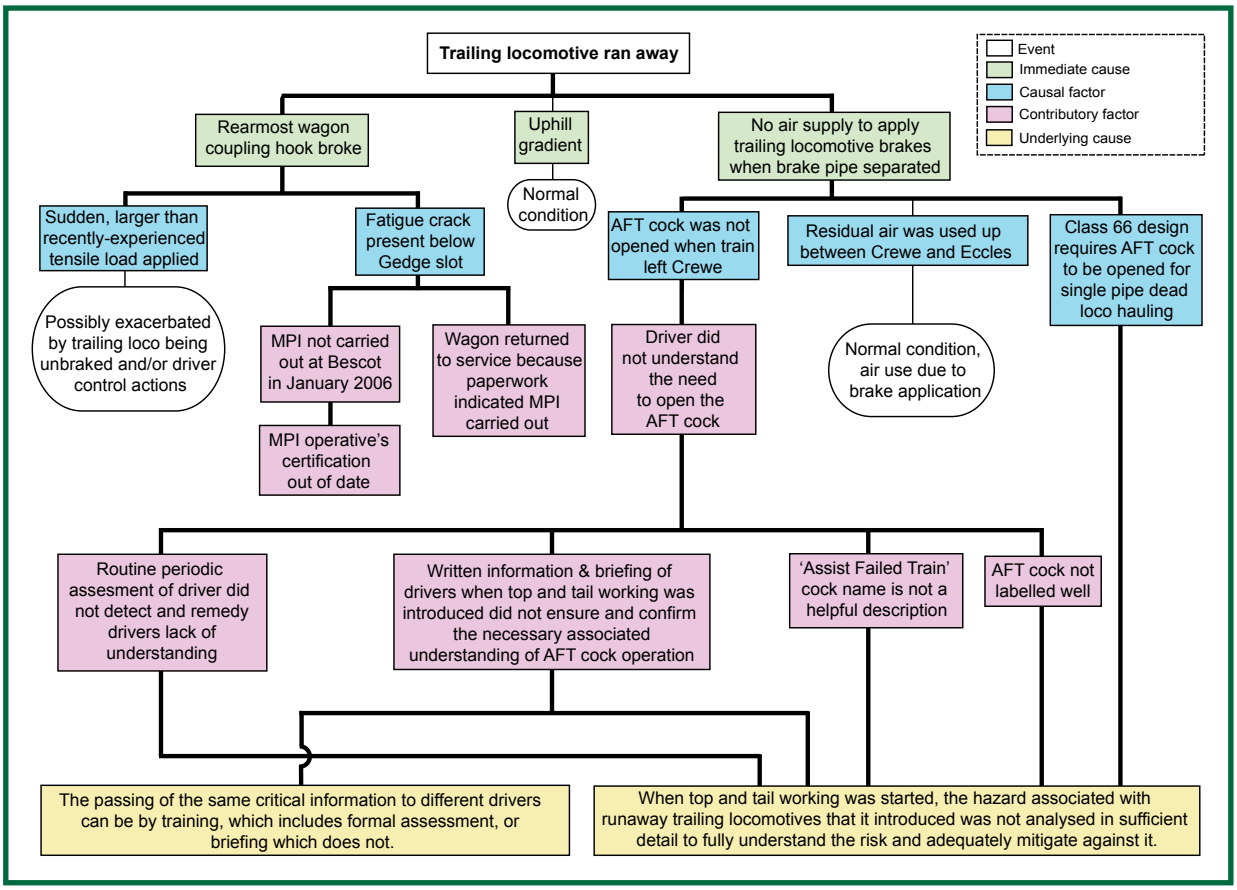


Figure 9: Diagram showing chain of events and factors

Conclusions

Immediate cause

94 The immediate cause of the incident was that the rearmost wagon drawhook broke at a time when the train was on an upward gradient and when the trailing locomotive had no air supply available in its air reservoirs to apply the brakes.

Causal and contributory factors

95 The following causal factors were identified:

- a sudden, larger than recently experienced tensile load was applied to the drawhook;
- the drawhook had a pre-existing fatigue crack below the gedge slot;
- the Assist Failed Train (AFT) cock on the trailing class 66 locomotive was not opened when train 6L22 left Crewe;
- residual air within the trailing locomotive's reservoirs was used up on the journey between Crewe and the incident location; and
- the class 66 locomotive design requires the AFT cock to be manually opened to allow the locomotive to be safely dead-hauled on the back of a single piped train (Recommendation 1).

96 In addition, the following contributory factors were identified:

- the MPI of the wagon drawhook stipulated in EWS maintenance procedures, had not been carried out at Bescot depot as scheduled in January 2006;
- the only MPI operative at Bescot was out of MPI competency certification during January 2006;
- the completed maintenance documentation indicated that the MPI had been carried out (Recommendation 2);
- the driver of train 6L22 did not understand the need to open the trailing locomotive's AFT cock prior to top and tail working (Recommendation 3);
- routine, periodic assessment of the driver's competency had not detected and remedied this lack of understanding (Recommendation 4);
- written information and briefings provided to EWS drivers when top and tail working was introduced did not ensure and confirm drivers' understanding of the necessary associated AFT cock operations (Recommendation 3);
- the widely and officially used terms 'Assist Failed Train' and 'AFT' cock are not helpful insofar as they suggest the function is primarily associated with failed trains. Under current working arrangements, the function is primarily associated with top and tail working (Recommendation 5); and
- the AFT cock was labelled 'DEAD ENGINE' and the labelling did not indicate the open and closed positions. Had the labelling been clearer, the driver's long term misunderstanding may well have been corrected (Recommendation 6).

Underlying causes

97 The following underlying causes were identified:

- the passing of the same critical information to different EWS drivers can be by training, which includes formal assessment, or briefing, which does not. This can be dependent upon factors other than the criticality of the information; in this case, the time the driver started in EWS employment (Recommendation 7); and
- when top and tail working was started, the hazard associated with runaway trailing locomotives that it introduced was not analysed in sufficient detail to fully understand the risk and adequately mitigate against it (Recommendations 8).

Other factors affecting the consequences

98 The following factor affected the severity of the accident:

- had people been working on the down line at East Didsbury station, as they were scheduled to do later that night, the incident would have almost certainly have resulted in far more serious consequences.

Additional observations

99 The paperwork in driver A's file was not complete indicating poor record keeping, scheduled assessments not being carried out, or both (Recommendation 7).

100 Within EWS, there is confusion as to what publications it is mandatory for a driver to carry whilst on duty (Recommendation 7).

101 Within EWS, there is confusion as to the nature and use of the Traction and Traincrew Advice, to whom it is issued and how its contents are updated (Recommendation 7).

102 Immediately after the incident, EWS issued an Urgent Safety Advice that included an instruction to exhaust all locomotive air before undertaking a brake test on top and tailed trains. This is impractical, may introduce other risks and has since been withdrawn. This further illustrates the need to fully understand the effect of changes before implementation (Recommendation 8).

Actions reported as already taken or in progress relevant to this report

103 Immediately after the incident, EWS identified all drivers who were to operate top and tail trains. Prior to taking their trains out they were individually briefed by an operations manager on the use of the AFT cock. Subsequently, a training module, including an assessment, was produced to be given to all top and tail drivers by the end of 2006. Any driver taking out a top and tail train that has not received the training is required to undergo the operations manager briefing. These measures have been applied to drivers of all locomotives fitted with AFT cocks.

104 EWS have developed a valve that combines the function of the Brake Pipe Pressure Control Unit isolating cock and the AFT cock; in essence one handle operates the two linked valves. This is currently being tested on modified locomotive 66 009.

105 EWS have reviewed their ongoing testing and assessment systems to make sure that drivers' competence in top and tail procedures is fully tested. As a result, their testing regime has been amended to include greater attention to AFT cock operation during locomotive preparation.

106 EWS have reviewed their monitoring system to physically check the status of AFT cocks in dead-hauled locomotives. As of April 2007, the sample checking regime for trains in engineering possessions has been expanded to cover the state of AFT cocks. However, in the longer term, this may be influenced by the action described in paragraph 104.

107 EWS have fitted labels to all their locomotives fitted with AFT cocks showing the open and closed positions and providing instructions on correct usage.

Recommendations

108 The following safety recommendations are made[1]:

Recommendations to address causal and contributory factors

1 Operators of locomotives that require the manual operation of a cock to allow such locomotives to be safely dead-hauled in single piped trains, should investigate possible design changes to mitigate the risks associated with the cock not being correctly operated. Design changes should be implemented so far as is reasonably practicable (paragraph 95 fifth bullet refers).

2 EWS should review and modify its procedures as necessary to ensure that when a maintenance action is not carried out at the scheduled time, the vehicle concerned is not returned to traffic and operated as if the maintenance action had taken place (paragraph 96 third bullet refers).

3 EWS should train all drivers in the correct use of AFT cocks, include an assessment procedure to confirm that driver's understanding and thereafter put in place a monitoring regime to confirm that AFT cocks are being operated correctly. This should apply to all relevant classes of locomotives and methods of operation (paragraph 96 fourth and sixth bullets refer).

4 EWS should modify their ongoing driver assessment procedures to ensure that drivers maintain a full understanding of, and can correctly use, the AFT cock. This should apply to all relevant classes of locomotives and methods of operation (paragraph 96 fifth bullet refers).

5 EWS should ensure that all their procedures, documents and labels use the same terminology to describe the AFT cock. They should also assess whether moving away from the term, 'AFT cock' at this juncture will add to or reduce confusion, bearing in mind that if a design modification is implemented the AFT cock or a need to separately isolate it, may be obsolete (paragraph 96 seventh bullet refers).

6 EWS should ensure that the AFT cock is clearly labelled with its name, function and open/closed positions (paragraph 96 eighth bullet refers).

7 EWS should undertake a full and thorough review of their processes for conveying critical information to drivers in a consistent manner and for assessing that the information has been understood. The control of these processes should also be considered as should the ongoing access to the information and ongoing understanding by drivers. Reasonably practicable measures should be implemented (paragraphs 97 first bullet, 99, 100 and 101 refer)[2].

continued

[1] Responsibilities in respect of these recommendations are set out in the Railways (Accident Investigation and Reporting) Regulations 2005 and the accompanying guidance notes, which can be found on RAIB's web site at www.raib.gov.uk

[2] Recommendation 7 addresses observations as well as causal and contributory factors.

8 EWS should review and if necessary modify their procedures to ensure that there are more thorough processes in accordance with best practice for hazard identification, risk assessment and mitigation associated with the introduction of technical or operational change. These processes should be proportionate to the change and be carried out before the change is implemented (paragraphs 97 second bullet and 102 refer)[3].

109 In addition to Recommendation 1, Recommendations 3, 4, 5 and 6 also have applications to other Freight Operating Companies which should assess the need to apply the lessons of this investigation to their own activities.

[3] Recommendation 8 addresses observations as well as causal and contributory factors.

Appendices

Glossary of abbreviations and acronyms — Appendix A

AFT	Assist Failed Train
BPPCUIC	Brake Pipe Pressure Control Unit Isolating Cock
ERA	European Rail Agency
EWS	The English, Welsh and Scottish Railway Company
MPI	Magnetic Particle Inspection
NIR	National Industry Report
OTMR	On Train Monitoring Recorder
UOA	Urgent Operating Advice
USA	Urgent Safety Advice
VIBT	Visual Inspection and Brake Test

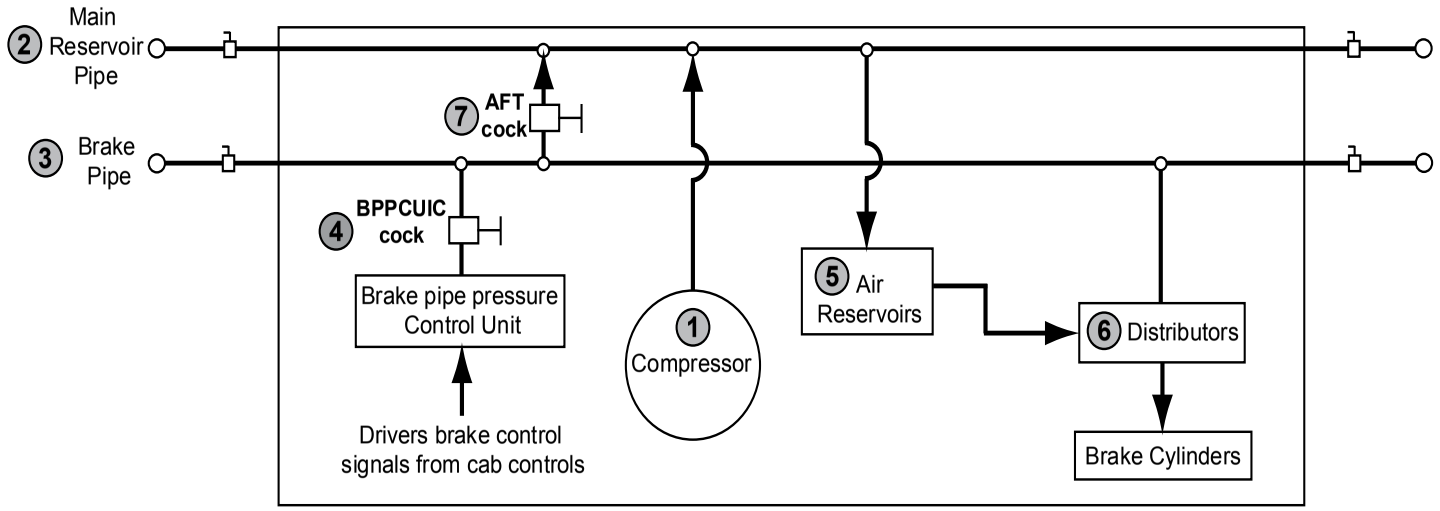
Glossary of terms — Appendix B

Accredited agent	A member of rail industry staff who has been trained and certificated by RAIB and who acts on behalf of RAIB at an incident site until an inspector arrives.
Air reservoirs	Tanks that store air under pressure to be used, amongst other things, to apply the brakes.
Assist Failed Train cock	A tap which when opened connects the train brake pipe to the main air reservoir via a non-return valve. It is used to allow the main reservoir to charge when the engine is shutdown (so there is no compressor operating on the locomotive) and there is no train main reservoir pipe.
Auto brake	Automatic brake, so called because a fault causing loss of air, for example a train dividing, automatically applies the brakes.
Ballast	Graded stone used for drainage and support of railway tracks.
Brake Pipe Pressure Control Unit Isolating Cock	The cock, colloquially known as the 'E70', that isolates a locomotive's brake control equipment from the train brake pipe. The locomotive from which the driver is controlling the train will have this cock open, otherwise it should be closed.
Brake rack	A frame housing a collection of air and brake system components in this case mounted within the body of the locomotive.
Buckeye coupler	A type of automatic coupler. On class 66 084 the buckeye coupler is hinged so it can be moved and latched clear of the other couplings when it is not being used.
Class 6, 7 and 8 trains	Classes of freight train with differing maximum speeds.
Dead-hauled	A powered vehicle being hauled with its own prime mover, in this case diesel engine, shut down.
Down	Generally away from London, in this case also towards Manchester.
Fatigue crack	A crack that grows as a result of the application of cyclic stress.
Formal investigation	A level of investigations that the railway industry undertake as defined by Rail Group Standard GO/RT3473.
Four foot	Area between the two running rails of any one railway track.
Gedge slot	Circular slot behind the hook to accommodate one end of the coupling.
Hand tail light	A battery operated red lamp that is hung at the tail end of trains.
Instanter link	A coupling linkage that allows two positions of length adjustment.
Magnetic Particle Inspection	A process, utilising a magnetic field and fine iron particles, by which cracks are revealed in metallic structures as a result of their distorting magnetic flux.
Notice cases	A series of special notice boards at train drivers' booking-on points. It is compulsory for drivers to read the contents of certain Notice Cases when they book-on for each shift.

Possession	Section of line which, for a period of time, is under exclusive occupation of an engineer for maintenance or repairs.
Propelling	The movement of a train with the controlling cab in the rear vehicle.
Railtrack	Infrastructure owner at the time of the top and tail Rule Book change. Superseded by Network Rail.
Rule Book	Book documenting the rules by which all personnel working on railway property must abide, also incorporating those for the safe operation of the network.
Safety briefing cycle	Cycle of briefings, often concurrent with the cyclic assessments of drivers within EWS.
Single pipe	The provision of a brake pipe within a train to provide both the brake air feed and brake control.
Straight air brake	An air brake for the locomotive alone that has a separate control from the automatic train brake.
Supplementary Operating Instructions	EWS publication to be carried by drivers when on duty, containing mandatory instructions on the operation of trains by EWS. Important safety related information can be transferred from Traction Digests to SOIs.
Temporary non-compliance	A waiver against a standard that applies for a fixed time and often with other fixed conditions attached (eg only allowed at certain locations).
Top and tail working	The working of a train with a hauling locomotive on the front and a dead-hauled locomotive on the rear. EWS work these trains single piped.
Traction and Traincrew Advice	A document produced by EWS which, amongst other things, includes currently applicable Traction Digests
Traction Digest	EWS document to provide information to train drivers. The issue of such a document is triggered by an adverse safety trend, the need for urgent safety advice, modifications to hardware, or changes to procedures or methods of working.
Twin pipe	The provision of separate main reservoir pipe (to provide a brake air supply) and brake pipe (to provide brake control) within a train.
Unbraked	A vehicle that is not automatically braked within a train.
Up	Generally towards London, in this case also towards Wilmslow.
Worksite	An area within a possession that is managed by an Engineering Supervisor. It may contain many workgroups.
Worksite marker boards	A lit board used to mark the limits of a worksite.
Wrong road	Travelling along a railway line in the opposite direction to that for which the signalling system provides protection.

Simplified explanation of a class 66 locomotive brake system

Appendix C



1) COMPRESSOR — When the locomotive engine is running the compressor charges the main reservoir pipe and the air reservoirs on the locomotive. If the engine is dead the compressor does not operate.

2) MAIN RESERVOIR - PIPE — On a twin piped train, this pipe supplies air to the air reservoirs on vehicles within the train from the compressor on the live locomotive. On a single piped train, this pipe is not used outside of any locomotives.

3) BRAKE PIPE — The level of air pressure within this pipe controls the amount of braking on the vehicles in the train. When the pipe is at full pressure, the brakes are off; as the pipe pressure reduces, the amount of braking is increased.

4) BRAKE PIPE PRESSURE CONTROL - **UNIT ISOLATING COCK** — If a train driver is in a cab of this locomotive, the BPPCUIC cock must be open so the brake pipe pressure is being controlled by this locomotive If this is not the controlling locomotive, the BPPCUIC cock must be closed.

5) AIR RESERVOIRS — Air Reservoirs store air at pressure that, amongst other things, is supplied to the brake cylinders to apply the brakes.

6) DISTRIBUTORS — These valves control the supply of air from the reservoirs to the brake cylinders dependent upon the level of pressure in the brake pipe.

7) AFT COCK — This cock, when open, allows the main reservoir pipe to be fed with air from the brake pipe.

In this incident the trailing locomotive was dead in a single piped train (ie a train that only uses a brake pipe). As such, the main reservoir pipe, and the air reservoirs, could not be charged from the leading locomotive or from the trailing locomotive's compressor. The only means of supplying air to the main reservoir pipe was from the brake pipe via the AFT cock. As the AFT cock was left closed at Crewe, this did not happen and the air in the reservoir was used up by braking during the journey. Once there was insufficient air in the reservoirs, the brakes could not be applied. When the coupling broke and the brake pipe separated, the rear locomotive would have seen the brake pipe pressure fall but there was no air in it's reservoirs to apply the brakes.

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

Any enquiries about this publication should be sent to:

RAIB
The Wharf
Stores Road
Derby UK
DE21 4BA

Telephone: 01332 253300
Fax: 01332 253301
Email: enquiries@raib.gov.uk
Website: www.raib.gov.uk