RAIB

Rail Accident Investigation Branch

Rail Accident Report

Report on the runaway manually propelled trolley between Larkhall and Barncluith Tunnel 2 November 2005

Department for Transport

Report 20/2006
November 2006

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

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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 Network Rail, Carillion, Skyblue, Harsco Track Technologies (Harsco), Torrent Trackside and Trimat to staff, data and records for the purposes of this investigation.

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

- acronyms and abbreviations are explained in the glossary at Appendix A; and
- certain technical terms (shown in *italics* the first time they appear in the report) are explained in the glossary at Appendix B.

Summary

Key facts about the incident

5 On 2 November 2005 between 06:49 hrs and 06:51 hrs a manually propelled trolley being used within a *T3* engineering *possession* on the partially built Larkhall branch in the Hamilton area in Scotland ran away from the trolley operator. The trolley travelled over three miles down hill, passing over steep gradients of up to 1 in 48 and reaching speeds above 20 mph (32.1 km/h), eventually leaving the limits of the possession and running onto a railway line open to traffic. The trolley eventually came to a stand within Barncluith tunnel. A possible collision with a passenger unit was prevented by the activation of a *track circuit* within the tunnel by the trolley.

Immediate cause, causal and contributory factors

6 The immediate causes of the runaway were:

- the use of a heavily loaded trolley on a gradient steeper than permitted;
- the use of inappropriate brake lining material on the trolley; and
- the lack of guidance given to the work force on the safe use of trolleys.

7 Causal factors were:

- the lack of guidance on the safe use of trolleys;
- the lack of on site testing procedures for trolleys;
- lack of recognition of the risks of the gradient;
- omission of key facts from the briefing on site;
- failure to follow the company's refusal to work procedure;
- contamination of the brake lining by mud and oil; and
- lack of detail in the risk assessments and method statements.

8 Contributory factors were:

- the use of the wrong handle on the trolley;
- technical standards that did not address the necessary safety performance;
- omissions in the *Rule Book*;
- the lack of a competence system for operating trolleys on *Network Rail*;
- poor understanding about product acceptance;
- the complexity of the Carillion Integrated Management System;
- the lack of knowledge, experience and training of key safety staff; and
- the working relationship between Carillion and Skyblue.

Recommendations

9 Recommendations can be found at paragraph 278. They concern:

- braking systems for manually propelled trolleys;
- instructions for using manually propelled trolleys;
- safety management with Carillion Rail and Skyblue;
- Rule Book coverage of manually propelled trolleys;
- approval of plant to operate on Network Rail;
- use of lights on a manually propelled trolley.

The Incident

10 On 2 November 2005 between 06:49 hrs and 06:51 hrs a manually propelled trolley being used within a T3 engineering possession on the partially built Larkhall branch in the Hamilton area in Scotland ran away from the trolley operator. The trolley travelled over three miles down hill, passing over steep gradients of up to 1 in 48 and reaching speeds above 20 mph, eventually leaving the limits of the possession and running onto a railway line open to traffic. The trolley eventually came to a stand within Barncluith tunnel. A possible collision with a passenger unit was prevented by the activation of a track circuit within the tunnel by the trolley.

Location

11 The branch line to Larkhall was originally built in the 19th century but closed in 1965. The re-opening of the branch line in 2005 was funded by The Scottish Executive, Strathclyde Passenger Transport and South Lanarkshire Council (see Figure 1 and Figure 2).

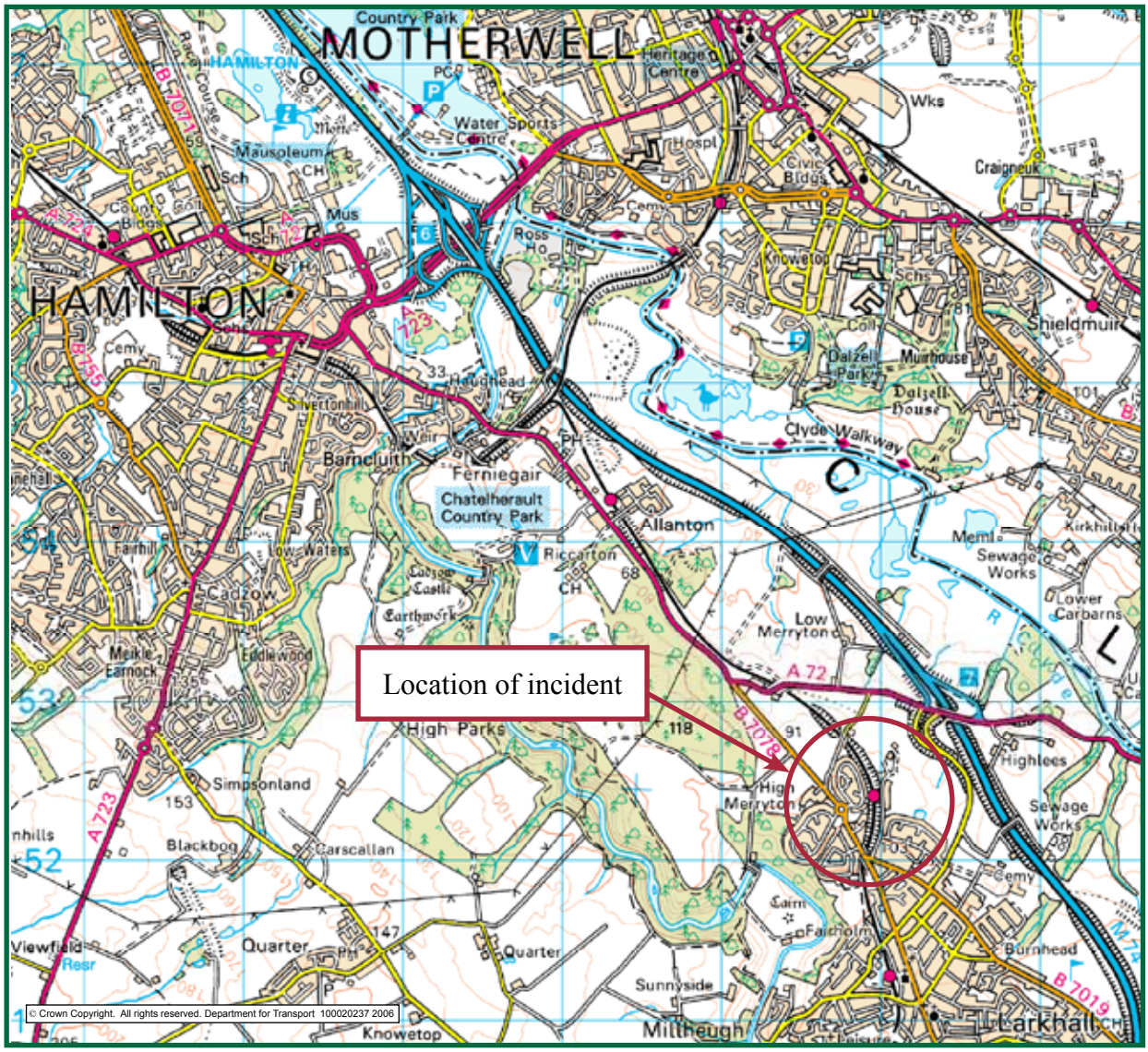


Figure 1: OS map extract showing location of the incident

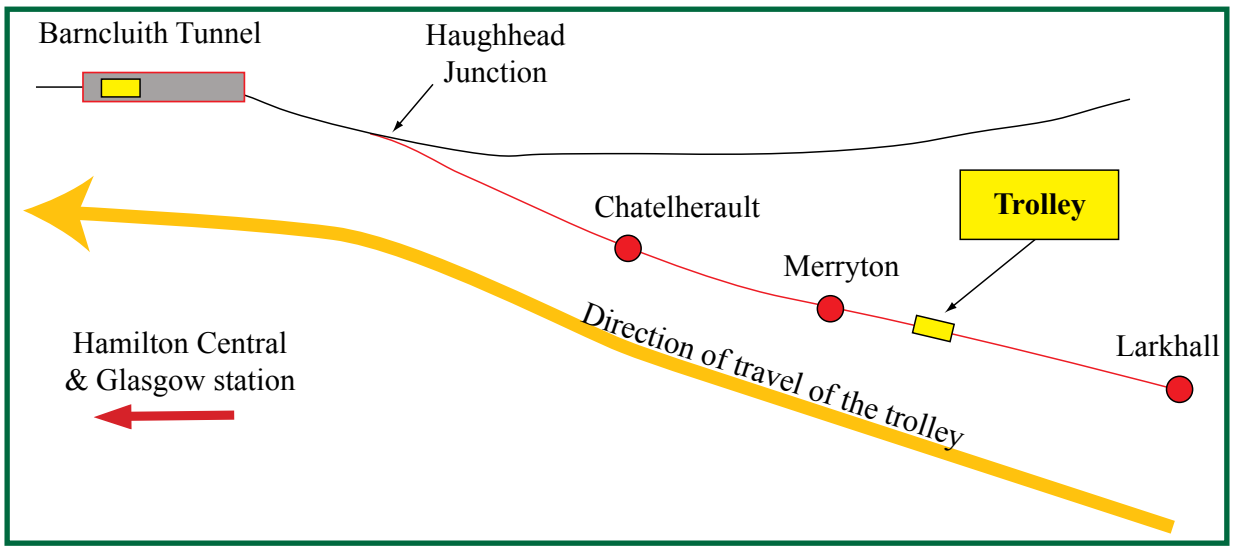


Figure 2: Larkhall branch line

12 The infrastructure owner is Network Rail. Since the re-opening they have been responsible for all maintenance activities.

13 The line is a bi-directional single line incorporating a passing loop at Chatelherault. The line is 4.7 km in length and runs south east from Haughhead Junction to Larkhall Station which forms the terminus. The link with the main Hamilton and Glasgow route is via no 58 *points* at Haughhead Junction.

14 The line between Larkhall and Haughhead Junction is operated under *track circuit block* regulations operated from Motherwell signalling centre; panel 1 (of six) is responsible for the Larkhall branch.

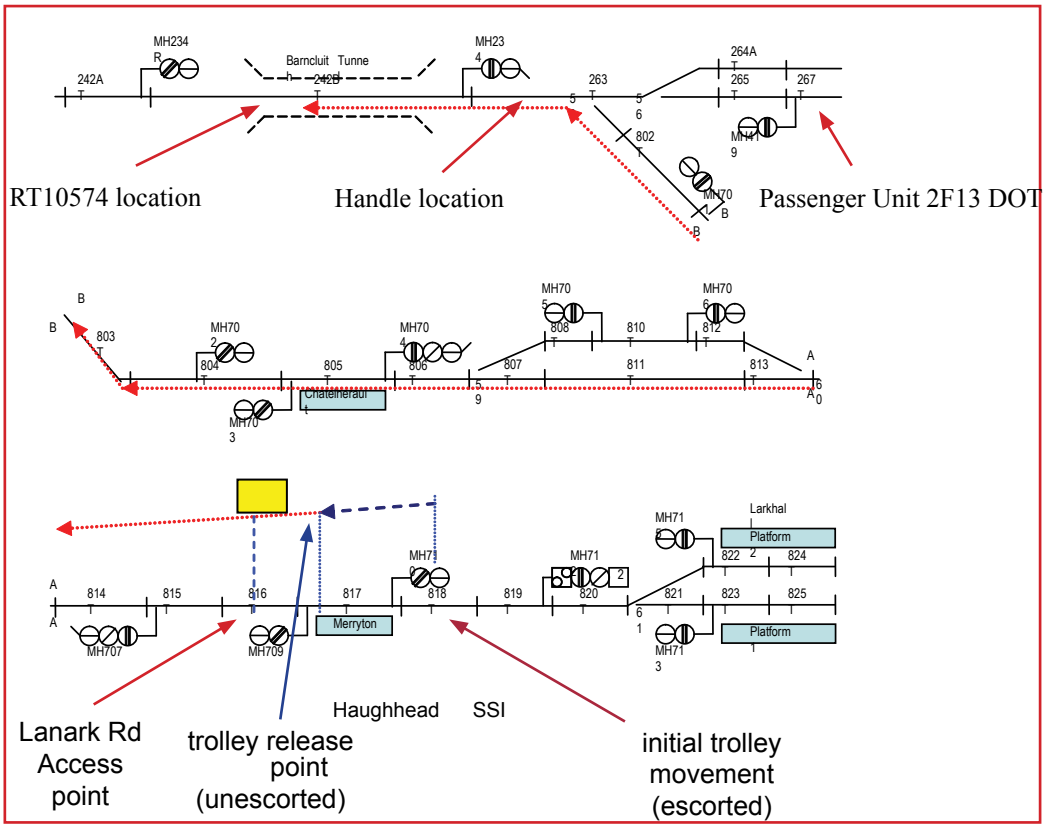


Figure 3: SSI/TC diagram

15 The line is laid with continuously welded CEN 60 rail.

16 *Closed circuit television* (CCTV) was installed on stations along the branch. It was due to be commissioned on 8 November 2005. The station CCTV was not operating at the time of the incident. Communication with signalling staff at Motherwell signal box was by telephone and, from train driving cabs, by *cab secure radio* (CSR).

17 The gradient on the Larkhall branch is shown in Figure 4. The trolley ran away from a location on the 1 in 47 gradient on approach to signal MH710 on the Larkhall side of Merryton Station (the lineside gradient marker at Merryton shows 1 in 48 although the gradient on the track diagram is 1 in 47). The station is on a 1 in 500 down gradient. Beyond the station the incline changes to a 1 in 47 down gradient for approximately 750 m followed by a 1 in 141 rising gradient for approximately 200 m. After this the gradient is downward to Barncluith Tunnel and varies between 1 in 56 and 1 in 840. It is only within Barncluith Tunnel that a 1 in 89 up gradient is reached. In railway terms, 1 in 47 is a steep gradient, with the steepest gradient on Network Rail controlled infrastructure being approximately 1 in 28.

18 The trolley ran away from a point on the branchline 2 miles 530 yards (3703 metres) from Haughhead Junction (railway chainage 6 miles 484 yards). The trolley came to rest inside Barncluith Tunnel a point 864 yards from Larkhall portal (railway chainage 5 miles 1380 yards).

The parties involved

Network Rail

19 Network Rail is the infrastructure owner for the Larkhall branch. Network Rail jointly managed the project to re-open the line with Carillion who were appointed as the project managers.

Carillion

20 Carillion plc is a public limited company, listed on the stock exchange, which carries out contracting and services. It is based in Wolverhampton and had a turn-over of £2,284 million in 2005.

21 Carillion Transport is one of the three main operating divisions of Carillion plc. Its headquarters were in Birmingham, and it had a turn-over of £650 million in 2005. Carillion Transport operated as a separate entity from December 2003 to April 2006, after which it was restructured into separate road and rail divisions.

22 Carillion (Rail) is the section of Carillion Transport that operates in the rail market. It was based in Birmingham at the time of the incident, and was formed in September 2001. It includes business elements originating within Tarmac, British Rail, GTRM, Swedish Rail Services and Centrac.

23 The Regional Projects Division of Carillion (Rail) carries out medium sized projects on the rail network around the UK. It has a depot at Bishopbriggs in north Glasgow from which Scottish projects were carried out including the £20 million Larkhall Branch project.

24 The depot at Lanark Road was the centre of operations for the Larkhall Branch project.

25 Skyblue is the labour employment division of Carillion (Rail). It had a turn-over of £50 million in 2005, of which £1 million was from its Scottish operations.

26 The Skyblue business operations in Scotland were relatively new at the time of the incident. It is effectively a labour supply agency which offers contracts on a 'shift to shift', weekend or short period basis. It does not directly 'employ' many people but has 'associates' who are contracted to the clients. Skyblue supplies its 'associates' to a number of organisations, both within the rail industry and outside it.

Harsco Track Technologies

27 Permaquip was established as a supplier of railway infrastructure equipment and services in the late 1960's. In 1992 Harsco Corporation acquired the company and it is now the UK operating division of Harsco Track Technologies, based in Nottingham.

28 Harsco is a major international supplier of railway track maintenance equipment and services for private and government-owned railways worldwide. It is a division of Harsco Corporation, a supplier of industrial services and engineering products with annual sales in excess of £2 billion.

Torrent Trackside Ltd

29 Torrent Trackside Ltd (TTL) lease and hire a range of engineering products and services within the rail industry.

Parties in relation to the trolley

30 The incident trolley (see Figure 5) was a Type B portable trolley serial number RT10574, manufactured by Harsco. It is also known as a s*tandard* design trolley. It was commonly referred to as a '*bogie*' by the local work force.

31 The trolley was sold to a company called Hewdens between1996-1998; Hewdens later sold the trolley as part of a fleet buy out to TTL, the current owner, in December 2000. The trolley was entered onto the TTL database on 9 November 2000, and was leased to Carillion on 30 September 2005.

32 The design of the trolley originates from the 1980's. The trolley comprises two separate lightweight steel frame sections with aluminium tops which facilitate easy handling. For use, the two sections are connected together with pins. A compression spring mechanism applies the brakes that are released by holding down a removable handle. The handle can be fitted to either end of the trolley. The wheels are cast aluminium.

Weather

33 At the time of the incident the weather was windy and raining, although not as severe as experienced during the previous hours. The poor weather had disrupted the scheduled work, in particular the time needed for *Thermit* welding of the rails. The temperature at the time of the incident was not recorded. There were no reports of frost or icy conditions affecting the work.

Lanark Road Depot

34 The Carillion depot at Lanark Road was situated between Merryton and Chatelherault. It had access from road and rail. The temporary facilities at the depot included offices and a storage area for equipment, materials and vehicles. The storage area was located on a plateau below the level of the road. It had no constructed or natural drainage. Road haulage vehicles arrived and departed from the depot frequently. The wet weather combined with the road haulage movements resulted in the depot becoming a very wet, muddy environment. It was also contaminated in certain areas by fuel and oil.

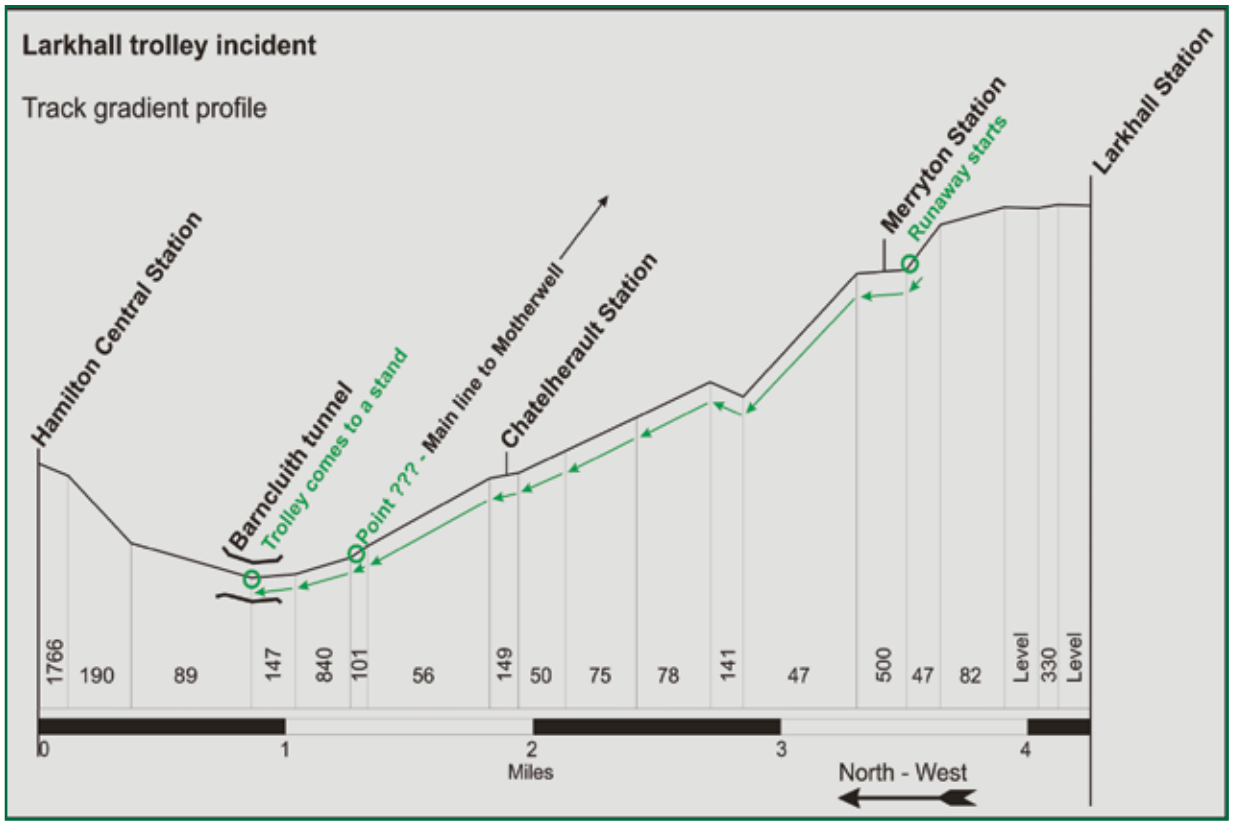


Figure 4: Gradient profile diagram from Larkhall to Hamilton Central

Events preceding the incident

35 At the time of the incident the main construction project had been completed. Track and signalling had been commissioned which allowed trains to run over the line, albeit not with passengers.

36 Driver training was in progress during daytime hours (10:00 hrs to 17:00 hrs). The Railway Rule Book (GE/RT/8000) was in force for both driver training and engineering activities. Subsequent to the incident the line was opened to passenger trains on 9 December 2005.

Status of the construction project.

37 The main construction project had been completed and daytime driver training for the forthcoming passenger service was in progress. The remaining contracted work was to identify and rectify 'snagging' work, that would be undertaken during planned engineering possessions between 17:00 hrs and 08:00hrs.

Work planning

38 The method statement was the primary means by which the work plan was communicated to the staff on site; it consisted of three principal documents. The first two of these concerned the project planning for the construction of the approach curve and interface with the operational network at Haughhead Junction. The third document concerned the construction work on the plain line section from the end of the curve from Haughhead Junction to Larkhall Station buffer stops.

39 The method statements for the work and the associated possessions were compiled by a Carillion project management team from Bishopbriggs and by staff from the Safety, Environment and Quality (SEQ) department at Lanark Road. Method statements and subsequent addendums were jointly signed by Network Rail and Carillion.

40 A generic method statement and addendum for the possession on 1 November 2005 to 2 November 2005 were signed and agreed by Network Rail and Carillion. They were not specific to the work to be undertaken within the possession.

41 The generic method statement was used to generate the entries in the *Weekly Operating Notice* (WON*)* for week 31. The information was included under items 71 and 77. The WON defined possession times, contact names and telephone numbers.

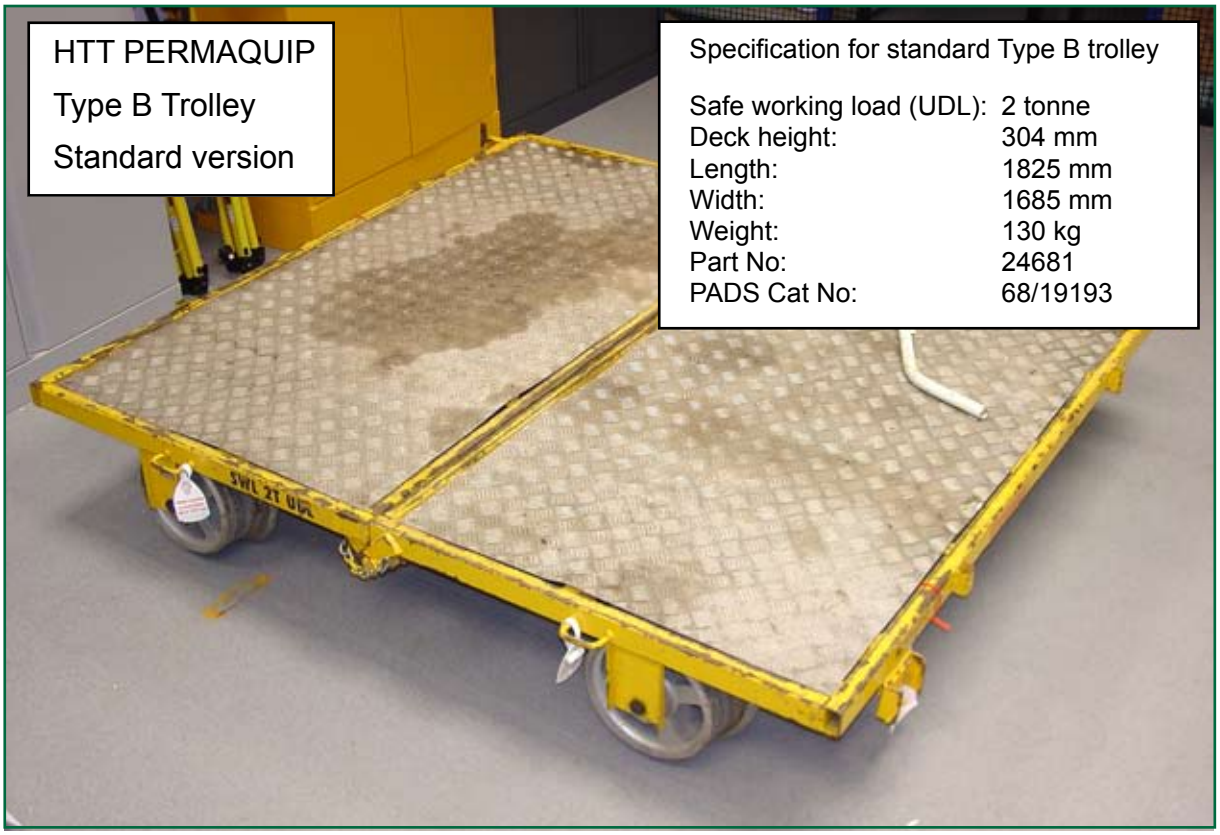


Figure 5: HTT Type B trolley

42 *Road/rail vehicles* (RRVs) were intended to provide transport within each worksite. They were to be used to move plant, equipment and new or scrap material. Manual 'welders' trolleys of a Type – A specification were also being used.

43 The Method Statement agreed by the contractor and Network Rail did not make any reference to the risk posed by the use of trolleys on a falling gradient, or of any measures to control such risks when trolleys were in use. The Carillion staff who prepared the method statement stated that they were not supplied with, nor did they seek, any information relating to the gradient within the possession limits and the additional risk posed to rail-mounted plant and equipment operating within the possession.

Possession structure

44 The engineering possession described in the WON issue 31, item 77 applied to the whole branchline from Haughhead Junction to the buffer stops at Larkhall. It covered the period from 17:00 hrs to 08:00 hrs on each day of the week. On 1 November 2005 driver training had finished by 17:00 hrs. Arrangements for the possession that day, including paperwork and communication with the signaller had been undertaken correctly.

45 Planned worksites within the possession were located at Haughhead, Chatelherault, Larkhall and Merryton. No train movements other than the use of the RRVs were planned to operate within the possession.

Work team

46 The Skyblue team at the worksite was made up of three grades of staff: two *Engineering Supervisors* (ES), two *Controllers of Site Safety* (COSS), and twelve trackworkers. Each COSS was responsible for a gang of six trackworkers. The gangs comprised a mixture of inexperienced recruits with no previous track experience, experienced railway workers and a small number of experienced staff who were also COSS trained. They were all contracted to Carillion for working a 12 hour duty excluding 3 hours travelling time to and from the worksite.

47 The majority of staff booked on at Lanark Road depot at 20:00 hrs. ES 1 was relieved at 04:00 hrs on 2 November 2005 by ES 2.

48 Carillion staff, comprising a Site Supervisor (SS) and a Technical Officer (TO), were present on site to ensure that the work was completed correctly and within the possession time. The SS was an authorised Crane Controller, and was present to operate the RRVs. The TO on site had drafted the method statement for the planned work.

49 The *Person in Charge of Possession* (PICOP) was employed and supplied by Network Rail.

50 ES 1 and then ES 2 were stationed at Lanark Road depot. Communication between the various parties on site was by company and personal mobile phone. As a result of the RRVs not being used (see paragraphs 58 - 60) the SS assumed the principal works management duties on the branch line. The Carillion *charge-hands* who would have normally managed the work remained on site under the direction of the SS as he was of a higher management grade.

Work plan

51 The objective of the nights work was described as ‘snagging work’ and ‘the renewing of sections of rail at various locations on the branch line and at Haughhead Junction’.

52 Following the completion of work at Haughhead Junction (WON 31, Item 71), that possession was given up at 03:45 hrs on 2 November to allow for a train to pass through the section on the main line.

53 The final worksite was at Merryton station where replacement of rails was undertaken (3764 metres from Haughhead Junction). The method statement stipulated that the scrap rail would be taken to the access point at Lanark Road depot by RRVs. This was to comply with Network Rail’s *Permanent Way* Special Instruction No.10, which requires all scrap to be cleared from the lineside.

54 On the night of the incident COSS 1 and COSS 2 were not provided with copies of the method statement. Instead they were verbally briefed by the Carillion SS on the work to be undertaken.

55 All trackworkers were briefed verbally by COSS 1 and COSS 2. This briefing focussed upon 'slips, trips and OLE' hazards. It did not include:

- the hazards of using RRVs or manually propelled trolleys;
- the added hazards of the steep gradients present on the branchline.

56 The initial briefing by COSS 1 to both gangs established that in the case of an emergency situation, either COSS would be the contact point for the signaller at the Motherwell signal box; however, the wrong panel and telephone number was listed in the WON.

57 Very few briefings on method statements had previously taken place at Larkhall. COSS trained staff had previously requested briefings and asked for the method statement to read. This had been refused as they were advised that the method statements were locked in the office and unavailable for inspection.

Use of Road Rail Vehicles

58 *Sentinel NCCA* are the custodians of the safety competence database for Network Rail controlled infrastructure. Crane Controllers using RRVs are required to be trained and have their competence confirmed in accordance with Network Rail requirements. Details are recorded on the Sentinel NCCA database. On 12 June 2005, organisations within the rail industry were informed about planned changes to the competence cards that were due to come into force on 31 October 2005. The closing date for details of accredited employees to be supplied to Sentinel NCCA was 31 October 2005. Employees who had not complied with the requirement by the closing date would have to complete the full training program again. Any person with an 'old' style card would not be authorised to use the RRVs after 31 October 2005.

59 Carillion responded to Sentinel NCCA within one week; however, the list of employees and their details that was supplied to NCCA was incomplete. The new arrangements were not effectively briefed out by Carillion to the Larkhall project team and operational staff thus the crane controller and machine operators did not have the correct certification to perform their work from 1 November 2005 onwards.

60 On the night of 1 November 2005 Carillion staff transported the new rails onto the site using RRVs. The change in the competency cards was not included in the briefing by the ES 1 prior to the work taking place, but the old style (invalid) competency cards were recorded and accepted by the ES 1 for the work to commence. There is conflicting evidence as to when the validity of the Crane Controllers' competency cards was first questionned, and in particular that of the SS. However the SS decided to act as Crane Controller during the outward journey, but after the new rails had been taken to site he decided not to use the RRVs for further work as his competency cards were invalid. It was decided instead to transport the scrap rail using hand propelled trolleys. Contrary to the Carillion Method Statement Procedure, no reference for guidance or confirmation of this decision was made to either on-call managers in Scotland, or to Carillion Rail's 24-hour manned control office at Rugby.

Figure 6: The incident trolley showing rails and relationship to 'as found' condition in Barncluith Tunnel

Requirements for the use of trolleys

61 The safety guidelines and operating instructions relating to the use of manually propelled plant are contained within the railway Rule Book GE/RT/8000 module T2 section 15 and the Carillion Infrastructure Safety Manual (ISM), Section I.01. Both documents cover different aspects but both mandate that the trolley is to be checked prior to and after any engineering work. This checklist/instruction was not included in the Method Statement or briefed out prior to the work. The required inspection and brake tests were not undertaken.

Figure 7: Bull tag on the incident trolley. This correctly indentifies the 3 month service date and incorrectly shows the annual inspection date as 2005

62 There are provisions relating to the safe use of a manually propelled trolley in module T2 of the rule book GE/RT/8000 that were relevant to its correct use at Merryton. However module T2 'Protecting engineering work or a hand trolley on a line not under possession' was not applicable to that work. The above provisions are not found elsewhere in the rule book.

Events during the incident

63 As previously described (see paragraph 33) the weather at the time of the incident was poor. The weather had affected the work being undertaken and some work had been delayed or abandoned.

64 The area near Merryton where rail recovery was undertaken was on a gradient of 1 in 48. The Railway Rule Book and Carillion ISM section I.01 both prohibit using a trolley on a gradient steeper than 1 in 50 unless specially authorised by local instructions. A load limit of 2 tonnes is painted on the trolley. There were no special or local instructions contained or referenced within the generic method statement that would have directed the COSS to a process that would enable the work to continue using a trolley. The decision to continue work was taken by the Carillion SS.

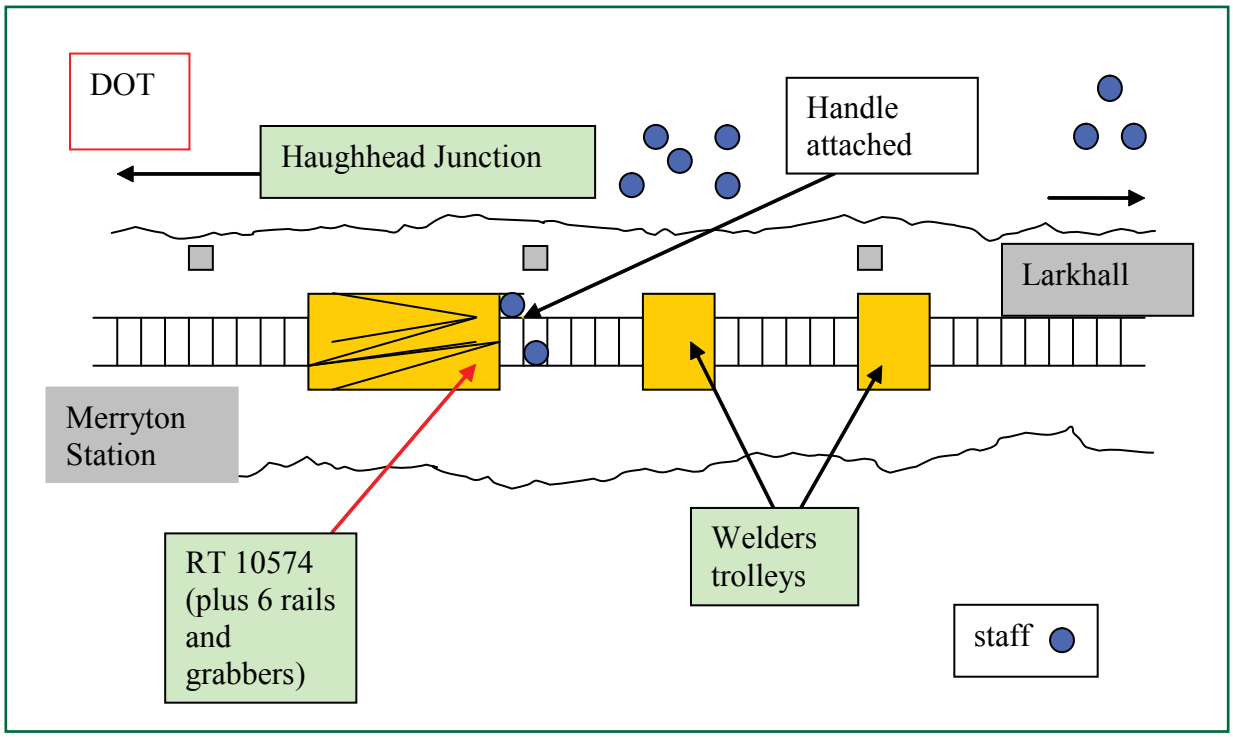


Figure 8: Merryton Worksite

65 The trolley that was used had contaminated brake linings (see paragraph 124) and had an inspection bull tag giving the date of next annual service as June 2005, ie before the date of the incident.

66 At the Merryton site (see Figure 9) old rails were removed from the track, and new rails installed and welded into longer lengths. The scrap rails were cut into smaller sections in order that they could be lifted onto the trolley for onward transportation. Two sections of rails loaded onto the incident trolley were 0.413 m and 0.161 m above the 6 m requirement for movement by a single trolley; the remaining four were within the specified limit. Appendix C contains full details of the rail lengths, weights and overhangs.

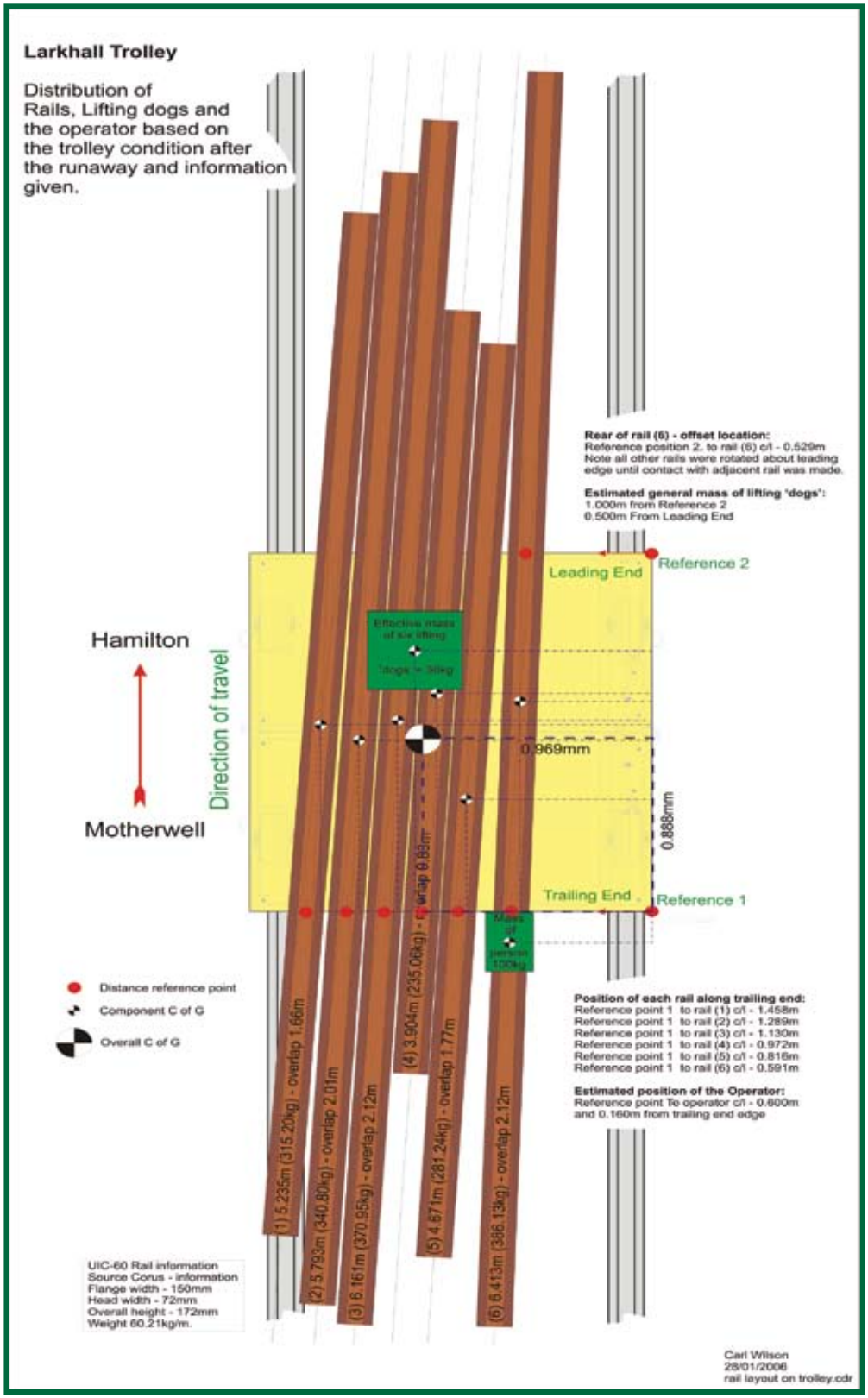


Figure 9: Load distribution diagram derived from photographic evidence

67 During the loading of the rails onto the trolley several members of staff from both of the Skyblue track gangs spoke to COSS 1 and COSS 2 at the site. They were concerned about the steep gradient between Merryton and Lanark Road depot, the means of lifting the rails on to the trolley, and the total weight of the rails to be transported by the single trolley.

68 During the lift and placement of the fourth rail onto the trolley a trackman and COSS 2 observed that the trolley moved slightly of its own accord down the gradient even though the brakes were applied. The safety of moving the trolley to Lanark Road depot was raised again within the gang. The unintended movement heightened their concerns and they again asked for this safety issue to be raised with the Carillion SS.

69 COSS 2, who had observed the unintended movement, instructed a trackman to stand within the *four foot* in the direction of travel down the gradient. COSS 2 also requested another trackman to use ballast to chock the front wheels and place the trolley handle through the front wheel to prevent any further movement (see paragraph 224).

70 The Carillion SS had observed the actions of COSS 2 who had issued the instructions outlined in paragraph 69. A discussion then took place between the two regarding these instructions and the safety implications of the loading and intended trolley movement. The lifting of the remaining two rails was then completed.

71 After the loading of the rails was completed, safety concerns regarding the unexpected movement of the trolley, its load and the gradient of the line were raised again by a number of trackworkers. These concerns were allegedly discussed again with the Carillion SS. No verbal resolution or documentation of the issues was completed in line with Carillion (reference 2) or Skyblue procedures (see details of Carillion Worksafe Procedure in paragraph 139 - 145). Carillion and Skyblue operated under the Carillion Work-Safe procedure although there are different reporting methods. Carillion use a paper based process, where as Skyblue use a telephone based process.

72 It has not been possible to establish all that took place regarding the safety of the trolley and its intended movement. There were however several discussions and some form of conflict relating to safety of the load and the gradient prior to the incident occurring. All but one trackman refused to accompany the trolley now laden with scrap rail and equipment almost to the maximum permitted weight.

73 COSS 1 reluctantly volunteered to operate the trolley. At approximately 06:45 hrs COSS 1 climbed onto the trolley and released the brake, riding on it in contravention of the Rule Book GE/RT/8000 module T2 section 15, through Merryton station en route to the access point at Lanark Road depot. He was initially accompanied by another trackman from the team at Merryton who was concerned about his colleague's safety; the second trackman walked some way behind the trolley. All other trackworkers refused to accompany the trolley. The additional weight of the operator on the trolley took the total weight over the maximum allowable, albeit only by some 50 – 60 kg assuming the weight of a 95 percentile male (see Appendix C).

74 After a short distance, the second trackman decided to leave the company of COSS 1.

75 The second trackman did not raise the issue through the Carillion Worksafe Procedure (see paragraph 139 - 145) to stop the trolley being used. There is evidence that he was concerned that there would be recriminations had he done so.

76 The trolley then travelled through Merryton station carrying the rails, rail grabbers and COSS 1.

77 COSS 2 remained at the Merryton site performing duties of supervising site safety and protecting the welders from the inclement weather.

78 The Skyblue associates who had refused to accompany the trolley made their way to Merryton station, walking some distance behind COSS 1 riding on the trolley and the single trackman walking within the four foot behind the trolley. The Skyblue gang left the track at the access point at Merryton Station and made their way to Lanark Road depot by road vehicle.

79 The trolley speed increased as it travelled over the first 1 in 48 down gradient. The speed increased again on a second 1 in 48 gradient reached after the 1 in 500 section through Merryton Station. As the trolley gathered speed COSS 1 became concerned and began to push hard on the brake lever believing that this would increase the braking force on the wheel. No reduction in speed was obtained even though COSS 1 pulled the lever up and down several times to try and apply braking. He had previously operated this type of trolley many times but never at the speed attained during this incident.

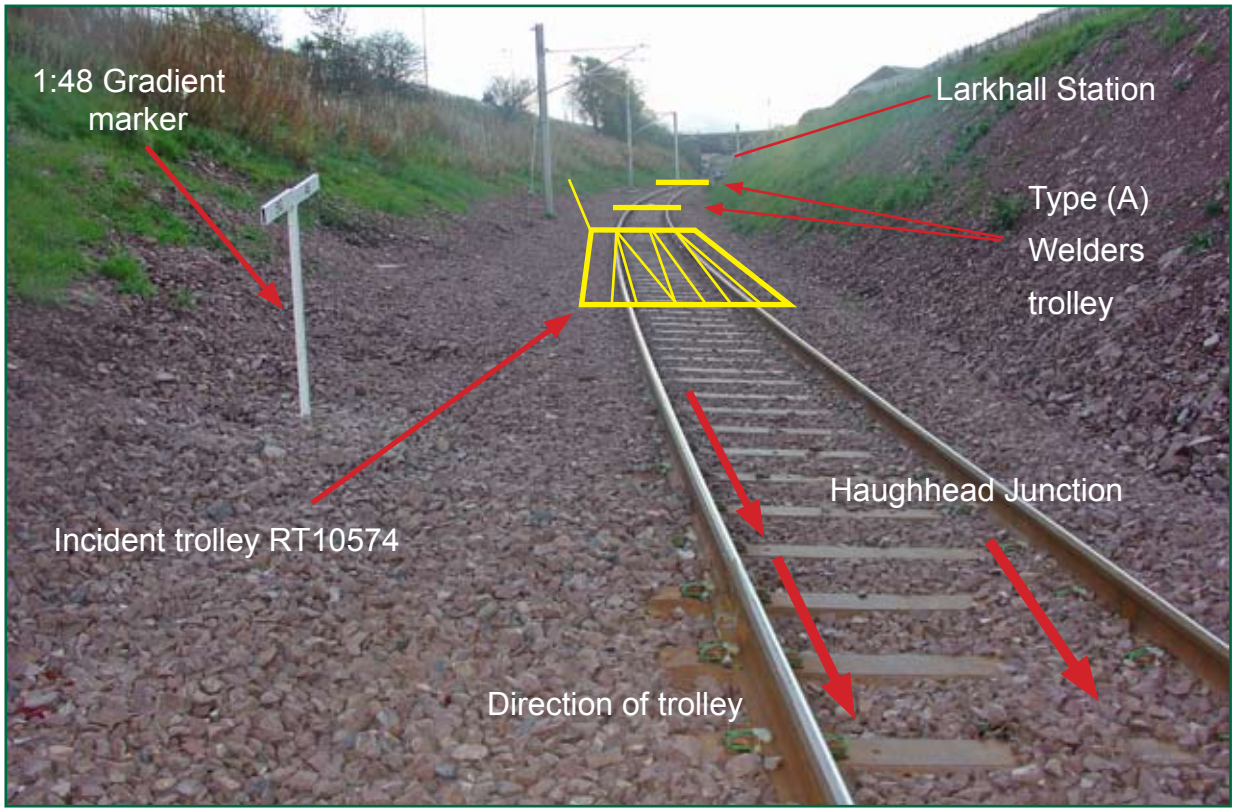


Figure 10: Virtual image showing trolley location prior to movement through Merryton station

80 Between 06:49 hrs and 06:50 hrs COSS 1 lost control over the speeding trolley; he then jumped or fell into the *cess*. This occurred on the approach to the *automatic warning system* (AWS) magnet for signal MH709 close to Lanark Road depot. At the time of its release the trolley is estimated to have been travelling at 8 mph or more. COSS 1 was later joined by the trackman who had initially set off with him from the Merryton worksite; they then made their way down the gradient towards Lanark Road depot.

81 There were no other track staff on the branchline between the trolley release point and the possession limits at Haughhead Junction. The Haughhead Junction and Hamilton Circle mainline possessions had been given up at 03.45 hrs on 2 November 2005 and were thus open for the passage of scheduled trains.

82 The following communications were then undertaken:

- From 06:51 hrs COSS 1 made several attempts to contact Carillion staff by mobile phone, commencing with the Carillion SS at the Merryton worksite. The Carillion SS was at that time giving a progress briefing to the Project Permanent Way Manager and no contact could be made.
- Between 06:52 hrs and 06:53 hrs COSS 1 contacted the Carillion TO.
- The TO immediately advised the SS of the runaway incident.
- The SS telephoned ES2 at Lanark Road.
- Before 06:56 hrs ES2 contacted the Network Rail PICOP.

83 The trolley approached Haughhead Junction at speed and ran over the three *detonator*s that had been placed on the *running line*, exploding one and pushing two aside. The *possession limit board* (PLB), which was operating correctly, was struck by the trolley and knocked into the cess.

84 The trolley continued to Haughhead Junction. It ran through number 58 points which were set for the main line. As it hit the switch rails (see Figures 14 and 15) the lurch from *running through* the points caused the brake handle to become dislodged. The handle bounced forward into the cess in the direction of Barncluith tunnel where it was later discovered.

85 The trolley then travelled along the line into Barncluith tunnel towards Hamilton Central station, this line being open to traffic. Up to this time the trolley had not activated any track circuit and no change of correspondence from number 58 points was indicated to the signaller on panel number 1 in the signal box at Motherwell.

86 At 06:51 hrs the signalling system recorded that the trolley repeatedly activated and cleared track circuit 242B within Barncluith tunnel. It finally activated the circuit for sufficient time to return signal MH419 back to red in front of an approaching train. Train 2F13, the 06:40 hrs Coatbridge to Motherwell stopped correctly at the signal. The track was later protected by the signaller after receiving a phone call about the runaway trolley from the Network Rail PICOP at 06:57 hrs (see paragraph 89).

87 Skyblue and Carillion staff had by this time made their way to Chatelherault station. Three fence posts were thrown onto the track onto in an attempt to derail the trolley and prevent it from proceeding down the line. Unknown to these members of staff, the trolley had already passed this location. The fence posts were later removed and placed on the station platform.

Figure 11: Image of fence posts thrown onto the running line in an attempt to prevent the trolley passing through Chatelherault station

88 Other staff from Skyblue and Carillion made their way by road vehicle to Haughhead Junction, where they then entered through an access point onto the operational network and outside the possession limits. This was done without the Signaller providing any protection before entry into the *red zone prohibited* area.

89 The PICOP enquired of ES 2 whether anyone had contacted the Signaller to protect the mainline from the moving trolley. This had not been done. The PICOP immediately made an emergency call to the Signaller at Motherwell at 06:57 hrs. The trolley had been in motion for 7-8 minutes at that time.

90 The first communication with the Signaller was the call from the PICOP at 06:57 hrs. The PICOP gave the facts to his knowledge and stated that he would make further enquires with Carillion to the whereabouts of the trolley. The Signaller immediately protected all lines by returning signals to red. Train 2F13 was immediately contacted by the signaller via CSR. The Driver confirmed he was at MH 419 that was displaying a red aspect. The Driver had not previously passed any signals displaying a cautionary aspect.

Figure 12: Image taken by the RIO from within Barncluith tunnel

91 Telephone communication between the PICOP, ES 1 and the Signaller established that the trolley might be in Barncluith tunnel in the vicinity of track circuit 242B.

92 At 06:57 hrs the signaller noticed that track circuit 242B was showing occupied. Number 56 points were then set to 'normal' for movements onto the '*Up*' Hamilton line thus protecting train 2F13 from any 'run back' of the trolley.

93 Some difficulties in communications with the Signaller were experienced because the COSS briefing had incorrectly identified the Motherwell contact point as panel 6 rather than panel 1 (see paragraph 56).

94 The ES 2 telephoned the Signaller himself at 06:59 hrs to make another emergency phone call. This was some 9-10 minutes after the trolley's release.

95 At 07:03 hrs, COSS 1 made an 'emergency call' to the signal box 12 -14 minutes after the incident. Motherwell signal box operated six panels. The Signaller on panel 6 explained to COSS 1 that he was not responsible for the Larkhall branchline and that he had telephoned the incorrect panel. A prolonged conversation took place between the signaller on panel 6 and COSS 1 to ascertain the facts of the incident, what action was required from the signal box and to confirm the correct telephone number for panel 1. The Signaller on panel 6 confirmed to COSS 1 that the line had been protected.

96 The Signaller on panel 6 was already aware of the incident from the conversations between the Signaller on panel 1 and the PICOP. This was not communicated to COSS 1 who was not told that the Signaller already knew of the incident.

Events immediately following the incident

97 Skyblue and Carillon staff made their way from Haughhead Junction and walked towards Barncluith tunnel. Other Carillion staff made their way into Barncluith Tunnel from the Hamilton entrance. All staff did this under their own initiative.

98 The trolley was located a short distance from the tunnel mouth at the Hamilton end of Barncluith Tunnel. The rails and rail grabbers were still in situ; however, the brake handle was not present. A track search was undertaken. The handle was not located on the route the trolley had taken, nor inside the tunnel.

99 Number 58 points were checked and a facing point lock (FPL) test completed. There was no damage to the points and stretcher bars even though the trolley had run through the points. Evidence of flange climb and debris from the aluminium wheels of the trolley was observed on the field side switch.

Figure 13: Image of flange climb marks from RT10574 wheel and number 50 points blade at Haughhead Junction

100 It was observed that one side of the trolley was 'dipped' due to the securing pin between the two halves having become loose and detached. It cannot be established when the two halves became separated, although it may have been caused by the impact when the trolley ran through the points at Haughhead Junction.

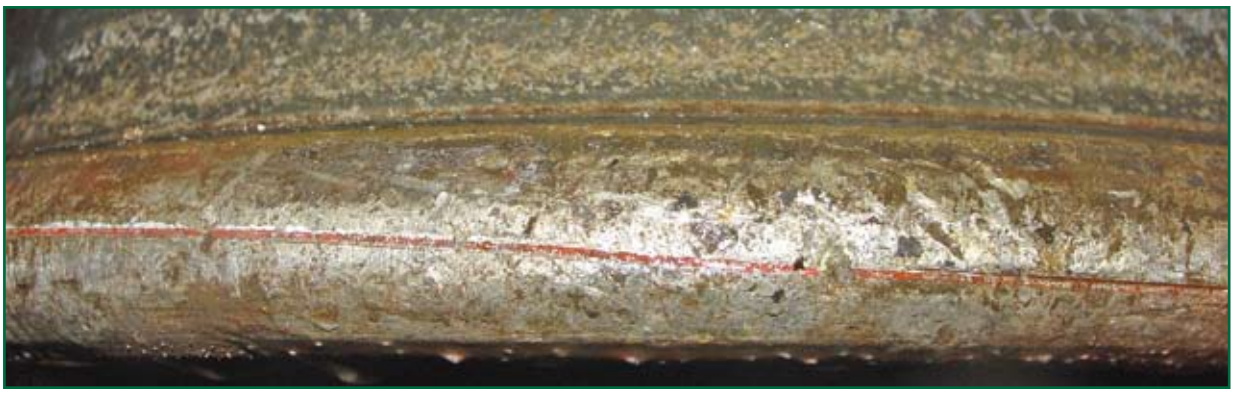


Figure 14:Cross contamination samples and flange climb marks (shown in red) on trolley wheel and Haughhead Junction number 58 points blade

101 The six rails were removed from the trolley and running line at 08:35 hrs and placed into the cess. The trolley was then split and moved through the tunnel by Skyblue associates whilst under the supervision of the PICOP and RIO. No thought had been given to notifying the RAIB at this stage, so the trolley was moved to the tunnel entrance contrary to the requirement of the (Railway Accident Investigation and Reporting) Regulations 2005. The parts of the trolley were covered to protect them from the weather.

102 Motherwell signal box implemented contingency plans and rail services were either turned back or diverted around the affected area. The line was reopened at 09.23 hrs.

Consequences of the incident

103 No fatalities or injuries occurred.

104 Although there was evidence of 'swarf' from the aluminium wheels of trolley on the switch blades of number 58 points, no damage was sustained by the rails, stretcher bars or point mechanisms. The points were examined and authorised for immediate use by Network Rail engineers. No remedial work was required.

The Investigation

105 Network Rail did not initially appreciate that the incident should be notified to the RAIB. As a consequence they initially took control of the scene and of the investigation. Two hours after the incident a Network Rail Director contacted the RAIB when the serious nature of the incident became apparent. The RAIB immediately mobilised a team of inspectors.

106 On arrival the RAIB took control of the investigation. The strategy for the investigation was agreed through liaison between the RAIB, Network Rail, Carillion, Sky Blue and the HMRI. Neither the British Transport police nor the local police force were involved.

107 The RAIB commenced its site investigation on 2 November with a site examination and interviews at Lanark Road depot. All immediate interviews were completed by 4 November 2005. The RAIB investigation and evidence recovery was completed within the scheduled possessions causing minimal disruption to daytime driver training. Site investigations were completed on 5 November 2005 after which the site was released back to Network Rail.

108 During the investigation two urgent safety notices were issued to railway industry, manufacturers and suppliers of manually propelled plant outlining safety issues affecting the Type B trolley brake handles and brake mechanism. Network Rail subsequently mandated that the working load of the Type B trolley should be reduced by 50 percent to 1 tonne.

Sources of evidence

109 Evidence that enabled the immediate cause of the incident to be established was:

- statements by witnesses;
- examination of the incident trolley;
- examination of the site;
- review of trolley design;
- review of requirements and approval processes;
- testing of the incident and sample trolleys;
- working procedures and practices.

Key Evidence

Site Evidence

110 The trolley was recovered by Skyblue and Carillion staff and moved to the Hamilton entrance of Barncluith Tunnel.

111 A brake handle from a trolley was recovered 25.68 m beyond number 58 points towards Barncluith Tunnel. No other trolley handle was found during a search of the track covered by the runaway.

112 No swabs or samples of contamination from the wheel or railhead were taken or recorded immediately after the incident. Samples from the wheel surfaces and ends of the brake lining of the incident trolley were taken and submitted for analysis following the arrival of the RAIB inspector on site. The brake linings from the incident trolley and a new lining for a reference sample were taken for analysis and destructive testing.

113 Prior to the arrival of the RAIB inspectors, summary statements were provided by some individuals to Network Rail and company representatives. Interviews were subsequently held by the RAIB with individuals directly or indirectly connected with the incident.

114 Data from the *On Train Monitoring Recorder* (OTMR) were obtained from the unit that formed train 2F13 via the train operating company.

115 SSI data tapes and voice recording tapes were recovered from Motherwell signal box for later analysis. On the SSI tapes the time stamp was incorrectly set to *British Summer Time* (BST), one hour earlier than the correct time. The time was adjusted on 2 November 2005 after the incident.

116 The recorded times of mobile phone calls made during the incident were accurate. A correlation was established between the mobile phone data and the SSI data for track circuit activation.

117 No accurate temperature or wind velocity readings were recorded at the time of the incident.

118 Photographic images taken by the Rail Incident Officer (RIO) and the *Mobile Operations Manager* (MOM) within the Barncluith Tunnel showed apparent skid marks on one running rail. These marks were not documented or measured. They were not visible to the RAIB inspectors during later examination because the normal train service had operated over the track.

Trolley (general)

119 Torrent Trackside supplied a further sample Type B trolley for dynamic testing and comparison purposes. Maintenance records for the incident trolley were also supplied by Torrent Trackside Ltd.

120 Harsco Track Technologies Ltd supplied design and manufacturing information for the Type B trolley, along with specific information relating to the incident trolley.

Inspection of the brake linings

121 The brake linings on the incident trolley have been identified as either Ferodo FF or Trimat CMB cotton type material. These materials have virtually identical properties and are visually very similar. It was not possible to conclusively identify which material was used or whether this was from the original equipment manufacturer (OEM).

122 The brake linings on the sample trolley were identified as Trimat CMB material.

123 The brake linings of both the incident trolley and the sample trolley both showed signs of having been used for dynamic braking when first inspected by the RAIB.

124 The brake linings of both the incident trolley and the sample trolley were contaminated when visually inspected by the RAIB. Subsequent laboratory testing showed that the contamination had been absorbed into the sub surface layers of the weave. The contamination of the incident trolley linings consisted of:

- silicaceous soil with cotton fibrous material (the cotton material would have most probably originated from breakdown of the brake pad);
- very small iron filings;
- mineral oil (both on the surface and with the mass of the lining);
- luminium material from the wheels which had become clogged in the weave of the brake lining surface.

Tests on a moving trolley

125 Dynamic tests were conducted by the RAIB at Wirksworth to determine the performance of the brakes under loaded trolley conditions. The gradient at this site is 1 in 30 hence the load on the trolley was reduced to 1.25 tonnes thus simulating a 1 in 48 gradient with 2 tonne load. The brake linings were those fitted at the time of the incident. The trolley was tested in wet, dry and contaminated conditions.

126 The test results showed that the trolley ran away and reached speeds of 19 mph. Higher speeds would have been obtained but were deliberately prevented for reasons of safety. After the completion of the dynamic tests, the trolley's wet brake linings were allowed to dry for thirty minutes to establish if the trolley would pass the manufacturers brake tool test. The trolley passed the static brake test using the manufacturers test tool and thus would have been validated for use (see paragraph 193 - 194). Fuller information on these tests is contained in a technical report that is available from the RAIB on request.

Figure 15: Image of incident trolley RT10574 showing incident rails in position and handle positions

Mobile phone & SSI data

127 The initial phone call from the trolley operator regarding the incident was at 06:51 hrs.

128 From the evidence of the SSI records the trolley reached speeds of over 21 mph (33.79 km/h).

129 The SSI data (using the corrected time) records the following:

06:45 hrs	Route called for *Down* train 2F13
06:49 hrs	Trolley released in proximity of signal MH709
06:51:40	Out of sequence occupation of 242 B track circuit
06:51:40	Signal MH419 reverts to Red as a result of the occupation of track circuit 242B inside Barncluith Tunnel by the incident trolley.
06:51:45	Track circuit 242B shows clear.
06:51:45	Signal MH 419 signal clears to green as a result of track circuit 242B clearing.
06:51:55	Track circuit 242B shows occupied.
06:51:55	Signal MH419 reverts to red as a result of the occupation of track circuit 242B bringing 2F13 to a halt.
06:57:00	PICOP telephones the Motherwell signal panel.
06:57:00	Signaller observes track circuit indication on the panel and ensures all lines blocked.
06:57:00	Train 2F13 (the 06:40 hrs Coatbridge to Motherwell passenger service) contacted by Motherwell signal panel.

Leasing of the trolley.

130 TTL has a computer based fleet inventory system known as P42. It records all service history relating to statutory inspection dates, service information and service due dates. The incident trolley was certificated by Lloyds British on 19 June 2005 with the next statutory date being twelve months later in June 2006.

131 The inventory system was checked by the RAIB and the service history of the incident trolley from 28 October 2004 was verified. All dates of maintenance and in particular the last annual inspection were in order; documents for the previous three months were checked in fine detail. One record had been misfiled and could not be located; however, this had no relevance to the incident.

132 On every occasion a trolley is returned to TTL from lease or hire it undergoes a return from works check to identify and rectify faults and damage. Also a mandatory three monthly maintenance examination is carried out. The documents controlling these checks are MSO29 - three Month Maintenance Schedule and AP38 - Fitters Daily Service Record. Both AP38 and MSO29 documents were revised and implemented by TTL in July 2005, and both only apply to TTL's internal processes, not to work on site. However, at the time of the incident TTL only hired out trolleys for a maximum period of three months, after which they were returned to their depot, and a MS029 check was carried out. The process was revised to ensure that parts that had been replaced were listed against specified trolleys and were entered on to the Torrent database. Inspection and maintenance dates were also entered on the database. Previously, the quality system did not require the fitter to record what parts were changed as a result of the inspection. TTL have stated that returned trolleys regularly arrive in a poor condition, often with significant damage. The quality check is also used, when appropriate, to initiate a financial claim on the client.

133 The two TTL instructions both required the use of the Harsco brake test tool on one quadrant of each of the braked wheels, and the test was only performed in dry conditions. Replacement brake blocks with linings attached are supplied to TTL either by Harsco or a brake block supplier (see paragraph 1615. Up until November 2003 TTL sent brake blocks requiring relining, to a brake lining supplier rather than to the manufacturer of the friction material. This was for commercial reasons. The brake lining supplier bonds new linings of the specified type to the blocks and returns them for reuse. After November 2003, TTL purchased brake shoes from the OEM.

134 TTL leased the incident trolley to Carillion on 30 September 2005. The trolley had been returned by the previous client in good order with no technical faults. It had passed the full TTL quality check before it was released for hire to Carillion. The bull tag attached to the trolley was completed by hand however the entry for the annual inspection date was wrong. It recorded the date as 19 June 2005 but should have been endorsed with the correct year 2006. The year 2006 was confirmed as correct by other records found during the investigation. This error should have prevented the trolley from being used by TTL's own processes and by Carillion's inspection prior to the trolley being taken onto the branch line.

Management processes

Carillion Systems

135 GTRM used an ISO9000 accredited safety system. This included an Infrastructure Safety Manual (ISM) which had been developed from the British Rail Civil Engineering Safety Manual. This manual incorporated various sections on guidance and standards for engineering projects and operations.

136 Carillion Rail was formed in 2001 from GTRM, Centrac Track Renewals and Carillion Rail Projects. The division inherited various complex and duplicate safety systems from the merged companies. For some time these systems ran in parallel, until in 2004 Carillion carried out a review of the various systems with the objective of centralising management systems thus avoiding duplication and document control problems. The resulting new system was known as the *Integrated Management System* (IMS). The IMS is intranet based, but the various systems made it difficult to search, archive and audit information. At the time of the incident the database comprised over 1200 documents. It was thus difficult to ensure that only current procedures and up to date guidance were displayed.

137 New procedures and revised versions of documents are listed within a 'BSafe' leaflet sent to the home of each Carillion employee every month. It is the main briefing 'tool' to advise employees and associates of new or amended safety procedures. A supply of the leaflet is sent to each Carillion subcontractor. Skyblue issues a monthly safety bulletin to its associates including information from this leaflet. Skyblue associates at Larkhall had very poor knowledge of the safety message being disseminated from Carillion.

138 The Infrastructure Safety Manual (ISM) continued to be used for the maintenance activities of Carillion in its original format but was not used for projects undertaken by the company. Section I.01 'Safe use of hand trolleys' was, however, incorporated into the IMS database.

Company culture

139 The company's 'Worksafe Procedure' originated in British Rail and has been incorporated into the 'Carillion Way'. It has been regularly updated, most recently in September 2005. The procedure aims to provide employees and sub-contractors with a method to deal with immediate safety problems. It aims to provide staff with a process to stop work until their concerns are dealt with and an open means of communicating safety issues to their line management.

140 The 'Worksafe Procedure' also aims to ensure that senior managers are made aware of incidents where work has been stopped on grounds of safety.

141 Carillion intends that its sub contractors apply the 'Worksafe Procedure'.

142 The intent of the Carillion 'Worksafe Procedure' is that the workforce can raise concerns about safety matters. The procedure states that if the matter is not resolved on the site then a line manager or on-call manager is required to make the decision on whether the work stops or continues, and to record the details in the daily log. Details of any incident should be reported to Carillion Transport Control by the supervisor of person in charge for example the SS, COSS or ES.

143 In the event of a stoppage of work the supervisor is required to notify their line manager or on-call manager immediately so that a risk assessment of the situation and decision can be made and documented. If the decision is not accepted or the work is stopped then the on-call manager will escalate the issue to their respective project management who can then be made aware of the incident.

144 Supervisors and on-call managers are intended to be competent to assess whether the risk or issue on safety that has been raised is realistic in relation to the planned work. The procedure states that if the manager decides there are grounds for stopping work, he/she should ensure corrective measures are implemented before recommencing any work. Details should be recorded on the Worksafe Record Form. A copy of the completed form should be sent to the SEQ manager at Carillion Headquarters.

145 The Carillion Worksafe Procedure aims to give feed back and is provided to all interested parties so that lessons can be learnt; however, Skyblue are of the opinion that sharing information is important but does not take place.

146 In the 18 months this process has been running in its present state, only 6 forms relating to a stoppage of work due to safety concerns had been submitted.

147 There is insufficient evidence to positively establish how effective Carillion's 'Worksafe Procedure' is. In relation to the incident on 2 November 2005 it was not effective.

Previous occurrences of a similar character

148 Two similar incidents have occurred in the last 5 years in Whiteball Tunnel in 2003 and Notting Hill Gate London Underground in 2006. Although the latter incident is still under investigation the trolley was fitted with highly contaminated cotton weave brake linings. Both incidents include the factor of a reduced braking force.

149 In the case of the Whiteball Tunnel incident a loaded Permaquip (see paragraph 27) Type B trolley of identical design to that used in the Larkhall incident was being used within a worksite under a T3 possession. The trolley ran away for approximately 770 yards on a 1 in 127 falling gradient. The cause of this incident was identified as a result of wear to the brake linings which resulted in the brake failing to secure the loaded trolley. The trolley had been passed fit for operational use only two days prior to the incident. The trolley's

brake material was likely to have been cotton weave as this material was widely used at that time. Whilst there was an absence of any form of competency training or assessment for the safe operation of Permaquip trolleys or training to operate the trolleys there was no operator error evident to the Network Rail investigators.

150 The conclusions of the investigation of the Whiteball Tunnel incident were;

- absence of competency, training or assessment for the safe operation of trolleys;
- method statement did not make reference to risks of falling gradients;
- sub contractor not supplied with any information about gradients within possession limits;
- lack of knowledge about effects of water and contamination on the brake lining material;
- lack of information on how to test brakes within the manufacturer's manual;
- lack of information about reduced efficiency of brakes in wet conditions within the manufacturer's manual;
- lack of information about limits of wear within the manufacturer's manual;
- absence of reference to use of trolleys within T3 section of the Rule Book.

151 Harsco had received no initial information of the incident and had no records of any contact with Amco or Network Rail about it.

Recommendations and actions from Whiteball.

152 Network Rail supplied the report to HMRI, who reviewed the investigation. HMRI took no further action on the matter. The majority of the recommendations from the Whiteball report have been closed and completed. Outstanding issues related to the following:

- 'Network Rail to ensure that all site method statements address the risks imposed by gradients within the vicinity of the worksite and if plant was to be used or intended for use';
- Network Rail to review competency, assessment and training of staff operating rail mounted equipment. This was rated a low risk and still outstanding.

153 Network Rail's investigation was focused on the particular incident, and the recommendations were addressed to the parties involved. There was no consideration of the possibility of applying them to the rest of their system.

Analysis

Identification of immediate cause

The trolley design

154 The trolley comprises two separate lightweight steel sections with aluminium tops which are connected together with pins. A compression spring mechanism applies the brakes to two wheels. The brakes are released by holding down a removable handle. The handle can be fitted to either end of the trolley. The wheels are cast aluminium and can rotate individually. The trolley is not designed to operate track circuits.

155 The trolley design originates from the 1980's. In the late 1980's British Rail required 'failsafe' brakes to be incorporated into the design. The trolley design has not changed significantly since the 1987-88 period, and only a limited number of design changes have been introduced over the life of the trolley. The failsafe brake mechanism has remained unchanged since its introduction.

157 Harsco have limited historical records relating to plant risk assessment, design changes and safety incidents. Harsco's current design process requires testing and risk assessment. Approval is formally recorded and auditable records are maintained. This process only provides an audit trail for more recent design decisions.

157 The Type B trolley was accepted by Network Rail under the '*grandfather rights'* concept (see paragraph 178). Harsco believed that no design changes had been made that would have required Product Acceptance in order to use the trolley on Network Rail (NR) infrastructure. TTL did not believe that any issues existed with regard to approval of the trolley.

158 The manufacturers of the plant lose control and knowledge of ownership of the plant after the warranty has ended. This can lead to unauthorised parts being used that may significantly degrade the performance from the original specification.

Design requirements for failsafe brakes

159 The current requirements for a trolley are contained in a Railway *Group Standard* (RGS): GM/RT/1310 'Design Requirements and Acceptance of Portable/Transportable Infrastructure Plant and Work Equipment'. Issue 2 dated December 1998 includes requirements for the performance of the braking system;

- all equipment fitted with rail wheels and which is capable of running away shall be fitted with a brake, which shall be capable of stopping and holding the item of equipment, complete with any load it is designed to carry/use, on a gradient of 1 in 30;
- the brakes shall self apply to prevent the equipment running away;
- no stopping distance is stated nor is the required performance in wet conditions specified.

160 A European standard EN 13977 'Safety requirements for portable machines and trolleys for construction and maintenance' was issued in October 2004. It specifies braking distances on gradients; this guidance had not been implemented on Network Rail controlled infrastructure in November 2005 due to certain incompatibilities with the UK loading gauge. The British Rail Board (BRB) Standard 2418/2 applicable at the time of original design specified the following performance criteria for a fully laden trolley;

- it should stop within 40 m on a 1 in 50 gradient in wet conditions when travelling at a speed of 5 – 7 kph (3 – 4 mph);
- it should remain stationary in wet conditions on a 1 in 40 gradient.

161 During 1989 correspondence to each British Rail Regional Civil Engineer from the British Rail Director of Civil Engineering stated that 1 trolley in every 10 should be tested to the specified standards (as detailed in BRB Standard 2418/2). This correspondence stated that the wet testing on the 1 in 40 gradient could be ignored provided the dynamic performance was satisfactory.

162 In 1987 British Rail stipulated that the brake system should operate in both normal and emergency conditions. Both should be obtained through the one lever. No guidance was given about what conditions 'normal' and 'emergency' were intended to include.

163 Tests on a Type 1 and 2 trolleys (see paragraph 156) were conducted on 10 April 1989. They established that if the brakes were contaminated with hydraulic oil the brakes would not hold on a 1 in 30 gradient. In wet conditions but with no oil the trolley stopped within 15 m on a 1 in 50 gradient. The brake lining material was Ferrodo FF3806.

Features of the trolley

Inspection

164 A pre-use inspection by a competent person should have identified the contamination of the brake lining since this contaminant was visible at the brake lining edge. The Harsco user instructions only requires visible contaminents to be wiped clean. The inspection would have also identified the service date discrepancy recorded on the bull tag. This would have invalidated the use of the trolley if Torrent's instructions had been correctly applied. No such pre-use examination was carried out (see paragraph 202).

Brake friction materials

165 At the time of the incident there were two main brake lining manufacturers in the UK; Ferrodo and Trimat. Their products were distributed through a number of brake lining suppliers. The plant manufacturer and plant hire companies may, either, purchase the lining and undertake their own bonding to the brake block or have the blocks relined by the lining supplier or a third party sub-contractor. Provided that the design of the trolley is not compromised by the method chosen then the trolley remains in conformity with its approval status. Lining materials may be sourced from either stockists or the manufacturers. All methods have been used for Type A and B manually propelled trolleys.

166 The friction material manufacturers undertake their own research and employ development and application engineers. The application engineers provide advice about the correct material for a given duty and application. Information on the materials and their application is also published in the form of technical specifications available to potential and actual customers.

167 Selection of the correct material for an application is not undertaken by the supply trade who will seek only to meet a client's requirement. They do not attempt to analyse the environment and application for the client although they undoubtedly have some knowledge in this area. Should the client specify an inappropriate material it is thus unlikely to be identified as such by the suppliers.

168 Three types of lining have been used on the Type B trolley:

- Ferodo 3806: a closely woven semi rigid non asbestos friction material incorporating copper wire and glass fibre. This pad has been used on the trolleys for over 10 years and is still in manufacture.
- Ferodo FF: a woven non-metallic cotton and resin based lining. This was first applied by Harsco in trolley manufacture in 2003/4 when Harsco changed their brake lining supplier. Although Ferodo FF ceased production approximately 8 years ago; stocks held by brake lining suppliers ensured that it was available until at least 2005.
- Trimat CMB: a replacement material for Ferodo FF with similar performance characteristics.

169 The Ferodo FF data sheet (NSo/29) states that the material has a high coefficient of friction but has a continuous use temperature range limited to 150ºC. Its intended application is stated as Industrial drum brakes, plate and cone clutches and miscellaneous applications but no examples are given.

170 Trimat CMB material is used for wet marine applications, such as winch brakes. This type of application is significantly different to that of a trolley because:

- the pad surface is of much larger area than the Type B trolley lining;
- the design of a winch band brake has almost 360 degree surface coverage;
- it is largely encased and any water to which it may be subject is unlikely to be contaminated with large amounts of geologically based material (mud & oil).

171 Both Ferodo and Trimat have advised that selection of the correct material properties and process used to bond the lining to the block are extremely important. Both will affect the performance of the equipment on which it is used. The cotton weave materials are only suitable for dry condition applications as they suffer from permanently reduced friction when subject to contamination becoming trapped within the weave or from water absorbed within the material. They are not suitable for use when diesel fuel, mineral oils and other hydro-carbons may contaminate the lining. The manufacturers advise that if the lining becomes contaminated then it should be replaced.

172 None of the main manufacturers of cotton weave friction linings (Ferodo, Trimat and Mintex) has any test data relating to contamination effects on these materials. This is consistent with the fact that they are not recommended for an environment with contamination present.

173 According to information supplied by Trimat the size of the lining and material used on the Type B trolley would restrict its application to that of a parking brake. It would not be suitable for use as a dynamic brake to slow the equipment to a stationary position.

174 Inappropriate friction material was used to line the brake blocks of the Type B incident trolley. This was an immediate cause of the runaway.

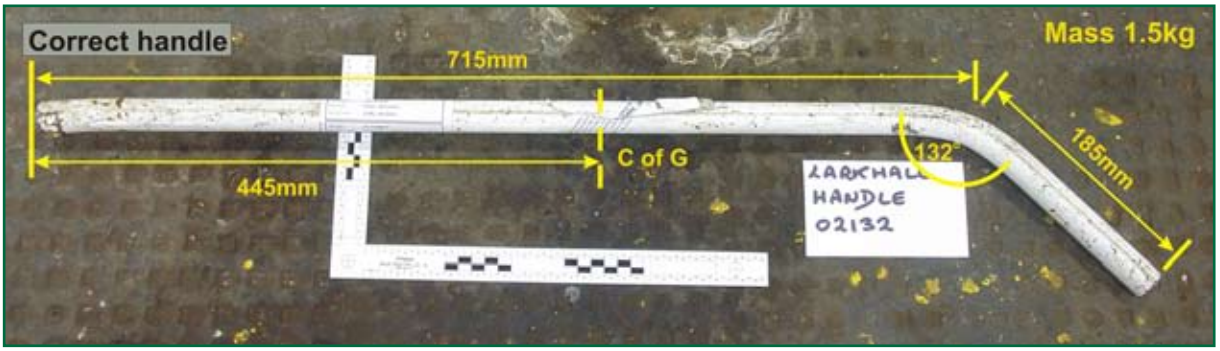


Figure 16: Type B trolley - correct brake handle

Brake handle

175 The handle found at Haughhead Junction (see paragraph 111) was identified as that used on the incident trolley. However it was not supplied for use with a Type B Permaquip trolley (Figure 10), but for use with a *Link* trolley also known as a Type A (Figure 12).

Figure 17: Handle and locating lug connected for Type B trolley

176 Torrent's records of their AP38 tests show that they had supplied the correct handle when the trolley was initially hired to Carillion. The investigation could not establish why an incorrect handle had been used with the incident trolley.

177 The Type B handle is designed specifically to activate and release the 'fail safe' brakes on the Type B trolley. The design of the spigot does not prevent 'predictable misuse' in that any tube-like handle of an appropriate diameter can be used. The Link type handle is designed to engage through the spade shaped end of the handle, but turning it end to end permits the handle to be fitted over the spigot of a Type B trolley. Such misuse will affect the load applied to the spring on the trailing brake mechanism in the 'applied' position. The Link type handle will apply a turning moment due to its position in that it will lie in a lower position, and there is an increase in the moment caused by the weight of the 'spade' which is some distance from the pivot when applied in this manner.

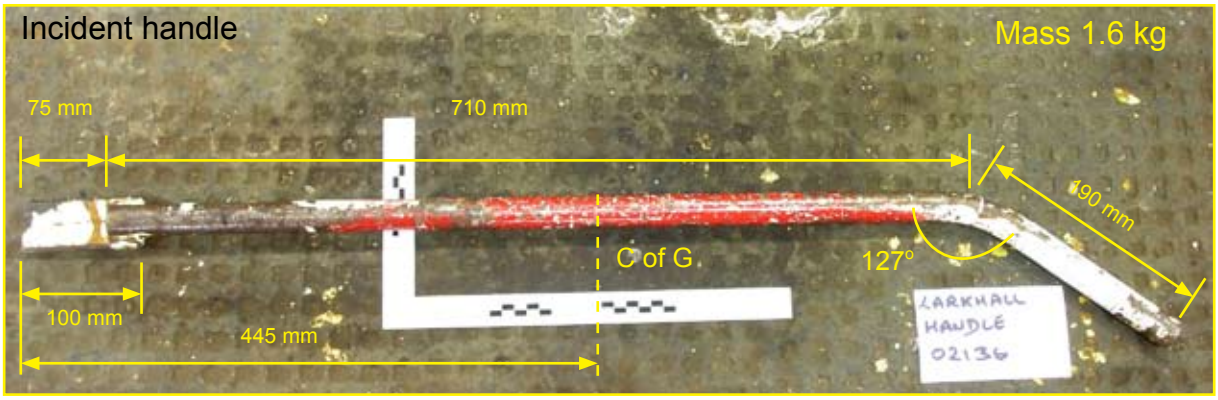


Figure 18: Link handle found in vicinity of Haughhead Junction number 58 points in rear of the runaway trolley. Identified by witnesses as the incident handle.

Product Acceptance

178 The Type B Trolley is covered by Product Acceptance document PA02/846 dated 20 April 2001 reporting the Type B trolley falls within criteria known as having 'grandfather' rights.

179 The design and approval requirements for a trolley used on the Network Rail infrastructure are contained in a number of documents. Other railways and users, e.g. London Underground and those outside the UK have similar but not always identical requirements. The Carillion requirements effectively duplicate those of Network Rail. The manufacturer's design specification is thus an amalgam of many different requirements in order to provide a single product design that can be used on a number of railways. Only those requirements that are immediately applicable to the incident are detailed in this report.

180 Prior to use on their infrastructure a new trolley design needs to be accepted by Network Rail. This involves a product acceptance process that assesses information supplied by the manufacturer and is verified by an independent organisation against GM/RT/1310. Each design requirement is included in this verification process. Substantial or significant modifications to an existing accepted design are also subject to this process.

181 For older designs, much of the information now needed for the verification process does not exist. A process known as 'grandfather rights' then applies. Acceptance in this case is based on the premise that the design has demonstrated acceptable performance over many years and hence continued use will be acceptable. 'Grandfather rights' apply provided that no significant or substantial changes have been made to the design or its intended use.

182 The investigation established that there was some confusion and lack of understanding within the plant manufacturing industry regarding the acceptance process, the criteria by which plant was accepted and the 'grandfather rights' concept.

183 The Harsco Product Engineer had received no formal training or handover from his predecessor regarding product approval processes and the implications of 'grandfather rights'. Only very general documentation was available from Network Rail to guide the industry parties on what was required.

184 Liaison between Harsco and Network Rail over product changes and new product developments did not work well. Harsco believed that their communications were often not addressed speedily or with the correct degree of emphasis. In particular they had sent correspondence in January 2006 to the Network Rail department dealing with product acceptance asking for clarification on proposed Type B design changes but had received no reply by October 2006. The investigation established that there existed a feeling of frustration over product acceptance with serious concerns over the financial costs that could be incurred. Improved channels of consultation over product developments would ensure that unacceptable design features would be identified sooner rather than later in product development (Recommendation 12 refers).

Incident trolley brake mechanism

185 The brake mechanism on the incident trolley is spring applied and manually released type through a lever arrangement. This requires a continuous force on the brake handle to hold the brakes 'off' and thus it ensures that if the trolley is left unattended that the brakes are applied automatically. In addition to providing the force on the brake blocks, the springs also have to overcome the weight of the brake handle causing it to rise from the 'on' position to the 'off' position.

186 The brake linkage from the brake rod spigot to the pair of brake chains, although slightly corroded and un-lubricated, appeared in reasonable working order. There was no evidence of twists, distortion or any impedance to rotation. It is unlikely that the condition of these parts contributed in any way to the runaway.

187 The brake linkage between the trolley halves can only be used to take the brakes off. The application is by the springs on each half of the trolley - if the linkage is totally disconnected then the brake on any part of the trolley without a handle being used will apply. Accordingly the link pin, which had detached from the trolley frame, would not have affected the performance of the brakes.

188 The examination of the leading (or downhill) brake mechanism showed that the brake was applied unless the brake handle was moved and held in the 'off' position. The leading brake pad was worn and that the wheel tread showed signs of significant scoring. This leading brake appears to have been functioning and providing braking effort during the runaway. However, contamination on the front brake lining material prevented the full brake force being applied (see paragraphs 124 and 126).

189 The trailing brake also applied unless the brake handle was moved and held in the 'off' position; testing showed that the wheel could not be rotated by hand. The brake pad was less worn than the leading end pad and the wheel tread less scored. The wheel tread had a more 'glazed' appearance which may indicate that this brake had been less effective dynamically than the leading end brake. Brake lining replacement were not recorded by Torrent at the time of the incident, thus it cannot be ascertained if both linings had been replaced and new linings fitted at the same time.

190 The weight and mass of the handle combined with the movement of the trolley along the track would have caused the handle to 'bounce' on the spring mechanism. This movement likely caused the trailing brakes to repeatedly apply and release during the unescorted runaway travel, further reducing their effectiveness.

191 When the brake handle was ejected from the trolley in the proximity of the number 58 points the braking effort changed to a larger value. This increased force and the change to an Up gradient within Barncluith Tunnel caused the trolley to eventually stop at its final location within the tunnel

192 No other issues in respect of the trolley other than the brake pad material, the pads contamination, the difference in performance between the two ends of the braking system and the inappropriate handle contributed to the incident.

Figure 19: Manufacturers brake test

Rotational brake tests

193 Prior to each period of use Harsco recommend in their Operations Manual that a rotational brake test is performed using a special tool. The tool works by applying a preset torque to one braked wheel at a time whilst the brake is applied. Movement of the wheel indicates a test failure. The tool is not normally used on site, and does not lend itself to such use

194 The brake test tool is designed to check the load and static performance of a fully loaded trolley on a 1 in 30 gradient as required by GM/RT/1310. It does not check the dynamic performance and stopping distances required in the original British Rail specification. The test is performed under dry conditions only.

195 Tests using the brake test tool, and with loads applied directly to the wheel were undertaken on both a sample trolley and the incident trolley. In dry conditions the sample trolley passed the manufacturer's theoretical brake test specifications of 680 N applied by the test tool to the wheel. The leading end brake of the incident trolley had a slightly reduced performance of 603 N (average over tests). More significantly the trailing brake of the incident trolley showed a marked deterioration in performance of 435 N (average over tests). In all these tests the brake handle was not fitted.

196 Further tests on the sample trolley showed that fitting either a Link type or a Type B brake handle had a small detrimental effect on performance of the non incident trolley (628-655 N) and greater effect on the incident trolley (343-508 N). The application of water both as a fine mist and in greater quantities did not cause significant effects during static tests, but did degrade braking performance during dynamic tests (see paragraph 126).

Safe Use of trolleys

Guidance from Network Rail

197 Requirements for the use of trolleys can be found within the GE/RT/8000 module T2 of the Railway Rule Book. It offers guidance to the COSS and trackworkers on the safe use of the hand trolleys.

198 RGS GE/RT 8000 module T3 which was in force for the work being undertaken at Larkhall, has no guidance on the use of trolleys, nor does it direct the reader to module T2 (Recommendation 9 refers).

Guidance from Harsco

199 The guidance and instructions issued by Harsco incorporate some of the requirements in GE/RT/8000 module T2, paragraph 15 and the instructions issued in the Carillion I.01 document relating to the use of a portable trolley. The RGS and Carillion I.01 document both mandate that an inspection is completed prior to use but do not identify how this is to be accomplished. Instructions and guidance on the testing of the brakes using an approved tool or procedure are not incorporated.

200 At the time of the incident Harsco provided new and existing clients with operational instructions for the trolley. The instructions did not incorporate the following:

- how the brake should be tested;
- whether the trolley should be tested in an empty or loaded condition;
- when the test is undertaken whether the handle should be attached to the spigot or not.

201 Harsco's brake test guide document version 115.1 was issued to plant hire/leasing companies in 2005. The document, which explained how to use the brake tool to test, was not incorporated into their operational instructions.

202 The Harsco operational instructions specify a safe limit of wear of the brake pad (2.5 mm), but do not define how it should be measured. The instructions also state that any visible contamination of the pad material whilst in service may be wiped from the side of the brake pad. However this does not remedy the contamination on the surface of the lining.

203 The Harsco instructions make no reference on how often checks on the braking system should be made and no maximum time limits are specified.

204 Harsco should review their documentation ensuring that sufficient emphasis is given to the safety critical processes to be undertaken by the user (Recommendation 4 refers).

Guidance from Torrent

205 When the incident trolley was leased to Carillon, TTL did not provide any operational guidelines or instructions to accompany the plant. TTL believed Carillion was a competent user and had their own processes and instructions to manage the use of the trolley. TTL should introduce appropriate documentation for issue to all users regarding the safe use of plant leased from them (Recommendation 5 refers).

Guidance from Carillion

206 An instruction on "the safe use of hand trolleys" was available within the Carillion Infrastructure Safety Manual – section I.01. This is accessible through Carillion's internal intranet system. This document was issued in July 2004 and requires that the contents are to be briefed to all relevant employees prior to the use of a trolley.

207 Instruction I.01 was not incorporated into the method statement for the work on the Larkhall branch because the author of the method statement was not aware of its existence (see paragraph 235 et seq). Carillion should thus review its processes for the preparation of method statements to ensure all relevant documents are identified and referenced (Recommendation 6 refers).

208 The Carillion Permanent Way Project Manager, SEQ staff, ES, COSS and trackworkers were thus unaware of the existence of Carillion's instruction I.01. Consequently a brake test of the trolley was not completed.

209 A risk assessment was not made of the changed work method, and hence the risks of the gradient were not identified. Carillion should review its training and briefing methods for staff engaged upon safety critical project work to ensure that they are aware of the tools that they are using, and the precautions that apply (Recommendation 6 refers).

Skyblue documentation

210 Skyblue issue all 'associates' with a guidance manual. The manual covers health and safety, drugs and alcohol policies and the use of plant and equipment. The manual does not refer to specific items of plant, and associates are expected to combine the guidance with their track knowledge and competencies. The guidance is general, and does not stipulate how requirements are to be met. Skyblue should thus urgently review its processes anddocumentation to ensure that safety related duties for its workforce are defined in an adequately detailed and auditable manner (Recommendation 8 refers).

3.27 Plant and Equipment

Always ensure that plant and equipment is in good working order before use. If you find any defective or faulty equipment do not use the item and report the problem to a site representative. Never attempt to use any plant or equipment you are not competent to use and have not received instruction to use.

Figure 20: Extract from Skyblue 'Associates' policy and guidance manual. Issue 4

211 Errors and omissions as documented above, that were made by Larkhall staff were caused by a lack of knowledge of the requirements for the safe operation of trolleys and the lack of guidance given to these staff is an immediate cause of the runaway.

Loading of the trolley

212 The trolley was used on the 1 in 48 gradient without assessment of the risks and without specific authorisation.

213 Rails in excess of the maximum permitted 6 m length were loaded on to a single trolley (see Appendix C). Rails of this size should have been transported using a pair of trolleys as mandated in the Carillion I.01 document.

214 Once fully loaded the total weight of the combined rail and rail hand 'grabbers' was 1959.38 kg, just below the limit of the 2 tonnes specified for the Type B trolley. The annual trolley inspection test is conducted with an increased safety factor in that it uses a load of 2.25 tonnes on a gradient of 1 in 30 (see Figure 9).

215 The SS oversaw the loading of the trolley and calculated that the load of scrap rail, which was uniformly distributed, was under the 2 tonne maximum weight limit. However, the SS did not allow for the weight of the 6 sets of rail grabbers in his calculations, but even with this extra weight the 2 tonne limit was not exceeded (Refer Appendix C).

216 Whilst the trolley was loaded within its nominal capacity this loading did not allow for the risk from the steep gradient on the Larkhall branch, which was outside the limitation of a 1 in 50 gradient.

217 The use of the heavily loaded trolley on a steep gradient is an immediate cause of the runaway.

Identification of causal factors

Lanark Road depot.

218 Lanark Road depot was very wet and muddy; a visible film of oil was present on the muddy surface water in and around the depot. This was consistent with the wet weather of the previous month and the lack of constructed or natural drainage.

219 Examples of both Link type and Type B of trolleys were stored at the depot in an area where contamination was evident. The incident trolley was based at the depot, on lease, over the previous four weeks. Evidence gathered indicates that the trolleys were regularly stored in areas where geological contamination had been in contact with the brake mechanisms. It is thus likely that the contamination of the brake block lining material on the incident trolley occurred here.

220 Contamination of the brake lining reduces braking performance, as demonstrated by the RAIB's tests (see paragraphs 125 and 126). The contamination of the brake lining of the trolley due to its use and storage was causal to the runaway.

Figure 21: Area at Lanark Road where manual trolleys were stored

Events during the incident

221 The work to move the rails was planned to be carried out using a road rail vehicle and associate trailers with continuous brakes. After delivery of the rails to site the problems with the certification of the Crane Controller and Machine Operators was recognised, and the SS decided not to use the RRVs further, but to manually load the rails and use manual trolleys to remove the rails from the site. There appears to have been no assessment of the risks involved in this decision, and there was no reference to either local management or to Carillion's 24-hour control.

222 The Carillion on-call (Project) Manager for Larkhall would not have identified the risks posed by the trolley and gradient being unaware of the Carillion standards and procedures on the safe use of hand trolleys.

223 The more senior Carillion on-call Manager for Scotland as a whole stated he would probably have made a decision to continue using the RRVs if he had been notified of the situation regarding the NCCA Road Rail accreditation.

224 It has not been possible to establish why the trolley moved slightly during the loading of the rails at Merryton. It may have been caused by one or several of the following;

- the shocks generated as the rails were loaded onto the trolley
- contact from the fourth rail with the brake handle when the rails were loaded onto the trolley may have momentarily released the brakes
- the lack of friction between the surface of the contaminated brake lining and the surface of the wet wheel;
- the lack of friction on the patch of rail under the trolley.

225 The event was not significant to the ultimate runaway. It did however identify to those present that something was not as it should have been (see paragraph 68).

226 As a result of this the staff challenged the COSS as to whether the trolley should be used on the gradient. Although there is some dispute over the facts the balance of evidence is that the COSSs then spoke with the SS. At the end of this discussion one member of staff agreed to take the trolley back to Lanark Road. The decision to use the trolley even when there was concern about its safety was causal to the runaway.

227 The staff on site had not been briefed effectively by COSS 1 and 2 in the safe use of trolleys, and the risks of using them on gradients. This was because of the lack of detail on these subjects in the work site risk assessment and method statement. The lack of detail relating to the use of the trolley in the briefing, and the lack of adequate risk assessment, were both causal to the runaway.

Identification of contributory factors

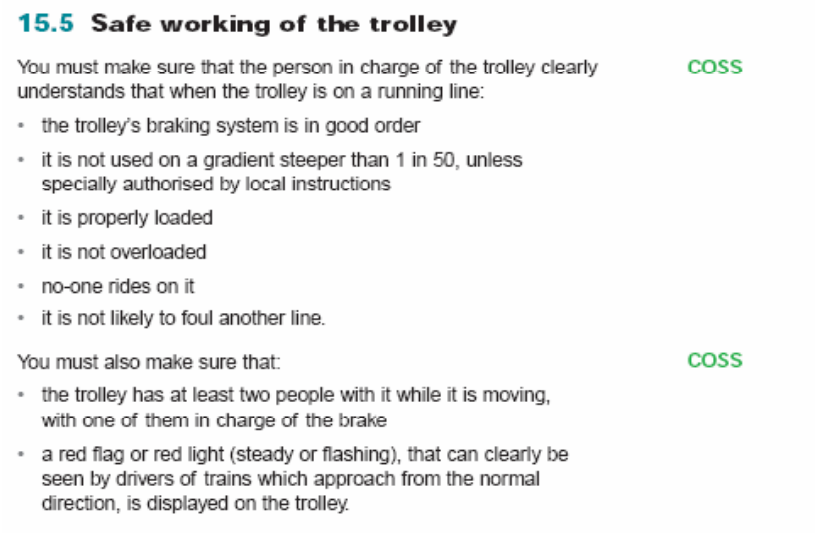
Events during the incident

228 The use of a Link type handle on the Type B trolley reduced the braking performance as the handle created an extra moment in opposition to the springs used. The use of the incorrect handle did not cause the runaway, but did contribute to the extent of it

Approval processes for trolleys

229 The original BR specification for a Type B trolley required a dynamic performance of the brakes. The later Railway Group Standard did not perpetuate this requirement in detail. As a result the testing regime for trolleys only measured static performance. The lack of a dynamic performance requirement for trolley braking contributed to the runaway.

230 Network Rail were seen by Harsco to be unresponsive to their submissions over approval of changes in the trolleys (see paragraph 184). As a result Harsco proceeded assuming the trolleys were covered by 'grandfather rights', and no approval was sought as the brake material was changed, despite the fact that the performance of the brakes is critical to safety. Both Network Rail's lack of response to Harsco's submissions and Harsco's assumption of 'grandfather rights' contributed to the runaway.



15.5 Safe working of the trolley

You must make sure that the person in charge of the trolley clearly understands that when the trolley is on a running line: COSS

- the trolley's braking system is in good order
- it is not used on a gradient steeper than 1 in 50, unless specially authorised by local instructions
- it is properly loaded
- it is not overloaded
- no-one rides on it
- it is not likely to foul another line.

You must also make sure that: COSS

- the trolley has at least two people with it while it is moving, with one of them in charge of the brake
- a red flag or red light (steady or flashing), that can clearly be seen by drivers of trains which approach from the normal direction, is displayed on the trolley.

Figure 22: Extract of GE/RT8000, module T2

Rule Book requirements and Competency

231 There are detailed relevant provisions in the safe use of manually propelled trolleys in Module T2 of the rule book which are not covered elsewhere in the rule book. This anomaly may have been contributory to the incident. (Recommendation 9 refers).

232 No Network Rail operating document makes reference to the potential hazards of increased stopping distances when a trolley is used in wet or icy conditions, or on how to identify contaminated brakes and action that must be taken if the brake lining is contaminated. The training material for Rule Book modules T2 and T3 do not include the risks associated with using a trolley on a gradient. On track staff are required to follow the rules but there is no explanation why they are so important or how to complete the tests if they have no experience. Rule T2 section 15.5 mentions a person in charge of the trolley, but there is no competence or training standard for this person. On London Underground Ltd.'s railways there is such a competence, and with some operators the person in charge has to sign that the trolley is fit for use. The lack of training material and competency in the risks of trolleys contributed to the runaway, and a review of the training modules and the introduction of a formal trolley operating competence should be undertaken to rectify this (Recommendation 10 refers).

Management processes

Carillion Systems

233 There were serious shortcomings in the use of the Integrated Management System (IMS) by the Larkhall Project team as the staff preparing the method statement were unfamiliar with documents that should have been included in it, and in particular ISM Section I.01. Had they been aware of this section they would have sought information on the gradients of the line. This information was available within the company. The lack of knowledge by the staff planning the work was contributory to the runaway. Carillion should thus review its processes for dissemination of safety critical information within its project teams so as to ensure that all such matters are covered in method statements (Recommendation 6 refers).

234 The lack of knowledge in how to search the system and locate the relevant procedures was at least partially caused by the complexity of the IMS, duplication of current and archived documents and competence which made it difficult or impossible for staff to be aware of all the procedures to which they should refer. This complexity was contributory to the runaway.

Figure 23: Image showing trolley, brake block and associated linkage (reference trolley)

Culture of the Larkhall project

235 Significant shortcomings in the Carillion *safety management system* were evidenced in relation to this incident:

- The Project Team and in particular the author of the Method Statement had no formal training in the formulation of writing a safety critical documents;
- The Permanent Way Manager and author of the method statement stated they had no knowledge of the gradient hazards at Larkhall, or gradient limits within the rulebook, or knowledge of the I.01document on 'The safe use of hand trolleys';
- The Method Statements were generically prepared and took no account of specific local hazards such as gradients or contingency planning. The generic method statement was used for items 71 and 77 in WON 31. The process for local supervisors to safely change to alternative methods of work from that detailed in the method statement was not implemented (see paragraph 60).

236 Mistakes occurred within the Method Statements such as the incorrect contact details for Motherwell signalling centre. The communications by Skyblue and Carillion staff prior to, during and after notifying the signalling centre of the incident were not initially directed to the signaller, as is required in the Rule Book when the safety of the railway is at risk, nor were they then addressed to the correct desk within the signalling panel.

237 SEQ staff stated that they experienced document version changes without a briefing being given on the changes, risk assessment forms were changed without notification and the SEQ staff were unable to locate the latest issue documents and safety forms on the IMS system.

238 The staff were not properly briefed before the possession or when it was decided that the trolleys would be used instead of the RRV. All trackworkers were briefed verbally by COSS 1 and COSS 2. This reflected the COSS's experience and was not bespoke to the site and its hazards. Details of the workplan were undertaken by the Carillion SS.

239 Very few briefings on method statements had taken place at Larkhall. COSS trained staff had previously requested briefings and asked for copies of the method statement, however this had not been provided. The explanation given to the COSS's was that the method statement was unavailable for inspection, due to it being locked in the Carillion offices.

240 The trolleys were not tested before or after use in accordance with Carillion I.01 document. Trackworkers on site and Carillion staff involved in the incident were not aware of the Carillion I.01 document on 'The safe use of hand trolleys'.

241 No consultation between on site staff and Carillion management occurred during the night to discuss the change in the method of work from the RRVs to the manually propelled trolleys for the removal of the rails. There was no effective consultation between the Skyblue ES and any Carillion project management staff on or off site in relation to the changed method of work and conflict on using the trolley to remove the scrap rail.

242 The ES and the SS had a lack of understanding and awareness in risk assessments and processes outlined in the Carillion Way Method Statement Procedure, which may have necessitated them consulting with the on-call manager when the method of work changed or had to be stopped. There was no effective process in place to validate and record these decisions if the manager could not be contacted.

243 The NCCA accreditation card change relating to the use of Road Rail vehicles and other crane equipment was not highlighted by the Larkhall SEQ staff or Project Team at any briefing to site staff, or before the change came into force on the 31/10/2005. It was only identified after the SS (who had assumed the role of the Crane Controller) had taken the replacement rails onto the site during the possession.

244 The working patterns of staff undertaking night work were not unusual for an infrastructure project. No evidence was found that fatigue had any bearing on the incident.

245 The COSS, and Carillion staff and management did not recognise that the use of the trolley generated any safety critical issues. The safety of using the trolley was raised by Skyblue associates on at least two occasions prior to the incident. This was due to the previous movement of the trolley during the loading of the rails, the perceived risk and load on the trolley and the obvious gradient of the line.

246 The role of the member of permanent way staff attending the Safety Action Group (SAG*)* forum at Larkhall was not understood. Staff were uncertain about the role they were actually performing in representing their views on safety matters at Larkhall. The SAGs are formed at each project site to represent the members of staff working on the site. They are drawn from various staff grades to discuss and feedback safety issues specific to the site. Safety issues raised can be elevated to national status within Carillion if it is perceived to be a wider safety concern. Likewise the dissemination of safety related items can be processed through the SAG.

247 Although the staff on site spoke up about the potential risk of personal injury to themselves prior to the trolley being moved they refrained from showing any discontent when one member of staff agreed to do so. It is not certain whether any of their number realised that the movement of the trolley would be in contravention of the rulebook and thus technically 'unsafe' although there were a number of COSS trained staff present who could have been expected to recognise this. There is evidence that their overall lack of objection was probably caused by;

- earlier encounters with a leadership intent on getting the job done;
- their previous safety concerns being ignored;
- lack of confidence in the staff designated for role of safety and management;
- a perceived breakdown in the working relationship between management and staff on the site that night.

Overall little evidence was found to confirm that Carillion could be certain that all of the staff with safety responsibilities who were engaged upon the project had the skills and knowledge necessary. (see paragraph 256, Recommendation 8)

248 Evidence gathered during this investigation suggested that an earlier concern over safety had occurred prior to the incident. Carillion site management dispute any earlier conflict taking place with COSS 1, COSS 2 or the trackworkers. No member of staff from either Carillion or Skyblue submitted any report about such a matter.

249 SEQ staff indicated they felt office administration and focus on performance statistics is driving the SEQ safety strategy. There were also concerns that the large amount of data on the company's IMS database could not, by virtue of its size, support front line staff effectively.

250 The SEQ staff at Larkhall were all relatively new to their post within the railway industry, having been in post less than a year. Their lack of railway experience and knowledge contributed to preventing them disseminating the correct information to the project managers and staff.

251 There was evidence that the Skyblue associates lacked confidence to raise safety issues because of the fear of recrimination.

252 Staff at Larkhall considered that there was a lack of trust existing between Carillion and Skyblue associates.

253 The branch line was scheduled to open on 12 December 2005 and Larkhall staff stated they felt they were under pressure to achieve this target date. Skyblue associates stated that they believed the time pressure was the reason a decision was made to lift the rails onto the incident trolley rather than use a RRV, the latter being the normal practice during the recent possessions.

Conclusions

Identification of the immediate cause

254 The immediate causes of the runaway were :

- The use of a heavily loaded trolley on a gradient steeper than permitted (see paragraph 217, Recommendation 13); and
- The use of inappropriate brake lining material on the trolley whose braking characteristics degraded with contamination (see paragraph 174, Recommendation 1); and
- Contamination of the brake lining (due to its operational environment, usage and storage) (see paragraph 220).

Causal and contributory factors

255 Causal factors were:

- The lack of guidance on the safe use of trolleys given to the work force on site (see paragraph 240, Recommendation 9).
- The lack of on-site testing procedures for the trolley (see paragraph 193, Recommendation 4)
- The lack of recognition that the gradient would affect the braking capacity of the trolley (see paragraph 216).
- The omission of key facts in the briefing given to the work team by the COSSs relating to gradient hazards and manually propelled trolleys (see paragraph 238, Recommendation 6)
- The decision to continue to use a manually propelled trolley despite the staff raising concerns over its safety on the gradient, and contrary to Carillion's 'Worksafe Procedure' (see paragraphs 71 – 73 and 139 - 147, Recommendation 6).
- The lack of detail within the worksite risk assessment and method statement on gradient hazards, and on plant and trolley operator competence (see paragraph 43, Recommendation 6).

256 Contributory factors were:

- The use of the wrong handle on the trolley that affected the effectiveness of braking mechanism during the unescorted part of the runaway (see paragraph 175, Recommendation 3).
- The Railway Group Standard for a manually propelled trolley which does not incorporate requirements for the dynamic performance of the failsafe brakes with a specified braking distance (see paragraph 159, Recommendation 2).
- Relevant detailed guidance about the safe use of trolleys is only found in Module T2 of the Rule Book, which was not applicable (see paragraph 231, Recommendation 8).
- The lack of training material and competency standards concerning the operation of trolleys on Network Rail controlled infrastructure (see paragraph 232, Recommendation 10).

- The lack of clear instructions from Network Rail to operators and suppliers on the need for acceptance and/or approval of design changes on plant subject to 'grandfather rights' (see paragraph 183, Recommendation 12).
- The lack of understanding by Harsco regarding acceptance and/or approval of design changes on plant subject to 'grandfather rights' (see paragraph 183, Recommendations 11 and 12).
- The incomplete listing by Carillion of their Crane Controllers affected by the changes to the Sentinel system. (see paragraph 59, Recommendation 6).
- The lack of a robust system at the site for checking Crane Controller competence against the current requirements. (see paragraph 60, Recommendation 6).
- The design of the Carillion Integrated Management System (IMS) which prevented staff being fully aware of all the documents pertinent to the possession and worksite (see paragraphs 233/234, Recommendation 6).
- The lack of knowledge, experience and training of Carillion staff planning safety critical work (see paragraph 43, Recommendation 6).
- The working relationship between Carillion Rail (Scotland) and Skyblue at Larkhall (see paragraphs 247, 251 - 253, Recommendations 6 and 7).

Additional Observations

The incident trolley

257 The Type B trolley comes in two parts. Normally both halves are always kept together, however exchanges are not unknown at construction sites. If one part is returned in a damaged state to TTL and is beyond repair, a replacement half, which could be old or new, would be married with the good half. The replacement half could then obtain identification carried forward from the defective half, or a completely new identification could be given. TTL refer to this as being 're-fleeted'.

258 Inspection of the incident trolley found the unique identification labels to be the same on both halves but the visual examination indicated that the two trolleys had seen different levels of service indicating that one part had been 're-fleeted'. Records relating to the exchanges of the trolley halves, brake blocks and brake lining material were not available. TTL records did not indicate that a 're-fleet' had taken place.

Trolley fitments for red lights

259 GM/RT/8000, Module T2, paragraph 15.5 requires that a red light be fitted onto the trolley to enable drivers of trains to clearly see the trolley when they approach from the normal direction. The incident trolley was not fitted with brackets for red lights, nor has it ever been a feature of the design. Harsco do however have a trolley design for use on London Underground infrastructure that accommodates a red light. From April 2006, Harsco have started to fit brackets for red lights as standard on the Network Rail Type B trolley. Network Rail should review this situation with a view to ensuring that the Rule requirement for red lights to be fitted to trolleys is correctly applied (Recommendation 14).

260 When a red light is fitted onto the trolley the Rule Book requires the light to be fitted in the direction of trains approaching by the normal route; this means that the trolley could run away not displaying a lamp if an incline fell in the direction of traffic, when there would be no visible warning to track personnel that a trolley was approaching (Recommendation 14).

Communications between parties

261 When Network Rail had formally commenced their investigation and before the involvement of the RAIB, Skyblue associates were instructed by their on-call manager not to communicate with Carillion staff about the incident. This embargo was extended to the management of the worksite itself. It could have had serious consequences because the engineering possession was still in force and welding work on the track was still continuing at Merryton. Evidence suggests that this was due to the events of the night and poor relationships that had developed between the Carillion and Skyblue associates.

Availability of Method Statements

262 Evidence was given that Method Statements were not available on site, and, indeed, were 'locked away' in the depot (see paragraph 57). For method statements to add value they should be comprehensible to, and available to, staff on site.

Access to the open line

263 When it was realised that the trolley had run onto the main line at Haughhead Junction the staff who were trying to find it went onto the open line in a Red Zone Prohibited area without setting up a *safe system of work* (see paragraph 88). Fortunately the trolley's operation of the track circuit had brought traffic to a halt, but staff should always be aware of the need for setting up appropriate safety system when going on to an open line, especially in unplanned circumstances.

Whiteball Tunnel incident

264 Had Network Rail considered the Whiteball Tunnel incident (see paragraphs 149 – 153) as a precursor event, rather than a single incident, the recommendations might have been applied nationwide, and consequently the runaway at Larkhall might have been averted.

Actions already taken or in progress that affect this report

Network Rail

265 In conjunction with both manufacturers of rail mounted plant, the Rail Standards Safety Board (RSSB), the working group of the Mechanical and Electrical Engineers (M&EE) Networking Group are producing new & revised requirements for manually propelled trolleys in Code of Practice No 18 (CoP0018). The document will cover the trolley operation and maintenance.

Railway Standards Safety Board (RSSB)

266 The RSSB is proposing to review GM/RT/1310 from November 2006 on with a view to improving its clarity. Terms of reference for this exercise have not yet been set.

Harsco Track Technologies

267 Harsco have been actively involved in the MEE working group. They have produced a new (draft) guidance manual that will include the MEE guidelines and detail the risks associated with using the trolley in wet or icy conditions and on a gradient. (see paragraph 266)

268 Harsco notified Network Rail in January 2006 to obtain Plant Acceptance body approval on design changes to the Type B trolley in accordance with GM/RT/1310. These design changes relate to the brake handle, push handle and side boards. To date Harsco have not received VAB acknowledgment from Network Rail.

269 Harsco have made an engineering change to a non cotton brake lining material on all of their products.

270 All new brake handles have had their ends permanently closed to prevent them being used incorrectly.

271 The brake test tool has been redesigned to accommodate all types of braked wheels and the new CoP0018 brake testing requirements.

272 The design of the Type B Trolley has been modified for full compliance with BS EN 13977:2005, Track, Safety Requirements for Portable Machines and Trolleys for Construction and Maintenance.

Torrent Trackside Ltd.

273 Torrent is undertaking the following:

- Review of workshop procedures, records and the issue of service tickets to ensure accuracy of plant service history and maintenance program;
- During maintenance carrying out brake testing using the Harsco brake test tool for all four quarters of the braked wheel;
- During maintenance inspection of the linings for contamination by water or geological material;
- Briefing to all their staff on temporary safe working load (NWR) of Rail Trolleys (completed);
- Briefing to all LUL staff on temporary safe working load plus re-badging of SWL on LUL trolleys (completed);
- Review of Safety Critical Competency checks on Torrent maintenance staff (completed);

- Re-drafting of MS029 - Maintenance Schedule for Rail Trolleys (awaiting CoP0018 before release);
- Drafting of Trolley Operator Training Course (completed);
- Refurbishment program of Manually Propelled Rail Trolley (completed);
- Rolling program to retro-fit red light brackets to Rail Trolleys;
- Modification of the brake handles to prohibit wrong way round fitment;
- IT system developments to provide data (via extranet) on out of service equipment;
- Training their fitters to ensure competence in identifying brake lining contamination during their MSO29 process (completed).
- The drafting of operator instructions for Rail Trolleys.

Carillion Rail.

274 Carillion is undertaking, or has undertaken the following:

- Revision or replacement of the Infrastructure Safety Manual I.01 consequent upon the work to develop CoP0018.
- Training on the use of trolleys for COSSs and trackworkers and the briefing of staff on the requirements for using trolleys safely on gradience in accordance with the rule book and ISM. Carillion will implement as a company procedure.
- Introduction of a simplified IMS and a reduction of the number of documents by approximately 500.
- Introduction of a database custodian manager and document control librarian to effect strict document control thus ensuring that the database incorporates only current versions.
- Carillion have set up a Task Force to emphasise and improve the safety culture in the company, headed by the Deputy MD of Carillion Rail. Evidence gathered by the task force has been used to generate action plans to address the issues found.
- Introduction of a new senior management post to oversee Carillon's Scottish Operations.
- The *Rimini* process within Carillion has been changed to ensure that risk assessments reflect changing site circumstances and, avoid the use of generic plans.
- Introduction of an enhanced risk assessment process supported by intranet based tools.
- Introduction of a 2-year programme to strengthen individuals' basis management skills with an emphasis on staff engagement and communication.
- Rebriefing of the Worksafe Procedure.

Skyblue.

275 Safety critical staff such as COSS and ES will be considered for permanent contracts to become employees of the company. These staff will effectively become team leaders on site.

276 The company intend to share intelligence on safety incidents with Carillion and other labour suppliers.

Recommendations

277 The RAIB's recommendations are directed at those parties who the RAIB believes are best placed to mitigate the identified risks (the implementers). When these parties have considered the recommendations they should establish their own priority and timescale for the necessary work, taking into account their health and safety responsibilities and the safety risk priorities within their organisations [1].

278 The recommendations below also have application to other organisations undertaking similar roles to those directly referenced by this report. Those other organisations should assess the need to apply the lessons of this investigation to their own activities.

Recommendations to address causal and contributory factors

1. Harsco should change the brake lining material used on their manually propelled trolleys to one that is capable of stopping a loaded trolley on a 1 in 30 gradient within a distance to be specified in a revised Railway Group Standard GM/RT/1310 (completed).

2. RSSB should propose a change to the Railway Group Standard GM/RT/1310 to include appropriate stopping distances for a fully loaded manually propelled rail plant on a 1 in 30 gradient. This stopping distance should be achieved in conditions representative of operational conditions (ie including wet and dry conditions). The proposed changes should also recognise the requirements of EN 13977.

3. Harsco should change the design of the brake handle on the Type B trolley to prevent incorrect usage (completed).

continued

[1] The RAIB addresses its recommendations to the ORR (HMRI), the safety authority, in accordance with Article 25(2) of the European Railway Safety Directive 2004 (the Directive) and Regulation 12(2)(a) and (b) of the Railways (Accident Investigation and Reporting) Regulations 2005) (RAIR). The RAIB does this to enable the ORR (HMRI) to discharge its responsibilities under Article 25(2) of the Directive and Regulation 12(2)(a) of the Regulations, namely that they must ensure that all RAIB recommendations addressed to it are duly taken into consideration and where appropriate acted upon by the end implementer.

The end implementer is required under Regulation 12(4)(b) of the Regulations, to provide the Safety Authority with the full details of the measures/actions they intend to take to implement the recommendation and the timescales for securing that implementation. The timeliness of this response to the Safety Authority is dictated by the Safety Authority's duty under RAIR Reg 12(2)(b) to report to the RAIB, without undue delay or within such other period as may be agreed with the Chief Inspector.

4. Harsco should revise their user guidance on the use of the Type B trolley with particular reference to;
   - the need for, and means of testing the braking system both at depot/works and at site as appropriate.
   - the risks and mitigations associated with braking performance on gradients.
   - the risk and mitigation associated with the braking performance in wet or icy conditions.
   - the risk and mitigation associated with contamination of the brake linings (all points completed).

5. Torrent Trackside should ensure that;
   - their maintenance procedures take account of the guidance issued by Harsco as in Recommendation 4.
   - instruction is available to identify the operational checks required and risks associated with trolley operation taking account of the information in Recommendation 4. This should be issued to those using the trolley (for inclusion in method statements and risk assessments).

6. Carillion should review its safety management system and related processes and introduce changes to;
   - ensure that information that affects safety can be easily sourced by those staff preparing method statements, and site supervisors, through the IMS database.
   - ensure that staff engaged in hazard identification, risk assessment and the production of method statements or safety critical documentation are competent for these tasks and that they have access to appropriate source information.
   - ensure that if short notice changes to working arrangements are to be made they are supported by appropriate risk assessments and method statements that are documented and can be subject to safety validation and audit.
   - ensure project staff are aware of safety critical information.
   - implement a means of assessing the effectiveness of site briefings so that necessary improvements are made.
   - ensure the national processes for checking competencies are adepuately briefed and implemented.

7. Carillion should conduct a review of the supervision and audit arrangements of their safety management system including but not limited, to the Worksafe Procedures, to ensure that its policy intent is being delivered in practice and to enable suitable remedial action to be taken.

continued

8. Carillion and Skyblue should ensure that there are auditable procedures in place to ensure all staff engaged upon safety management roles have the capability to manage the safety of relevant staff.

9. RSSB should propose revision of the rulebook to recognise the risks associated with the braking performance of trolleys in wet or icy conditions, on gradients and with contaminated brakes, along with instruction to perform any necessary brake test to demonstrate the trolley brake is performing to its specification in all circumstances.

10. Network Rail should revise its training requirements to match the output of recommendation 9, and introduce a competency within the Sentinel system for a person in charge of trolleys.

11. Harsco to ensure that plant acceptance approval is obtained for all existing plant (Harsco are awaiting a Network Rail response and approval to the Type B design change submission made in January 2006).

12. Network Rail should review their guidance on product acceptance processes and 'grandfather rights', with particular reference to plant, to ensure that there is clarity to relevant parties on the design change approvals criteria and particularly in respect where it affects 'grandfather rights'.

13. All Infrastructure Controllers should brief relevant contractors and staff of the risks associated with braking performance on gradients, in wet/icy conditions, and with contaminated brakes.

Recommendations to address observations

14. Network Rail should carry out a risk assessment on the use of red lights on trolleys used in T2 sites and either;
    - enforce the existing requirement for such lights, which will include the fitting of brackets to all existing and future trolleys on the network; or
    - propose a modification to Rule Book Module T2, paragraph 15.5, to remove the requirement for a red light on a trolley.

15. Network Rail and Carillion should review their instructions to staff and contractors to ensure that accidents and incidents are notified to RAIB as required by the RAIR Regulations 2005.

16. Network Rail should review its procedures for accident investigation to ensure that lessons learned from such investigations are adequately reviewed as potential precursor events, and when so identified are briefed on an industry wide basis.

Appendices

Glossary of Abbreviations and Acronyms — Appendix A

COP	Code Of Practice
COSS	Controller of Site Safety
CSR	Cab secure radio
CCTV	Closed Circuit Television
ES	Engineering Supervisor
ELR	Engineers Line reference
FPL	Facing Point Lock
HMRI	Her Majesty's Railway Inspectorate
HSE	Health and Safety Executive
IMS	Integrated Management System
M+EE	Mechanical and Electrical Engineering
MOM	Mobile Operations Manager
NWR	Network Rail
OLE	Overhead Line Equipment
OTMR	On Train Monitoring Recorder
PAB	Plant Acceptance Body
P Way	Permanent way
PICOP	Person in Charge of Possession
PLB	Possession Limit Board
PPE	Personal Protective Equipment
PTS	Personal Track Safety
RAIB	Rail Accident Investigation Branch
RSC	Railway Safety Case
RIO	Rail Incident Officer
SB	Signal Box
SC	Signalling Centre
SSI	Solid State Interlocking
T2	Blockage of the line for engineering work

T3	Possession of the line. See possession
TOC	Train Operating Company
TC	Track circuit
TCB	Track circuit block
USA	Urgent safety Advice issued by the RAIB
VAB	Vehicle Acceptance Board

Automatic Warning System	A form of TWS with train detection provided by detection devices. ATWS is typically used to provide a suitable warning for work exceeding one day in duration.
Bogie	Phrase used by trackworkers referring to a Type B trolley.
Cab secure radio	a radio system allowing direct and one-to-one communication between a signaller and a train driver.
Cess	The area either side of the railway immediately off the ballast shoulder. This usually provides a safe area for authorised workers to stand when trains approach.
Chargehand	A senior operative who may deputise for a supervisor.
Closed-Circuit TV	System used for train station security and monitoring level crossings
Controller of Site Safety	Person responsible for organising Safe Systems of Work on Network Rail infrastructure.
Detonator	A small disc shaped warning device designed to be placed on the railhead for protection and emergency purposes. It explodes when a train passes over thus alerting the driver. Correctly known as a railway fog signal.
Down	Generally the line taking trains away from London.
Engineering Supervisor	A person who takes control of a worksite within a possession during engineering operations.
Four foot	The area between the inner running faces of a pair of rails.
Group Standard	Mandatory technical or operational document which sets out what is required to meet system safety and safe interworking responsibilities on Network Rail infrastructure
Integrated Management System	A Carillion internal 'intranet' networked company database used to hold policy and documents.
Link trolley	A small trolley which can be used alone or connected to other trolleys for the carriage of larger loads.
Mobile Operations Manager (MOM)	A Network Rail operational manager who provides first line response to incidents.
Network Rail	The company responsible for the fixed infrastructure of the national rail network.
On Train Monitoring Recorder	A data recorder fitted to traction units, collecting information about the performance of the train.
Permanent way	The track structure which includes rails, sleepers, ballast, blanketing material and drainage.
Person in charge	A person who takes control of a section of line during engineering

of Possession	operations.
Points	The items of permanent way which may be aligned to one of two positions, normal or reverse, according to the direction of train movement required.
Possession	A section of the line which is under exclusive occupation of an engineer for maintenance or repairs. The engineer may run his own trains within the limits of the possession but no other trains are allowed to run within it and comprehensive safety arrangements ensure that these conditions are kept.
Possession Limit Board	A marker board positioned at the detonator protection of a T3 possession.
Red Zone Prohibited	A section of line into which persons must not enter in the course of their duties, during the normal operation of trains.
Rimini	Risk Minimisation. Term used to describe work planning arrangements as described in Network Rail standard NR/SP/OHS/019.
Road/Rail Vehicle	A motor vehicle which is equipped both with flanged steel wheels for rail use, and with pneumatic tyres for road use.
Rule book	Railway Group Standard GE/RT8000, which incorporates most of the rules to be observed by general railway staff for the safe operation of the network.
Running line	A railway line which is not a siding and is ordinarily used for the passage of trains.
Running Through	Points run through – a movement which runs through a set of trailing points which are not set in the correct position for the movement.
Safe System of Work	An agreed method of undertaking defined tasks which minimises the risks to employees and the public.
Safety Management System	A proven system which when followed enables a company to perform tasks at all levels of the organisation safely. The system to achieve this blends personnel, resources, policies and procedures together. Such a system must also recognise instances where it is inadequate to requirements and generates change to the system to correct the deficiencies.
Sentinel NCCA	The National Competency Control Agency (NCCA) was established in 1999 as part of Project Sentinel. The NCCA is run by Capita on behalf of Network Rail and is based in offices in Basingstoke. The agency issues Sentinel cards to authorised bodies following training events carried out by approved training providers.
Snagging work	Work which is completed after the main project build has been completed but before the project build has been agreed and signed off as complete.

Standard	A document established by consensus and approved by a recognised body that provides for common and repeated use, rules, guidelines or characteristics for activities or their results aimed at achieving the optimum degree of order in a given context.
Up line	Normally the line taking trains towards London.
Thermit	A trademark used for a welding and incendiary mixture of fine aluminium powder with a metallic oxide, usually iron, that when ignited yields an intense heat.
Track circuit	An electrical device using rails in an electric circuit which detects the absence of trains on a defined section of line.
Track circuit block	A modification of the absolute block system employing track circuiting throughout. A train may proceed as soon as the line is clear to the next stop signal plus the overlap beyond that signal.
Weekly Operating Notice	A weekly notice issued by Network Rail. Section B contains details of planned engineering work.

Loading details of the trolley

Appendix C

Load reference (from left hand side)	Length (m)	Mass (kg)	Approximate overhang on trailing end of trolley (m)
Rail 1	5.235	315.20	1.66
Rail 2	5.793	340.80	2.01
Rail 3	6.161	370.95	2.12
Rail 4	3.904	235.06	0.83
Rail 5	4.671	281.24	1.77
Rail 6	6.413	386.13	2.12
	Mass of rails	**1929.38**	
Lifting dogs – 6off	-------	30	-------
	Equipment load	**1959.38**	
Person on trolley (worst case 95th percentile male)	-------	100	-------
	Total load	**2059.38**	
	Max rated load	2000.00	
	Overload	**59**	Insignificant

References Appendix D

- Railway Rule Book GE /RT 8000 T2.
- The ‘Carillion Way’ Worksafe Procedure.
- GM/RT1310 ‘Design Requirements and Acceptance of Portable / Transportable Infrastructure Plant and Work Equipment’. Issue 2 dated December 1998.
  Standard EN 13977 ‘Safety requirements for portable machines and trolleys for construction and maintenance’.

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

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