



Rail Accident Investigation Branch

Rail Accident Report



Collision between a train and a piece of equipment at Barrow-upon-Soar, Leicestershire, 14 February 2016

Report 21/2016
October 2016

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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Preface

The purpose of a Rail Accident Investigation Branch (RAIB) investigation is to improve railway safety by preventing future railway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability. Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The RAIB's findings are based on its own evaluation of the evidence that was available at the time of the investigation and are intended to explain what happened, and why, in a fair and unbiased manner.

Where the RAIB has described a factor as being linked to cause and the term is unqualified, this means that the RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident. However, where the RAIB is less confident about the existence of a factor, or its role in the causation of the accident, the RAIB will qualify its findings by use of the words 'probable' or 'possible', as appropriate. Where there is more than one potential explanation the RAIB may describe one factor as being 'more' or 'less' likely than the other.

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, the words 'probable' or 'possible' can also be used to qualify 'underlying factor'.

Use of the word 'probable' means that, although it is considered highly likely that the factor applied, some small element of uncertainty remains. Use of the word 'possible' means that, although there is some evidence that supports this factor, there remains a more significant degree of uncertainty.

An 'observation' is a safety issue discovered as part of the investigation that is not considered to be causal or underlying to the event being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

The above terms are intended to assist readers' interpretation of the report, and to provide suitable explanations where uncertainty remains. The report should therefore be interpreted as the view of the RAIB, expressed with the sole purpose of improving railway safety.

The RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of any inquest or fatal accident inquiry, and all other investigations, including those carried out by the safety authority, police or railway industry.

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Contents

Preface	3
Summary	7
Introduction	8
Key definitions	8
The accident	9
Summary of the accident	9
Context	11
The sequence of events	13
Key facts and analysis	17
Background information	17
Identification of the immediate cause	20
Identification of causal factors	20
Identification of underlying factors	30
Observations	32
Summary of conclusions	34
Immediate cause	34
Causal factors and underlying factors	34
Underlying factors	35
Additional observations	36
Actions reported as already taken or in progress relevant to this report	37
Recommendations and learning points	38
Recommendations	38
Learning points	39
Appendices	40
Appendix A - Glossary of acronyms and abbreviations	40
Appendix B - Glossary of terms	41
Appendix C - Investigation details	42

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Summary

At around 10:26 hrs on 14 February 2016, a passenger train collided with a conveyor boom projecting from an aggregates train standing in sidings at Barrow-upon-Soar, Leicestershire. The train was travelling at approximately 102 mph (163 km/h).

Two of the cars of the train were damaged by the impact but the train did not derail. The unloading wagon conveyor boom was also damaged. A fitter, who had been working on the conveyor, was seriously injured. Nobody on the train was injured.

The wagon involved in the accident was part of a train which had been loaded with aggregates ready for departure the following day. While checking the operation of one of the wagons in the train, the fitter identified that it needed maintenance.

During the maintenance activity a subsequent failure occurred in the control circuit: A push button switch controlling the movement of the unloading wagon conveyor boom became stuck in the 'on' position. This caused the boom to fully rotate and, because of the location of the siding in which the maintenance was being undertaken, this placed the end of the boom foul of the nearest of the main lines. There was no instruction to prevent the wagon being maintained on this siding. The risk assessments undertaken in support of the systems of work adopted at the site had not considered the risk of the boom moving out of control and affecting other train operations.

It is probable that the contact block of the push button switch became stuck due to corrosion deposit obstructing its moving parts. This was most likely due to the contact block being exposed to environmental conditions for which it was not designed.

The underlying causes of the accident related to the maintenance of the electrical system of the wagon, and the management of the associated safety risk.

The RAIB has made four recommendations relating to:

- Tarmac's (the owner of the wagon) and Wabtec's (the maintainer) processes for hazard identification and risk assessment;
- Wabtec's management arrangements and procedures at Barrow-upon-Soar;
- Tarmac's processes for determining when it is necessary to implement interim safety measures after it becomes aware of deficiencies in the condition of its wagons; and
- Restoring the condition of the wagon's electrical system, should the wagon re-enter service.

Three learning points are also noted relating to the responsibilities of Entities in Charge of Maintenance and vehicle registration holders.

Introduction

Key definitions

- 1 Metric units are used in this report, except when it is normal railway practice to give speeds, distances and locations in imperial units. Where appropriate the equivalent metric value is also given. The terms left and right in this report refer to the direction of travel of the train.
- 2 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report). These are explained in appendices A and B. Sources of evidence used in the investigation are listed in appendix C.

The accident

Summary of the accident

- 3 At around 10:26 hrs on Sunday 14 February 2016, a passenger train collided with an unloading wagon conveyor boom projecting from an aggregates train standing in Barrow-upon-Soar sidings (figures 1 and 2). The train was travelling at approximately 102 mph (163 km/h). The driver applied the emergency brake and the train stopped approximately 0.72 miles (1.17 km) from the point of impact.
- 4 Two of the cars of the train were damaged by the impact, but did not derail (figure 3). The unloading wagon conveyor boom was also damaged.
- 5 A *fitter*, who had been working on the unloading wagon, was seriously injured and was taken to hospital by air ambulance. Nobody on the train was injured, but the driver was badly shaken.
- 6 After the accident, the train was moved at low speed around two miles (3.2 km) to Loughborough station where the passengers were detrained to continue their journeys on other services.

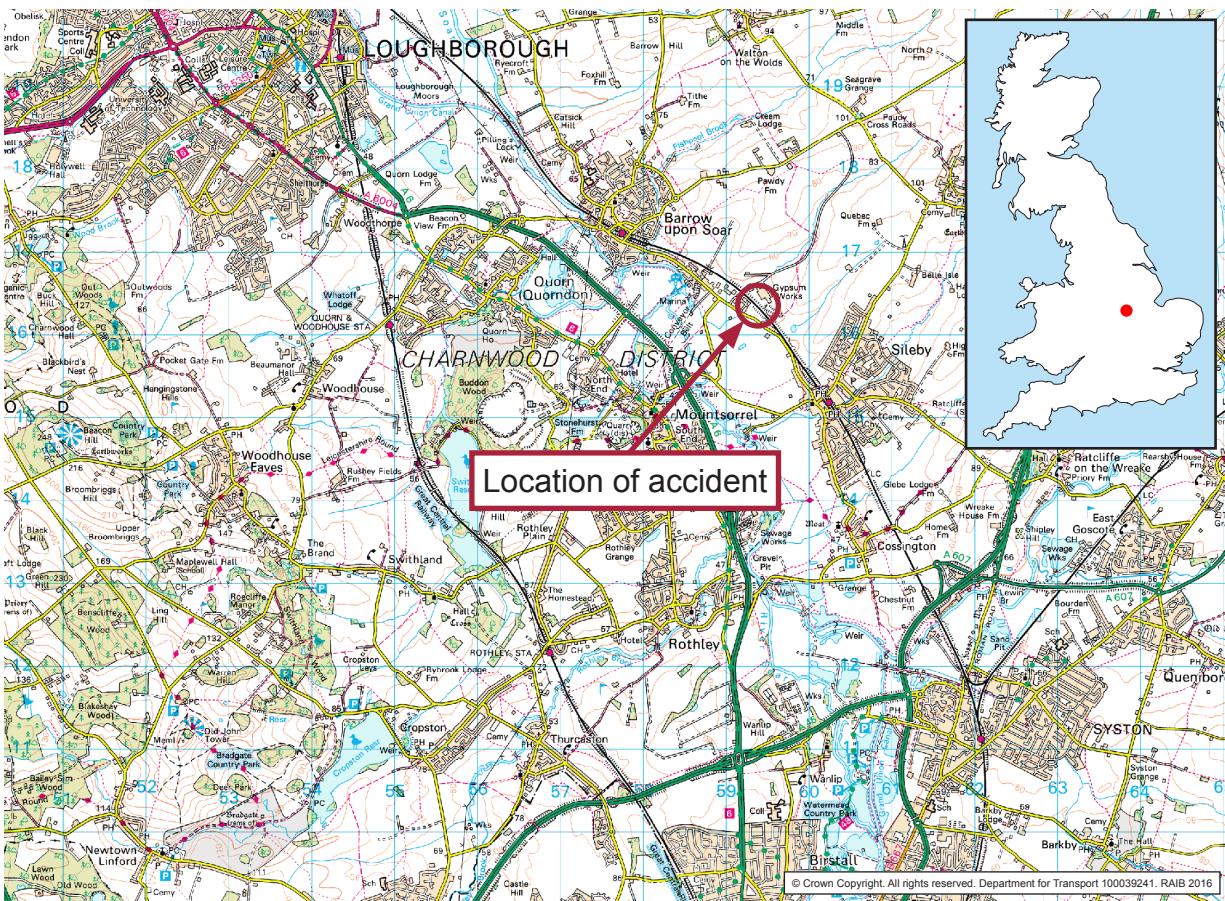


Figure 1: Extract from Ordnance Survey map showing location of accident



Figure 2: Site of the accident



Figure 3: The damaged train

Context

Location

- 7 Barrow upon Soar sidings are situated between Sileby and Barrow upon Soar stations in Leicestershire, 108 miles (173 km) from London St. Pancras station. The sidings are on the left in the direction of travel of the train. Granite from the nearby Mountsorrel quarry is loaded into rail wagons at the sidings. Network Rail's *sectional appendix* refers to the site as Mountsorrel sidings. However, the operator of the site refers to it as Barrow Railhead. Figure 2 shows a general view of the site from the control cabin for the stone loading process. Train movements within the sidings are controlled from this cabin.
- 8 The main line is controlled from the Leicester *workstation* at Network Rail's East Midlands Control Centre (EMCC) in Derby. The maximum speed of trains on the line adjacent to the sidings is 110mph (176 km/h). The line is curved to the left in the direction of travel of the train.

Organisations involved

- 9 The main line track is owned and maintained by Network Rail and is part of its London and North Eastern and East Midlands Route. Network Rail also owns the sidings which it leases to Tarmac Aggregates.
- 10 Tarmac Aggregates, a company within the Tarmac Group, operates the sidings and employs the staff in charge of loading the wagons and shunting them within the sidings. It also owned the wagon involved.
- 11 East Midlands Trains (EMT) operated the passenger train and employs its driver.
- 12 Wabtec Rail maintained the unloading wagon which the train struck, employs the fitters who were working on it and is the appointed Entity in Charge of Maintenance (paragraph 51).
- 13 Network Rail's Network Certification Body provided professional technical services to Wabtec through its Entity in Charge of Maintenance Support Provision Agreement (ESPA) (paragraph 57).
- 14 Schneider Electric manufactured the electrical push button switches which were used in the control system of the unloading wagon.
- 15 East Midlands Trains, Network Rail, Schneider Electric, Tarmac and Wabtec freely co-operated with the investigation.

Trains involved

- 16 The train involved was the 10:20 hrs passenger service from Leicester to York, reporting number 1F01. It comprised a 7-car diesel-electric multiple unit, number 222 005.
- 17 The wagon involved (figure 4) was an unloading wagon, number REDA92545, which is part of the self-discharge train (SDT) fleet. The wagon is fitted with a conveyor belt mounted on a boom which can rotate in plan view (figure 5). Its purpose is to provide a means of discharging stone from the hopper wagons which make up most of the SDT fleet. The boom can be rotated to discharge the stone to either side of the wagon.



Figure 4: SDT unloading wagon REDA92545

- 18 The unloading wagon involved in the accident was part of a train which had been loaded with aggregates ready for departure the following day.

Staff involved

- 19 The Wabtec fitter who was working on the wagon at the time of the accident (fitter 1) had worked for Wabtec at Barrow Railhead for 10 years. Wabtec's competence management system showed he met the competence requirements as defined by Wabtec's competence management system for the job. However, the competence management system did not cover electrical systems (paragraph 112). He was Wabtec's person in charge at the site that day.
- 20 The fitter was assisted by another member of Wabtec's maintenance staff (fitter 2). He had worked at the site for 2 years and Wabtec's competence management system recorded that he was fully competent for the tasks that he was required to carry out.
- 21 The Wabtec staff at Barrow Railhead reported to the Wabtec site supervisor who was also based there. He had worked at the site for 2 ½ years and his previous experience included working as an electrical engineer for 17 years in another organisation. He was not on duty on the day of the accident.
- 22 Tarmac had a site manager based at Barrow Railhead. He had a number of staff reporting to him; those present on the day of the accident were a shunting locomotive driver, a member of *groundstaff* (GS1) and the person in charge (PIC) in the control cabin. The person in charge was responsible for the operation of the sidings and the loading of stone into the wagons.

External circumstances

- 23 The weather at the time of the accident was sunny and dry, but there were rain showers during the day. The weather played no part in the accident.

The sequence of events

Events preceding the accident

- 24 The Wabtec and Tarmac staff at Barrow Railhead started their shifts at 06:00 hrs on the day of the accident. The Wabtec staff assembled in the Wabtec cabin preparing for the work they had to do that day. The instructions to the Wabtec staff were written on a white board in the cabin. These stated that fitter 1 was to inspect any JNA type wagons in the sidings while fitter 2 was to carry out the pre-departure inspection of the SDT wagons scheduled to depart for Peterborough the following day. Fitter 1 had received an email from his supervisor the previous day. This asked him to investigate a problem with the slewing of an unloading wagon. The wagon number was stated towards the bottom of the email and fitter 1 had not noticed it. The wagon mentioned in the email was not the one involved in the accident, and fitter 1 and fitter 2 had already attended to this wagon in the preceding days. Therefore, although the Wabtec fitters were not scheduled to carry out any maintenance on the SDT wagons, fitter 1 was not surprised to find that maintenance was required.
- 25 The Tarmac PIC briefed the locomotive driver and member of groundstaff in the control cabin. The driver and groundstaff then shunted unloading wagon REDA92545 onto the SDT hopper wagons for the Peterborough train which had already been loaded with stone and were in siding 1 (figure 2). This train was scheduled to depart at 05:43 hrs the following day (Monday). The driver and groundstaff then proceeded to shunt other wagons that needed to be moved to make up other trains.
- 26 The two Wabtec fitters went to the control cabin and were briefed by the Tarmac PIC. There were no JNA type wagons in the sidings, so fitter 1 decided that he would work with fitter 2 on the pre-departure inspection of the wagons for the Peterborough train. He told the Tarmac PIC that they intended to conduct a pre-departure inspection of the train in siding 1 and asked the PIC for *protection* from moving trains for that siding. The PIC granted the protection and asked the fitter to clamp the points, put out a 'stop' sign and put 'do not pull' signs on the point handles. The Wabtec staff then put these in place. The fitters had a radio handset to communicate with the control cabin while in the sidings, which was carried by fitter 2.
- 27 The fitters then started the inspection of the train. Both started with the unloading wagon, with one of them standing on each side of it, as the wagon has controls on both sides. They started the engine on the wagon and tested the slewing mechanism of the boom¹. They unlocked the mechanism which secures the boom while in transit and raised it slightly. The boom is fitted with a switch to detect which way it has rotated (paragraph 29) and it has to be unlocked and slewed a short distance to allow this switch to operate. Fitter 1 was standing on the side closest to the main line and he found that the boom would slew towards the main line but the button to slew back towards the central position did not work. Both buttons on the other side of the wagon worked and fitter 2 could slew the boom in both directions from his side.

¹ Witness evidence conflicted over the details of the correct method to be used for this test (paragraph 111).

- 28 Fitter 1 assumed that there was a problem with the button which controlled the inwards slewing from the main line side and decided to change the switch attached to that button. He told fitter 2 to continue with the pre-departure inspection of the rest of the train while he did this.
- 29 Fitter 1 replaced the switch contact block on (paragraph 49) the inwards slewing push button on the main line side and tested it, but the fault was still present. He then considered that the fault might be with the ‘spider’ switch which detects which way the boom has slewed. It is mounted in the centre of the wagon behind the slewing turret (figure 5) and has arms which engage with rods attached to the turret. This switch has two pairs of contacts, one of which is wired in series with the ‘in’ push button on each side, and is arranged such that the ‘in’ push button only becomes active when the boom is slewed to that side. This means that the boom can only be slewed in towards the centre using the controls on the side that the boom is slewed out over. Figure 6 shows the circuit diagram of the slewing control circuit, as surveyed by the RAIB after the accident.

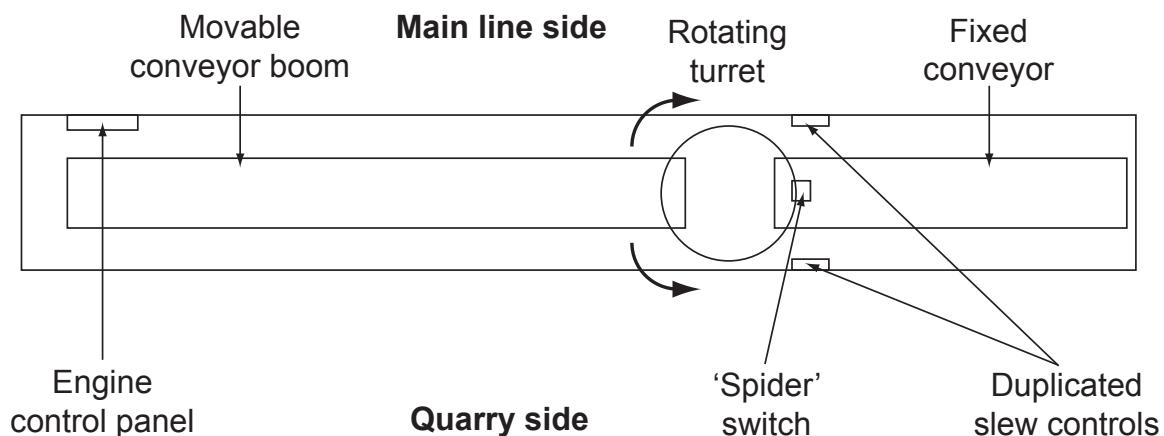


Figure 5: Wagon schematic plan

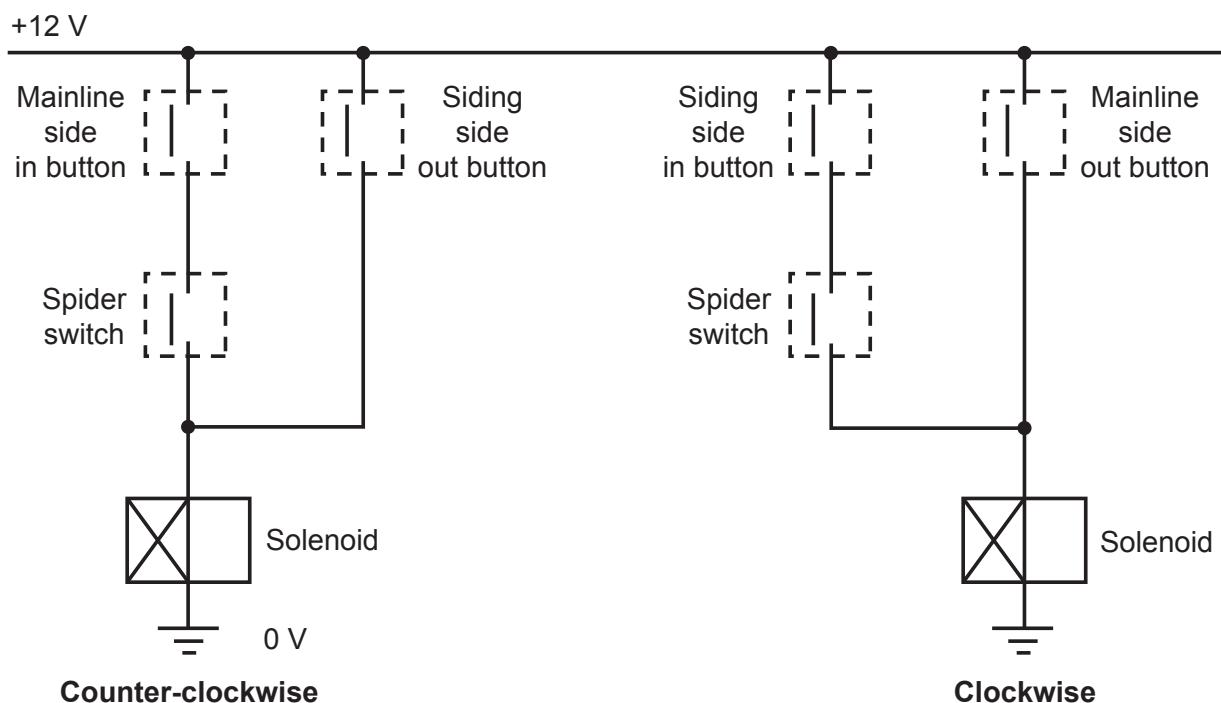


Figure 6: Circuit diagram

- 30 At approximately 10:00 hrs, fitter 2 returned from inspecting the rest of the train and reported that the pre-departure checks were complete and the train was fit to run. The two fitters discussed the problem with the slewing controls. Fitter 2 suggested that they could simply raise the issue as a fault and send the train out with it, as the unloading site staff would know how to manually move the 'spider' switch to allow the boom to be operated from the other side. Fitter 1 said he would change the 'spider' switch and, as it was almost break time, suggested that fitter 2 took his meal break. Fitter 2 left site to travel to a nearby food shop. The Tarmac site manager and the PIC also left site to go for food at the same time.

Events during the accident

- 31 Having fitted the new 'spider' switch, at approximately 10:25 hrs, fitter 1 again tested operation of the slew controls by pressing the 'slew outwards' button on the main line side. The boom started slewing clockwise but did not stop as it should have done when the button was released. The boom quickly moved to the end of its travel where it collided with part of the framework surrounding the conveyor at the rear of the wagon.
- 32 Fitter 1 ran to the other side of the wagon and pressed the 'slew out' button on that side to try to get the boom to move anticlockwise, but it would not move. Fitter 1 called out to GS1 to stop trains on the main line, and then returned to the main line side to try again to control the boom from there.
- 33 GS1 ran to the control room and used the dedicated line to the signaller at the EMCC to ask for trains to be stopped, but the train collided with the boom just as the call started at 10:26 hrs. Figure 7 shows the position of the boom, and fitter 1, just before the collision, as captured by the FFCCTV system on the train.



Figure 7: View from train's FFCCTV just before the collision (image courtesy of East Midlands Trains)

- 34 The collision caused parts of the conveyor belt and boom, and parts of the train, to become detached. An unidentified piece of debris struck fitter 1's leg from behind and knocked him over.
- 35 The train driver was looking down to reach for a drink² at the moment the collision occurred and did not know what the train had hit. He applied the train's emergency brake and the train stopped 0.72 miles (1.17 km) from the point of collision.

² Note that it is acceptable for train drivers who are not driving 'line of sight' (as tram or road vehicle drivers do) to look away from the track if they know there are no signals to observe at that moment.

Events following the accident

- 36 The train driver called the signaller using the GSM-R radio. The call was received at the EMCC at the same time as another signaller was dealing with the emergency call from GS1. The driver reported that he had hit something but did not know what. The signaller was able to tell him that the object was the boom of a wagon in the sidings as he knew this from the emergency call from GS1.
- 37 The signaller blocked the down fast line to traffic and diverted down trains over the down slow line. The signaller contacted the driver of an up train which was approaching the site and asked him to stop alongside train 1F01 to check on the driver's welfare. Another member of EMT's staff, a fitter who was on the up train, also went to the driver of train 1F01 and remained with him.
- 38 Network Rail sent a mobile operations manager to the sidings and reported the accident to the RAIB at 10:42 hrs. An RAIB investigation team was sent to the site.
- 39 The EMT fitter checked that the train was safe to move and it then continued at low speed to Loughborough where the passengers were transferred to other services to continue their journeys.
- 40 The incident train was then taken to the EMT depot at Derby where the RAIB later examined it. The damage to the train is shown in figure 3. Figure 8 shows the wagon shortly after the collision, and after a winch had been attached to the boom ready to pull it back clear of the main line.



Figure 8: Position of the conveyor boom shortly after the collision (and after a winch had been attached in preparation to move it) (image courtesy of Network Rail)

Key facts and analysis

Background information

The Self Discharge Train (SDT)

- 41 The SDT was designed and built by the Standard Wagon Company for Redland, a building materials company, in 1988. The concept was a train of hopper wagons with a built-in conveyor belt to discharge the stone. Conveyor belts run along the train in between all the wagons in a group of five or ten. At the end of each group of wagons the conveyor belt can discharge onto the conveyor belt of the next group of wagons or onto an unloading wagon. The unloading wagon (figure 4) is provided at the end of the rake of hopper wagons and is fitted with a boom which can be rotated to discharge the stone to either side of the wagon.
- 42 The SDT was used to deliver stone to sites around UK. Its unique feature is that it does not require special unloading facilities as it can discharge straight onto a stockpile adjacent to the track. The SDT has also been used for track reballasting and embankment repair works. The SDT fleet consists of 110 hopper wagons and 4 unloading wagons. All of the wagons operated from Barrow Railhead.
- 43 Redland was acquired by Lafarge in 1996 and Lafarge merged with Tarmac in 2013 to form Lafarge Tarmac. Lafarge Tarmac was acquired by CRH plc in 2015 and now trades as Tarmac. Ownership of the SDT vehicles transferred with the changes of ownership of the companies and, at the time of the accident, was with Tarmac Aggregates Limited. Marcroft maintained the SDT fleet between 1988 and 1998 and since 1998 Wabtec has maintained it.
- 44 The original scope of Wabtec's maintenance contract was the wagon structure and running gear below the floor level. The equipment above floor level, which consists of the conveyor belts, hydraulic drive system, diesel engine and the associated electrical control circuits, was subject to a separate maintenance contract with another company. This arrangement ceased in 2010, whereupon all maintenance became the responsibility of Wabtec.
- 45 The unloading wagons have been modified several times. The original means of control for all functions was by manually operated hydraulic valves. These were mounted in the centre of the wagon and the operating rods had a handle on each end that could be reached from either side of the wagon. Shortly after introduction to service, these operating rods were extended to bring the handles closer to the edge of the wagon deck.
- 46 The control of the slewing function was changed from a manual lever to push button operated *solenoid valves* between 1992 and 1998. The actual date of modification is not recorded. The conveyor belt guarding arrangements were revised between 1988 and 1992 and again between 1992 and 1998. The dates of modification and the reasons for it are not recorded.
- 47 The present configuration of the wagon is with hydraulic lever control of all functions except slewing, which is electrically controlled by push buttons on each side of the wagon. A diesel engine powers all functions via a hydraulic system and is fitted with an electrical emergency stop circuit which includes emergency stop push buttons adjacent to the slew controls on each side of the wagon.

Push button switches

- 48 The push button switch units which control the slewing are made up of several parts. The button itself consists of a plastic button mounted in a metal collar which is provided with a neoprene seal where it passes through the control panel formed by the front plate of the metal box in which the switches are mounted. The button itself is sprung so that it returns to the original position when released. The button is rated to be waterproof and dustproof but its life can be enhanced by means of a silicone rubber cap which covers it but still allows the button to be pressed. These caps were missing from the push buttons on the main line side of the wagon.
- 49 Behind the button unit, within the control panel enclosure, there is a diecast metal bracket (or collar) which secures the button unit and provides a mounting point for one or more switch contact blocks (figure 9). These switch blocks are not rated to be waterproof or dustproof (paragraph 78). Each of these switch blocks is itself sprung and has a protruding operating arm which presses against the back of the push button (coloured red in figure 9). It is possible, when the pushing force is removed, for the button to return to the normal position but the switch block remain in the operated position if the switch block were to stick in that position. If this were to occur, it would not be apparent from the front of the panel, as the button would spring back out.

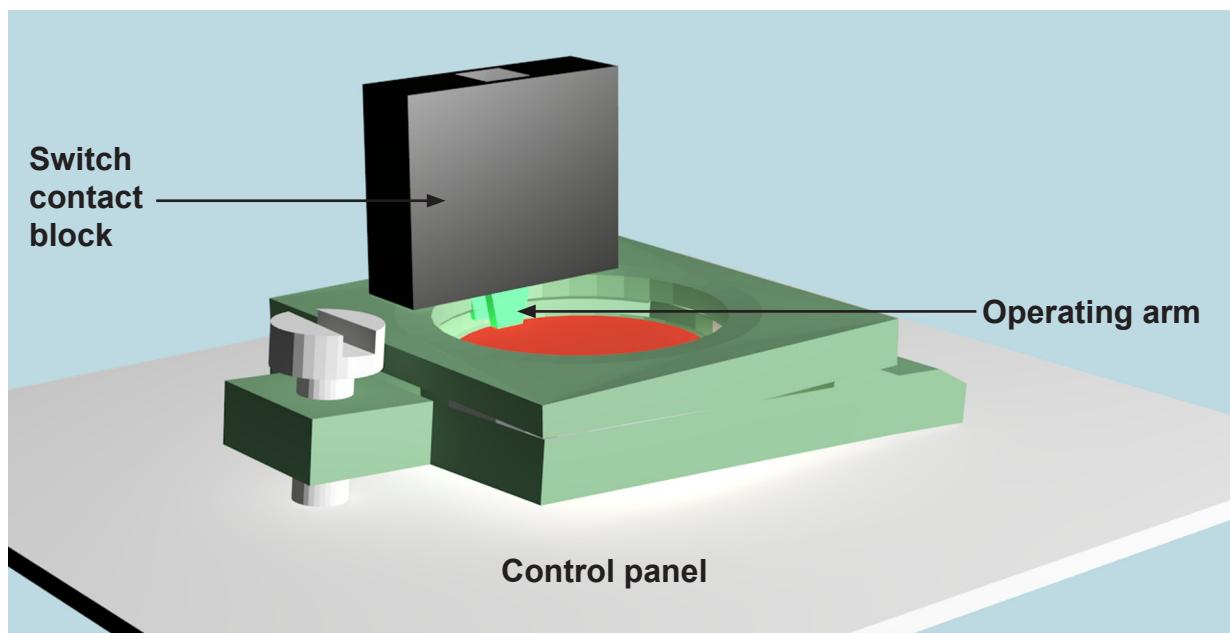


Figure 9: Arrangement of switch and button unit (button coloured red)

- 50 The switch contact blocks are available as *normally open* or *normally closed* types. The switch contact blocks fitted to the unloading wagon consisted of one of each of these types, but the normally closed ones were not connected in to the wiring. The push button assembly and the switch contact blocks were made by Schneider Electric.

Entities in Charge of Maintenance

- 51 European Commission Regulation EU/445/2011 requires the appointment of an Entity in Charge of Maintenance (ECM) for every vehicle used on the national railway network of a member state.

- 52 The ECM is responsible for ensuring that its wagons are maintained in a safe condition. The ECM does not have to carry out the maintenance itself; it can use a contractor, but the safety responsibility remains with the ECM.
- 53 Each member state must maintain a national vehicle register to record who is the ECM for each wagon. In the UK, the Secretary of State for Transport has appointed a registration entity, Network Rail Infrastructure Ltd, to maintain the UK national vehicle register. This showed that the ECM for wagon REDA92545 was Wabtec Rail Ltd.
- 54 The European Commission Regulation requires that ECMs hold an ECM certificate and, at the time of the accident, Wabtec held ECM certificate UK/31/0013/0003, issued by the Office of Rail Regulation (ORR) and valid from 25 February 2013 to 24 February 2018³.
- 55 The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) were amended in 2011 and 2013 to include the ECM requirements in Regulation 18A. This establishes the legal responsibility of an ECM in UK law and extends the scope of offences under section 33(1)(c) of the Health and Safety at Work Act 1974 to include an offence committed by an ECM that does not ensure that a vehicle it is responsible for has been maintained in a safe condition and is safe to run on the network.
- 56 The ORR published guidance to ROGS Regulation 18A in its Railway Guidance Document RGD-2012-01 ‘Guidance on the requirements in ROGS (regulation 18A) that relate to entities in charge of the maintenance of railway vehicles’. This quoted European Rail Agency guidance and stated that

‘... the registration holder (normally the keeper) has to: ... ensure where technical problems are detected, corrective action is taken by the ECM, for example through the contract with the ECM’.

In the case of the SDT fleet, Tarmac was the keeper and registration holder.

ECM Service Provision Agreement (ESPA)

- 57 Network Rail has established a team within its Network Certification Body to provide professional technical services to ECMs responsible for wagons which formerly came within the scope of the *Private Wagon Registration Agreement* (PWRA). The PWRA was set up by British Rail to provide technical support to private wagon owners.
- 58 The PWRA became redundant when the ECM Regulations were introduced but Network Rail had an ongoing obligation to the PWRA members to continue to provide professional technical support. It does this through the SPA management group within its Network Certification Body.
- 59 The SPA management group carries out no formal approval or certification function, but provides advice, assistance, technical support and audit activities for ECMs. The SPA audits include the ECM’s maintenance facilities and processes. The ORR’s guidance to its inspectors on surveillance assessment of ECMs suggests that its inspectors may consider these audit reports as evidence towards demonstrating compliance with the ECM regulations (the ORR conducts surveillance assessments of ECMs on an annual basis).

³ The SDT fleet were the only wagons for which Wabtec was registered as the ECM.

Identification of the immediate cause

- 60 The unloading conveyor boom was in a position where it obstructed the down fast line as a train approached.
- 61 The boom had travelled to the end of its range of movement and, in this position, the tip of the boom obstructed the passage of trains on the down fast line. Although siding 1 is 10 metres from the down fast line, the boom is 12 m long and, even at the end of its travel (which is beyond 90 degrees), reached to the down fast line.
- 62 Fitter 1 immediately realised that the boom might obstruct a passing train and, while trying to get it to move back, called out to GS1 to arrange for trains on the main line to be stopped (paragraph 32). However, there was insufficient time before train 1F01 passed. The RAIB analysed FFCCTV footage from 1F01, and from an up train which passed the site just before the accident. This showed that the movement of the boom occurred within 2 1/4 min of the arrival of train 1F01. This was not enough time to notify the signaller and get train 1F01 stopped.

Identification of causal factors

- 63 The accident occurred due to a combination of the following causal factors:
- The normally open switch contact block on the button which commands the boom to move out on the main line side had stuck in the 'on' (closed) position (paragraph 64)
 - Maintenance work was being undertaken on the unloading wagon on a siding which was within boom-reach of the main line (paragraph 88).

Each of these factors is now considered in turn.

The condition of the wagon's electrical system

- 64 The normally open switch contact block on the button which commands the boom to move out on the main line side had stuck in the 'on' (closed) position.
- 65 Fitter 1 pressed the main line side out button and released it, but the boom continued to slew. The button itself sprung back to its normal position (paragraph 49) but the switch behind it remained stuck in the on position. The switch contact block was still stuck in this position when photographed by the RAIB shortly after arrival at site (figure 10). The normally closed switch contact block on the same button had returned to its normal position, showing that the push button had moved back out and it was the normally open switch contact block that had stuck closed.
- 66 Neither Tarmac nor Wabtec had any written information on the electrical control circuits of the wagon. The RAIB examined a similar unloading wagon, number REDA92546, to derive the slewing control circuit diagram (figure 6). The RAIB then checked that the circuit was same on the incident wagon, REDA92545, and carried out tests of it. During these tests the normally open switch on the out button on the main line side of the wagon was operated a number of times and stuck on one occasion (figure 11). This would have caused the boom to move out of control to the end of its travel, had the solenoids on the hydraulic valve not been disconnected for the test.



Figure 10: Control panel on mainline side of wagon after the incident

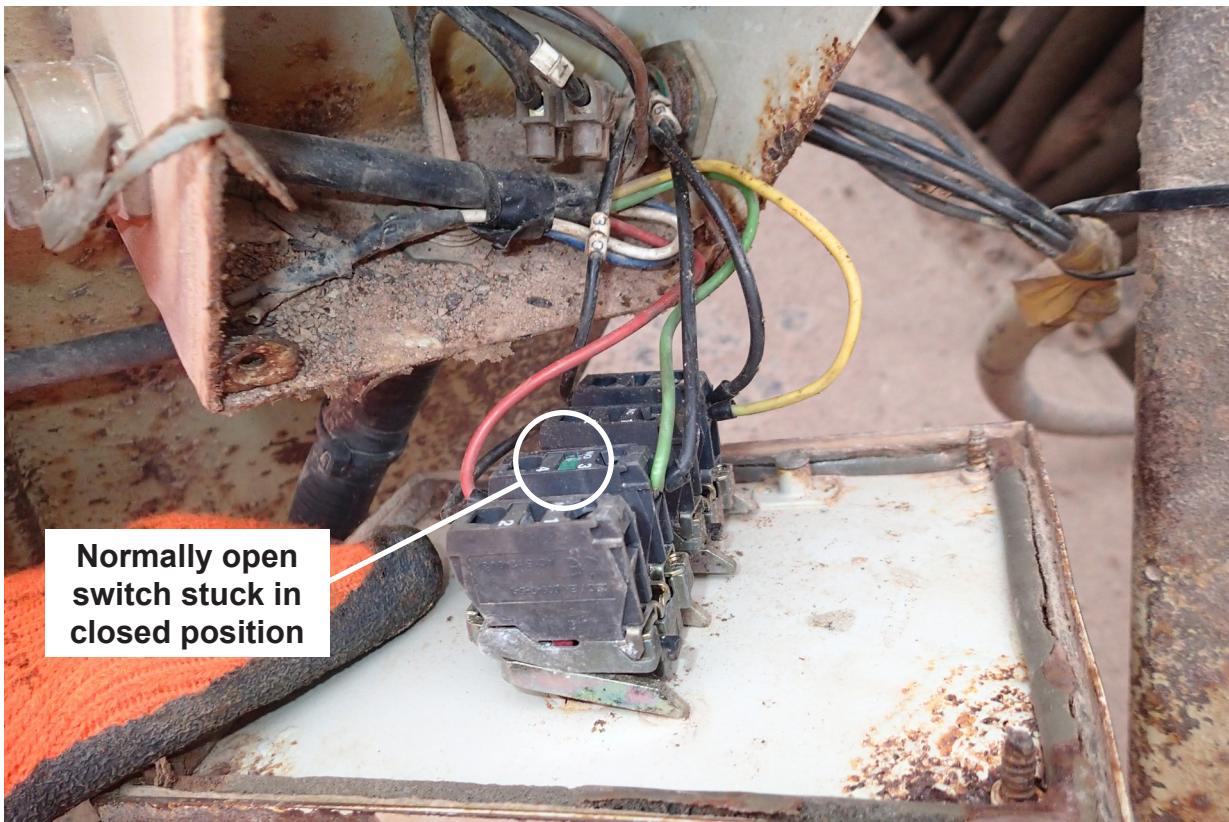


Figure 11: Normally open switch on 'out' button on main line side of wagon stuck in closed position during RAIB test of wagon on 8 March 2016

- 67 The solenoids were reconnected and the accident sequence recreated. The out button on the main line side was held in while the out button on the other side of the wagon was pressed. The test found that the movement of the boom continued in the outwards direction towards the main line when the button on the other side was pressed. This demonstrated that, during the accident with the out switch on the main line side stuck in the 'on' position, pressing the out button on the other side of the wagon would have had no effect on the boom.
- 68 It is probable that this switch stuck because:
 - a. the moving part of the normally open switch contact block had become coated with corrosion product (paragraph 69);
which in turn was most likely caused because;
 - b. the switch was used in environmental conditions that it was not rated to withstand (paragraph 76).

Each of these factors is now considered in turn.

69 The moving part of the switch had become coated with corrosion product.

- 70 The RAIB removed the complete push button assembly, including the switch contact blocks, and took it to the manufacturer's laboratory for further examination and testing.
- 71 The exterior of the switch casing showed evidence of contamination from a dust which was chemically analysed and found to match the composition of Mountsorrel granite.
- 72 The complete switch contact block was x-rayed from three different angles; the interior appeared normal.
- 73 The switch was tested in a test rig which measured the operating force-displacement characteristic of the *operating arm* and another which measured the electrical resistance of its contacts. The force-displacement characteristic was measured to be within the envelope of allowable values for a new switch. The contacts were observed to open and close correctly and the contact resistance when the switch was closed was within the range allowed for a new switch.
- 74 The switch contact block was then broken open (it is not designed to be taken apart). No foreign bodies or defects were found inside. There was evidence of some corrosion of the metal parts (figure 12), but not sufficient to have caused the switch to stick. There was some blackening of the contacts, as would be expected from a switch that was 15 years old, but no evidence of welding of the contacts.
- 75 The plastic moving part of the switch contact block was coated with a hard white deposit (figure 13). Chemical analysis showed this to consist of oxides of zinc and aluminium. This was most likely to have come from corrosion of the zinc/aluminium alloy used for the casting on which the switches were mounted (figure 9). There were also traces of silicon, which is not present in any of the materials the switch is made from, but is a major component of granite. This corrosion deposit is probably the cause of the switch sticking. Figure 14 shows a close up view of the bracket on which the switch was mounted showing where the moving part of the switch had been rubbing against the corrosion deposit.

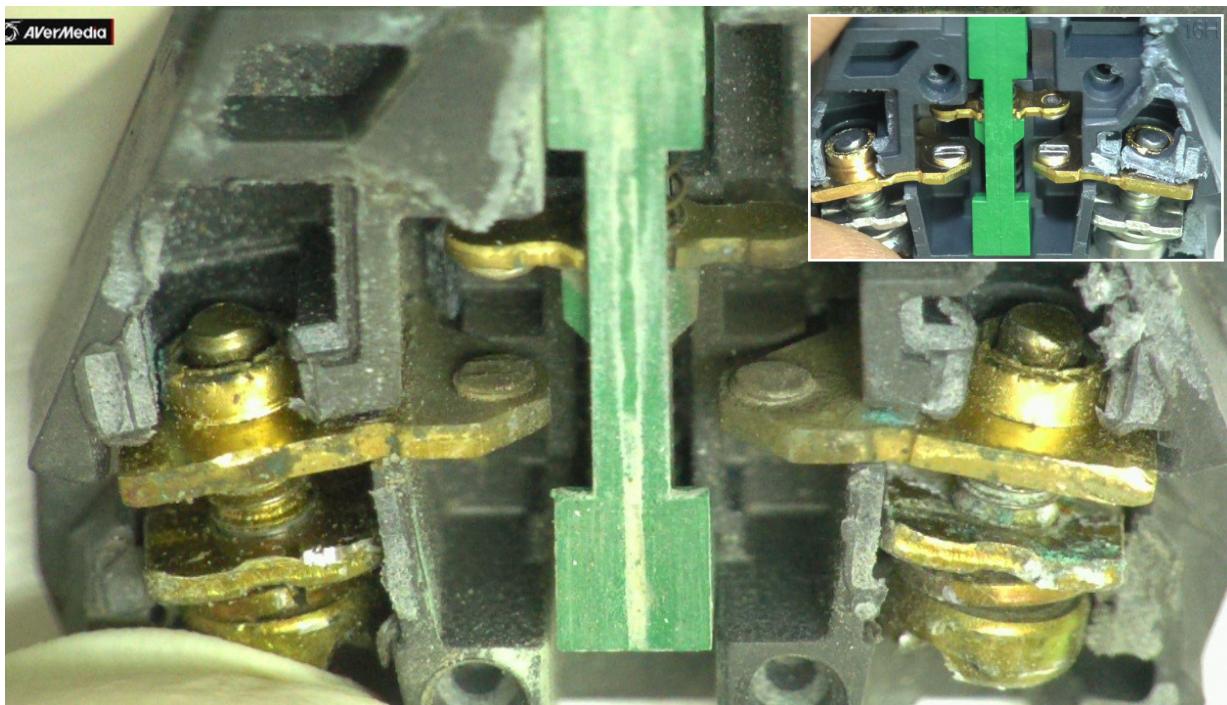


Figure 12: Interior of normally open switch from 'out' button on main line side of wagon (inset shows corresponding view of new switch) (images courtesy of Schneider Electric)

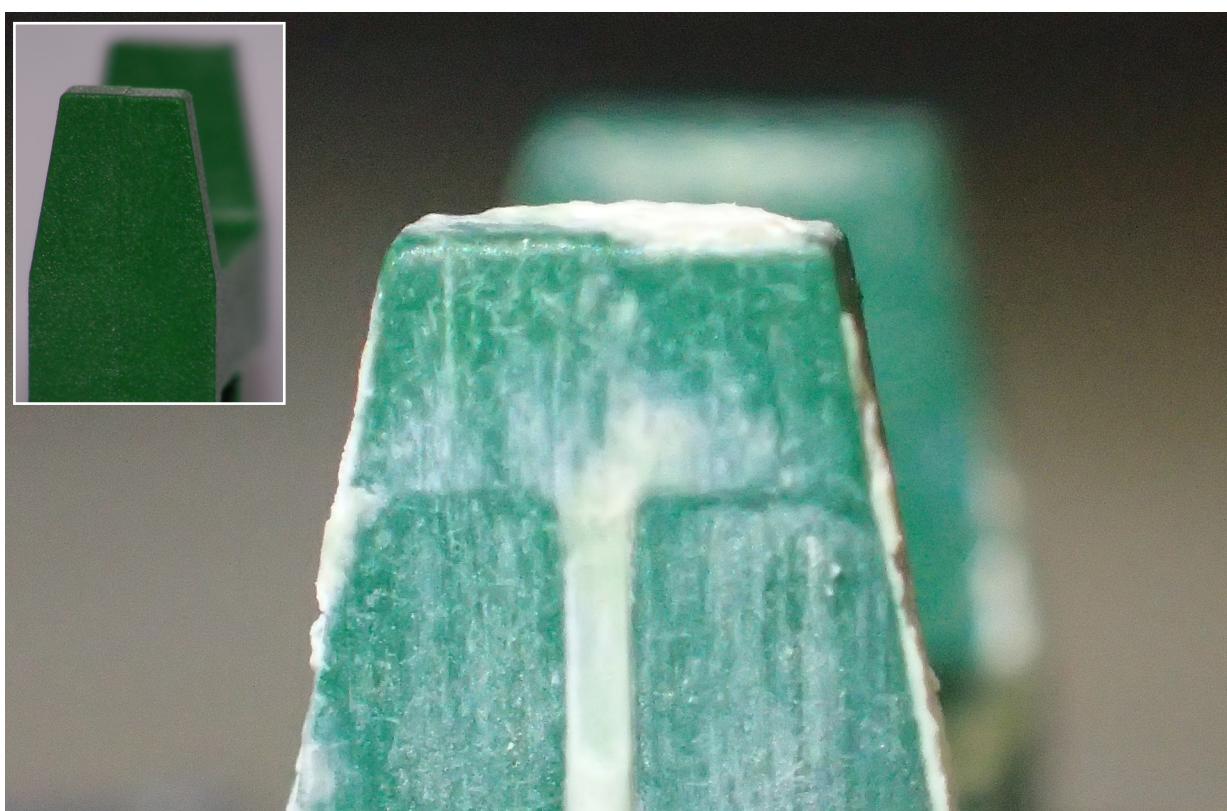


Figure 13: Close-up of moving part of switch from 'in' button on quarry side of wagon (inset shows corresponding view of new switch) (images courtesy of Schneider Electric)

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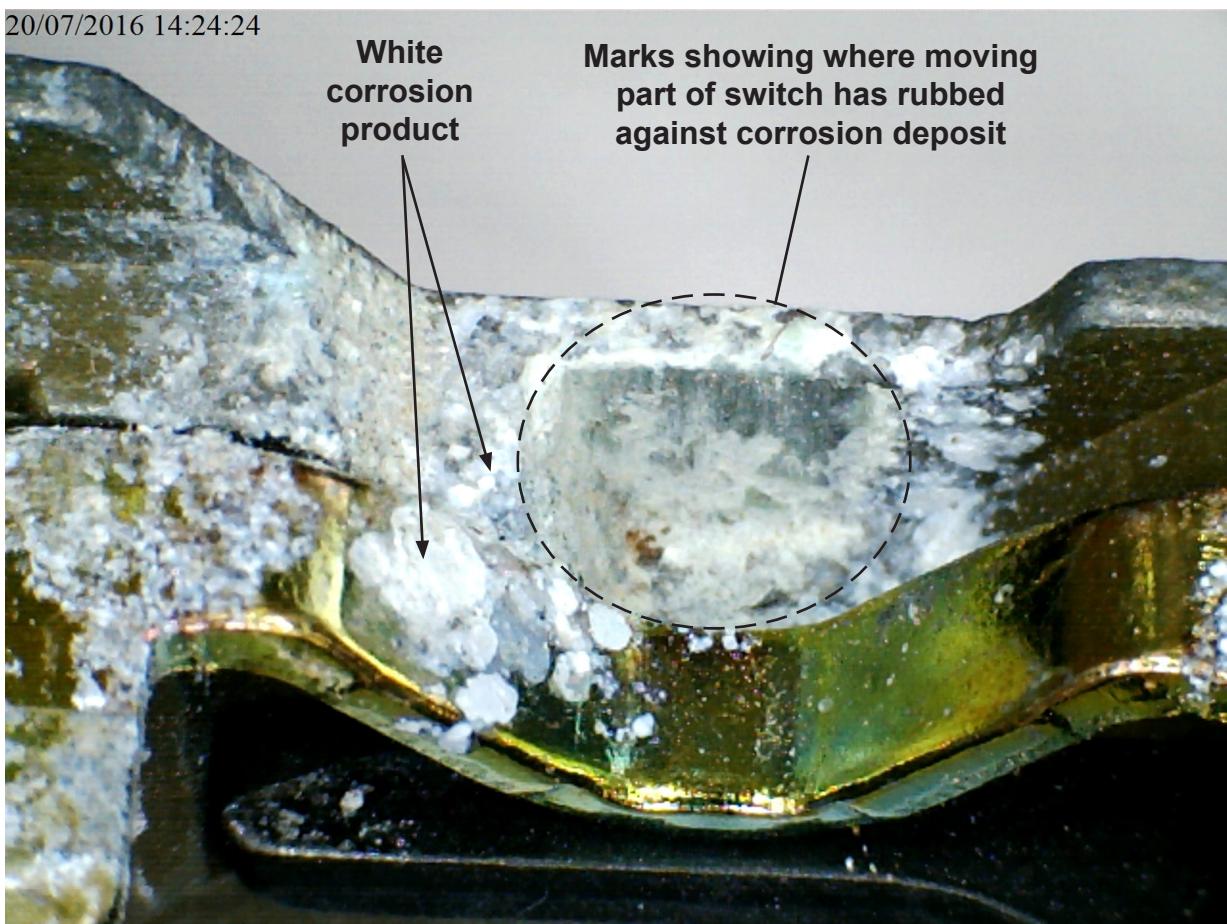


Figure 14: Close-up of diecast metal bracket (collar) from 'out' button on main line side of wagon

76 The switch was used in environmental conditions it was not rated to withstand.

- 77 The switch contact block was type ZBE101, manufactured by Schneider Electric in Angoulême, France, in week 28 2001.
- 78 Electrical equipment is given a rating for its resistance to external objects and moisture. This rating is defined in standard IEC 60529:1989 and consists of the letters IP (Ingress Protection) and a 2 digit number. The first digit refers to the size of object it is tested to withstand. The second digit refers to its resistance to water. The ZBE101 switch contact block is rated IP20. The '2' means that it is has been tested to resist intrusion of objects such as fingers, up to 80 mm long and 12 mm diameter. The zero means that it has no protection against water.
- 79 The switch contact block was designed to be mounted in an enclosure which would protect against moisture and dust to a degree suitable for the environment in which the equipment would be required to operate. The enclosure used on the SDT wagon was a steel box with a sealed lid and glands where the cables enter it. The boxes on both sides of the wagon had deteriorated to the extent that the lid seal was no longer effective and the cable entry points were no longer sealed (figure 15). The box was corroded inside and contained dust and debris. The corrosion indicated that moisture had penetrated the box. As there are no records of the electrical system on these wagons, the intended IP rating of the box is unknown.



Figure 15: Switch enclosure box on main line side of wagon

80 The RAIB examined other electrical junction boxes and panels on the wagon. These were also found to be badly deteriorated, with part of the lid completely corroded away in one case (figure 16 shows the junction box for the 'spider' switch cables).



Figure 16: Wiring junction box beneath 'spider' switch

- 81 Wabtec mentioned the poor electrical condition of the wagons in a quarterly report to Tarmac which covered the period December 2011 to March 2012, however the report stated that Wabtec was awaiting a date when its engineering department would be able to carry out a condition survey. Wabtec commissioned a specialist electrical assessment and survey of the SDT fleet from an external consultant in June 2012. The purpose of the assessment was to carry out '*... an assessment of the electrical health of the SDT vehicles to determine the level of attention, which may be required to prolong their operational life*'. The consultant inspected a sample of the SDT wagons at Barrow Railhead in July 2012 and reported back to Wabtec in a report dated 28 August 2012. The report stated that:

'The condition of the electrical systems on the SDT vehicles is very poor and is unlikely to provide reliable operation unless the complete electrical systems are overhauled.'

It listed a number of areas for improvement, the first of which stated that:

'The existing control panels are completely beyond use'.

The report recommended that the control panels were replaced.

- 82 The consultant's report covered the whole SDT fleet, both hoppers and unloading wagons. Wabtec produced report TR-13-018, dated 26 March 2013. This mentioned the poor condition of the electrical emergency stop system and the electrical junction boxes on the hopper wagons. Tarmac has stated that it did not receive this report at the time.
- 83 Wabtec later reported the poor condition of the whole SDT fleet to Tarmac in report TR-13-097, dated 30 Jan 2014. Both of these reports recommended complete redesign and replacement of the electrical system on the hopper wagons and the second report also included the unloading wagons. The hopper wagons were considered first as, at the time, they were undergoing a programme of modifications to their suspensions following derailments at Ely in June 2007 ([RAIB report 02/2009](#)) and Bordesley in August 2011 ([RAIB report 19/2012](#)).
- 84 Wabtec gave Tarmac an estimate of the costs of this work in technical report TR-014-016 dated 7 February 2014. Wabtec also carried out a risk assessment of continued use of the SDT with its very poor electrical systems in document RA-14-002 of the same date. The risk assessment listed eight safety risks, all of which were assessed as 'high'. The mitigation for these risks was divided into 'pre modification' and 'post modification' measures. The 'pre modification' measures centred on making staff aware of the hazards and only working on the electrics with the power off (as there were no circuit diagrams or other documentation available, the RAIB observes that it would be very difficult to diagnose electrical faults with the power off). The final assessed risk was 'low' for all of the risks after the proposed mitigation of rewiring the wagons had been done. Furthermore, the risk assessment did not identify uncontrolled slewing as a risk.
- 85 Wabtec revised its cost estimate report TR-014-016 on 11 August 2015 and provided the new cost estimate to Tarmac. Wabtec stated to the RAIB that it had worked up the scheme in sufficient detail to be able to price it, but had not yet carried out any detailed design. Tarmac gave Wabtec the go-ahead to start detailed design in an email dated 13 August 2015, but Wabtec had not started it at the time of the accident, due to a lack of sufficient electrical design resource at that time.

- 86 Tarmac has not been able to explain to the RAIB why it took from February 2014 to August 2015 to authorise the work on the electrical system. Tarmac has stated that in order to mitigate risks identified in document RS-14-002 (paragraph 84) it monitored faults with the electrical system and recorded low failure rates. It also stated that, based on the fact that it was a 12V system, Wabtec and Tarmac had assessed the safety risk arising from the electrical system as very low and decided that no action was necessary.
- 87 Wabtec recorded the risk from continued operation of the SDT fleet in its project risk register for the Tarmac contract on 27 October 2014 and Tarmac stated that this was discussed at undocumented performance meetings. The risk was assessed as medium risk and the consequence was stated as 'Breakdown of equipment resulting in failure of the train to discharge'. The control measures to deal with the risk were stated as 'Continue to monitor reliability and fault reports and review in quarterly contract meeting with customer. Undertake component exchange as and when parts fail. Review approach if trends begin to emerge.' The safety risk was recorded as minor and no specific action to deal with the safety risk was recorded.

Systems of work at Barrow Railhead

- 88 **Maintenance work was being undertaken on the unloading wagon on a siding which was within the 12 metre boom-reach of the main line.**
- 89 This causal factor arose because neither the site rules, nor the systems of work for staff, dealt with the risk of an uncontrolled movement of the unloading boom.

Tarmac's system of work for Barrow Railhead

- 90 Tarmac's site rules were given in the document 'Joint method of working for Barrow Railhead' Issue 5 dated 27 May 2015. Most of the document was concerned with train working within the sidings. The document stated that the parties to it were Tarmac, Wabtec, the freight operating companies which used the sidings (which were listed) and Network Rail. It also mentioned that Wabtec carry out maintenance activities at the site and said that maintenance work should be carried out on a siding that was 'locked off', the points leading to it clipped and padlocked and a flashing stop board erected. It also stated that if the work was to be carried out 'outside the vibt road'⁴, then that siding should be locked off, a red flashing light displayed and the Wabtec staff must be in radio contact with the Tarmac PIC.

⁴ The RAIB understands that the term 'vibt road' refers to the dedicated Wabtec maintenance siding (shown as 'WAB1' in figure 2).

- 91 Tarmac produced a safe system of work document for each of its sites, based on risk assessment. Tarmac's risk assessment procedure is 'Safety and Health Standard 01' dated September 2015. This stated:
- 'Local management shall follow procedures for identifying Hazards and carrying out and recording Risk Assessments for activities that have significant potential to cause injury, ill health or damage to the environment. Management must ensure that the risk assessment and risk rating process is carried out by competent people, individually or in a team, using a methodology consistent with the Example Local Procedure. A Safe System of Work shall be written where the Hazard Identification & Risk Assessment process has determined that:*
- *controls cannot eliminate or reduce the risks to a low level*
 - *the task is non-routine or complex and has to be done in a specific order*
 - *a Permit to Work is required'*
- 92 The joint method of work stated that it controlled the risks identified in risk assessment RARH 017. The latest version of this was dated 8 December 2015.
- 93 There is no hazard listed in RARH 017 for a part of a wagon (eg an unloading boom) moving out of control. The site rules therefore did not recognise the possibility of uncontrolled movement of the unloading boom.
- 94 Tarmac's risk assessment RARH 017 listed 18 hazards, only two of which were noted as having any effect on people other than workers at the site. These both mentioned noise nuisance to nearby residents. The hazards did not mention risk to other railway operations.
- 95 The Wabtec staff working in the sidings on 14 February 2016, fitter 1 and fitter 2, had complied with the joint method of work in that they had received a briefing in the control room before starting work and had a radio (though it was carried by fitter 2, who was not on site at the time of the collision). However, the radio would not have been of use to fitter 1 as the control room was unmanned at the time of the accident (the only other people on site were GS1 and the locomotive driver who were in the sidings).
- 96 When the RAIB arrived at the site, there was a 'do not pull' sign on the points lever leading to siding 1 and a stop board was in place on that siding, but there was no red flashing light. However, the lack of this light was not a factor in the accident.

Wabtec's systems of work

- 97 Wabtec's system of work is contained in its Fleetcare document 008 'Safe Systems of work – For Wabtec Rail Personnel At Tarmac'. The version current at the time of the accident was dated 20 January 2016 and marked for next review on 20 January 2017.
- 98 Fleetcare document 008 stated that the Wabtec person in charge must ensure on-going compliance with the site procedures and Wabtec's health and safety policies. The 'person in charge' was defined as the most senior Wabtec employee on site at the time. On the day of the accident this was fitter 1.

- 99 The document had a heading 'WAB1 Road' which started by describing the procedure for work in the dedicated Wabtec maintenance siding (WAB 1, indicated in figure 2). It then went on to mention 'pre loading' inspections and said these:
- 'can take place on any available line in the sidings if repairs are needed the Wabtec competent person must contact the loading cabin to report the defect'.*
- It also stated:
- 'when carrying out pre-departure brake tests on either No1 or No2 lines the competent person must be in full radio contact with the Tarmac loading cabin, if any repairs are needed to be carried out the Wabtec competent person must contact the loading cabin and report the defect, ...'*
- 100 The pre-departure inspection on the day of the accident took place on siding 1 and the Wabtec competent person (fitter 1) was briefed by the Tarmac PIC prior to starting the inspection. However, fitter 1 did not report that he intended to repair the fault with the slewing system to the Tarmac PIC or to the Wabtec site supervisor⁵. Although it is possible that the Tarmac PIC may have considered the risks associated with slewing the boom and prevented the work being undertaken on siding 1, the RAIB considers it unlikely that this deficiency contributed to the accident because there was nothing in Tarmac's joint method of work that would have given the PIC any reason to tell the fitters not to proceed with the work.
- 101 After the two fitters had split up, fitter 1 did not have a radio. The RAIB does not consider that this was relevant to the accident as the radio goes through to the control room, which was unmanned at the time of the accident, so he could not have used it to raise the alarm.
- 102 Fitter 1 was working on the wagon on his own at the time of the accident. Wabtec has a lone working procedure, but told the RAIB that this is applicable to sites where the Wabtec person is the only person there, which was not the case at Barrow Railhead, as there were also two Tarmac staff working in the sidings at the time.
- 103 In addition to the Fleetcare document 008, Wabtec also had a set of 'safe systems of work' for various defined maintenance tasks. These were based on risk assessments. The Wabtec procedure for hazard identification and risk assessment is its 'H&S procedure Hazard identification & risk assessment HSP-5 issue 4 24/5/12'. The Wabtec risk assessments seen by the RAIB covered the risk to Wabtec staff and to others engaged in the work; there did not appear to be any consideration of the risk to other railway operations.
- 104 The Wabtec 'safe systems of work' for some tasks stated that the work must not take place within 3 metres of an open line and, in the case of the 'safe system of work' for use of a mobile crane, it said that no part of the crane should come within 3 metres of an open line. However, no Wabtec documents seen by the RAIB included the risk of a part of a wagon being worked on becoming foul of a line open to traffic.

⁵ Wabtec's instructions for carrying out a pre-departure check were contained in its maintenance plan WMP008BM (paragraph 111) but at the time of the accident it also had a draft version (not yet approved or issued) of a 'safe work instruction' for pre-departure inspections. This required all rectification work found during the inspection to be reported to the Wabtec site supervisor. The Wabtec site supervisor was not on duty on the day of the accident and fitter 1 was the Wabtec person in charge at the time (paragraph 98).

- 105 Wabtec's site supervisor stated that there was an 'unwritten rule' that work on the slewing system of an unloading wagon was not to take place on siding 1. Tarmac has since stated that it had considered the reception siding, adjacent to siding 1, to be a running line and therefore work should not have been taking place within 3 metres of it. For this reason it has argued that carrying out maintenance activities on siding 1 was prohibited. The RAIB has found no evidence that the status of the reception line as a running line was documented, or that rules applicable to a running line were generally applied on this line.
- 106 No other witnesses have stated that they were aware of a rule prohibiting maintenance activities on siding 1 and it was not part of any Wabtec or Tarmac procedure seen by the RAIB. The appropriate place for a rule such as this would be in Wabtec's Fleetcare document 008. This was reviewed annually by Wabtec's site manager but the site supervisor had not suggested to the site manager that this 'unwritten rule' be recorded in it.

Identification of underlying factors

Management of wagon REDA92545

- 107 **Wabtec did not exercise adequate control over the maintenance of the electrical system on wagon REDA92545.**
- 108 The enclosures protecting the electrical components of the wagon had deteriorated in the environment they were exposed to. The stone which the wagons delivered from Mountsorrel quarry was granite. This is an acid rock and may have accelerated corrosion of the steel covers to the electrical enclosures. In cases where the lids of the enclosures had not been perforated by corrosion, the seals which were intended to prevent moisture ingress were damaged or missing (figure 15). The maintenance that had been carried out on the electrical system was limited to fixing faults by like-for-like replacement of failed components. The sealing of the enclosures had not been maintained.
- 109 The following paragraphs describe the specific issues with the control of maintenance of this wagon highlighted by this investigation.
- 110 Tarmac appointed Wabtec to be the ECM from 1 May 2013. Wabtec had maintained the wagons since 1998 but no records from the previous maintainer had been transferred. Wabtec had minimal technical documents and drawings describing the unloading wagon.
- 111 Wabtec's maintenance procedure for the unloading wagons was maintenance plan WMP008/BM 'A Balanced Maintenance Strategy for Lafarge Aggregate Bogied Transfer Vehicles'. This had sections for each type of maintenance intervention (eg pre-departure check, Vehicle Inspection and Brake Test (VIBT)). Within each of these sections the inspection and maintenance work required was listed under broad headings of parts of the wagon, such as underframes, wheels and axles and bogies. There were no maintenance requirements relating to the electrical systems on the wagons. The section dealing with pre-departure checks listed the tasks to be performed and stated '*Where possible lift, lower and slew the boom conveyor on the discharge cars*'. It did not state whether the transit lock should be removed for this test.

- 112 The competence management system which Wabtec used for its Fleetcare staff did not have a competency for electrical system maintenance (it is uncommon for a wagon to have an electrical system).
- 113 The ECM regulations (paragraph 51) require an ECM, as part of its management function, to monitor the performance of its vehicles. The first item in the list of requirements is:
- 'The organisation must have a procedure to regularly collect, monitor and analyse relevant safety data, including:*
- (a) *the performance of relevant processes;*
 - (b) *the results of processes (including all contracted services and products);*
 - (c) *the effectiveness of risk control arrangements;*
 - (d) *information on experience, malfunctions, defects and repairs arising from day-to-day operation and maintenance.'*
- 114 Wabtec had monitored the faults with the electrical system on the unloading wagons that had been reported by the operators, but considered that these problems only affected reliability, and not safety (paragraph 87).
- 115 In January 2014 Wabtec recommended to Tarmac that the entire electrical system needed to be replaced (paragraph 83). However, Wabtec did not take any actions to mitigate the safety risk as a result of the degraded condition of the electrical system pending its replacement, other than to continue to monitor electrical failures.
- 116 Network Rail's SPA management group (paragraph 57) had carried out site and vehicle audits on the SDT fleet maintained by Wabtec at Barrow Railhead. The most recent audit was carried out on a sample of the wagons on 19 January 2016. The audit scope included '*view vehicles to establish that maintenance work is being undertaken in accordance with the approved vehicle maintenance plans*'. The audit team only examined the hopper wagons, as the only unloading wagon on site at the time was in a position deemed to be unsafe for examination. Its report concluded that '*...Wabtec operate with staff who have been assessed as competent for undertaking wagon maintenance work...*', and that the site should remain registered with the Network Rail SPA management group as a maintenance site. The audit report dealt with most parts of the wagons but did not mention the electrical system or its condition. As the audit scope was led by the vehicle maintenance plans, and these plans did not include the electrical system (paragraph 111), the audit did not identify the poor condition of the electrical system.

117 Tarmac did not ensure that the safety risk from the condition of the electrical system on wagon REDA92545 was adequately managed.

118 In January 2014 Wabtec recommended to Tarmac that the entire electrical system needed to be replaced (paragraph 83). However, even though Tarmac was the registration holder and ORR guidance states that the registration holder has to ensure corrective action is taken by the ECM (paragraph 56), it did not ensure that this was done. Neither did Tarmac take any actions to mitigate the safety risk during normal operation of the wagons (paragraph 119) as a result of the degraded condition of the electrical system pending its replacement, apart from discussing the failure trends at regular meetings with Wabtec. Tarmac told the RAIB that it took no action because it had not been made aware that the condition of the electrical system posed a safety risk.

Observations

SDT unloading sites

119 The risk of the boom of an unloading wagon moving out of control was not recognised in the risk assessments for its use at unloading points.

120 Barrow Railhead is a loading site, however the SDT ran to various unloading sites around the UK. Some of these were adjacent to running lines, but most sites are far enough away for the boom not to be able to reach the running line. However, at two sites, Stevenage and Banbury, movement of the boom to the wrong side could obstruct adjacent running lines. At both sites one line could be completely obstructed and another partly obstructed (this accident involved partial obstruction).

121 Tarmac had carried out risk assessments for these unloading sites and prepared a 'safe system of work' for each site. The hazards included in the risk assessments did not include uncontrolled movement of the boom as a potential hazard. Tarmac stated that this was because it was not a credible event. These are additional examples of Tarmac's risk assessments not considering risks to other railway operations (paragraph 94).

Emergency stop function on wagon REDA92545

122 The emergency stop system on unloading wagon REDA92545 was not functional.

123 Conveyor belts are required to have an emergency stop within reach of someone who might become trapped in the moving conveyor. Since 1992 this has been required by regulation 16 of the Provision and Use of Work Equipment Regulations (PUWER) 1992 and 1998. When the wagon was built, the original system consisted of a pull wire emergency stop mounted adjacent to the conveyor. By August 1998 this had been changed to a system with two emergency stop push buttons, one on each side of the wagon, mounted adjacent to the slew control panels.

124 When tested by the RAIB after the accident, the push button on the side furthest from the main line was jammed with stone dust and could not be operated. The stop button on the main line side of the wagon was free to operate but did not stop the conveyor belt or the engine, as it was intended to do. The control circuit for the emergency stop buttons was traced and tested. It was found to contain an additional feed wire (figure 17). This wire supplied 12V from the battery to a point in the circuit which should have been capable of being de-energised by the push buttons. This false feed prevented the push buttons from having any effect.

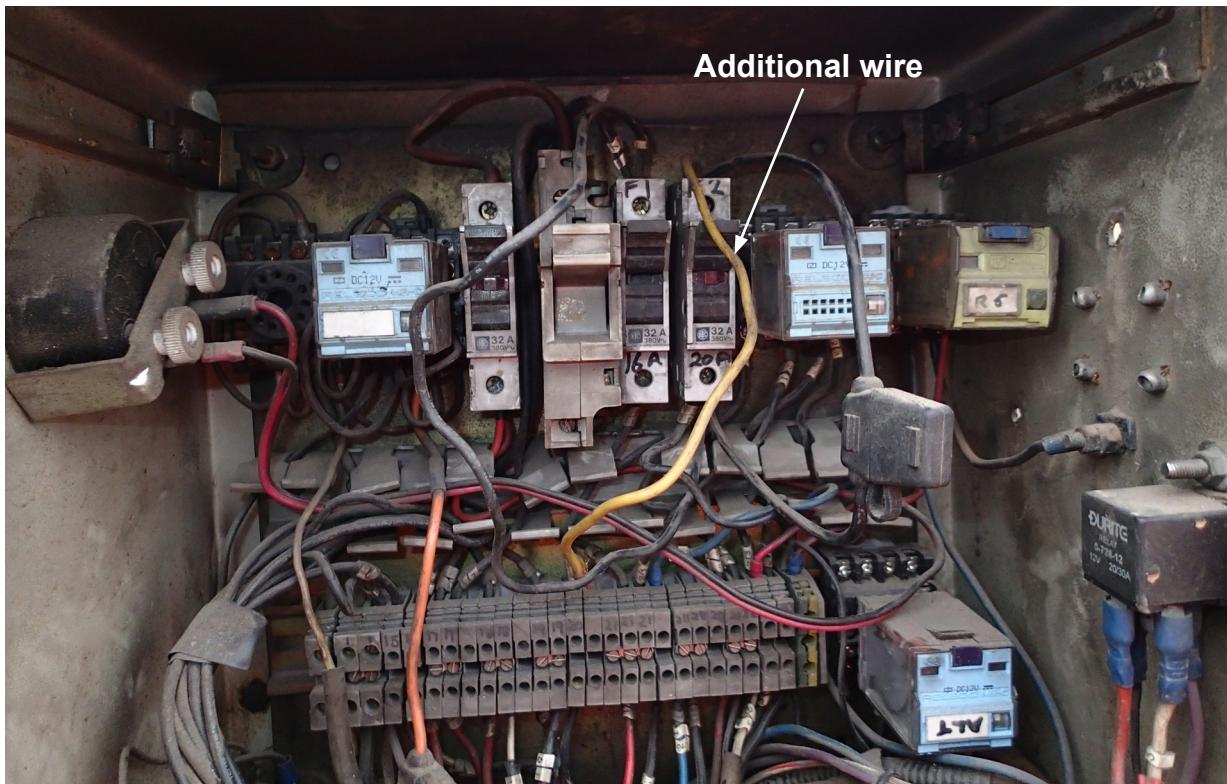


Figure 17: Interior of engine control panel enclosure

125 The report which Wabtec's consultant had written in 2012 (paragraph 81) had warned that this was a possibility and stated:

'No documentation exists for the existing electrical system and therefore fault finding is difficult resulting in long diagnosis times or the temptation to false feed the system.'

Wabtec and Tarmac stated that they were not aware of when or why this wire was fitted.

- 126 The emergency stop system should be checked as part of the pre-departure and traffic inspections. The RAIB obtained the check sheets for the last five inspections. These were all pre-departure inspections and were done on 25 January, 29 January, 31 January, 4 February and 6 February 2016. All of the check sheets had the emergency stop check box ticked to show that no fault was present. Four of these inspections were carried out by fitter 1. This indicates that either the wire was added between the last check on 6 February and the accident on 14 February, or the check boxes had been ticked without the test being done. Witness evidence was that the checklist was not used during pre-departure inspections, but filled in in the cabin afterwards. This gives rise to the possibility of checks having been overlooked and the inoperative emergency stop button not being detected.
- 127 The lack of an operational emergency stop had not been detected by Wabtec or Tarmac. It is likely that it had not been tested by Wabtec during the pre-departure or traffic inspections as the circuit was false fed so that even if the circuit through the buttons was interrupted, the engine would continue to run. Furthermore, the stop button on one side of the wagon appeared to have not been operated for some time as it was jammed with stone dust.
- 128 Fitter 1 stated that he did not attempt to use the emergency stop button on the day of the accident as he wanted to move the boom back, not to stop it. However, the emergency button, if it had worked and been promptly pressed, could have prevented the boom moving outwards, as it would have stopped the engine.
- 129 Wabtec's system of supervision of its maintenance staff at Barrow Railhead had not noticed that checks were not being done using the check sheet. This shortcoming reinforces the underlying factor concerning inadequate control of maintenance (paragraph 107).

Summary of conclusions

Immediate cause

130 The unloading conveyor boom was in a position where it obstructed the path of a train on the down main line as it approached (paragraph 60).

Causal factors and underlying factors

131 The causal factors were:

- a. The normally open switch contact block on the button which commands the boom to move out on the main line side had stuck in the on position (paragraph 64, **Recommendation 4**). This causal factor probably arose because:
 - i. the moving part of the normally open switch contact block had become coated with corrosion product (paragraph 69);
which in turn was most likely caused because;
 - ii. the switch was used in environmental conditions that it was not rated to withstand (paragraph 76, **Learning points 1 and 2**).
- b. Maintenance work was being undertaken on the unloading wagon on a siding which was within boom reach of the main line (paragraph 88, **Recommendation 2**). This causal factor arose because neither the site rules nor the systems of work for staff had addressed the risk of an uncontrolled movement of the unloading boom (paragraph 89, **Recommendation 1**).

The supporting risk assessments were focussed on direct risks to staff and there was no consideration of the risk to other railway operations.

Underlying factors

132 The underlying factors were:

- a. Wabtec did not have adequate control of the maintenance of wagon REDA92545 such as to manage the risks the condition of the electrical system on the wagon presented (paragraph 107, **Recommendations 2 & 4, Learning points 1 and 2**).
- b. Tarmac did not ensure that the safety risk from the condition of the electrical system on wagon REDA92545 was adequately managed (paragraph 117, **Recommendations 1 and 3**).

Additional observations

133 Although not linked to the accident on 14 Feb 2016, the RAIB observes that:

- a. The risk of the boom of an unloading wagon moving out of control was not recognised in Tarmac's risk assessments for its use at unloading points (paragraph 119, **Recommendation 1**).
- b. The emergency stop system on unloading wagon REDA92545 was not functional at the time of the accident and possibly for a considerable time beforehand (paragraph 122, **Recommendation 4, Learning point 2**).

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

134 Following the accident, Tarmac removed all the SDT wagons from service and placed them in store.

Recommendations and learning points

Recommendations

135 The following recommendations are made⁶:

- 1 *The intent of this recommendation is that Tarmac and Wabtec take steps to address the risk that the use and maintenance of rail vehicles poses to passing trains, not just directly to staff.*

Tarmac and Wabtec should review and improve their processes for hazard identification and risk assessment to ensure that they encompass consideration of the risk that their rail operations, including maintenance activities, might pose to other railway operations (paragraphs 131b, 132b and 133a).

- 2 *The intent of this recommendation is to ensure that Wabtec's management of maintenance and inspection is effective.*

Wabtec should review its management arrangements at Barrow Railhead to ensure that the maintenance and inspection procedures are clearly defined, understood and correctly executed. This should include definition of the areas of the site where the type of work is prohibited or permitted (paragraphs 131b and 132a).

This may also apply to other Wabtec maintenance sites.

- 3 *The intent of this recommendation is for Tarmac to prevent continued operation of rail wagons it owns with known defects, without introducing measures to mitigate the associated risks.*

Tarmac should review its management processes, and their implementation, to identify why no action was taken to manage the risk from continued operation of the unloading wagons after it had been informed of the unacceptable condition of the electrical system. It should introduce any necessary changes to prevent a similar occurrence (paragraph 132b).

continued

⁶ Those identified in the recommendations have a general and ongoing obligation to comply with health and safety legislation, and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail and Road (ORR) to enable it to carry out its duties under regulation 12(2) to:

- (a) ensure that recommendations are duly considered and where appropriate acted upon; and
- (b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

The RAIB has also advised the Health & Safety Executive of Recommendations 1 and 3 in order that it can provide assistance as required by the ORR in carrying out its duties under regulation 12(2) of the Railways (Accident Investigation and Reporting) Regulations 2005.

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on RAIB's website www.gov.uk/raib.

- 4 *The intent of this recommendation is to ensure that the electrical system deficiencies are addressed before any of the SDT fleet re-enters service.*

Before any re-entry to service, the registered keeper of the SDT vehicles should ensure that the condition of the electrical system is restored to be safe to operate in the environment in which it is to be used (paragraphs 131a, 132a and 133b).

Learning points

137 The following learning points⁷ have been identified:

- 1 The ECM Regulation places many obligations on Entities in Charge of Maintenance that are essential to the safe operation of trains. It is therefore important for every organisation that is a certified ECM to fully recognise the importance of its role and its legal obligation to maintain a vehicle in a safe condition.
- 2 Specific learning relevant to ECMs also includes:
 - a the need for ECMs to have a procedure to manage the removal of vehicles from operation when either individual defects, or a series of defects, have been identified that make the vehicle so unreliable that it might be unsafe (as per Annex III of the European Commission Regulation 445/2011 and ORR guidance);
 - b the importance of ECMs having full and accurate records of the assets they are responsible for;
 - c the need for ECMs' maintenance procedures to encompass all of the systems fitted to their vehicles, including electrical systems;
 - d the importance of ECMs maintaining equipment such that electrical components are not exposed to dust and moisture conditions for which they are not rated.
- 3 The findings of this investigation also reinforce the importance of a vehicle registration holder working with the ECM to ensure that technical problems are dealt with promptly, as recommended in ORR and ERA guidance (Railway Guidance Document RGD-2012-01, available at www.orr.gov.uk).

⁷ 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when the RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where the RAIB has not identified management issues that justify a recommendation) and the consequences of failing to do so. They also record good practice and actions already taken by industry bodies that may have a wider application.

Appendices

Appendix A - Glossary of abbreviations and acronyms

ECM	Entity in Charge of Maintenance
EMCC	East Midlands Control Centre
EMT	East Midlands Trains
ERA	European Rail Agency (now called the European Union Agency for Rail)
ESPA	ECM Service Provision Agreement
FFCCTV	Forward-facing closed circuit television
GSM-R	Global System for Mobiles – Rail
ORR	Office of Rail and Road
PIC	Person in Charge
PUWER	Provision and Use of Work Equipment Regulations 1998
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006
SDT	Self discharge train
VIBT	Vehicle Inspection and Brake Test

Appendix B - Glossary of terms

Diesel electric multiple unit	A train made up of vehicles powered by diesel engine with an electric transmission.
Fitter	A person who maintains mechanical equipment.
Groundstaff	A member of staff who is responsible for moving wagons in sidings and coupling and uncoupling them.
JNA	A type of wagon for conveying aggregate.
Normally open (or closed)	A type of electrical switch which has its contacts open (or closed) in the at-rest position. The contacts change state when the switch is operated.
Operating arm (of a switch)	The part of an electrical switch which is moved to operate the switch.
Protection	The system whereby trains are prevented from encroaching on a site where work on a wagon is taking place.
Sectional appendix	A Network Rail operational document that gives information specific to particular locations on its network.
Solenoid valve	A type of hydraulic valve which uses an electrical current to control the flow of the hydraulic fluid.
Workstation	A computer terminal used by a signaller to control part of the rail network.

Appendix C - Investigation details

The RAIB used the following sources of evidence in this investigation:

- photographs taken by the RAIB and by Network Rail;
- FFCCTV from passing trains;
- post-incident testing of a similar wagon and of the incident wagon;
- Tarmac and Wabtec documents;
- drawings and records relating to the wagon;
- published material on the wagon and information from its chief designer;
- witness interviews;
- meetings with industry parties;
- published photographs of the incident wagon;
- examination of the switch; and
- a review of previous RAIB investigations that had relevance to this accident.

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