RAIB
Rail Accident Investigation Branch

Rail Accident Report

Collision between a passenger train and a hand trolley at Challow, Oxfordshire 21 October 2021

Report 11/2022
October 2022

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC
- the Railways and Transport Safety Act 2003
- 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.

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 RAIB has described a factor as being linked to cause and the term is unqualified, this means that RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident or incident that is being investigated. However, where RAIB is less confident about the existence of a factor, or its role in the causation of the accident or incident, RAIB will qualify its findings by use of words such as 'probable' or 'possible', as appropriate. Where there is more than one potential explanation 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 or incident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, words such as '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 accident or incident 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 RAIB, expressed with the sole purpose of improving railway safety.

Any information about casualties is based on figures provided to RAIB from various sources. Considerations of personal privacy may mean that not all of the actual effects of the event are recorded in the report. RAIB recognises that sudden unexpected events can have both short- and long-term consequences for the physical and/or mental health of people who were involved, both directly and indirectly, in what happened.

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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Collision between a passenger train and a hand trolley at Challow, Oxfordshire, 21 October 2021

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Summary

At 06:09 hrs on 21 October 2021, a passenger train travelling at 123 mph (198 km/h) struck a hand trolley on the track near Challow, Oxfordshire. The train was the first to pass through the area after the completion of overnight maintenance work. There were no injuries among the passengers or crew on board and the train did not derail. The hand trolley was destroyed by the impact and debris from it caused damage to equipment under the train. The collision also resulted in minor damage to the track.

A maintenance team had carried out overnight work at Challow and no one noticed the team had left its hand trolley on the track. The checks undertaken before handing back the railway for normal operation also had not identified the hand trolley's presence. A process which formed part of these checks was the line clear verification process. It was used to monitor what vehicles, including hand trolleys, were placed on and taken off the track during the overnight work. However, there were weaknesses within this process, and these were compounded by the maintenance team not following the process as it was required to on the night concerned.

Underlying factors related to the weaknesses within the line clear verification process were:

- It was reliant on human actions for its successful implementation, which the rail industry had recognised, but not yet implemented any measures to avoid or mitigate errors.
- It was separate to the work planning process as defined by Network Rail's company standards. This was a possible underlying factor.
- Network Rail's assurance activities had not detected that staff in the Swindon delivery unit welding and grinding section were not complying with the line clear verification process. This was a possible underlying factor.

A further probable underlying factor was that hand trolleys were being routinely used at night without displaying any red lights and that no assurance activities were taking place within work sites to monitor compliance to this requirement.

RAIB observed that after the accident, the train was allowed to travel at a speed above that which should have been permitted given the level of damage it had sustained. RAIB also observed that there were multiple issues with how the work at Challow was planned by Network Rail.

RAIB has made five recommendations to Network Rail. The first is to establish how the existing line clear verification process can be improved while the second is to consider what technology could be used by its staff to support the process. The third recommendation is to propose an amendment to the Rule Book so that hand trolleys are required to display an illuminated red light in both directions at all times when on the track. The fourth is for Network Rail to have processes in place to ensure that any hand trolley placed on its track has illuminated red lights displayed in both directions. The fifth recommendation is to review the effectiveness of its safety assurance activities which check that hand trolleys are being used correctly and safely.

RAIB also identified three learning points. The first reminds maintenance staff about the importance of complying with all rules and standards concerning how trolleys and rail skates should be used on Network Rail's infrastructure. The second highlights the importance of clear communication between the staff at a train involved in an accident and those based in control rooms to establish what damage has been sustained by a train, so that the appropriate controls can be put in place before the train is permitted to move. The third is that staff involved in planning maintenance work produce documents that are accurate, appropriate and specific for the task that is being carried out, and involve those responsible for the work in the planning of it.

Introduction

Definitions

1 Metric units are used in this report, except when it is normal railway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.

2 The report contains abbreviations which are explained in appendix A. Sources of evidence used in the investigation are listed in appendix B.

The accident

Summary of the accident

3 At 06:09 hrs on 21 October 2021, a passenger train travelling at 123 mph (198 km/h) struck a hand trolley on the track near Challow, Oxfordshire (figure 1). A maintenance team had left the hand trolley on the track after using it the previous night to transport equipment in a work site[1] within a possession.[2] The train was the first to pass through the area after the work site and possession were handed back so that service trains could start running again.

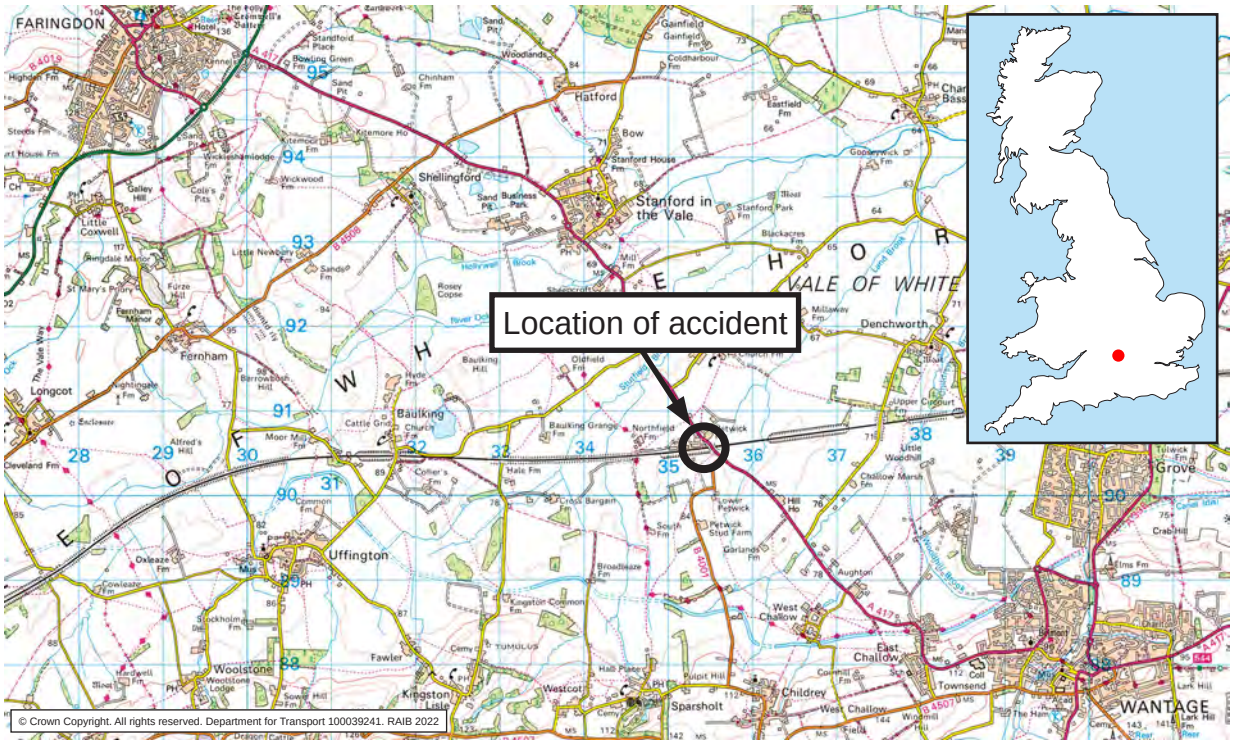

Figure 1: Extract from Ordnance Survey map showing location of accident

4 The train came to a stop about 1.0 mile (1.6 km) beyond the point of collision (figure 2). There were no injuries among the passengers or crew on board and the train did not derail. The hand trolley was destroyed by the impact. Its handle became wedged under the leading bogie of the train (figure 2) and debris from the trolley caused damage to equipment under the train. The collision also resulted in minor damage to the track.

5 Staff from Network Rail and Hitachi Rail went to the train to assess the damage to it and to remove the debris from under it. At 08:53 hrs, the train departed and continued westwards as far as Swindon where the service was terminated. The train then ran eastwards empty to North Pole depot in London.

[1] A portion of line within a possession where work will take place and usually has a work site marker board at each end to denote its limits.

[2] A period of time that a section of railway line is blocked to service trains so that engineering work, such as maintenance, repair or renewal activities, can be safely carried out.

Figure 2: The train once stopped and the handle from the hand trolley wedged under it (courtesy of Network Rail)

Context

Location

6 The accident happened between Didcot Parkway and Swindon on straight and level track at the site of the former station at Challow, at about 63 miles 69 chains[3] from a zero reference at London Paddington (figure 3). Challow is on the Great Western main line, which is part of Network Rail's Western route[4] within its Wales and Western region.[5] At Challow, the railway comprises four tracks (figure 4). The hand trolley was struck on the down main line which has a permissible speed of 125 mph (201 km/h).

7 Challow is an authorised access point and is used by railway staff to gain access to the railway. It is also a designated road-rail access point (often referred to as a RRAP), where adapted vehicles that can run on either a road or railway (road-rail vehicles (RRVs)), can transfer from one to the other. It comprises large rubber panels, like those found at some level crossings, to provide a level surface for vehicles to drive onto (figure 5). The hand trolley involved in this accident was on the track at the road-rail access point.

8 Signalling in the Challow area, which is controlled by signallers in the Thames Valley Signalling Centre (TVSC) at Didcot, determines whether trains are in each track section using axle counters.[6] The railway at this location is electrified with 25kV AC overhead line equipment.

[3] A unit of length equal to 66 feet or 22 yards (around 20 metres).

[4] Part of Network Rail's organisation which manages, operates and maintains the railway from London Paddington to Penzance, through Bristol, and up to the boundaries with Wales, the Cotswolds and Hampshire.

[5] Part of Network Rail's organisation which supports two of its routes: Wales and Western.

[6] A system that determines if a train is in a section of track by counting the individual axles of a train in at one end and out at the other end.

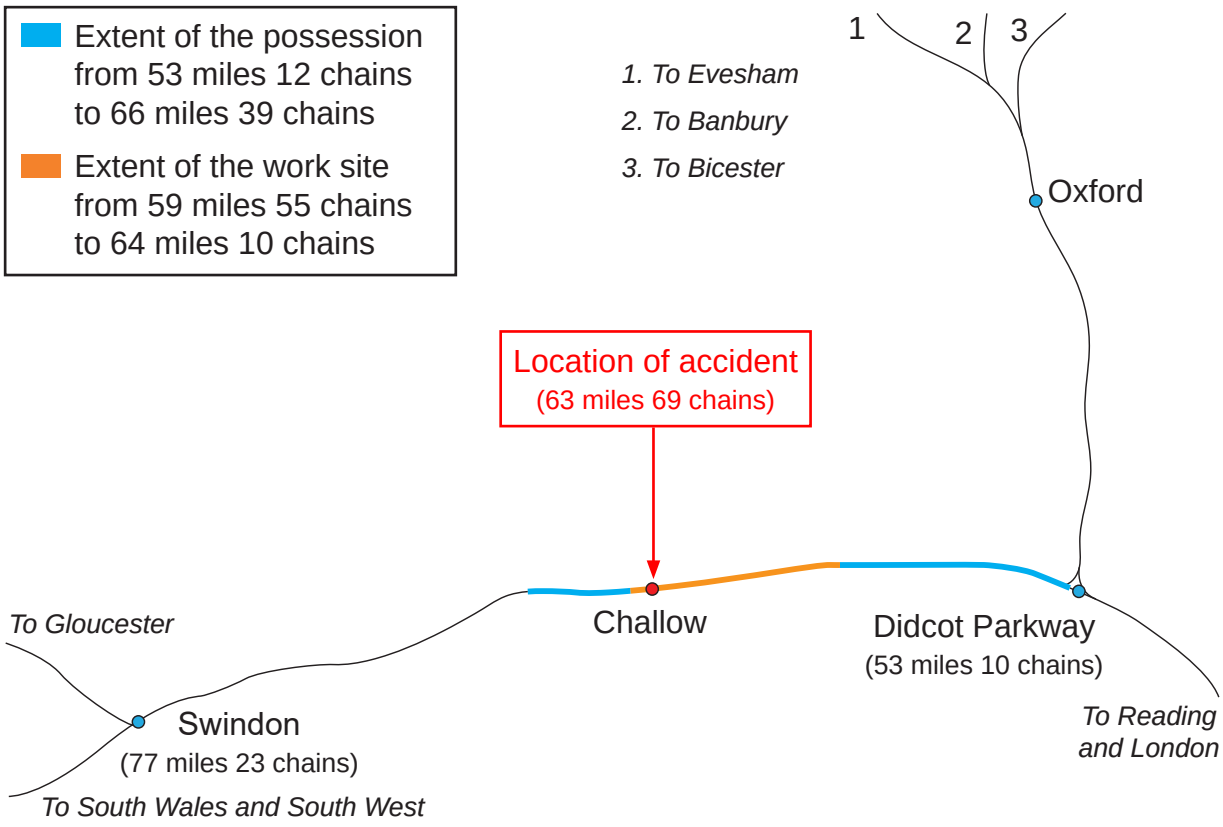

Figure 3: Location of Challow

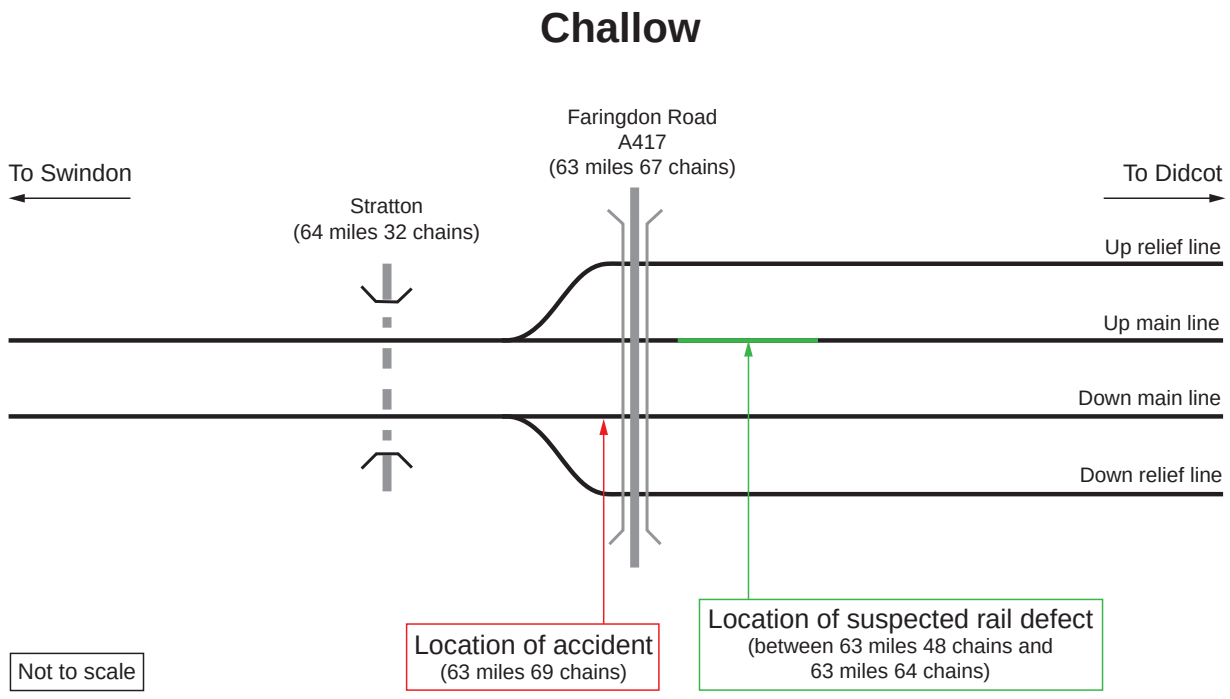

Figure 4: Track layout at Challow

Figure 5: The road-rail access point at Challow

Organisations involved

9 Network Rail is the owner and maintainer of the infrastructure at Challow. It is the employer of the maintenance staff who had used the hand trolley and was also the owner of the hand trolley.

10 Great Western Railway was the operator of the train and is the employer of the train driver. Hitachi Rail is the maintainer of the train and the employer of the staff who determined what restrictions needed to be applied to the damaged train before it could continue its journey to Swindon.

11 Network Rail, Great Western Railway and Hitachi Rail all freely co-operated with the investigation.

Train involved

12 The train involved in the accident, reporting number 1C00, was the 05:23 hrs service from London Paddington to Swansea. It comprised a nine-car, class 800 bi-mode[7] multiple unit, number 800301.

Rail equipment involved

13 The hand trolley that was struck was a Permaquip link trolley (figure 6). This type of hand trolley has a wooden deck on top of a metal frame that is painted yellow. Its wheels are electrically conductive and are braked. The brakes are controlled by a detachable brake handle that slots into the trolley. The trolley was 1.68 metres wide, 0.75 metres long and its deck sits 0.22 metres above the head of the rails. Such trolleys weigh about 48 kilograms and can carry a uniformly distributed load of up to 1000 kilograms.

Figure 6: The type of hand trolley struck by train 1C00 (courtesy of Network Rail)

[7] A train that can operate as an electric multiple unit in areas where the railway is electrified with 25kV AC overhead line equipment, or can operate as a diesel-electric multiple unit, with its power provided by diesel generator units that are fitted to it.

Staff involved

14 The maintenance team that had left the hand trolley on the track comprised a controller of site safety[8] (COSS) and a welder, who were both members of the welding and grinding section within the Swindon track maintenance delivery unit. Both were based at the maintenance depot at Didcot and had worked alongside each other on many occasions. The COSS had just under 18 years' experience working for Network Rail and had been in the technician[9] grade since 2011. He had held the COSS competency since 2016 and had not been involved in any previous safety incidents or accidents. The welder, who was also the person in charge[10] (PIC) for the work, had 16 years' experience working for Network Rail and had been in the technician grade since 2012. He had held the COSS competency since 2007 and had also not been involved in any previous safety incidents or accidents.

15 An engineering supervisor was responsible for managing the safe execution of the works taking place within the work site. This included the arrangements for setting up and handing back the work site, managing access to the work site by each COSS working within it, and authorising the use of any vehicles, which included hand trolleys, within the work site. The engineering supervisor carried out these activities from an access point at Wantage Road, which was at the eastern end of the work site (figure 3). He had just under five years' experience working for Network Rail and had been a team leader since 2020. He was a member of the track maintenance section based at Swindon maintenance depot. His engineering supervisor competency was last assessed in May 2021, and he had not been involved in any previous safety incidents or accidents.

16 The driver of train 1C00 had 19 years' experience of driving trains and was based at London Paddington. No issues were identified with the driver's actions.

17 The technical riding inspector who went to assess the damage to train 1C00 had been in his current role with Hitachi Rail since 2017. He had moved to Hitachi Rail from Great Western Railway when the class 800 and 802 train fleets had entered service. He was based at Bristol, but the role required him to be mobile to respond to failures, incidents and accidents involving these trains.

18 The maintenance controller who managed Hitachi Rail's response to this accident had been in this role for four years. He was based in the control room at Swindon, working alongside Network Rail and Great Western Railway staff.

External circumstances

19 It was dark when the maintenance team left the hand trolley on the track at the road-rail access point. There was no site lighting at the access point, or any environmental light sources from nearby buildings and roads, to illuminate the road-rail access point.

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[8] Defined by Network Rail as a person who is certified as competent to enable activities to be carried out by a group of persons on Network Rail infrastructure in accordance with the requirements of the Rule Book.

[9] Responsible for inspecting the rails (both visually and using measuring equipment) for signs of damage or deterioration, testing the rails, prioritising work and organising appropriate materials, equipment and staff to be onsite, and finding faults and repairing them using techniques such as welding or grinding.

[10] Defined by Network Rail as a person involved in the planning and who is on site where the work is being undertaken and has the overall accountability of supervising and overseeing works. This person will normally be the team leader (or equivalent) and hold the COSS competency to make sure planned controls are put in place to keep persons safe from trains, activity and site risks.

20 Witness accounts and data from local weather stations[11] showed that it was raining when the maintenance team started work at about 22:30 hrs on 20 October but had stopped by about 01:00 hrs on 21 October. The weather stations reported that, while the maintenance team were working at Challow, the air temperature in the area fell from about 9.5°C (at 23:30 hrs on 20 October) to 7.5°C (at 03:45 hrs on 21 October).

[11] Data was obtained from four local weather stations that were located between 2.0 miles (3.2 km) and 2.7 miles (4.3 km) away.

The sequence of events

Events preceding the accident

21 On 26 February 2021, a Network Rail ultrasonic test train[12] recorded a suspected rail defect on the up main line near to Challow, located between 63 miles 48 chains and 63 miles 64 chains (a length of around 320 metres). After the recorded data was downloaded and checked, Network Rail staff went to site on 7 March and tested the suspected defect. This testing confirmed it was a genuine defect, which required repair within 26 weeks. The rail defect was recorded on Network Rail's system for managing track defects and fell within the remit of the local welding and grinding section to repair by 26 September 2021. This deadline was later extended to 3 November 2021 after the welding and grinding section obtained a temporary dispensation, as it was unable to repair the defect within the required timeframe.

22 To facilitate access to the railway to carry out maintenance activities, Network Rail has agreements in place with train operators to set up pre-planned cyclical possessions. A supervisor for the welding and grinding section identified that the repair could be carried out in a cyclical overnight possession that was planned for 20 to 21 October, when no trains would be running between Didcot Parkway and Swindon. The possession included two work sites, one of which was between Wantage Road and Challow (figure 3). The repair was planned to take place in this work site and documents relating to the possession and work site, which were published in the weeks before the repair was scheduled, showed that a maintenance team would be carrying out welding and grinding work.

23 On 14 October, the supervisor for the welding and grinding section prepared and authorised a safe work pack[13] for the repair work planned for the night of 20 to 21 October. On the same day, the welder who was allocated to be the PIC for the work verified the safe work pack. It is often the case that the PIC will also be the COSS for the work being undertaken. However, in this case, the supervisor decided to allocate the COSS duties to the other team member. This was because it was the first time that the welder had carried out this type of repair, so the supervisor thought the welder's workload would be too great if he was to act as both PIC and COSS, and carry out the repair work.

[12] A train equipped with ultrasonic rail flaw detection equipment. It is capable of scanning both rails at speeds up to 30 mph (48 km/h) with reliable results, although detailed analysis of each rail flaw still requires manual methods to verify the suspected rail defect.

[13] A pack of information used by a person in charge that provides the safety arrangements for work to be undertaken on site, including details of the safe system of work that is to be implemented by the COSS. The safe system of work is the method of working to be used by the COSS to keep those in their group, who are to walk or work on or near the line, safe from passing trains.

24 On 16 October, staff carrying out inspections in the Swindon area found two other rail defects that required the welding and grinding section to repair them within seven days. On 19 October, staff from the section repaired one of these rail defects. On 20 October, the supervisor was concerned that the repair of the remaining rail defect near Swindon was by now becoming urgent. As a result, that morning he decided to reallocate the COSS who was originally planned to work at Challow later that evening to go to Swindon to repair this defect instead, because they were one of the few people he had available who was competent to do that repair. After making this decision, he arranged for another member of staff to work at Challow that evening and be the COSS for the work. He emailed the welder and the (replacement) COSS to advise them they would now be working together that night. During the afternoon and early evening, the COSS and the welder saw the email from the supervisor informing them of the change of plan.

25 At about 22:30 hrs, both the welder and COSS for the work at Challow arrived at the depot at Didcot. The welder checked the team's van, which had both a rear and a side sliding door, to make sure it was loaded with all the equipment that was needed for the planned repair work. The COSS went into the depot office to collect the safe work pack and any other documents needed for the work. The COSS found the safe work pack but was unable to find a copy of the possession management pack, which provided details about the possession and work sites. However, he was able to obtain a copy of it from a track maintenance supervisor who was at the depot.

26 At about 23:00 hrs, both the welder and the COSS left the depot. The welder drove the team's van directly to the access point at Challow and the COSS drove his own car to an access point at Wantage Road. Here he met up with the engineering supervisor to receive a briefing and sign the paperwork for the activities in the work site. Afterwards, the COSS drove to Challow to join the welder, arriving at the access point at about 23:30 hrs.

27 At 00:41 hrs, the engineering supervisor obtained permission from the person in charge of the possession[14] (PICOP) to start setting up the work site. The engineering supervisor and his support staff placed marker boards at each end of the work site, which were at 59 miles 55 chains at Wantage Road and 64 miles 10 chains at Challow (figure 3). The work site included the road-rail access point at Challow. By 00:58 hrs, the work site was set up and the engineering supervisor called the COSS and gave him permission to start working in the work site. The engineering supervisor also authorised the COSS to place his hand trolley on the track.

[14] The person responsible for managing the possession, which includes liaising with the signaller to establish the protection for the possession and its removal at the end of the possession, managing access to the possession by engineering supervisors, and establishing work sites within the possession. Responsibilities also include liaising with the signaller for vehicle movements into and out of the possession; and controlling vehicle movements between the possession protection and work sites.

28 Shortly afterwards, at about 01:00 hrs, the welder reversed the van onto the road-rail access point (figure 7). The welder and the COSS then took their hand trolley out of the back of the van and placed it on the down main line and loaded equipment onto it. Once the trolley was loaded, the welder moved the van forward a short distance and left it parked near to the road-rail access point. The welder and the COSS then set off towards Didcot Parkway, with the COSS pushing the loaded hand trolley along the down main line, while the welder walked along the up main line (figure 4).

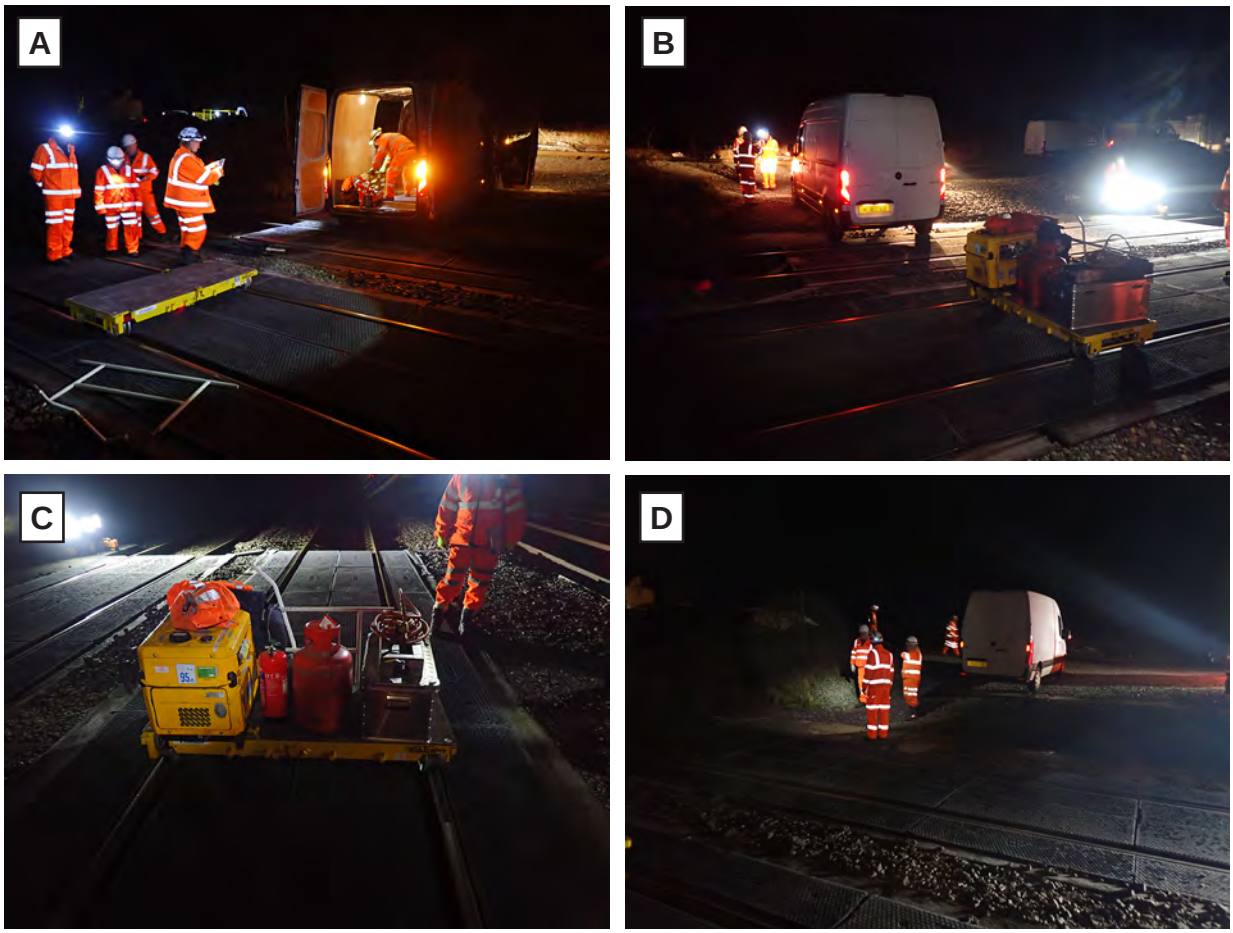

Figure 7: A reconstruction undertaken following the accident, showing the van reversing onto the road-rail access point to load equipment onto the hand trolley and then parked afterwards

29 At about 01:30 hrs, the welder and the COSS arrived at the location of the rail defect and began to carry out the repair. After they had completed the repair, they loaded their equipment back onto the hand trolley and headed back to the road-rail access point, arriving there at about 03:25 hrs. The welder went to unlock the van but could not find the van keys. He helped the COSS move the heavier items of equipment from the hand trolley to the side of the parked van, before setting off to look for the van keys, thinking he had dropped them. Meanwhile the COSS continued to unload the remaining items from the hand trolley and found the van keys in a pocket of a coat left on the trolley. He called out to the welder, who turned round and walked back to the van. The COSS walked back to the van with the last few items from the hand trolley. The COSS and the welder then loaded their equipment into the van, finishing by about 03:40 hrs.

30 At about the same time, one of the engineering supervisor's support staff arrived at Challow in readiness to remove the work site protection (marker boards) at that end of the work site. At 03:45 hrs, the COSS called the engineering supervisor and confirmed that all the team's work was complete and that they no longer needed the work site. Shortly afterwards, the engineering supervisor obtained permission from the PICOP to remove the work site protection. He called the member of support staff at Challow, who then collected the marker boards on his behalf. While this was taking place, the COSS and the welder left Challow in their vehicles.

31 At 03:56 hrs, once the marker boards had been removed at both ends of the work site, the engineering supervisor handed back the work site. At 04:00 hrs, he signed off documents for the work site to record that all work was complete, declaring that the section of line that had been covered by the work site was now clear and safe for trains to run on.

32 After work was completed in the second work site within the possession, at 04:40 hrs, the signallers at TVSC gave the PICOP permission to remove the protection at each end of the possession. Once this task was completed, the PICOP handed the possession back to the signallers at 05:01 hrs.

Events during the accident

33 At 05:23 hrs, train 1C00 departed on time from London Paddington station. It stopped at Reading and Didcot Parkway. After departing from Didcot Parkway at 06:02 hrs, the train accelerated to 123 mph (198 km/h) and was travelling at this speed as it approached Challow. At 06:09 hrs, as the train approached the road-rail access point, the driver noticed the hand trolley on the track ahead of him (figure 8) but had no time to react before the collision. Train 1C00 struck the hand trolley at 123 mph (198 km/h) and the driver immediately made an emergency brake application.

Figure 8: Still image from the forward-facing CCTV footage recorded by train 1C00 (courtesy of Great Western Railway)

Events following the accident

34 After coming to a stop, at 06:10 hrs, the train driver called the signaller at TVSC to report the accident. The signaller informed staff in the control room at Swindon and they mobilised a Network Rail mobile operations manager to go to Challow and a Hitachi Rail technical riding inspector to go to the train. At 06:30 hrs, after arranging protection with the signaller, the driver examined the outside of train 1C00. He reported back that there was damage to equipment underneath the train. He also reported that there were parts of the hand trolley under the train, including its detachable brake handle wedged above the leading bogie (figure 2) and its wooden deck on the track under the second vehicle (figure 9). Network Rail staff in the control room then mobilised a second mobile operations manager to go to the train.

Figure 9: The hand trolley's wooden deck underneath the second vehicle (courtesy of Network Rail).

35 At 06:45 hrs, after the driver had handed his protection back to the signaller, the signaller asked the driver of freight train 6A15, which was at a stand to the west of Challow, to pass over the up main line at caution[15] and examine the line. After passing through the Challow area, the driver of train 6A15 reported that there were remains of the hand trolley across the tracks at about 64 miles 0 chains in the Challow area, but that it was safe for trains to pass through on the up main line if they too travelled at caution.

[15] If instructed to proceed at caution, a driver must, as well as not exceeding any specified speed, proceed at a speed which takes account of conditions (such as the distance they can see to be clear), that will allow them to stop the train short of any train, vehicle or other obstruction, or the end of their movement authority.

36 At 07:24 hrs the first mobile operations manager arrived at Challow. Staff in the control room instructed him to prioritise removing the hand trolley debris from the tracks at Challow. At 07:32 hrs, the second mobile operations manager arrived at the nearest access point to train 1C00, to the west of Challow. Here he met up with the technical riding inspector, who had also just arrived. Together they walked to train 1C00, arriving at about 07:45 hrs.

37 Shortly after 08:00 hrs, the mobile operations manager at Challow was joined by a track maintenance team. The team's supervisor reported that one of the rails on the down main line was contaminated with oil and would need to be treated. At the train, the technical riding inspector identified that the oil had leaked from a damaged drain plug on a diesel generator unit under the second vehicle (figure 10). He estimated that between 15 and 20 litres of engine oil had leaked out, so he isolated the diesel generator unit concerned. This did not affect the train going forward, as it was in electric mode and drawing power from the overhead line equipment.

Figure 10: The oil leak under the second vehicle and oil contamination on the rail (left image courtesy of Hitachi Rail and right image courtesy of Network Rail)

38 At 08:13 hrs, the signaller blocked the up main line to train movements so that the first mobile operations manager could clear the debris from the track at Challow and the second mobile operations manager and technical riding inspector could examine both sides of the train. These activities were completed by 08:28 hrs and the signaller reopened the up main line and allowed trains to pass over it at its maximum permissible speed of 125 mph (201 km/h).

39 By 08:45 hrs, the technical riding inspector had removed the hand trolley debris from under the train, completed his examination of the train and had isolated the equipment that was damaged. He had also spoken to the Hitachi maintenance controller in Swindon about the damage and equipment he had isolated. It was agreed between them that the train could go forward to Swindon with the passengers still on board. The technical riding inspector then authorised the driver to move train 1C00.

40 At 08:50 hrs, the track maintenance team supervisor advised staff in the control room that he had walked from Challow to the train. He confirmed that the hand trolley debris had been removed and placed a safe distance from the tracks, that he could not see any damage to the track that would affect trains running over it, and he would remain on site to inspect the rails after they had been treated.

41 At 08:53 hrs, train 1C00 set off to Swindon, now running 164 minutes late. At 09:05 hrs, the train arrived at Swindon, where it terminated.

42 At 09:36 hrs, the down main line reopened with trains allowed to run at the permitted speed of 125 mph (201 km/h). This was after a train had treated the head of each rail with high pressure jets of water, and the track maintenance team supervisor had inspected the rails and given permission for trains to run without any restrictions in place.

43 At 09:40 hrs, the train departed from Swindon to go back, empty, to North Pole depot in West London so that the damage to it could be assessed and repaired. The technical riding inspector travelled on the train in case of any further problems. The train arrived at the depot at 10:49 hrs.

Analysis

Identification of the immediate cause

44 A hand trolley was left on the track after the railway was handed back for the normal operation of trains at the completion of overnight maintenance work.

45 After all the overnight work in the possession was complete, the railway was handed back to the signaller for the normal operation of trains. However, when the railway was handed back, a hand trolley remained where it had been left behind on the track. This trolley was struck by train 1C00 at the Challow road-rail access point.

46 After the accident, the hand trolley involved was identified as belonging to the maintenance team from the local welding and grinding section, who had been working the previous night within a work site, and had accessed and exited the railway via the road-rail access point at Challow (paragraph 26).

47 The hand trolley was not detected by the signalling system which uses axle counters for train detection at this location (paragraphs 75 and 76 explain why this was). As the signaller and the signalling system were unaware of the hand trolley, the signaller was able to clear the signals ahead of train 1C00 so that it could pass through Challow. Train 1C00 was the first train to pass through the area that morning, and the forward-facing closed-circuit television (CCTV) footage from the train shows the hand trolley on the down main line, at the road-rail access point (figure 8). The driver also reported seeing a yellow trolley on the track, immediately before the train struck it (paragraph 33).

Identification of causal factors

48 The accident occurred due to a combination of the following causal factors:

a. The maintenance team that carried out overnight work at Challow left their hand trolley on the track (paragraph 49).

b. No one who was at the Challow access point noticed the hand trolley was still on the track when the work site was handed back (paragraph 59).

c. The checks undertaken before handing back the railway for normal operation did not identify that the hand trolley was still on the track (paragraph 71).

Each of these factors is now considered in turn.

Hand trolley left on the track

49 The maintenance team that carried out overnight work at Challow left their hand trolley on the track.

50 The COSS and the welder had placed the hand trolley on the down main line at 01:00 hrs, after taking it out of the rear doors of their van, which the welder had reversed onto the road-rail access point at Challow (paragraph 28). The rail defect was on the up main line so they planned to push the hand trolley along the adjacent down main line and stop it parallel with the rail defect. After they had loaded all their equipment onto the hand trolley, the welder parked the van a short distance away from the road-rail access point.

51 When the COSS and the welder set off to find the rail defect and repair it, because it had been raining (paragraph 20), they both wore their high visibility coats in addition to their usual high visibility clothing. Later, the welder took his coat off and placed it on the empty hand trolley. This was because it had stopped raining and the welder was getting hot while grinding out the defect. After completing the repair, the COSS and the welder packed up their equipment, loaded it all back on the hand trolley on top of the coat (figure 11), and then pushed the hand trolley back to the road-rail access point.

Figure 11: A reconstruction of how the hand trolley was loaded by the COSS and the welder after completing the repair

52 When they arrived back at the road-rail access point, the welder began searching for the keys to the van but could not find them. The welder and COSS worked together to unload the heavy items of equipment from the hand trolley, such as the arc weld kit and generator, as these required two people to lift and move them. They carried these items to where the van was parked, just off the road-rail access point, and placed them by the van's side door. The welder then went back onto the track, walking east along the up main line to search for the van keys (figure 12). Meanwhile, the COSS unloaded the remaining items from the hand trolley and placed them with the other items of equipment by the side of the parked van. Due to the way that they had loaded the hand trolley (figure 11), one of the last items that the COSS picked up was the welder's coat. As he did so, he heard some keys rattle in one of the pockets. The COSS checked it was the van keys and called out to the welder to come back.

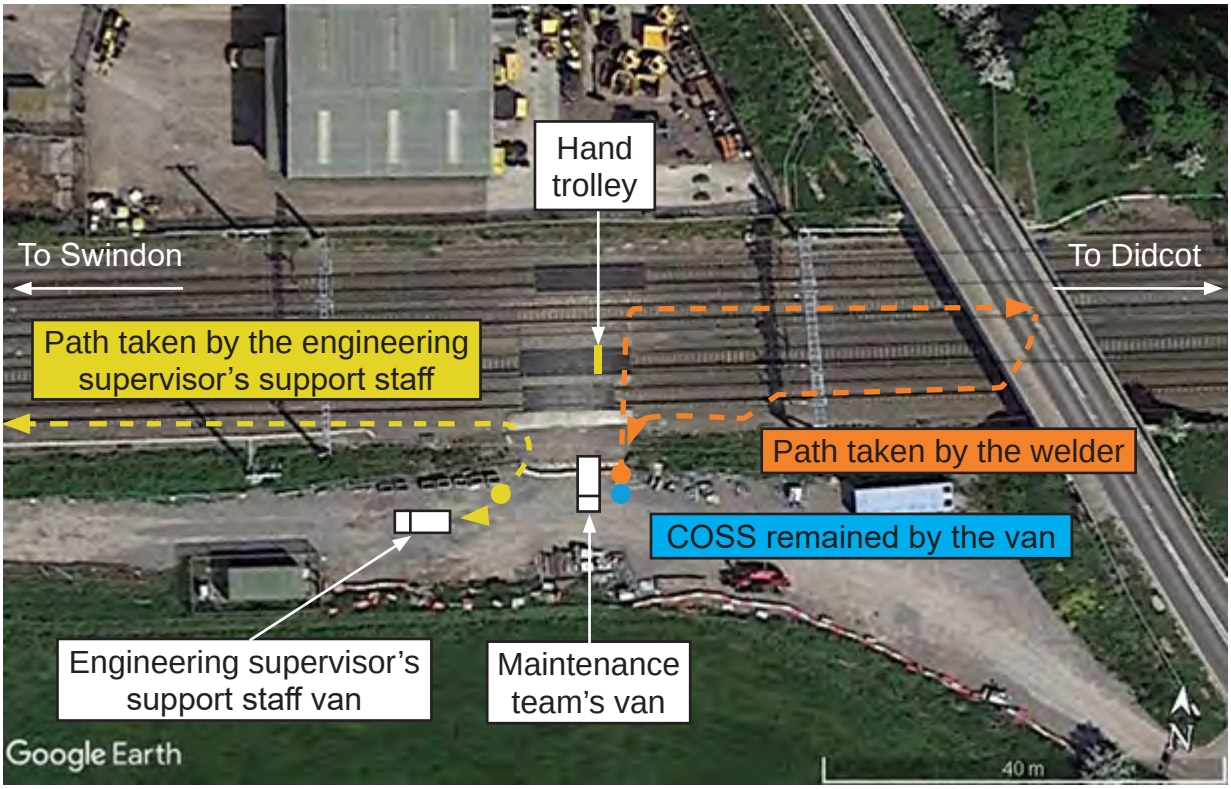

Figure 12: Aerial view of the path taken by the welder when looking for the van keys and the path taken by the engineering supervisor's support staff to collect the work site protection

53 By this time, the welder was walking under the nearby road-over-rail bridge (figure 12). In response to the COSS's call, the welder turned back and crossed over the down main line to the down relief line. After walking along this line for a short distance, he moved into the cess to complete his journey back to the road-rail access point. Meanwhile, the COSS had used the keys to unlock the parked van and had begun loading the equipment into it through the side door. The welder joined the COSS at the side of the van and together they loaded the heavier equipment and remaining items into the van through the side door. The van's rear doors remained closed throughout.

54 After loading all the equipment that had been placed next to the van, the welder walked round the front of the van and got into the driver's seat. The COSS joined him in the passenger seat and then called the engineering supervisor to say that they had completed their work and were clear of the track. At 03:45 hrs, the engineering supervisor recorded that the COSS no longer needed the work site protection and that the hand trolley was off the track. Shortly afterwards, the COSS and the welder departed from Challow in their vehicles, without realising that they had left the hand trolley behind on the down main line.

55 There are several possible reasons why the maintenance team left their trolley behind in this way. Witness evidence is that the maintenance team deviated from its usual way of loading the van, due to the misplacing of the van keys. The team would normally have reversed the van onto the road-rail access point, so that it was close to the hand trolley. They would then unload their equipment from the hand trolley before loading it into the van first, through the rear doors. However, on this night, the initial lack of van keys meant that they instead carried their equipment off the access point to the side of the parked van and, once the keys had been found, loaded it into the van via the side door, away from the road-rail access point.

56 This disruption to their usual routine made it more likely that they would miss a step in the loading process. It also meant that the loading activity took place further away from the access point (and the hand trolley) than would normally have been the case, making it easier for them to miss that the hand trolley remained on the track. The welder also acknowledged that he had become distracted during the unloading of the hand trolley because he was worried about leaving the welding equipment out in the open next to the van, as it might get wet or be stolen. He was also worried about how he was going to get the van back to the depot with the keys missing. This may also have increased the likelihood of him forgetting to load the hand trolley into the van once the keys had been recovered.

57 The COSS and the welder did not notice that the hand trolley was missing when they had finished loading their equipment into the van. This may have been because their van was a hire vehicle, so did not have any racking or allocated spaces within it for equipment to be stored. This meant that equipment was just placed onto the van floor, making it more difficult to spot that the hand trolley was missing.

58 This was also the first night that week that the COSS had used a hand trolley due to the amount of equipment that the welder needed for the repair, plus additional kit was required to protect the work from the wet weather. Because the COSS had used a rail skate[16] on previous nights, this may also have increased the likelihood that they would forget that the hand trolley had not been loaded into the van.

[16] A small device, with a platform or basket sitting on two wheels, which is designed to run along the head of one rail, and is used to assist in transporting heavy items of equipment along the track.

Hand trolley not noticed

59 No one who was at the Challow access point noticed the hand trolley was still on the track when the work site was handed back.

60 After taking the equipment off the hand trolley and finding the van keys, the COSS did not go back onto the road-rail access point. He stayed next to the van and loaded equipment into it.

61 After the COSS found the van keys, the welder walked straight back to the van (figure 12) to help load the equipment. He walked past the edge of the road-rail access point, but he did not see the hand trolley because it was dark and because the trolley was positioned about 8 to 10 metres away from the closest point of his route.

62 The member of the engineering supervisor's support staff (paragraph 30) also did not see the hand trolley on the road-rail access point. He had arrived at Challow just after the COSS and the welder had finished loading their van. When the engineering supervisor asked him to remove the work site protection at about 03:50 hrs, he accessed the track near the road-rail access point, but only walked past its edge to walk west towards Swindon (figure 12). After collecting the protection equipment, he followed the same path in reverse back to his van. He too passed within about 8 to 10 metres of the hand trolley but also did not see it in the dark.

63 Despite both the welder and the engineering supervisor's support staff walking near to the hand trolley, neither of them noticed it in the darkness. There were no light sources (paragraph 19) to illuminate the road-rail access point, which is often the case for an access point in a rural location.

64 It is a requirement of Rule Book Handbook GE/RT8000/HB10,[17] for a hand trolley to display a red light or flag, which is visible in both directions (although a red flag would not be visible in darkness). Section 3, which describes the duties of the person in charge of the hand trolley, states this requirement. Other requirements placed on the person in charge include testing the hand trolley's braking system, getting permission from the COSS to put the trolley on the track, considering the effect of gradients, correctly loading the trolley, and ensuring that two people are with the trolley when moving it. While section 3 also states that when the hand trolley is not being used it should be placed well clear of the line, there is no specific requirement for the person in charge of the hand trolley to ensure it is taken off the track at the end of work.

[17] Rule Book Handbook 10, GE/RT8000/HB10, 'Duties of the COSS or SWL and person in charge when using a hand trolley', issue 3, September 2014.

65 The welder was the person in charge of the hand trolley as he was the PIC for the work (paragraph 14). Any member of Network Rail staff who is in charge of a hand trolley on the track is required to hold a company-specific competency called 'PTMP 16 Safe use of trolley equipment'. Network Rail has a training course for the PTMP 16 competency which includes a specific reference to the requirement to display red lights, or a red flag, on the trolley. Knowledge of this requirement is also checked in a practical assessment that forms part of the course. The welder held the PTMP 16 competency although the COSS who pushed the trolley along the track that night did not. Network Rail stated that, in its view, while the COSS had pushed the hand trolley, the welder, in his role as the PIC, was in charge of the hand trolley and was controlling its use throughout.

66 As a holder of the PTMP 16 competency, the welder knew that hand trolleys should have lights on them but stated post-accident that they are sometimes broken or have flat batteries after being left on. He could not recall if any red lights were illuminated on the night concerned. The COSS stated that there were red lights fitted to the hand trolley, but he did not know if they were switched on or not. It is probable, based on their experience of them not working, that neither the COSS nor the welder switched on the hand trolley's red lights, if working red lights were indeed present.

67 The engineering supervisor's support staff did not see any illuminated red lights when he was walking near to the road-rail access point and the train driver did not see any red lights illuminated on the hand trolley when he noticed it in the train's path. The absence of any illuminated red lights on the trolley when it was struck was confirmed by the forward-facing CCTV footage from the train. Taken together, this evidence indicates that no red lights were illuminated on the trolley on the night concerned.

68 Without illuminated red lights, the hand trolley would be very difficult to see in the darkness. During a reconstruction of events in more favourable circumstances because of the presence of distant light sources, RAIB observed that the hand trolley was still very difficult to see (figure 13), even when standing only about five metres away from it. The hand trolley was painted yellow to improve its visibility in daylight, but this paint was not reflective or luminescent. It was not fitted with any type of reflective tape or reflective markings to improve its visibility in the dark. The COSS and the welder could have complied with the requirements of GE/RT8000/HB10 by placing a red flag on the hand trolley. However, this would not have prevented this accident as the red flag would not have been visible in darkness.

69 This type of hand trolley is fitted with a bracket on each long side (the side which crosses between the two rails) to house a red-light unit (figure 14). The provision of these brackets is a requirement in Network Rail's specification for manually propelled trolleys. The brackets were checked at the hand trolley's last maintenance inspection in August 2021 and recorded as serviceable. Although there was no witness evidence which suggested that the red lights units were not fitted in the hand trolley's brackets, RAIB has not been able to confirm this independently. None of the hand trolley debris removed from the track (paragraph 38) was kept afterwards by Network Rail, meaning it could not be examined. The forward-facing CCTV footage from train 1C00 (figure 8) is also too dark and of insufficient quality to determine if non-illuminated red-light units were fitted to the hand trolley.

Figure 13: A hand trolley, with no illuminated red lights, on the road-rail access point in darkness during the reconstruction (top image) and illuminated by torch light for comparison (bottom image)

Figure 14: The red-light units on the same model of hand trolley.

70 Hand trolley red-light units are considered by Network Rail to be a consumable item, with batteries expected to give 48 hours of continuous use. However, there was no process in place for the maintenance teams to check that the red-light units were working before using a hand trolley, and no defined supporting mechanism for maintenance staff to get the red-light units or batteries changed when they were not working.

Handing the railway back for normal operation

71 The checks undertaken before handing back the railway for normal operation did not identify that the hand trolley was still on the track.

72 When taking a possession, setting up the work site and before starting work:

- The PICOP is responsible for taking the possession in accordance with Rule Book Handbook GE/RT8000/HB11.[18]
- The engineering supervisor is responsible for setting up the work site within the possession in accordance with Rule Book Handbook GE/RT8000/HB12.[19]
- The COSS is responsible for setting up a safe system of work within the work site in accordance with Rule Book Handbook GE/RT8000/HB9.[20]
- The PIC is responsible for supervising and overseeing the work. They must make sure the planned controls are put in place to keep persons safe from trains, activity and site risks, in accordance with Network Rail standard NR/L2/OHS/019.[21]

73 The reverse happens when the railway is handed back for trains to start running again:

- When work is completed, the PIC shall check that everyone they are responsible for is clear of the line and the site is left in a safe state. This is in accordance with section 4.14 of NR/L2/OHS/019/mod02.[22]
- The COSS shall then confirm that the line is clear and safe to the engineering supervisor and sign out of the engineering supervisor's work site, as defined in section 4.15 in NR/L2/OHS/019/mod02. The COSS must also tell the engineering supervisor that they, and their group if they have one, are no longer on or near the line and then complete a work site certificate with the engineering supervisor, either face to face or by telephone. This is in accordance with section 3.9 of GE/RT8000/HB9.
- Once every COSS in the work site no longer needs to be on or near the line and has signed out of the work site, the engineering supervisor must get permission from the PICOP to remove all the work site protection. Once done, the engineering supervisor shall tell the PICOP that the work site is given up and as far as the engineering supervisor is concerned, the line is safe and clear for the passage of trains. This is in accordance with section 10.3 of GE/RT8000/HB12.
- When all work sites have been given up, the PICOP shall give the possession up and shall tell the signaller that the line is clear and safe for trains to run on as stated in section 12.4 of GE/RT8000/HB11.

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[18] Rule Book Handbook 11, GE/RT8000/HB11, 'Duties of the person in charge of the possession (PICOP)', issue 8, September 2020.

[19] Rule Book Handbook 12, GE/RT8000/HB12, 'Duties of the engineering supervisor (ES) or safe work leader (SWL) in a possession', issue 8, September 2020.

[20] Rule Book Handbook 9, GE/RT8000/HB9, 'IWA or COSS setting up safe systems of work within possessions', issue 7, September 2019.

[21] Network Rail standard NR/L2/OHS/019, 'Safety of people at work on or near the line', issue 10, 05 December 2020.

[22] Network Rail standard NR/L2/OHS/019/mod02, 'Module 02 - Planning and working in a possession', issue 1, 04 March 2017.

74 In summary, Network Rail standards require the PIC and COSS to check the line is clear and safe at hand back, while the Rule Book places the onus on the engineering supervisor to confirm that the line is clear and safe for the passage of trains. However, in many cases the work site is too long for an engineering supervisor to physically check it all. The work site that included Challow, for example, was just over four miles (6.4 km) long.

75 In areas where the signalling system uses track circuits for train detection, any hand trolleys or items of on-track plant that are left on the rails will often be detected by track circuits. Their metal wheels and frame act like the wheels of a train to electrically connect the running rails together, causing the track circuit to be in its occupied state. This means that, when the PICOP hands the railway back to the signaller, the signaller will see that a track section is unexpectedly occupied, identifying that there is a problem.

76 This is not the case in areas where axle counters are used for train detection by the signalling system. Instead, trains are detected at discrete points along the track, by equipment that counts the passing wheels of rail vehicles. An evaluator then monitors how many wheels have been counted into and out of a track section to determine if the track section is clear of trains. Many signalling schemes over the past 15 years have installed axle counters, including those at Challow (paragraph 8).

77 In 2010, as more and more signalling schemes began installing axle counters, Network Rail issued a new standard NR/L3/OPS/084, 'Line Clear Arrangements Following Engineering Works in Axle Counter Area – Line Clear Verification Process'. Issue 5 of this standard was published in March 2020 and was current at the time of this accident. NR/L3/OPS/084 states that its purpose is to manage the risk of vehicles and rail mounted plant being left on the track following a possession in areas fitted with axle counters. The standard mandates the use of the line clear verification (LCV) process to manage this risk, in addition to general checks defined in the Rule Book and NR/L2/OHS/019.

78 However, the LCV process did not prevent the hand trolley from being left on the track at Challow when the railway was handed back. This causal factor arose due to a combination of the following:

a. There were weaknesses within the overall LCV process making it susceptible to error (paragraph 79).

b. The maintenance team did not carry out its part of the LCV process as it was required to. This is a possible factor (paragraph 89).

Each of these factors is now considered in turn.

Weaknesses within checks

79 There were weaknesses within the overall LCV process making it susceptible to error.

80 NR/L3/OPS/084 states that the LCV process is based 'on the principle of a diverse means of proving the line clear and safe following an engineering possession.' It is designed to align as closely as possible with established methods of working and must be applied to all lines where train detection is achieved by axle counters. Exceptions are permitted where a safety validation has determined that the LCV process is not required. No such exception was in place for the work at Challow.

81 All areas fitted with axle counters are identified in the sectional appendix[23] and the requirement to use the LCV process for a possession is published in documentation such as the weekly operating notice[24] (often referred to as the WON). The LCV process can also be used in non-axle counter areas where a check, over and above that set out in the Rule Book, is deemed beneficial by those planning the work. Examples of this would be in complex possessions or in a series of possessions involving many vehicles.

82 The LCV process operates using vehicle management forms (VMFs). These are intended to be used for the duration of any possessions and work sites to record the placement of any vehicle on the track, and to confirm the removal of the same vehicles off the track. There are six VMF templates and their respective usage depends on the role of the person using them and the type of vehicles placed on the track. NR/L3/OPS/084 states that the aim of completing these VMFs is to give staff confidence that the line is clear when it is handed back.

83 NR/L3/OPS/084 defines a vehicle as any item with at least two wheels that is permitted to access a possession, even if it is not actually travelling on the rails. Examples listed in NR/L3/OPS/084 include:

- Any on-track machine, engineering train or self-propelled machinery which runs only on rails, which enters the possession from a siding, or an area controlled by a signaller.
- Any on-track plant item which enters on or near the lines under possession from the trackside. This includes items such as motorised trolleys, self-propelled plant such as road-rail vehicles, tracked or rubber wheeled machines, trailers, and towed or wheeled attachments with three or more rail wheels.
- Any hand-operated equipment, such as a hand trolley or rail skate, which has two or more wheels.

84 For the work site involved, the engineering supervisor and COSS were required to use VMFs to record when the hand trolley was put on and taken off the railway infrastructure in the work site. While the engineering supervisor filled in a VMF when the hand trolley was placed on the track, the COSS did not (see paragraph 90).

[23] A publication produced by Network Rail that includes details of running lines, permissible speeds, and local instructions.

[24] A Network Rail document published each week for each route, providing information about engineering work, speed restrictions, alterations to the network and other relevant information to train drivers.

85 After loading the equipment in the van at the end of the work, the COSS called the engineering supervisor, who was at Wantage Road (paragraph 26), to say that his work was complete and that he no longer needed the work site. The COSS believed that all the equipment that the team had used had been loaded into the van, so he told the engineering supervisor that the line was clear. After the COSS had reported that the track was clear and safe for the passage of trains, the engineering supervisor completed his VMF at 03:45 hrs to record that the hand trolley the COSS had been using was now off the track (figure 15). This meant the engineering supervisor's VMF now showed that there were no vehicles on the track in his work site.

Engineering Supervisors Vehicle Management Form for On-Track Plant and Hand Trolleys

WON No and Possession Item No _____ Work Site ID _____

OTP

Unique No.	MC Name	Access Point	Time Authorised on Line Hr	Time Authorised on Line Min	Line	Relieving MC Name	Exit Point	Time Reported Clear Hr	Time Reported Clear Min

TROLLEY

No of trolleys authorised to be placed on the line	COSS Name	Access Point	Time Authorised on Access Hr	Time Authorised on Access Min	Line	Relieving COSS Name	Exit Point	Time All Trolleys Raported Clear Hr	Time All Trolleys Raported Clear Min
1	[redacted]	WANTAGE	01	00	DOWN		WANTAGE	03	45
1	[redacted]	CHALLOW	01	00	DOWN		CHALLOW	03	45

All OTP and Hand Trolleys Confirmed as Clear of the Work Site; Date 0345 Time 21/10/21

Figure 15: The VMF completed by the engineering supervisor

86 If an engineering supervisor identifies an anomaly on their VMF when handing back a work site, NR/L3/OPS/084 requires the engineering supervisor to carry out checks to establish the whereabouts of any vehicles that are unaccounted for. NR/L3/OPS/084 explains that the engineering supervisor shall contact the COSS responsible for the vehicle which is unaccounted for to verify the location of that vehicle. Unless the engineering supervisor obtains unequivocal evidence from the COSS to resolve the anomaly on the VMF, the engineering supervisor must carry out a physical inspection of the entire work site, known as a work site sweep. The engineering supervisor must inform the PICOP when an unplanned work site sweep is necessary due to the amount of time it could take to complete.

87 NR/L3/OPS/084 also allows for pre-planned work site sweeps. These must be arranged in advance and staff must also be briefed in advance. They are only used in specific circumstances, such as when there is expected to be a high level of vehicle activity to monitor. No such sweep was planned for the work site that included Challow, as only a small number of hand trolleys were going to be used within it.

88 After completing a VMF which showed all the hand trolleys used in the work site were accounted for, the engineering supervisor then handed the work site back to the PICOP (paragraph 31). The engineering supervisor gave the PICOP the same assurances that he had received from each COSS that the line was clear and safe for the passage of trains. While the engineering supervisor had successfully completed his VMF and followed the LCV process, this accident highlights how the process of handing back the railway for trains to start running again is reliant on the accuracy of the initial report from the COSS.

Checks not carried out

89 The maintenance team did not carry out its part of the LCV process as it was required to. This is a possible factor.

90 While the engineering supervisor followed the LCV process, the COSS did not use a VMF to record when the hand trolley was placed onto the track or when it was taken off.

91 The COSS and the welder were both aware of the LCV process, having been briefed about it back in 2016. This briefing was recorded on their competency records. Information about the LCV process is refreshed as part of the training for the COSS, engineering supervisor and PICOP competencies. Each training course covers what the LCV process is, when it applies, what a VMF is and the responsibilities of each role in the process. Both the COSS and the welder had received this training as part of their COSS competency training in 2020.

92 The COSS stated that he did not follow the LCV process as he did not have a copy of the VMF to fill in that night. It was not included with any of the other documentation provided by the supervisor for the work the team was tasked to do, he did not pick up a blank copy from the depot before heading out to site, and he did not carry any blank copies of the VMF with him as he was not required to do so.

93 It is possible that using a VMF might have reminded the COSS that the hand trolley was still on the track. However, for several reasons, the COSS had forgotten that the hand trolley was still on the track (paragraph 55) and no one else noticed it in the darkness as it had no illuminated red lights (paragraph 68). This led the COSS to tell the engineering supervisor that the line was clear of all personnel and equipment. This belief that the work was all complete meant he could have also completed a VMF at this time to record that the hand trolley was off the track, without realising it was still on the track.

Identification of underlying factors

Red lights on hand trolleys

94 Hand trolleys were being routinely used at night without displaying red lights and no assurance activities were taking place within work sites to monitor compliance. This is a probable underlying factor.

95 Evidence indicates that there were no illuminated red lights on the hand trolley on the night when it was used by the maintenance team (paragraph 66).

96 Staff in other maintenance sections in the delivery unit had magnetic rechargeable red lights to attach to their hand trolleys when a red-light unit was missing or not working. The teams in the local welding and grinding section did not have these alternative red lights, so this was not an option for the COSS or welder.

97 When asked after the accident, senior managers within the delivery unit were not aware that any work had ever been cancelled because red-light units were not working on a hand trolley. Managers believed that, in the event that a light was not fitted or not functional, the welding and grinding teams were likely to carry on working without a red light being displayed and then report the problem at the end of the shift.

98 When introduced in 2010, GE/RT8000/HB10 superseded Module T2[25] of the Rule Book which had previously required a red flag to be displayed on the trolley during daylight, or a red light (steady or flashing) during darkness. GE/RT8000/HB10 states that a red flag can be used instead of a red light, and that it must be visible in both directions (paragraph 64), but GE/RT8000/HB10 does not provide any further details about when a red flag can be used or what criteria are used to determine if it is visible. Witness evidence, plus supporting evidence provided by senior managers, showed that in practice, maintenance staff in the delivery unit intended to use red lights, rather than flags, on their hand trolleys.

99 The lack of illuminated red lights on hand trolleys was identified by RAIB as a factor in three previous investigations (see paragraphs 132 to 134). It has also featured as a factor in other hand trolley accidents and incidents from 2017 to 2021 (see paragraphs 135 to 137).

100 The use of hand trolleys without adequately illuminated red lights was also observed during the reconstruction of this accident at Challow in January 2022 (paragraph 68), where Network Rail maintenance staff placed two hand trolleys on the track at the road-rail access point. There were no working red lights on one hand trolley, and the red lights on the other were very dim, due to low battery charge. When challenged, the maintenance staff said that they were not cancelling their work because of a lack of red lights on their hand trolleys, citing that the site lighting they had placed on the trolleys was a suitable replacement.

101 Network Rail did not provide RAIB with any evidence to show that assurance activities were taking place in work sites and possessions to check compliance with the Rule Book requirement to display red lights, or a red flag, on hand trolleys.

[25] Rule Book Module T2, GE/RT8000/T2, Protecting engineering work or a hand trolley on a line not under possession, issue 2, October 2007, withdrawn December 2010.

The LCV process

102 The LCV process was reliant on human actions for its successful implementation, which the rail industry had recognised, but not yet implemented any measures to avoid or mitigate errors.

103 NR/L3/OPS/084 states that the LCV process is based on a diverse means of proving the line clear and safe following engineering work in a possession (paragraph 80). This diverse means is reliant on staff, in at least two different roles, recording information about what vehicles are on the track within the possession and work sites at any time. The signaller, PICOP and engineering supervisors communicate with each other to monitor the movements of trains and on-track machines in the possession, with machine controllers[26] also involved in monitoring the movements of on-track plant, such as RRVs in the possession. The engineering supervisor communicates with machine controllers for on-track plant movements within their work site, and with each COSS working in their work site to monitor the hand trolleys and rail skates being used.

104 The Network Rail staff responsible for standard NR/L3/OPS/084 believed that the LCV process was robust if followed correctly. However, they recognised that it relies on staff using the VMFs and doing so accurately. There are no other engineered safeguards or controls within the LCV process to ensure that staff follow it correctly or to mitigate any mistakes they might make.

105 Information about whether a vehicle is on or off the track relies on the word of one person telling the next. This information is often communicated by phone calls between the parties. There is no cross checking by another person, or any way for an engineering supervisor to verify that a hand trolley has been taken off the track, other than by a sweep of the entire work site (paragraphs 86 and 87). Without other checks, the LCV process is vulnerable to singular errors.

106 The perceived value of the VMF is also likely to vary from role to role:

- PICOPs are responsible for larger vehicles such as trains and on-track machines and must remotely record multiple movements by this type of vehicle into, within and out of their possession. This involves communicating with both signallers and engineering supervisors when using a VMF.
- Engineering supervisors are responsible for all types of vehicles, ranging from trains to hand trolleys and rail skates, and must record their multiple movements into, within and out of their work site, often remotely. This might involve communicating with the PICOP, multiple machine controllers and every COSS signed into the work site, when using a VMF.
- A COSS is only responsible for any hand trolleys or rail skates that their group place onto, and take off, the track. The COSS should be present with their group when this happens and, when using a VMF, will only need to communicate with the engineering supervisor.

[26] A person trained and authorised to control and supervise an item of on-track plant other than a rail crane.

107 This means that for a COSS, particularly when with a group using just one hand trolley, the perceived value of the VMF could be much reduced. This is because the COSS will only be recording the status of a single hand trolley, that they should in any case remain with while it is on the track. Any perception of a lack of usefulness may reduce the likelihood of the VMF being used. Evidence from assurance checks carried out after the accident found that staff in the engineering supervisor and COSS roles were much less likely to have filed completed VMFs (see paragraph 115).

108 The Network Rail staff responsible for NR/L3/OPS/084 have recognised there are weaknesses in the LCV process. Consequently, work is underway to improve the LCV process by using technology to provide additional safeguards and reduce its reliance on one person telling the next when a vehicle is removed from the track (see paragraph 153).

109 RAIB has found that since the accident Network Rail's Western route has also started work to look at what technology can be used to improve the LCV process (see paragraph 154). Other work has also been taking place within the rail industry, through groups facilitated by RSSB,[27] to look at the risk of objects left on the line following maintenance work. This work has included looking at how this risk can be reduced through solutions that use technology (see paragraphs 155 to 157).

110 RAIB found there was no overall strategy or lead within the rail industry to provide a co-ordinated approach as to what solution to implement. RAIB found that opinions varied on the cost and benefits of the different solutions, which in turn was driving diverse views on what should be done. Meanwhile, the current LCV process remains vulnerable, with no safeguards to mitigate singular human errors as shown by this accident.

Planning process

111 The LCV process was separate to Network Rail's work planning process as defined by standard NR/L2/OHS/019. This is a possible underlying factor.

112 NR/L2/OHS/019 defines the requirements for managing the safety of people who work on or near the line, which includes identifying safety responsibilities and accountabilities. It describes in detail the requirements that need to be met when planning work on Network Rail's infrastructure and the processes that need to be followed when producing safe work packs for staff working on the track. Module 02 of NR/L2/OHS/019 covers planning and working in a possession, including the responsibilities placed on the COSS and the PIC when the work is complete (paragraph 73).

[27] A not-for-profit company owned and funded by major stakeholders in the rail industry, and which provides support and facilitation for a wide range of cross-industry activities to help the rail industry work together to drive improvements in the rail system. The company is registered as 'Rail Safety and Standards Board', but trades as 'RSSB'.

113 NR/L2/OHS/019 makes no mention of the LCV process or NR/L3/OPS/084, so the LCV process is not considered when the work is planned. In addition, the LCV process is not referenced in any of the documentation produced for the planned work. Consequently, none of the VMFs are included in the safe work pack, which is meant to be the pack of information that provides the safety arrangements for work to be undertaken. Instead, the COSS needs to determine for themselves whether the LCV process will apply where they are working. If the COSS determines that it does, they then need to obtain their own copy of the VMF. This did not happen for the work at Challow (paragraph 90).

Compliance and assurance

114 The Network Rail Swindon delivery unit welding and grinding section was routinely not complying with the LCV process and Network Rail had not detected this through its assurance activities. This is a possible underlying factor.

115 NR/L3/OPS/084 includes a requirement that all completed VMFs and supporting documentation used to record vehicle details are retained. It defines who the person completing the VMF should send the form to afterwards, although not the purpose of retaining the forms. After this accident, the Network Rail staff responsible for operational standards, including NR/L3/OPS/084, challenged several Network Rail routes about the retention of VMFs. Their overall findings indicated that the retention of completed VMFs varied greatly across roles. While they found that PICOPs and signallers were generally compliant in completing and filing VMFs, they found that a much smaller number of VMFs were being completed and filed by staff in the engineering supervisor and COSS roles.

116 The operational standards staff responsible for NR/L3/OPS/084 thought that compliance with this requirement was likely to be poor as unannounced safety assurance checks were no longer taking place within possessions or work sites. This was based on their interpretation of the planning process in NR/L2/OHS/019 which they believed meant that unannounced safety assurance checks by operations staff, such as mobile operations managers, had to be shown in documentation and discussed in pre-work briefings. Therefore, the maintenance staff who would be working on site would know in advance that they were going to be checked, so they tended to be compliant on the day. The Network Rail workforce safety team held a different view. It thought that unannounced checks by operations staff were still possible, as those carrying out the checks could plan their work separately and then sign in with the COSS to check staff once at the work site.

117 Within Network Rail's Western route, compliance with company standards is monitored through routine audit plans and manager self-assurance activities. What is checked by these audits is defined in a self-assurance matrix. This sets out who within each maintenance function needs to be asked about compliance with standards. NR/L3/OPS/084, and thus the LCV process, was not included in the self-assurance matrix for the track maintenance function. Therefore, compliance with the LCV process was not being checked by these audits.

118 As well as the lack of checks at route level, Network Rail was unable to provide any evidence of manager-led self-assurance checks for compliance with the LCV process within the delivery unit itself. After this accident, senior management within the delivery unit carried out a review into practices related to the use of rail skates and hand trolleys by its maintenance teams. This review concentrated on checking adherence to the LCV process over a three-month period before the accident. The results of the review showed that the five track maintenance sections within the delivery unit were following the LCV process, with VMFs being correctly completed and filed by the track maintenance teams.

119 The review also found, however, that the LCV process was not always followed within the delivery unit's welding and grinding section and that VMFs were not being completed, especially when staff were using rail skates (which came within the remit of the standard). This is despite the fact that staff working in the welding and grinding section would be expected to be some of the most frequent users of the LCV process, because of the number of times they need to use a hand trolley or rail skate to transport their heavy equipment.

Observations

Restrictions placed on the train

120 After the accident, the train was allowed to travel at a speed above that which should have been permitted given the level of damage it sustained in the collision.

121 The train sustained damage to equipment underneath it from striking the trolley. The driver inspected the train and reported the damage he had found to the Hitachi maintenance controller (paragraph 34). The Hitachi maintenance controller also received an update on the damage to the train from the Hitachi technical riding inspector who had attended to assess the damage to the train before it could be moved (paragraphs 36 to 39).

122 The Hitachi maintenance controller, in conjunction with Great Western Railway's duty control manager, then applied parts of a document, known as a defective on-train equipment plan, to restrict the speed at which the train would be allowed to travel. Due to the damage the train had sustained, the brakes on two vehicles were isolated (paragraph 39), which left functioning brakes on seven out of the nine vehicles. The defective on-train equipment plan stated that, if there are fewer than four vehicles with working brakes for every unbraked vehicle, the train shall proceed at a reduced speed to the first suitable station where passengers shall be detrained. The plan also states that the speed that the train can travel at will depend on the driver's opinion, which in turn is based on consideration of available brake force, weather conditions, and gradients. This message was conveyed from the Hitachi maintenance controller to the driver via the technical riding inspector. Afterwards, the driver reported being told that he could manage the speed of train going forward to Swindon, where the train would terminate, based on how he felt the train's brakes were performing.

123 The Hitachi maintenance controller was not aware that the lifeguards[28] at the leading end of the train were also damaged after striking the hand trolley (figure 16). According to the defective on-train equipment plan, this level of damage to the lifeguards required a 40 mph (64 km/h) speed restriction to be imposed on the train when this end of the train was leading to Swindon. As the damaged lifeguards still had all their fixing bolts in place, the defective on-train equipment plan did not require any restrictions to be imposed when the train travelled in the opposite direction back to North Pole depot.

Figure 16: The damaged lifeguards on the leading vehicle (courtesy of Hitachi Rail)

124 As the 40 mph (64 km/h) speed restriction required by the defective on-train equipment plan was not applied to the train, with the vehicle with the damaged lifeguards leading from Challow to Swindon, the train reached a speed of 85 mph (137 km/h) with passengers on board. The restriction was not applied due to the maintenance controller and the staff at the train not coming to a clear understanding about what damage had been sustained by the train. Rule Book Module M3,[29] which covers managing incidents, provides some guidance on what to check after a train has collided with an obstruction on the track. Lifeguards are listed as an item that could possibly be damaged in these circumstances.

[28] Heavy metal brackets which are fitted vertically immediately in front of the leading end wheels of a rail vehicle, one over each rail, to deflect small objects away from the path of the wheels.

[29] Rule Book Module M3, GERT8000-M3, Managing incidents, floods and snow, issue 4, March 2021.

Work planning

125 There were multiple issues relating to how the work at Challow was planned.

126 The supervisor for the welding and grinding section carried out both the planning and authorisation roles to produce the safe work pack. He was planning and preparing the packs because there was no planner in post at the time, who would normally be responsible for these activities. He was also covering for his line manager, the section manager, who was off work at the time. This left no one to authorise the packs that he had prepared. NR/L2/OHS/019 does allow one person to carry out the planning and authorisation roles for a safe work pack, but notes that this is not ideal as it means there is no independent check of the contents of the safe work pack.

127 The welder, as the PIC, had signed off the safe work pack but had taken no part in the planning as required by NR/L2/OHS/019. Network Rail's investigation of this accident suggested that this was common practice, with the detailed arrangements for the work given to the PIC by the section's team leaders and supervisor instead.

128 The welder had been trained on plain line arc welding but this was to be the first time that he had done it out on the track. The supervisor for the welding and grinding section had planned that the team leader originally allocated to be the COSS (paragraph 24) would mentor the welder and then sign him off as competent after completing the activity that night. This meant that the safe work pack named the welder as the PIC for a task that he was not yet passed out as competent to do.

129 The COSS told Network Rail's investigation that the documentation provided to him on the night was inadequate for the task, but he felt it was the right thing to accept the safe work pack as it was, rather than reject it. The safe work pack itself was generic so did not include any specific task details. The work activity was simply described as 'welding and grinding maintenance / inspections'. It relied on the skills and knowledge of the staff on the night to know what to do. It also included inaccuracies that no one noticed or reported. The specified authorised access point was incorrect, and it included extracts from the sectional appendix which covered the wrong mileages, so did not show the area covered by the work site.

130 Overall, the planning and validation processes resulted in a generic safe work pack, which allowed the welder and the COSS to do the work but, otherwise, added very little value in terms of safety. Similar issues were identified by the RAIB's Shawford (RAIB report 05/2017) and Margam (RAIB report 11/2020) investigations. At Shawford, RAIB found that the safe work packs that were issued for repairing rail defects were generic, covered long mileages and contained errors. The staff using these safe work packs were not involved in the planning activities and were accepting them just to get the work done. At Margam, RAIB found that safe work packs were not perceived by the supervisors and track workers as having much value in keeping people safe. The packs were seen as something that needed to be signed off correctly as complete, rather than documents that guided and assisted staff in undertaking work activities safely.

131 Although there were similarities in the deficiencies in the planning process found in all three investigations, the level of non-compliance with the requirements of NR/L2/OHS/019 found for planning the work at Challow, and its significance for staff safety, was much less than those found by the Shawford and Margam investigations.

Previous occurrences of a similar character

RAIB investigations

132 RAIB investigated an incident where a manually propelled trolley ran away between Larkhall and Barncluith Tunnel on 2 November 2005 (RAIB report 20/2006). The investigation found that the hand trolley did not have any red lights because it was not fitted with brackets to hold them, nor had it ever been a feature of the trolley's design. This observation led to a recommendation about Network Rail risk assessing the use of red lights on trolleys. The implementation of this recommendation resulted in the introduction of GE/RT8000/HB10 in 2010, which required that all hand trolleys display red lights or red flags in both directions. It also led to Network Rail specifying that all hand trolleys used on its infrastructure were required to be fitted with brackets to house red-light units.

133 RAIB investigated an incident involving a runaway track maintenance trolley near Haslemere, Surrey on 10 September 2011 (RAIB report 14/2012). The investigation identified non-compliances and examples of deficient safety behaviours which, when taken together, constituted evidence of a weak safety culture at Network Rail's Havant maintenance depot. One of the listed non-compliances was that the trolley that ran away was not equipped with a red light, which was a requirement of GE/RT8000/HB10. This requirement had been briefed out to Network Rail staff before the introduction of GE/RT8000/HB10 in December 2010.

134 More recently, RAIB investigated an incident where ironmen[30] trolleys ran away, which subsequently led to a near miss at Raven level crossing, Garnant, Carmarthenshire on 1 November 2014 (RAIB report 13/2015). This investigation observed that although the ironmen trolleys had brackets to hold battery operated red lights, neither was equipped with red lights on the night as required by GE/RT8000/HB10. RAIB recommended that Network Rail should review its arrangements for compliance with the requirements of GE/RT8000/HB10, specifically the responsibilities assigned to the person in charge of the trolley. In response, Network Rail updated its manual for this type of trolley so it was clear who on site was accountable for the responsibilities assigned to the person in charge of an ironman trolley. This was supported by revisions to relevant competence and training materials for using ironmen trolleys.

Accidents and incidents from 2017 to 2021

135 RAIB collated data from rail industry logs and safety reporting systems about accidents and incidents involving hand trolleys and rail skates that were left on the track. The data set covered a five-year period from 1 January 2017 to 31 December 2021.

[30] A piece of manually propelled equipment used for transporting lengths of rail within a work site.

136 RAIB identified 23 events, including Challow, where a hand trolley or rail skate had been left on or near the track when the railway was handed back by maintenance staff for the normal operation of trains. Of these events, thirteen involved hand trolleys and on eight occasions the hand trolley was left unattended on the track (figure 17). On two occasions, hand trolleys were left unattended in an axle counter area and both were struck by trains. Meanwhile, four out of the five trolleys left unattended in a track circuited area were detected by the signalling system. Out of the ten events that involved rail skates being left unattended on the track, nine were struck by a train.

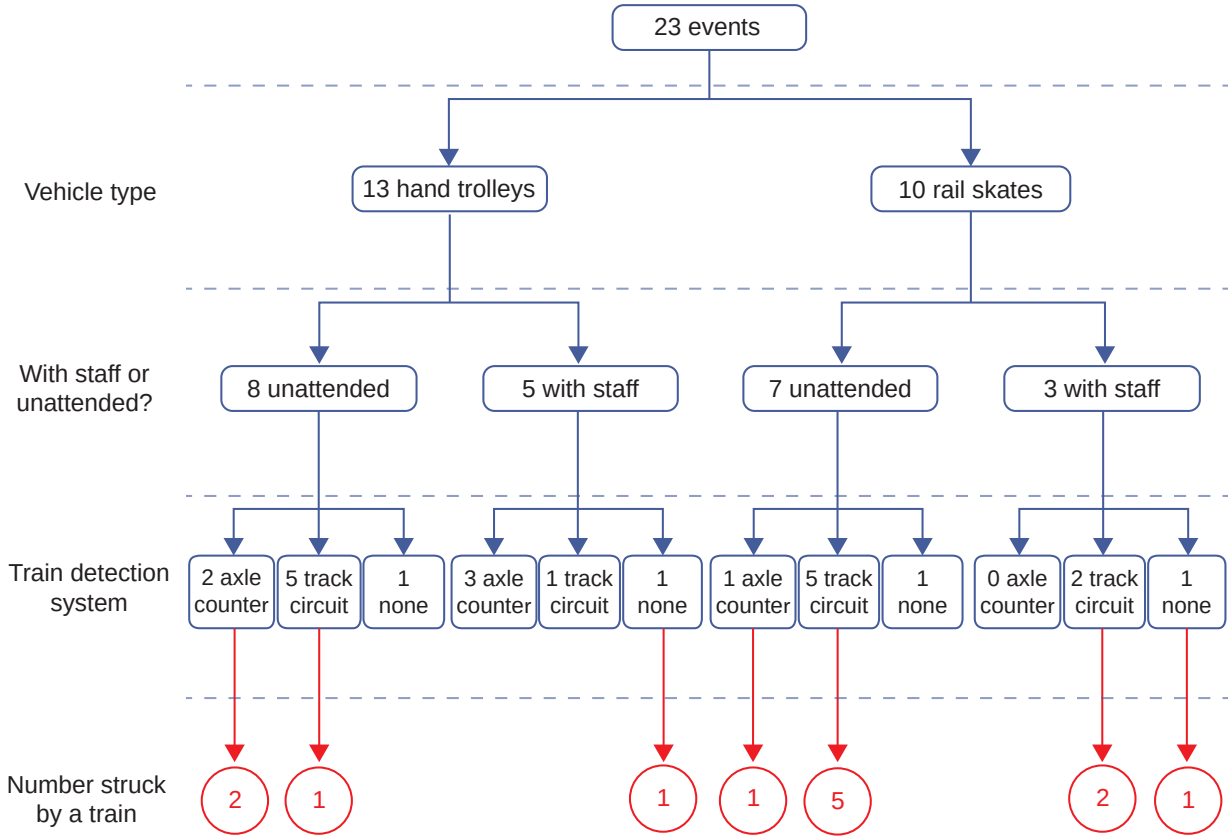

Figure 17: Events involving hand trolleys or rail skates left on or near the track after handback by maintenance staff

137 Similarities with the accident at Challow that were found within these events include:

- Five of the events happened in axle counter areas and the records for all five referred to issues with the LCV process not being followed correctly. Issues with the LCV process not being followed correctly were also noted for a further two events which happened in track circuited areas (paragraph 81).
- Three of the thirteen events involving a hand trolley reported that it was not displaying any red lights. Two of the three hand trolleys not displaying red lights were struck by a train. The other hand trolley was left in a track circuited area and detected by the signalling system, but the incident description stated that the hand trolley was missed when the line was checked at hand back due to a lack of any red lights on it. Four of the events which involved rail skates made references to them not being visible in darkness.

- Three of the events referred to staff being distracted from their usual routine when taking their equipment off the track, which led to them leaving a rail skate or hand trolley behind.

Twickenham

138 On 8 September 2021, about six weeks before the accident at Challow, a similar accident happened near to Twickenham station. At 05:55 hrs, an empty passenger train travelling from Staines to London Waterloo struck a hand trolley on the up main line on the approach to Twickenham station (figure 18). The train was travelling at about 25 mph (40 km/h) at the time. It was the first train to pass through this area after the railway had been handed back for normal operation following track renewal work by the Southern Rail Systems Alliance (SRSA) in an overnight possession. No injuries were reported and there was minor damage to the train and hand trolley.

Figure 18: The train and hand trolley after the collision at Twickenham (courtesy of Network Rail)

139 RAIB gathered initial information to understand what had happened and to decide what its response would be. RAIB decided not to undertake an investigation and instead publish a safety digest, as the safety learning to be gained from this accident mainly related to compliance with existing rules, procedures or standards. After the accident at Challow, RAIB reviewed this decision and decided not to publish a separate safety digest for the Twickenham accident, but to consider it as part of the Challow investigation.

140 The rail industry investigation into the Twickenham accident was carried out by the SRSA. This found widespread non-compliances by a team of contractors made up of four welders that had used the hand trolley and subsequently left it on the track. The welders had used several hand trolleys that night which they had found in a storage area in the compound for the work (figure 19). They accessed the track at the far end of the compound, away from the official access point, which was at the road-rail access point at the other end of the compound. They stated that they accessed the track at that location due to congestion in the compound caused by vehicles and materials. Before starting work, the welders did not report to a COSS nor receive a briefing, and they put the hand trolleys onto the track without obtaining permission from a COSS. They then used the hand trolleys all night.

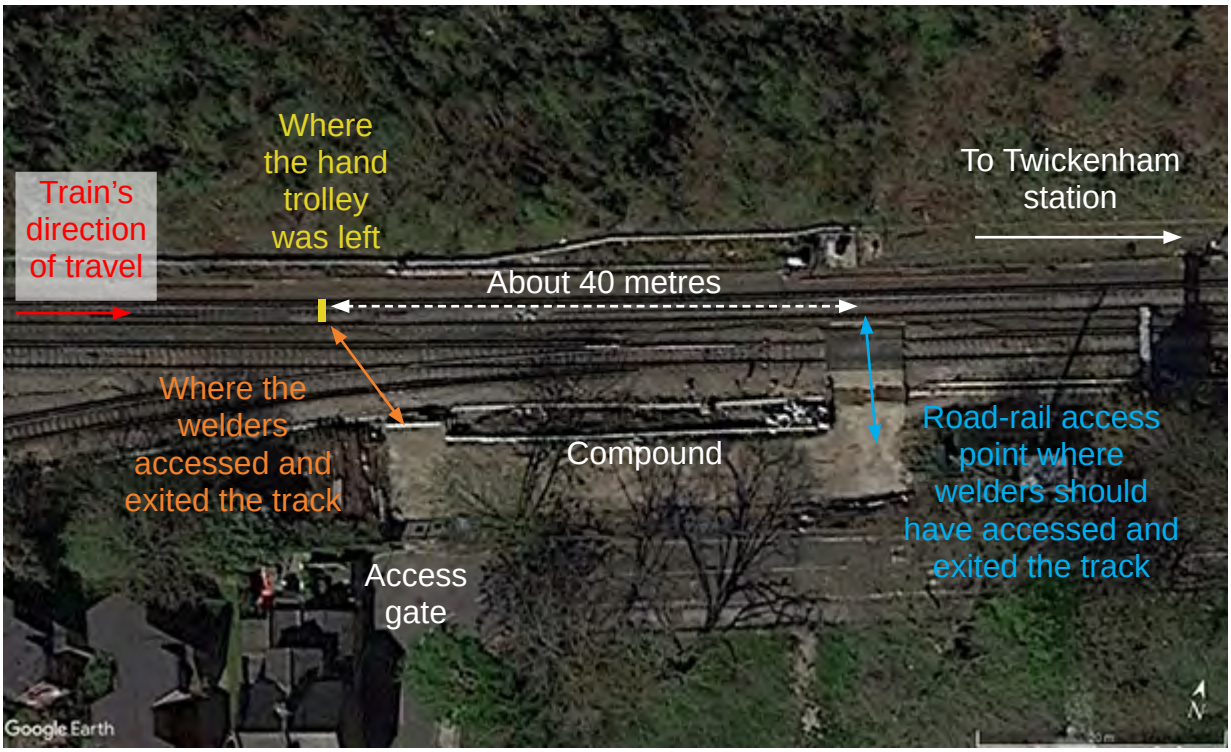

Figure 19: The layout at the access point near Twickenham

141 After finishing their work, the welders went back to the place they had used to access the track and unloaded their equipment. They then left one of the hand trolleys on the track, thinking that someone else would take it off the track before the work site was handed back. As the welders had gone about 40 metres beyond the official access point, no one checked beyond this point when the work site was handed back.

142 Axle counters were used for train detection where the hand trolley was struck so the LCV process should have been followed, with a COSS recording on a VMF when the hand trolley was placed on the track. This did not happen as the welders did not tell anyone that they were using hand trolleys, so none were recorded on a VMF by a COSS. As there were multiple groups working within the work site, each COSS thought that the other must be controlling the hand trolleys that were being used by the welders.

143 Forward-facing CCTV footage from the train showed there were no red lights illuminated on the hand trolley that was struck. The lack of red lights also meant no one at the road-rail access point noticed the hand trolley in the dark when the work site was handed back.

144 The rail industry investigation made 15 recommendations. These included:

- removing the track safety competencies of the welders
- investigating the use of technology for tracking hand trolleys while they are on the track
- carrying out audits and inspections in SRSA track renewal sites to ensure that the associated controls for using hand trolleys are being cascaded thoroughly down to those using this equipment and that VMFs are being used
- requiring staff working in SRSA track renewal sites to follow the LCV process, irrespective of whether it is a location fitted with axle counters
- risk assessing track hand back procedures for SRSA track renewal sites, with a recommendation to check at least 150 yards (137 metres) beyond the access point and areas of work.

Summary of conclusions

Immediate cause

145 A hand trolley was left on the track after the railway was handed back for the normal operation of trains at the completion of overnight maintenance work (paragraph 44).

Causal factors

146 The causal factors were:

a. The maintenance team that carried out overnight work at Challow left their hand trolley on the track (paragraph 49, **Recommendations 1 and 2**).

b. No one who was at the Challow access point noticed the hand trolley was still on the track when the work site was handed back (paragraph 59, **Recommendations 3, 4 and 5**).

c. The checks undertaken before handing back the railway for normal operation did not identify that the hand trolley was still on the track (paragraph 71). This causal factor arose due to a combination of the following:

   i. There were weaknesses within the overall LCV process making it susceptible to error (paragraph 79, **Recommendations 1 and 2**).

   ii. The maintenance team did not carry out its part of the LCV process as it was required to. This is a possible factor (paragraph 89, **Recommendations 1, 2 and 5**, **Learning point 1**).

Underlying factors

147 The underlying factors were:

a. Hand trolleys were being routinely used at night without displaying red lights and no assurance activities were taking place within work sites to monitor compliance. This is a probable underlying factor (paragraph 94, **Recommendations 3, 4 and 5**).

b. The LCV process was reliant on human actions for its successful implementation, which the rail industry had recognised, but not yet implemented any measures to avoid or mitigate errors (paragraph 102, **Recommendations 1 and 2**).

c. The LCV process was separate to Network Rail's work planning process as defined by standard NR/L2/OHS/019. This is a possible underlying factor (paragraph 111, **Recommendation 1**).

d. The Network Rail Swindon delivery unit welding and grinding section was routinely not complying with the LCV process and Network Rail had not detected this through its assurance activities. This is a possible underlying factor (paragraph 114, **Recommendation 5**).

Additional observations

148 Although not linked to the cause of the accident on 21 October 2021, RAIB observes that:

a. After the accident, the train was allowed to travel at a speed above that which should have been permitted given the level of damage it sustained in the collision (paragraph 120, **Learning point 2**).

b. There were multiple issues relating to how the work at Challow was planned (paragraph 125, **Learning point 3**).

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

149 Since this accident happened, Network Rail has issued safety advice across all of its regions to alert its staff about what happened, and to remind them of what should be done when a line under possession is handed back.

150 Network Rail's Western route has also addressed several issues identified by this investigation since the accident:

- It has purchased and issued magnetic rechargeable red lights to the teams in the local welding and grinding section (paragraph 96).
- It has amended its self-assurance matrix to include NR/L3/OPS/084, so that specific questions on the LCV process are now included in the audits of its track maintenance function (paragraph 117). This change took effect from the start of April 2022.

151 Immediately following the accident, senior management within the Swindon delivery unit also mandated an increase in manager self-assurance for the LCV process, with both desktop and site checks of LCV documentation (paragraph 118). This included reviewing documented evidence, such as completed VMFs.

152 As an interim measure, Network Rail's Western route has introduced an equipment checklist that is pre-populated with medium and large items of equipment that could be left on track by staff in either the track or the welding and grinding sections. Staff from these sections are required to record if any of these items of equipment are used during the work. They must also sign the checklist to confirm that all items have been returned to the road vehicle afterwards. This process has been briefed and introduced throughout all the track sections and welding and grinding sections in the Swindon delivery unit. It was also being cascaded throughout all the Western route delivery units.

153 The Network Rail staff responsible for NR/L3/OPS/084 are considering a solution to support the LCV process that uses codes to track vehicles used in possessions and work sites (paragraph 108). Any vehicle that can be placed on the track will have a code on it. The COSS will use a software application (app) on their mobile phone to scan the vehicle's code when it is placed on, or taken off, the track. The app will then give the engineering supervisor and PICOP visibility of what vehicles are on the track at any time. There is no timescale for implementation yet, as this solution is still at the concept stage and staff are seeking funding for it. As with the existing LCV process, this solution still has a potential weaknesses in being reliant on the COSS using it correctly.

154 Network Rail's Western route is also considering what technology can be used to improve the LCV process (paragraph 109). It has identified a system which uses a 'tag' fitted to the hand trolley and a 'gateway' to the road vehicle used to bring the hand trolley to site. The road vehicle gateway communicates with the tag fitted to the hand trolley every few seconds to determine if the hand trolley is either separated from or with the road vehicle. The gateway also updates an app so remote users can see if the hand trolley is with, or separated from, the road vehicle. As this system will identify whether a hand trolley has been returned to the road vehicle electronically, the engineering supervisor can use this information to support the verbal response given by a COSS during the latter stages of the LCV process.

155 In 2021, industry groups facilitated by RSSB started looking at the risk of objects left on the line (paragraph 109). The train operating companies had raised concerns, through the Train Accident Risk Group, specifically about hand trolleys and other large objects being left on the track following maintenance work. This concern was passed to the Infrastructure Safety Leadership Group (ISLG). A paper to ISLG in July 2021 noted that the risk to trains over the previous year from objects on the line, excluding those relating to earthwork and structure failures, had accounted for around 15% of the total risk to trains, which was a higher proportion than trains passing signals at danger over the same period. The paper also identified eight accidents where a train had struck a hand trolley or rail skate in a three-year period.

156 The paper to ISLG reported on an initiative by a contractor which had implemented an additional control for this risk by using a nominated site inspection person. If the risk assessment for the work determined that equipment could be left on the track, the need for an inspection was planned and a person was nominated to do it. This person would then carry out a site inspection and provide an independent confirmation to the engineering supervisor that the site was clear of materials, plant, on-track plant, and other equipment at hand back.

157 In response, ISLG decided to support work to mitigate the risk of hand trolleys being struck by trains by communicating the risk to the rail industry through its briefings, collating and promoting good practice, liaising with Network Rail, and tracking this risk through data. ISLG also began looking at work that was taking place within the rail industry to make improvements by using technology. This technology would allow people to monitor the location of a hand trolley, so they could check if it is being used in the correct places as well as taken off the track at the end of the work.

158 During 2021, RSSB commissioned work to look at the issue of objects on the line. This work considered the many different types of object that a train could encounter, so it included categories for vandalism, road vehicles, animals and maintenance work. Data over a five-year period was analysed. The analysis of the maintenance work category focused on the most frequent types of objects encountered by a train. These were ballast bags, followed by items of equipment related to the protection for a work site or possession, such as detonators and marker boards. Hand trolleys and rail skates were only a very small percentage of the objects left on track after maintenance work, so were not analysed in any detail, as this work did not consider each type of object in terms of the risk to a train from striking it.

Recommendations and learning points

Recommendations

159 The following recommendations are made:[31]

1 *The intent of this recommendation is to make shorter-term changes to the existing line clear verification process to reduce the likelihood of vehicles such as hand trolleys or rail skates being left on the track when the line is handed back after engineering work*.

Network Rail should examine the safeguards and controls in the existing line clear verification process to establish what improvements could be made. This should build on any relevant existing work that has already been undertaken by Network Rail and should specifically consider:

- why the current vehicle management forms are not being used by some hand trolley and rail skate users
- whether the overall risk of using hand trolleys and rail skates could be reduced through a consistent application of an improved line clear verification process across its infrastructure, rather than limiting its use to only those areas that use axle counters for train detection
- if the line clear verification process should be integrated with the planning processes for managing the safety of people working on or near the line.

Network Rail should then implement any changes identified to create a revised line clear verification process, clearly define when and where the revised process should be applied on its infrastructure, and brief staff on any changes that are made (paragraphs 146a, 146c.i, 146c.ii, 147b and 147c).

[31] 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 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.

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.

2 *The intent of this recommendation is to consider longer-term changes to the line clear verification process which incorporates technology to reduce the risk of vehicles such as hand trolleys or rail skates being left on the track when the line is handed back after engineering work*.

Network Rail should investigate what technology could be used to support the line clear verification process and minimise the influence of predictable limitations of human performance. This should build on the existing work that has already been undertaken by Network Rail and the Infrastructure Safety Leadership Group to look at potential solutions which use technology. Network Rail should then implement any changes identified to:

- create a revised line clear verification process that is supported by technology
- clearly define what equipment is needed
- provide the equipment to allow the use of the revised process on its infrastructure
- brief and/or train staff on the changes that are made to the process and the equipment that is introduced (paragraphs 146a, 146c.i, 146c.ii, and 147b).

3 *The intent of this recommendation is to remove the risk of hand trolleys with red flags not being seen by staff during darkness and subsequently left on the track*.

Network Rail, following the prescribed industry processes, should propose an amendment to Rule Book Handbook 10, GE/RT8000/HB10, so that hand trolleys are required to display an illuminated red light in both directions, at all times when on the track, and that the existing reference to the red flag is completely removed (paragraphs 146b and 147a).

4 *The intent of this recommendation is to reduce the risk of hand trolleys not being seen by staff during the hours of darkness and subsequently left on the track*.

Network Rail should develop and implement processes to ensure that any hand trolley placed on its track has illuminated red lights displayed in both directions at all times. These processes should include pre-use equipment checks, provision of spare parts, availability of alternative equipment should a red light fail or break, and a mechanism to report and rectify faults before the hand trolley is used again (paragraphs 146b and 147a).

5 *The intent of this recommendation is to reduce the risk of hand trolleys or rail skates being used in an unsafe way and left on the track when the line is handed back after engineering work*.

Network Rail should review the effectiveness of its safety assurance activities relating to the use of hand trolleys. It should address any deficiencies that are identified so that the associated risks are better controlled (paragraphs 146b, 146c.ii, 147a and 147d).

Learning points

160 RAIB has identified the following learning points:[32]

1 Network Rail staff and contractors are reminded of the importance of complying with all of the rules and standards concerning how trolleys and rail skates should be used on Network Rail infrastructure, such as displaying red lights on a hand trolley or following the required processes to ensure that hand trolleys or rail skates are off the track when the line is handed back (paragraph 146c.ii).

2 It is important that communications between the driver, the staff who attend accidents and those based in control rooms are clear and establish exactly what damage has been sustained by the train involved as described in Rule Book Module M3. This will permit control room staff to apply the appropriate parts of the defective on-train equipment plan and tell the driver what restrictions are in place before the train is permitted to move (paragraph 148a).

3 Staff involved in planning work on Network Rail's infrastructure are reminded that standard NR/L2/OPS/019 requires them to produce safe work pack documentation that is accurate, appropriate and specific for the task that is being carried out and that the planning process should involve the person nominated to be the person in charge (paragraph 148b).

[32] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where 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

CCTV	Closed-circuit television
COSS	Controller of site safety
ISLG	Infrastructure Safety Leadership Group
LCV	Line clear verification
PIC	Person in charge
PICOP	Person in charge of possession
RRAP	Road-rail access point
RRV	Road-rail vehicle
SRSA	Southern Rail Systems Alliance
TVSC	Thames Valley Signalling Centre
VMF	Vehicle management form

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from the train's on-train data recorder
- CCTV recordings taken from the train
- site photographs
- weather reports and observations at the site
- voice communications between the driver, signaller, technical riding inspector and staff in the control room
- train running information
- industry control logs
- documentation for the overnight maintenance work, work site and possession
- staff competency and training records, plus contents of the training course presentations
- information about the hand trolley
- Rule Book modules and Network Rail company standards
- photographs and documents describing the damage to the train
- reports and data for previous accidents and incidents involving hand trolleys and rail skates left on the line
- rail industry investigation reports for Challow and Twickenham
- a review of previous RAIB investigations that had relevance to this accident.

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