RAIB

Rail Accident Investigation Branch

Rail Accident Report

Collision between two road-rail vehicles at Cholmondeston, Cheshire 19 September 2018

Report 08/2019
July 2019

This investigation was carried out in accordance with:

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

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Preface

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

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

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

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, 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 event being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

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

Information about casualties is based on figures provided to the 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. The 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.

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

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Collision between two road-rail vehicles at Cholmondeston, Cheshire, 19 September 2018

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Summary

At around 02:30 hrs on Wednesday 19 September 2018, a road-rail ballast distributor, that was travelling in reverse on the line between Chester and Crewe, collided with a small personnel carrying vehicle, near Cholmondeston in Cheshire. Two track workers who were in the rear of the personnel carrier were injured, one of them suffering life changing leg and back injuries. There was some damage to the two vehicles involved and minor damage to the track.

The collision occurred because the design of the ballast distributor was such that there was very limited visibility of the line ahead when it was being driven in reverse, and because no-one was controlling its movements from the ground, as mandated by both the railway Rule Book and the vehicle-specific operational restrictions.

There was also confusion amongst the staff involved about the location of the work that was being undertaken and the location of personnel. As a result, those on the ballast distributor believed that the personnel carrier was further up the line than it actually was.

The RAIB has made two recommendations. One is addressed to RSSB to review the effectiveness of technical standards for managing safe travelling with road-rail vehicles, in particular considering controls for maintaining visibility of the line ahead and controlling speed. A second similar recommendation is targeted at Network Rail for it to consider the same risks for machines that are already operating on the network.

The RAIB has also identified five learning points, relating to the use of safety related communications protocols at site, awareness of measures to be taken when visibility of the line ahead is compromised, taking account of machines' limitations when planning their use, the control of risk in long worksites, and ensuring that machine operators are fully trained in the operation of their machines.

Introduction

Key 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.

The accident

Summary of the accident

2 In the early hours of Wednesday 19 September 2018, a ballast distributor (see paragraph 13) road-rail vehicle (RRV) was being driven in reverse, on the line between Chester and Crewe, in connection with overnight track repair work. At around 02:30 hrs, the ballast distributor collided with a personnel carrying RRV, known to rail staff by its brand name 'kubota' (the term used throughout the rest of the report). Two track workers were seated in the rear of the kubota immediately prior to the collision.

3 The design of the ballast distributor was such that there was very limited visibility of the line ahead when it was being driven in the reverse direction. The machine controller[1] was in the cab of the vehicle with the machine operator, instead of controlling the reverse movement from the ground. The ballast distributor was also being driven at a speed considerably above the maximum allowed by its operational certification and by the railway Rule Book[2].

4 One of the track workers in the kubota suffered life changing leg and back injuries, while the other suffered sprains and bruising to his arm. There was significant damage to the kubota and damage to the conveyor belt mechanism on the rear of the ballast distributor. There was also minor damage to the track as a result of the kubota becoming derailed.

Context

Location

5 The accident occurred on the line between Chester and Crewe, near Cholmondeston (figure 1). The RRVs had been put on the down line[3] at Calveley road-rail access point (RRAP), at 166 miles 221 yards[4], before travelling to undertake work in the vicinity of 162 miles 1450 yards, beyond the Cholmondeston access point (figure 2). The collision occurred at that site of work, when the moving ballast distributor encountered the stationary kubota.

6 The railway at this location comprises two non-electrified tracks, with a downhill gradient towards Crewe of 1 in 427. The speed limit for trains travelling in both directions is 90 mph (145 km/h). However, the ballast distributor was mechanically limited to a top speed of around 20 mph (32 km/h) with a procedural limit of walking pace when travelling in reverse (see paragraph 65).

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[1] The competent person who controls and supervises the safe operation of on-track plant that is being driven, or operated, by a machine operator.

[2] GE/RT8000 – Rule Book, published by RSSB.

[3] The down line is normally used by trains travelling towards Chester, while the up line is normally used by trains travelling towards Crewe.

[4] The mileage is measured from London Euston station.

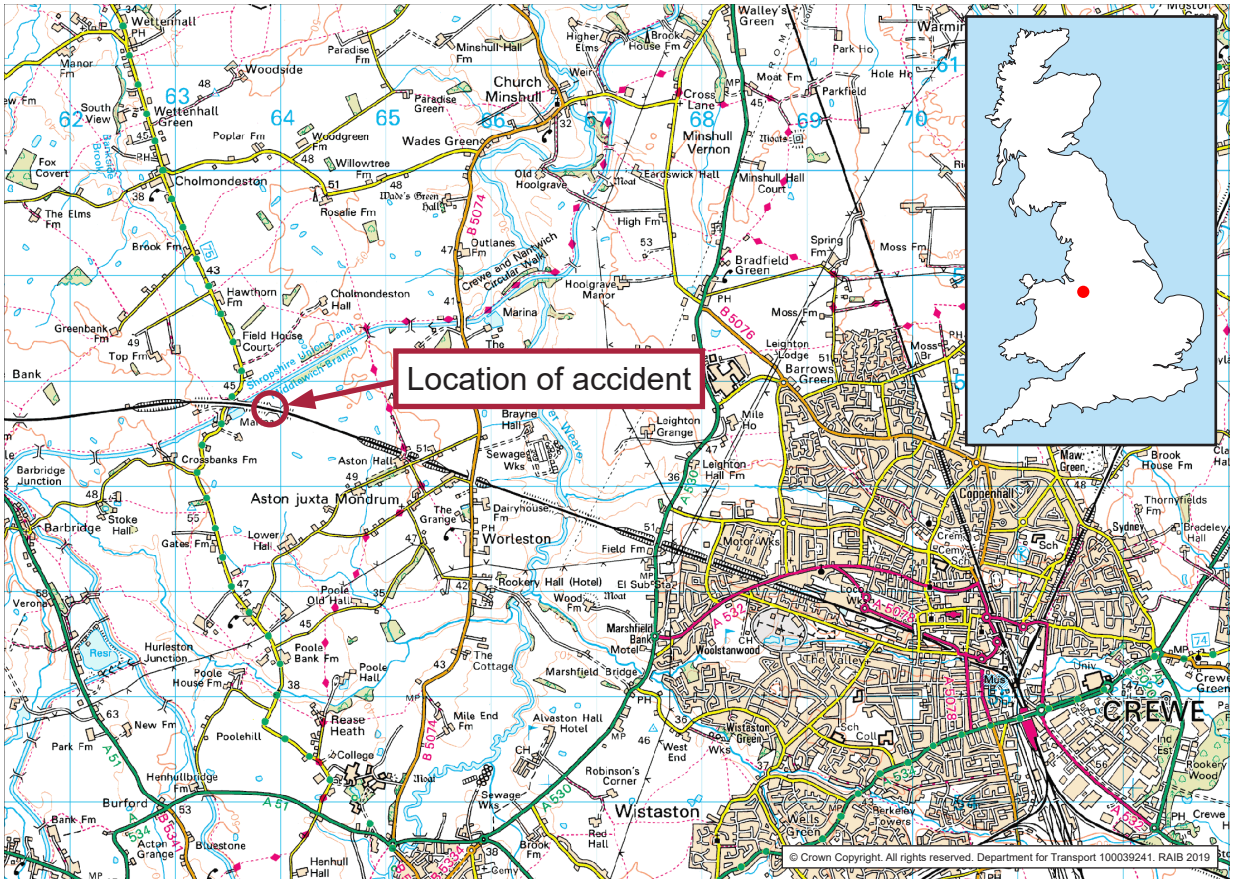

Figure 1: Extract from Ordnance Survey map showing location of accident

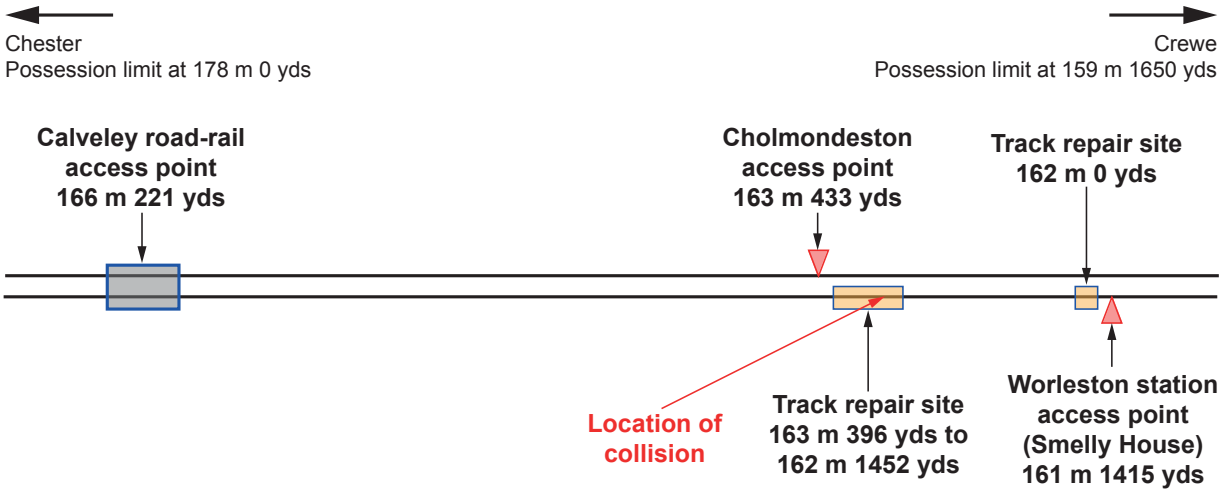

Figure 2: Overview of site showing geographical relationship of key features

7 The signalling on the section of line where the accident occurred is controlled by Beeston Castle & Tarporley signal box to the west and Crewe Steel Works signal box to the east. However, at the time of the accident, the section of line was under possession with responsibility for authorising traffic movements lying with the PICOP[5] and engineering supervisor[6].

[5] Person in charge of possession.

[6] The person nominated to manage the safe execution of works within a worksite. This includes arranging the marker boards, authorising movements of on-track plant and trains into and out of the worksite and managing access to the site.

Organisations involved

8 Network Rail owns and manages the infrastructure as part of its London North Western route, and was the owner and operator of the kubota. It was also the employer of the track maintenance staff, including the machine controller, who were based at its Chester depot.

9 AP Webb Plant Hire was the owner of the ballast distributor RRV and had hired it to Network Rail. It was also the employer of the machine operator for the ballast distributor. AP Webb Plant Hire is part of Webb Plant Group Ltd.

10 Railability carried out the road-rail conversion of the ballast distributor. Railability is also part of Webb Plant Group Ltd.

11 SNC-Lavalin Rail & Transit Verification Ltd, and its predecessor Interfleet Technology Ltd, carried out the plant approval assessment activities for the ballast distributor in 2005, 2010 and 2017.

12 Network Rail, AP Webb Plant Hire, Railability and SNC-Lavalin freely co-operated with the investigation.

Vehicles involved

Ballast distributor RRV

13 The ballast distributor RRV (figure 3) is a road based dumper truck, manufactured by JCB, and converted for use on the UK rail network by Railability in 2005. After conversion, the cab of the RRV remained unidirectional, with the operator's seat facing forwards away from the hopper. There is no evidence that JCB played any part in the factors relating to the accident.

Figure 3: The ballast distributor road-rail vehicle

14 The vehicle is fitted with a ballast hopper module that has a conveyor belt in the bottom. This conveyor belt extends to the rear of the vehicle and can swing laterally to allow the ballast to be deposited where required on, or beside, the track. The hopper can carry up to 10 tonnes of ballast.

15 The ballast distributor is a type 9B high ride[7] RRV. Each of the rail wheels has a brake that is applied when the vehicle is not being driven forwards or backwards. On this RRV, the tyres make contact with an extended hub on each of the rail wheels. This means that when the RRV is in rail mode, forward movement of the road wheels corresponds to reverse movement of the rail wheels, and vice versa. The differences in diameters of the extended hubs, the rail wheels and the road wheels alters the overall vehicle gearing when operating in rail mode. As a result, for a given road wheel rotational speed, the vehicle travels 2.5 times faster in rail mode than it does when in road mode. The RRV software was configured to limit the available gears when in rail mode such that the maximum speed was approximately 20 mph (32 km/h).

Personnel carrier RRV

16 The personnel carrier RRV was a Permaquip Kubota (figure 4). This is a four-wheeled Kubota all-terrain vehicle that had been converted for use on rail by Permaquip. When on the track, the rail wheels are lowered to provide guidance. The road wheels remain in contact with the rail, taking the weight and providing traction and braking (type 9C[7]).

Figure 4: A 'kubota' personnel carrier RRV, similar to that involved in the accident

17 The kubota has seating for two people, including the driver, in the front, as well as space for up to four people and/or equipment in the rear. There is no evidence that the design, construction or conversion of the vehicle for rail use played any part in the cause of the collision.

[7] The friction forces used to power or to brake the rail wheels on high ride RRVs are provided by pressing the rubber road tyres into contact with either the tread of the steel rail wheel or with an extended hub which protrudes from the rail wheel (both type 9B). There are also low ride type RRVs (type 9C) where, when operating on the railway, the traction and braking forces are transmitted to the rails by the road wheels with the load shared between the road and rail wheels; and direct drive machines (type 9A), where the traction and braking forces are transmitted directly to the rail wheels (ie the rail wheels are self-powered). Type 9A and 9B RRVs also have braking directly on the rail wheels.

Staff involved

18 The machine operator who drove the ballast distributor had worked on the railway in this role for approximately 9 months, having been trained by AP Webb Plant Hire at its training school. He had operated the ballast distributor on site several times since his training. He held the appropriate competences required to operate the vehicle, including 'machine operator', and had no safety related incidents on his employment record. On the night of the accident he was operating the ballast distributor under the supervision and direction of the machine controller.

19 The machine controller for the ballast distributor had worked in railway track maintenance in the local area for 34 years. He had held the 'machine controller' competence for the last 9 years. He was very familiar with use of the ballast distributor and had worked with it many times over a period spanning several years. He was acting as both COSS[8] and PIC[9] for the ballast distributor.

20 The section manager for Chester depot, who was responsible for the day to day maintenance of the track within a defined maintenance area, had worked for 37 years on the railway, with most of the last 14 years being based at Chester. He had experience working on both track maintenance and signalling.

21 The machine operator for the kubota was also acting as machine controller and PIC for both the kubota and a tamper bank RRV (see paragraph 34). He had worked in track maintenance for 39 years, and had always been based in this area.

22 The COSS for the track workers with the kubota, who was also acting as PIC for them, had worked in track maintenance for 41 years. He had worked for 20 years as a team leader, and had always been based in this area.

23 Three other track workers were part of the gang working with the kubota, including the two who were injured in the accident. Their roles and experience played no part in the causes of the collision between the two vehicles.

24 Network Rail stated that there were no safety-related incidents recorded on the employment records of its members of staff who are listed above.

External circumstances

25 It was dark throughout the work. There was no site lighting, and staff used lights on the vehicles and head torches to see what they were doing. When stationary, the kubota displayed red marker lights on both ends.

26 It was overcast and damp at the time of the accident, but it was not raining. There was no external noise, apart from that coming from the vehicle engines.

27 There is no evidence that any external factors affected the accident.

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[8] The COSS (controller of site safety) is 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] The PIC (Person in Charge) is a person who has been involved in the planning of the work and has the overall accountability for supervising and overseeing it where it is being undertaken.

The sequence of events

Events preceding the accident

Previous nights

28 During the week of the accident, a routine possession[10] of the railway between Chester and Crewe was scheduled for each night to allow track maintenance, vegetation management and drainage work to take place.

29 On the night of Sunday 16 September, a tamper[11] had carried out some tamping work near Beeston Castle & Tarporley signal box (168 miles 1320 yards). The track maintenance staff had identified that the ballast level had dropped as a result of the tamping and that it needed to be topped up with fresh ballast. They also anticipated that tamping due to take place at Cholmondeston, on the night of Wednesday 19 September, would require a similar ballast top up. As a result of this, on the morning of Monday 17 September, the section manager at Chester depot arranged for the ballast distributor (figure 5), and an operator, to be hired for the nights of Monday 17 and Tuesday 18 September to drop ballast at the two tamping locations.

Figure 5: A ballast distributor dropping ballast (courtesy of AP Webb Plant Hire)

[10] A possession is a period of time during which one or more lines are blocked to trains to allow engineering work to be safely undertaken.

[11] An on-track machine used to lift and/or adjust the position of the track while consolidating the ballast under the sleepers.

30 Also on Monday 17 September, the machine controller for the ballast distributor prepared the on-track plant (OTP) planning paperwork for the proposed use of the ballast distributor and submitted this to the planning staff for inclusion in the safe work pack (SWP) paperwork[12]. This paperwork was completed and the revised SWP was issued and approved for the work to be done on the nights of Monday 17 and Tuesday 18 September. This work was to include both the dropping of ballast from the ballast distributor on both nights and repair of track faults within the worksite.

31 On the night of Monday 17 September, the ballast distributor was used to drop the required ballast near to Beeston Castle & Tarporley signal box, as planned.

Night of Tuesday 18 September

32 Most of the track maintenance team met at Chester depot from about 22:30 hrs. They travelled to the Calveley RRAP and met up with another team member there. The team received confirmation from the PICOP that the possession was in place at about midnight. The COSS gave a safety brief to the team and they all signed the SWPs to acknowledge this before they accessed the track.

33 The first vehicles to on-track at the RRAP were a drain cleaning vehicle and a second kubota. These were operated by an off-track team that were working independently of the Chester track maintenance team, and set off to undertake drainage work on the up line on the Crewe side of the 162 milepost.

34 The track maintenance team then on-tracked their kubota on the down line at the RRAP, followed by a 360 degree excavator type RRV that was fitted with a tamper bank attachment[13] instead of a bucket (henceforth referred to as the tamper bank RRV - figure 6). The five members of the team then travelled to 162 miles 1450 yards, with the two RRVs, where they were intending to repair a track geometry fault by lifting and tamping the track.

Figure 6: The tamper bank RRV

[12] A pack of information used by a person in charge that provides the safety arrangements for work to be undertaken on site.

[13] This consists of a number of vibrating tines that are plunged into the ballast under track that has been manually lifted using jacks. The tines vibrate the ballast to settle it in place under and around the sleepers, thus stabilising the track position.

35 The machine controller for the ballast distributor remained at the RRAP at Calveley, along with the machine operator. After the ballast distributor had been loaded, they moved it on to the down line at the RRAP and on-tracked it at about 00:30 hrs. The ballast distributor was on-tracked facing Chester because the adjacent disused platform hindered on-tracking facing Crewe. The machine operator was unable to release the rail wheel brakes and therefore could not carry out the required brake check. The machine controller called the track maintenance team to advise them of the problem with the ballast distributor. After spending a little time carrying out initial investigations, the machine operator called an on-call fitter for assistance. He arrived at the RRAP at approximately 01:50 hrs.

36 Between 01:00 hrs and 01:30 hrs, the track maintenance team had completed the work using the tamper bank RRV. After discussion with the ballast distributor machine controller, the kubota machine controller sent the tamper bank RRV back to Calveley RRAP, where it was off-tracked, after the ballast distributor had been moved clear of the RRAP. The track maintenance team agreed with the ballast distributor machine controller that they would wait where they were until the ballast distributor was able to get there.

37 The fitter repaired the ballast distributor by about 02:10 hrs and the machine operator was then able to release the brakes and undertake a successful brake test. The machine controller deployed the conveyor ready for dropping stone, as was normal practice, and he then got into the ballast distributor's cab, alongside the machine operator. At approximately 02:20 hrs, they set off towards the track maintenance gang, which they understood to be at 162 miles 0 yards, close to Worleston station access point (colloquially referred to by staff as 'Smelly House').

Events during the accident

38 The track maintenance team were waiting where they had completed the track repair, around 162 miles 1450 yards. Three of the staff were sitting in the stationary kubota, with two of them in the rear. The other two staff were standing on the track close to the kubota as the ballast distributor approached.

39 The track maintenance staff were able to hear the ballast distributor approaching before they were able to see it. Witness evidence described that the sound of it approaching gave a clear impression of it travelling at a significant speed. Calculations, based on the estimated time of departure from Calveley and the time of the emergency call to the ambulance service, indicate an average speed of between 11 mph (18 km/h) and 15 mph (24 km/h).

40 On first hearing the approaching ballast distributor, the COSS started walking towards it. He was expecting it to stop, before being walked in to the site of work by the machine controller.

41 On the approach to the accident site the machine controller was looking out of the ballast distributor windscreen, backwards in the direction of travel, to identify how much ballast was required to be dropped there. His intention was to do a second ballast drop there later, on the return trip from Smelly House.

42 The COSS saw the approaching ballast distributor, and recognised that it was travelling faster than he expected, and was showing no signs of slowing down. He then started waving his arms and shouting to alert the staff on the ballast distributor that they should stop.

43 The kubota's machine operator also recognised that the ballast distributor was not slowing down and got into the driving seat to attempt to move it forwards to prevent a collision. The kubota's engine was already running and the machine operator started moving the kubota forwards, but he was unable to prevent the collision from occurring (figure 7).

Figure 7: The position of the two vehicles after the collision

44 The two track workers in the back of the kubota tried to leave the vehicle before the collision. One was able to clamber over the side. The other was unable to escape in time and became trapped between the conveyor on the ballast distributor and the cab of the kubota. The third track worker, who was in the passenger seat in the front of the kubota was able to get out before the collision. The kubota machine operator remained in the driving seat, but did not suffer any injuries.

45 Following the collision, the kubota became derailed and was pushed for a distance of about 30 metres along the track before the ballast distributor came to a stop.

Events following the accident

46 The machine operator for the ballast distributor made an emergency call for an ambulance at 02:33 hrs. It arrived at Cholmondeston access point, approximately 500 metres from the location of the accident, at about 02:50 hrs. The kubota associated with the drainage work on the up line was used to shuttle people and materials between the access point and the accident location, aiding movement of the injured parties.

47 The railway remained closed until approximately 11:30 hrs, while the machines were recovered from the line.

Key facts and analysis

Background information

Plant approval

48 As part of its plant approvals process, Network Rail currently requires RRVs to be certificated against RIS-1530-PLT issue 6 'Rail Industry Standard for Engineering Acceptance of On-Track Plant and Associated Equipment' before they are allowed to operate on its infrastructure. This standard is owned by RSSB[14] and defines the technical criteria that on-track plant, including RRVs, has to meet before an Engineering Conformance Certificate (ECC) is issued.

49 The ballast distributor was converted from a road vehicle in 2005. At that time, the relevant technical standard was GM/RT1300 issue 4 'Engineering Acceptance of Road-Rail Vehicles and Associated Equipment'. The machine was assessed against this standard, resulting in it being issued with an Engineering Acceptance Certificate (EAC)[15].

50 Subsequent to its first certification in 2005, the ballast distributor was reassessed against RIS-1530-PLT issue 2 in 2010 and a new EAC was issued. EACs issued against RIS-1530-PLT are valid for a maximum of seven years, and after that period machines have to be reassessed against the latest version of the standard and modified as necessary, to ensure compliance. Consequently the ballast distributor was reassessed against RIS-1530-PLT issue 6 in 2017 and issued with a new certificate (ECC). A copy of the current ECC was kept in the cab of the ballast distributor, as mandated by Network Rail standard NR/L2/RMVP/0200/module P504 'Infrastructure plant manual - Plant documentation and marking'.

Identification of the immediate cause

51 **The ballast distributor did not stop before it collided with the stationary kubota on the down line.**

Identification of causal factors

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

- The ballast distributor was being driven with neither the machine operator nor the machine controller having sight of the line ahead (see paragraph 54).
- The track workers in the tamping track gang were not where the machine controller for the ballast distributor expected them to be (see paragraph 96).

[14] A not-for-profit body whose members are the companies making up the railway industry. The company is registered as Rail Safety and Standards Board Ltd, but trades as RSSB.

[15] Until 2015, compliance with GM/RT1300 and RIS-1530-PLT was documented by issuing an EAC. With the introduction of RIS-1530-PLT issue 6 in 2015, EACs were superseded by ECCs.

53 Line of sight driving (at a speed enabling the machine operator to stop on sighting an obstruction), as mandated by the Rule Book (see paragraph 79), would have been sufficient to prevent the accident. However, it is also the case that the accident would not have happened if the staff involved had reached a common understanding of the locations of work and where the track workers were located.

Design and operation of the ballast distributor

54 The ballast distributor was being driven with neither the machine operator nor the machine controller having sight of the line ahead.

55 When a rail vehicle is being driven inside a possession or in a worksite, the primary means of avoiding collisions is for the machine operator or, under certain situations, the machine controller, to have clear sight of the line ahead.

56 Both the machine controller and the machine operator were in the cab of the ballast distributor during the trip from the RRAP at Calveley to the site of work. Visibility of the line ahead from the cab of the ballast distributor is very restricted when travelling in reverse. Both of the seats in the cab face forwards and the view to the rear is obscured by the hopper and any load contained within it.

57 This causal factor arose due to a combination of the following:

- Personnel seated in the cab of the ballast distributor have a very restricted view of the line ahead when driving in reverse (see paragraph 58).
- The machine controller for the ballast distributor was not controlling movements from the ground when it was being driven in reverse, in contravention of the requirements of the Rule Book and the limitations in the ECC (see paragraph 72).

Each of these factors is now considered in turn.

58 Personnel seated in the cab of the ballast distributor have a very restricted view of the line ahead when driving in reverse.

59 The ballast distributor was originally a unidirectional road machine that was converted for bidirectional use on the railway. However, no modifications were made to the cab to improve rear visibility as part of that conversion. This was despite use on the railway requiring routine travel in both directions. The driver's seat and the second person's seat are both fixed facing forward and are positioned at a height that means the view to the rear is obscured by the hopper and any load (figure 8). The need for the driver to operate foot pedals when travelling also limits his ability to turn round to attempt to look towards the direction of travel when reversing.

60 Although the ballast distributor is fitted with external rear view wing mirrors, these are not intended to be used to see the line ahead when travelling backwards in rail mode. Handbook 15 of the railway Rule Book (GERT8000 HB15 'Duties of the machine controller and on-track plant operator') states that 'the OTP operator must always have a clear view of the line ahead' and that 'mirrors cannot be used for this purpose'.

Figure 8: Rear visibility from the driver's cab (as found after the collision)

Ballast distributor approval

61 Network Rail's plant approval process is a strict check of a machine's compliance with standards. For OTP the primary relevant standard is RIS-1530-PLT (paragraph 48). Network Rail also applies a product acceptance process to equipment and materials to be used on its infrastructure. The objective of this is to assess the compatibility of those products with the infrastructure and the potential for importing risk to the railway. The product acceptance process has included RRVs in its scope since 2004.

62 Neither Network Rail nor Railability were able to provide any evidence of whether the ballast distributor was subject to the product acceptance process when it first entered service. However, Network Rail has stated that completion of the plant approvals process, with the issuing of an EAC/ECC with suitable operational limitations, has historically been taken as sufficient evidence for meeting the requirements of product acceptance.

63 The ballast distributor was last certificated against issue 6 of RIS-1530-PLT in 2017 (see paragraph 76). Section 5.9 of that standard sets out a hierarchy of options for machines where the design is such that the operator does not have a clear view of the line ahead when travelling in reverse. This hierarchy, in order of preference, is as follows:

- Provision of a space on the machine for an assistant that has a clear view of the line ahead and has access to separate brake and horn controls; or
- Provision of rear view CCTV meeting defined technical criteria for field of view (both in the machine vicinity and sufficiently far ahead to be able to stop at maximum speed) and for image and colour resolution in all lighting conditions (including darkness); or
- Provision of staff on the ground to control reverse movements.

64 Although the ballast distributor has a platform at the rear (figure 9), this was intended to allow personnel access to view the hopper contents. It was not intended for use while moving and was not fitted with any controls or seating.

Figure 9: Rear platform on the ballast distributor

65 The ballast distributor was not fitted with rear view CCTV, as this was not an option offered by GM/RT1300 issue 4 at the time that the machine was first converted in 2005 (paragraph 49). However, the use of staff on the ground to control reverse movements did allow compliance with the relevant clause of GM/RT1300, the requirements of the railway Rule Book (see paragraph 79) and the technical requirements of issues 2 and 6 of RIS-1530-PLT in 2010 and 2017. As a result, rear view CCTV was not required to be retrofitted in order for the machine to be issued with new certificates. The requirement to use staff on the ground to control reverse movements was specified as a limitation of use in the ballast distributor's EAC/ECC in 2010 and 2017.

66 Neither Network Rail nor Railability has been able to provide any evidence that a risk assessment of the machine had included consideration of the practicality of the limited permitted reverse speed when travelling in reverse over long distances, or any likely associated misuse (see paragraph 123).

Selection for use

67 Network Rail has not provided any evidence that the staff at Chester depot carried out any methodical or documented assessment of the ballast distributor's capabilities and limitations when they decided to hire it to undertake the work (paragraph 29). Such assessment is required by Module P519 'Planning for the use of on-track plant' of Network Rail Standard NR/L2/RMVP/0200 issue 9 'Infrastructure plant manual'[16]. Both the section manager, who requested the machine, and the machine controller, who planned its use, were familiar with the machine, as it had been used by the depot staff many times before. They were both familiar with the machine's capability of easily delivering large quantities of ballast to site and how much time such tasks normally took. These timings would have been based on how they normally operated the machine rather than on how it should have been operated (see paragraph 87).

68 On Monday 17 September, the machine controller completed the OTP planning paperwork required by Module P519 of NR/L2/RMVP/0200. This documented the risks that he recognised as being present during the various stages of using the ballast distributor and the tamper bank RRV planned for the nights of 17 and 18 September. This paperwork was incorporated into the SWP by the planner at Chester depot, approved by the section manager and issued to the persons in charge of the work prior to the work taking place.

69 For travelling to the site of work, the only hazards and mitigations recorded were the need to take care when traversing points (by communication with a person on the ground monitoring this) and ensuring that the vehicle remained within gauge (by locking the slew of the rear conveyor).

[16] NR/L2/RMVP/0200 has since been revised to issue 10, and the planning elements of module P519 have been incorporated into module P501.

70 The paperwork did not record that visibility from the machine was limited when travelling in reverse. It also did not record that, because of this, the speed was effectively limited to walking pace in reverse, mandated by both the Rule Book and the limitations recorded in the ECC (paragraph 65). Because the machine controller was a regular user of the ballast distributor and was tasked with planning its use at short notice, he did not identify any hazards beyond those that he was already aware of through his regular use of it. His awareness of the normal way the machine was used meant that he did not consider the hazards in as much depth as he might have if he had been less familiar with use of the machine. As a result, the planning for its use did not take account of the extended times that these limitations required for the reverse direction moves nor the option of using the RRAP at Smelly House to turn the ballast distributor to avoid a reverse direction move.

71 His familiarity with the machine also meant that he saw no need to obtain a copy of the ECC or the operations manual to allow him to plan its safe use. To do so, he would have had to request this from the supplier, AP Webb Plant Hire, as Network Rail does not maintain a database of documentation for approved machines.

72 **The machine controller for the ballast distributor was not controlling movements from the ground when it was being driven in reverse, in contravention of the requirements of the Rule Book and the limitations in the ECC.**

73 Although both the ECC for the ballast distributor and the railway Rule Book required reverse movements to be controlled by staff located on the ground, the machine controller was riding in the cab at the time of the collision. The machine controller believed that the route to the destination was clear of personnel (see paragraph 103).

Engineering Conformance Certificate

74 The ballast distributor was approved for use when it was built in 2005, to the requirements of GMRT1300 issue 4. The EAC that was issued placed an overall speed limit of 20 mph (32 km/h) on the machine. This was similar to its actual maximum speed, which was constrained by software that limited the number of gears available when in rail mode. This speed limit applied equally to both forwards and reverse directions and there were no specific operational limits placed on reverse direction travel by the EAC.

75 The ballast distributor was re-approved in 2010, at which time the technical requirements standard was RIS-1530-PLT issue 2. The EAC that was issued specified a speed limit of 20 mph (32 km/h) in the forwards direction and 10 mph (16 km/h) in the reverse direction. The EAC also specified that, unless the driver had a clear line of sight of the line ahead, reverse direction movements had to be controlled by staff on the ground, normally the machine controller. Because of the driving position facing forwards, that effectively meant that all reverse movements would need controlling from the ground.

76 In 2017, having come to the end of its 7-year approval period, the ballast distributor was again approved, this time against the requirements of RIS-1530-PLT issue 6. This time, the ECC specified a speed limit of 20 mph (32 km/h) in the forwards direction and 4 mph (6 km/h) in the reverse direction. No change was made to the software to limit the maximum possible reverse speed to align with this limit, nor was this required by RIS-1530-PLT. The ECC also specified that reverse direction movements had to be controlled by staff on the ground at all times. The ECC also permitted the driver to use rear facing CCTV, although this was not relevant as there was no CCTV fitted to the machine.

77 The effect of the above, at the time of the accident, was to require all reverse movements to be controlled by the machine controller, who had to be situated on the ground. This limited the operational speed of the ballast distributor to the pace of a machine controller walking along the track, which in practice is likely to be less than 3 mph (5 km/h).

78 AP Webb Plant Hire stated that it did not issue briefings on the limitation changes in 2010 and 2017 to its staff or to Network Rail. It relied on machine operators and machine controllers referring to the EAC/ECC each time the machine was used, as is required by Network Rail procedures, and for them to recognise for themselves that the limitations had changed.

Rule Book

79 Handbook 15 of the railway Rule Book is specifically targeted at users of OTP, such as machine operators and machine controllers, and forms part of their training. Issue 5 came into force in December 2017 and was current at the time of the accident. Section 7.9 of this relates to operators 'having a clear view ahead'. This states that:

- The OTP operator must always have a clear view of the line ahead. Mirrors cannot be used for this purpose. If for any reason the OTP operator cannot get a clear view of the line ahead, the OTP operator and the machine controller must arrange to turn the OTP.
- If the OTP cannot be turned, all movements must be controlled by the machine controller using radio or handsignals. The machine controller must do this from a safe position on the ground or riding on the leading end of the OTP if it is authorised in the EAC or ECC.
- Some OTP have an approved on-board CCTV colour display. This may be used as long as … the EAC or ECC allows its use …

80 At the time the ballast distributor was converted for rail use, the equivalent Rule Book requirements were contained in module OTP (GERT8000 - 'OTP - On-track plant'). Issue 1 came into force in December 2003, and was current at the time the ballast distributor was first approved for use. Section 2.4 relates to the operator's 'driving position'. This states that:

- If a machine has only one cab and you cannot get a full view of the line ahead, you must, if possible, turn the OTP so that the cab is leading.
- If it is not possible to turn the OTP, you must arrange for rail movements to be controlled by handsignals from a suitable position on the ground, or a person riding at the leading end (where special provision has been made to do so).

81 This, although worded slightly differently, also requires reverse movements to be controlled by a person on the ground, and effectively limits the reverse movement speed to walking pace. So although the EAC at the time the machine was built did not place any reverse movement limitations, the Rule Book did place operational restrictions on the ballast distributor. Thus all reverse movements of the ballast distributor should always have been controlled by ground staff and limited to walking pace since it was first introduced into service.

Machine controller compliance

82 Chester depot staff frequently use this type of ballast distributor and other similar RRVs to assist with transporting materials during track maintenance work. Witness evidence indicates that the ballast distributor, and other similar RRVs, are routinely used in the same way that it was used on the night of the accident. Multiple witness accounts indicated that the normal usage is for machine controllers to ride in the cab when travelling in both directions to and from sites of work, and for them to stop, get out of the cab and control from the ground when approaching the site of work. When visibility is compromised, such as when reversing, this method of working is reliant on correctly identifying the destination location and confirming that the line is clear of personnel through to the destination.

83 The presence of a dedicated second seat in the cab (figure 10) is likely to influence the behaviour of machine controllers when travelling. Because it is permitted for machine controllers to ride in the cab when traveling forwards, the convenience and relative comfort, compared to walking alongside the machine, might have led them to lose sight of the ECC and Rule Book limitations in the reverse direction, contributing to riding in the cab becoming the accepted norm.

Figure 10: Driver's and second person's seats in the ballast distributor cab

84 Another factor in the normalisation of users' behaviour is likely to be the time efficiency of riding in the cab compared to walking alongside the ballast distributor. The limitations meant that travel in the reverse direction would take much longer than equivalent travel in the forward direction. On the night of the accident, the ballast distributor was supposed to travel 3.3 miles (5.3 km) from the RRAP at Calveley to the site of work in reverse, and then the same distance forwards again to the RRAP. Restricted space at the RRAP meant that it was easier to on-track with the cab facing towards Chester, and so they would be reversing on the way to the site of work and driving forwards on the return leg. Using the ECC forwards speed limitation of 20 mph (32 km/h), the return journey would have taken about 10 minutes. However, using the ECC walking pace reverse limitation, the journey to the RRAP should have taken considerably more than an hour.

85 Because of his familiarity with the machine, the machine controller did not routinely read all of the EAC/ECC every time he used the ballast distributor. Instead he checked the validity of the certificate and recorded this as part of his record of use. The machine controller was aware of the limitations in the ECC relating to controlling movements from the ground, but those did not form part of his thought process when travelling with the machine.

86 The machine controller held an up-to-date competence for that role, but was not fully conversant with the detailed requirements relating to visibility of the line ahead contained in Handbook 15 of the Rule Book. He had last refreshed his machine controller competence in March 2017, but this assessment had not included rules relating to visibility of the line ahead.

87 In summary, this machine controller, as well as others, had developed a method of working with the ballast distributor, and probably other similar machines, that optimised working efficiency and, particularly in bad weather, comfort. However, that method went outside the operational restrictions required by the ECC and the Rule Book. They had developed a new norm for working with the machines that they perceived to be safe.

Machine operator compliance

88 The machine operator was first trained in use of the ballast distributor by AP Webb Plant Hire about 9 months prior to the accident. This training took place at AP Webb Plant Hire's training school, where there are two lengths of track, each approximately 100 metres long. This training covered the role of the machine operator, which is largely defined by Network Rail and covers its procedures and the content of the Rule Book. In addition, it covered the use of this specific machine, including both theoretical and practical assessments.

89 The machine specific theory training material provided to RAIB did not explicitly cover the lack visibility from the cab when travelling. However, the practical assessment did refer to a check that the operator was able to 'travel in reverse in line with the current OTP standards'. The machine operator's training record stated that he had passed this section with 'no issues'.

90 The limited track length at the training school means that the opportunity to simulate travelling to a site of work is very limited. At the training school, the machine operator practised on and off-tracking, as well as dropping ballast, with the opportunity to move short distances between the activities. All of these activities were carried out with the machine controller on the ground, and in daylight. The movements between activities were very short and there would be no benefit in the machine controller riding on the machine.

91 The machine operator was also given mentorship at site, subsequent to training at the training school. This involved supervision by experienced AP Webb Plant Hire operators, while working with machine controllers. However, during this mentorship, both the mentors and the machine controllers rode on the ballast distributor with the machine operator while travelling over long distances.

92 On the night of the accident, the ballast distributor had to travel in reverse for more than three miles in the dark. The machine operator was working with an experienced machine controller that he had never met before. This was a very different scenario to those experienced during training at the training school, but similar to work done with the mentors. As a result, the machine operator was content to go along with the practice of the machine controller when he entered the cab for the journey to the site of work.

93 The machine operator stated that he was specifically trained in how to read an EAC/ECC. However, like the machine controller (paragraph 85), his regular use of the ballast distributor meant that he did not consider it necessary to read the ECC in detail every time he used the machine. He stated that he did access the ECC every time he used the machine in order to provide it to the machine controller for him to carry out his check of it.

94 The machine operator believed that he had been trained in the specific operational limitations of the ballast distributor, but was unable to recall what those limitations were. AP Webb Plant Hire's training material for the ballast distributor does not explicitly mention the operational limitations. However, AP Webb Plant Hire stated that the limitations are set out in the ECC and it expects its operators to read these and be familiar with them.

95 The machine operator stated that he had been trained to challenge other staff, such as a machine controller, if work was to be carried out unsafely. However, he also stated that he did not perceive that the machine controller riding in the cab with him on the night of the accident was unsafe, and so he saw no need to challenge this.

Planned work and communications

96 **The track workers in the tamping track gang were not where the machine controller for the ballast distributor expected them to be.**

97 The machine controller was intending to travel to Smelly House (162 miles 0 yards) to undertake the first ballast drop, and understood that there was no-one on track between the RRAP and there. However, the track maintenance team had been working at 162 miles 1450 yards, close to Cholmondeston access point, and they were waiting there. There was confusion between the section manager, the track maintenance team and the machine controller as to the location of the work and where ballast was required.

98 This causal factor arose due to a combination of the following:

- There was no common understanding of where the track repairs were supposed to be carried out (see paragraph 99).
- Communications between the machine controller for the ballast distributor and the tamping track gang were casual in nature and did not lead to a common understanding of the location the ballast distributor was heading to (see paragraph 114).

Each of these factors is now considered in turn.

99 There was no common understanding of where the track repairs were supposed to be carried out.

Understanding of the section manager

100 The section manager intended that a track geometry fault at Smelly House (162 miles 0 yards) was to be corrected by the track maintenance team and tamped using the tamper bank RRV. This repair had originally been planned to be undertaken on the night of Monday 17 September, but the work was rescheduled on the afternoon of Tuesday 18 September to be carried out that night.

101 The section manager was aware that he did not have enough qualified machine controllers to be able to use a kubota to move men and materials as well as the tamper bank RRV. As a result, he intended the tamper bank RRV to access the track at Calveley, with the rest of the track maintenance team accessing the track at Smelly House.

102 The section manager also knew that another track geometry fault at 162 miles 1450 yards was scheduled to be corrected by a tamper on the night of Wednesday 19 September (paragraph 29). He intended that the ballast distributor would drop ballast there on the night of Tuesday 18 September in preparation for the tamping the following night.

103 In summary, the section manager's intention was for the track maintenance team to be working at Smelly House, and for the ballast distributor to drop ballast near to the Cholmondeston access point. As a result, the two sites of work were to be about three quarters of a mile apart, and there should have been no conflict between the track maintenance team and the ballast distributor.

Understanding of the track maintenance team

104 Discussions between the section manager and members of the track maintenance team on the afternoon and evening of 18 September resulted in the team not recognising that the section manager intended that the track fault at Smelly House was to be rectified that night, and that ballast was to be dropped at the second fault near to Cholmondeston. They came to the understanding that they were to correct and tamp the track fault near Cholmondeston (162 miles 1450 yards), using the tamper bank RRV. This was despite a tamper being planned to rectify that fault the following night. They also understood that the ballast distributor would drop ballast where they were working. Additionally, they intended to use a kubota to transport staff and materials from the access point at Calveley.

105 A note, handwritten by the COSS in the track maintenance team, and given to the ballast distributor machine operator, showed that there was some awareness of ballast being required at Cholmondeston and separate work to be done at Smelly House (figure 11). However, the team leader took the maintenance staff to Cholmondeston to carry out the track repair work, and no work was carried out at Smelly House.

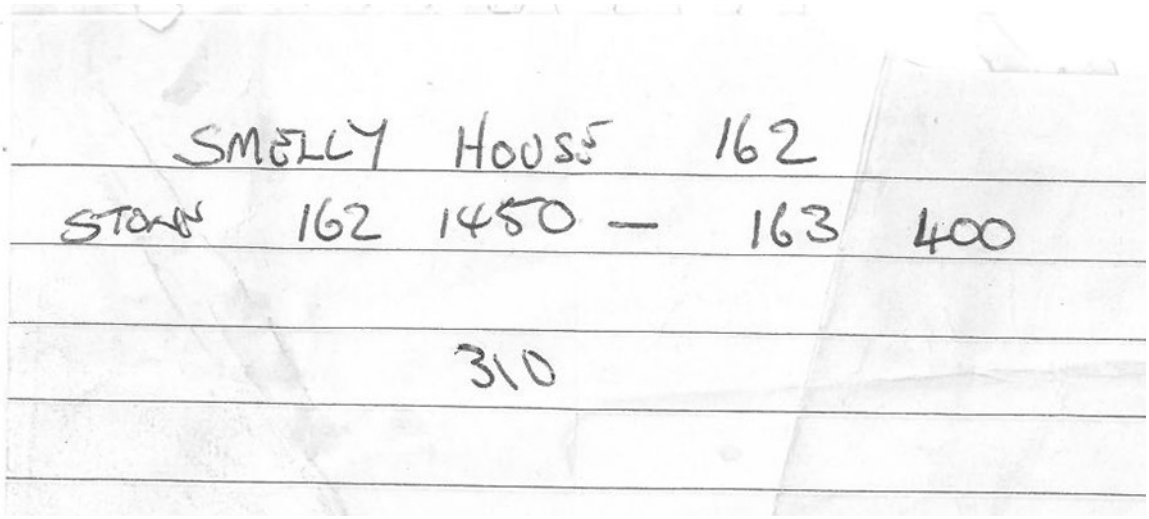

Figure 11: The note written by the COSS and given to the machine operator

Understanding of the machine controller

106 The machine controller for the ballast distributor had the note that was written by the COSS for the track maintenance team (figure 11). He was aware that the ballast distributor was required to drop ballast at 162 miles 1450 yards, near to Cholmondeston access point. He also believed that the track maintenance team were working on the track fault at Smelly House (162 miles 0 yards), as the section manager had intended. On the night, the machine controller also believed that the track maintenance team required ballast to be dropped at Smelly House, probably as a result of talking with them on the night.

107 As a result, the ballast distributor set off towards Smelly House, to drop ballast for the track maintenance team, with the intention of dropping additional ballast at Cholmondeston on the return trip.

Control of the work to be done

108 The SWP for the work on the night of 18 September 2018 described a possession between Crewe Steel Works and Chester East Junction. Within this possession, a single 18 mile long worksite was set up between 159 miles 1650 yards and 178 miles 0 yards. The SWP paperwork correctly recorded the requirements down to worksite level. A number of work activities were planned to take place at a number of sites of work within this long worksite. Each group undertaking work was allocated a PIC who had been involved in planning the SWP. This included the work by the ballast distributor and by the track maintenance team (paragraphs 19 to 22), as well as work by other parties not based at Chester depot.

109 Some of this track maintenance work is described, including locations, in the Weekly Operating Notice (WON) for that week. However, the entry in the WON for the track maintenance work does not specify the location within the 18 mile worksite. Normal practice was for routine track maintenance work to be planned close to the time it was done, to allow flexibility to deal with urgent faults. But this planning was routinely discussed verbally between the staff involved and, in accordance with normal Network Rail practices, no formal documentation of what was to be done within the worksite, and the precise locations of that work, was prepared.

110 The engineering supervisor, who was under mentorship on the night of the accident, was responsible for authorising vehicle movements within the long worksite. Neither he nor his mentor was fully aware of the detail of the work that was planned for that night in advance of the shift starting. The engineering supervisor only found out what work was to be done when the staff assembled at Chester depot on the night, but the detail of the locations of that work remained undocumented.

111 The engineering supervisor and his mentor were not in full control of the RRV movements being undertaken by the machine controllers for the kubota and the ballast distributor. Although the engineering supervisor and his mentor had agreed to a plan for the work at the pre-work brief, they did not authorise the on-tracking of each RRV at the time. The actual on-tracking and subsequent movements were controlled by the staff at the RRAP. This was despite the Rule Book requiring the engineering supervisor to authorise all RRV movements in the worksite, to instruct the locations all movements were to be made to, and to authorise any speeds in excess of 5 mph (8 km/h) (see paragraph 137). However, the machines were being on-tracked and undertaking movements in the intended sequence.

112 Use of multiple shorter worksites, each with its own engineering supervisor authorising vehicle movements in and out of it, could have reduced the risk of collision. However, the use of multiple shorter worksites requires more staff resource and time to operate. It can also be argued that multiple worksites would also expose more staff to risk while placing marker boards on the track, increase the potential for miscommunications between the PICOP and multiple engineering supervisors, and reduce the flexibility to reschedule work tasks at short notice. In practice, many worksites are effectively the same length as possessions.

113 Network Rail standard NR/L2/0PS/202 issue 7 ‘Principles, Timescales and Functional Responsibilities for Engineering Work, Access and Heavy Resource Planning’ includes processes for managing access to the railway to undertake maintenance work. This includes a preference that possessions and worksites are kept as short as possible. There is also a requirement that those ‘that are not as short as possible are only permitted where additional control measures have been considered and applied to reduce and mitigate the risk of a collision’. In this instance the worksite was not ‘as short as possible’ and the controls applied to the work within the worksite were inadequate to manage the risk. They were informal in nature, not documented and informally communicated to the work groups. This resulted in two different interpretations of which track fault was to be repaired on the night.

Communication at site

114 Communications between the machine controller for the ballast distributor and the tamping track gang were casual in nature and did not lead to a common understanding of the location the ballast distributor was heading to.

115 The track maintenance team was waiting at 162 miles 1450 yards, when they should have been at 162 miles 0 yards (paragraph 103).

116 The machine controller spoke to more than one member of the track maintenance team several times during the shift. This was both face-to-face before they left the RRAP at Calveley and by mobile phone after they had arrived at the site of work. However, none of this communication resulted in the machine controller correctly understanding the location where the track maintenance team were working or waiting. During the phone calls at site, the staff made reference to 'here' and 'there' when discussing the location of the track work and the staff, rather than to a specific location.

117 Railway industry safety related communications protocols require staff to refer to locations by recognisable descriptions, such as a mileage, place name, signal number or similar. They also require the sender of a safety critical message to ensure that the recipient repeats the message back to ensure that the message has been received and understood. The lack of clear safety critical communications resulted in lost opportunities to correct previous misunderstandings, and avoid the accident.

Identification of underlying factors

Identification of non-compliance

118 Neither Network Rail's local management at Chester depot nor regional OTP monitoring had identified and addressed the routine non-compliance with the Rule Book and ECC requirements for driving machines with restricted reverse visibility.

119 It had become normal practice for machine controllers to use the provided seat in the cab of the ballast distributor when it was being used to travel significant distances (paragraph 87). This was contrary to the limitations of use specified in the ECC, and to the Rule Book, when the ballast distributor was travelling in reverse.

120 The section manager had previously seen the ballast distributor being used in this fashion on at least one occasion when at site. However, he had not recognised that this was contrary to the Rule Book and the ECC, and so had not corrected the machine controller's behaviour. No-one else had identified and corrected the machine controller's method of working.

121 Module P101 'Monitoring plant activities' of Network Rail standard NR/L2/RMVP/0200 issue 9 requires operations of RRVs to be sample monitored to review compliance with procedures, ECC limitations and the Rule Book. This monitoring was being undertaken by Network Rail OTP specialists. A number of monitoring site visits in the preceding months covered OTP activity undertaken by Chester depot. However, a visit during planned use of the ballast distributor, undertaken in February 2018, was unable to take place due to the work being cancelled at the last minute. Network Rail stated that its monitoring activities had not detected this type of non-compliant use of this, or similar machines, anywhere on its infrastructure.

Potential for misuse

122 **The machine was accepted for use on Network Rail infrastructure without recognising, or adequately mitigating, the potential for operational misuse when travelling in reverse.**

123 Although RIS-1530-PLT focuses on technical requirements for RRVs, issue 6 introduced a requirement for the overall machine design to be assessed to identify potential hazards, including those that would arise during foreseeable misuse. However, this requirement only applies to machines that were first certificated after 1 January 2016, and is not retrospective. As this machine was first certificated in 2005 (paragraph 49), this requirement would not have applied to it when it was certificated against issue 6 of RIS-1530-PLT in 2017. This requirement was not included in earlier versions of RIS-1530-PLT, nor in its predecessor, GM/RT1300.

Factors affecting the severity of consequences

Speed of the RRV

124 **It is probable that the speed at which the ballast distributor was driven exacerbated the consequences of the accident.**

125 The RAIB estimates that the ballast distributor was travelling at between 11 mph (18 km/h) and 15 mph (24 km/h), at the time of the accident. The ECC speed limit when reversing was limited to walking pace on the track (paragraph 65); less than 3 mph (5 km/h). If the ballast distributor had been driven at a lower speed, the consequences of the collision would probably have been significantly reduced.

126 It is possible that a lower speed could have given the kubota operator more time to react and to try to outrun the ballast distributor, or given the staff in the kubota more time to get off before the collision. However, because the witnesses at site all said that their attention was attracted by the speed of the ballast distributor, it is also possible that a lower speed would not have alerted them to its approach and they may not have reacted in the way that they did. As a result, and because neither the machine controller nor the machine operator could see the line ahead, it is probable that the collision would not have been avoided at a lower speed.

Observations

RRV Compliance

127 **A number of features of the RRV and its documentation were non-compliant with RIS-1530-PLT, against which it had been certified.**

Speedometer

128 When in rail mode, the ballast distributor moves approximately 2.5 times faster than it would in road mode for a given road wheel rotational speed (paragraph 15). Railability stated that they understood the ballast distributor speedometer had a software correction factor when operating in rail mode, such that it indicated ground speed correctly in both rail and road modes. However, RAIB testing, followed up by more detailed Railability testing, showed that the speedometer gave a reading derived from the road-wheel speed, even when in rail mode. This meant the speedometer reading was only about 40% of the actual speed when in rail mode.

129 GM/RT1300 did not require the ballast distributor to have a rail mode speedometer when it was built in 2005 because its top speed did not exceed 20 mph (32 km/h). This meant that the plant approval at the time would not have included a check of the functionality of the speedometer in rail mode and the discrepancy would not have been recognised.

130 Recertification in 2010 and 2017 required compliance with issues 2 and 6 of RIS-1530-PLT, respectively. These both required the ballast distributor to have a speedometer capable of indicating the speed on the rail. At that time, it is likely that the pre-existence of the speedometer meant that its calibration was not checked, and that it was assumed to be operating to read rail speed as originally intended and the ECCs were issued on the basis of that assumption.

Speed limiting

131 RIS-1530-PLT issue 6 requires speed when on rail to be controlled by either an engineered limitation appropriate to the maximum permitted speed, or the fitment of a speedometer, or provision of an audible and visual warning when the speed limitation is exceeded. When built, the machine was mechanically limited to 20 mph (32 km/h) and was fitted with a speedometer (paragraph 74). However, the 2010 and 2017 recertifications reduced the permitted reverse speeds (paragraphs 75 and 76) while the actual speed capability stayed unchanged. The provision of the speedometer could have meant that the machine remained compliant, but because it was not accurately reading rail wheel speed (paragraph 128) it was not. Neither Railability nor AP Webb Plant Hire were aware of the issue with the speedometer, and so were not aware of this non-compliance either.

Notices

132 RIS-1530-PLT issues 2 and 6 both require a notice to be displayed at the driving position stating the maximum travelling speeds, for both forward and reverse directions. The label in the cab of the ballast distributor only stated the original GM/RT1300 maximum permitted speed of 20 mph (32 km/h), with no forward or reverse differentiation. That suggests that the label was the original as fitted when the ballast distributor was built. It did not include the 2017 reverse speed limitation of 4 mph (6 km/h), and should have been replaced for compliance with RIS-1530-PLT issue 6.

Handbook

133 Issue 6 of RIS-1530-PLT requires operating restrictions, such as speed limitations when travelling, to be documented in the instruction handbook for the ballast distributor. The operator's manual for the ballast distributor did not include details of the operating restrictions, such as maximum speed when reversing or the need for the use of a machine controller on the ground. Railability and AP Webb Plant Hire stated that this information was contained in the ECC, and because this was kept on the machine, it was always available to the machine operator. The operator's manual was not kept on the machine, but was accessible to the operator at the depot. However, the absence of this information from the operator's manual did not meet the requirement specified in RIS-1530-PLT.

Compliance with OTP Procedures

134 **There were a number of non-compliances with procedures relating to use of OTP.**

135 Because only two machine controllers were expected to be available, the planning paperwork for the work on the night of Tuesday 18 September did not include use of the kubota by the track maintenance team. However, the track maintenance team chose to use the second kubota and a copy of the SWP was issued to its machine controller.

136 This meant that as well as acting as machine controller, COSS and PIC for the kubota, its machine operator also acted as machine controller, COSS and PIC for the tamper bank RRV. However, as he had to remain with the kubota, he was unable to be with the tamper bank RRV when it travelled in both directions between Calveley RRAP and the site of work at Cholmondeston. The tamper bank RRV was moved between the two locations without a machine controller travelling with it, although there was a machine controller present at each end of the movements. Module P507 'On-track plant' of NR/L2/RMVP/0200 allows for such 'send and receive' arrangements, but only when they have been risk assessed as part of the planning process. Although the two machine controllers informally considered the movements to be safe, this was not part of the OTP plan for the night, which allocated a machine controller to each of the two machines planned to be on site.

137 Although the ballast distributor ECC limited it to 20 mph (32 km/h) forwards and walking pace in reverse, Handbook 15 of the railway Rule Book also specifies a 5 mph speed limit within a worksite, unless higher speeds are authorised by the engineering supervisor. It also requires the speed to be such that the operator can stop the vehicle 'within the distance that can be seen to be clear of any obstruction'. The engineering supervisor had not authorised any higher speeds and therefore all vehicle movements were subject to this limit. The ballast distributor, travelling at an estimated 11 mph (18 km/h) to 15 mph (24 km/h), was non-complaint with both this limit and the limitations of the machine's ECC.

Previous occurrences of a similar character

138 The RAIB has previously investigated a number of OTP collisions, but these have generally involved machines that have run away, rather than machines that were under the operator's control at the time. As a result, the lessons and associated recommendations were not directly relevant to the circumstances of this accident.

139 The RAIB has also investigated a number of accidents involving collisions in long worksites, although most of these have involved trains rather than on-track plant. Examples include accidents at Badminton (RAIB report 30/2007), Leigh-on-Sea (RAIB report 24/2009), Arley (RAIB report 12/2013) and Kitchen Hill (RAIB bulletin 01/2014). The requirements in Network Rail standard NR/L2/0PS/202 issue 7 (paragraph 113) post-date these accidents. This standard aims to reduce the use of long worksites and only permit longer worksites when suitable additional control measures are applied.

Summary of conclusions

Immediate cause

140 The ballast distributor did not stop before it collided with the stationary kubota on the down line (paragraph 51).

Causal factors

141 The causal factors were:

a. The ballast distributor was being driven with neither the machine operator nor the machine controller having sight of the line ahead (paragraph 54). This causal factor arose due to a combination of the following:

   i. Personnel seated in the cab of the ballast distributor have a very restricted view of the line ahead when driving in reverse (paragraph 58, **Recommendations 1 and 2** and **Learning point 2**).

   ii. The machine controller for the ballast distributor was not controlling movements from the ground when it was being driven in reverse, in contravention of the requirements of the Rule Book and the limitations in the ECC (paragraph 72, **Learning point 5**).

b. The track workers in the tamping track gang were not where the machine controller for the ballast distributor expected them to be (paragraph 96). This causal factor arose due to a combination of the following:

   i. There was no common understanding of where the track repairs were supposed to be carried out (paragraph 99, **Learning point 4**).

   ii. Communications between the machine controller for the ballast distributor and the tamping track gang were casual in nature and did not lead to a common understanding of the location the ballast distributor was heading to (paragraph 114, **Learning point 1**).

Underlying factors

142 The underlying factors were:

a. Neither Network Rail's local management at Chester depot nor regional OTP monitoring had identified and addressed the routine non-compliance with the Rule Book and ECC requirements for driving machines with restricted reverse visibility (paragraph 118, **Learning point 2**).

b. The machine was accepted for use on Network Rail infrastructure without recognising, or adequately mitigating, the potential for operational misuse when travelling in reverse (paragraph 122, **Recommendation 1** and **Learning point 3**).

Factors affecting the severity of consequences

143 It is probable that the speed at which the ballast distributor was driven exacerbated the consequences of the accident (paragraph 124, **Learning points 2 and 3**).

Additional observations

144 Although not linked to the accident on 19 September 2018, the RAIB observes that:

a. A number of features of the RRV and its documentation were non-compliant with RIS-1530-PLT, against which it had been certified (paragraphs 127 and 149).

b. There were a number of non-compliances with procedures relating to use of OTP (paragraph 134, **Learning point 2**).

Previous RAIB recommendations relevant to this investigation that are currently being implemented

145 The following recommendation, which was made by the RAIB as a result of a previous investigation, has relevance to this investigation.

Trailer runaway near Hope, Derbyshire on 28 May 2017, RAIB report 03/2018, Recommendation 3

146 This recommendation addressed one of the observations identified, relating to the Cholmondeston accident (paragraph 134). So as to avoid duplication, it is not remade in this report.

Recommendation 3

The intent of this recommendation is for Network Rail to improve levels of compliance with standards and codes of practice.

Network Rail should take steps to understand the factors at its Manchester Delivery Unit that led to the non-compliances identified in this report, and implement the measures required to improve compliance with the relevant standards and codes of practice. Network Rail should also consider whether the lessons learnt are relevant with respect to other activities at its Manchester Delivery Unit and elsewhere.

147 Network Rail has reported to the Office of Rail and Road (ORR) that it 'undertook a review to understand the causes of the non-compliances with procedures related to the use of the gator and trailer' by staff within Manchester Delivery Unit, and that this 'will be independently assessed … to validate its completeness in identifying and understand the circumstances and causes of these non-compliances and the effectiveness of the actions taken in preventing the likelihood of recurrence'. It also reported that 'the review will also consider whether the lessons learnt from the review are relevant with respect to other activities at the Manchester Delivery Unit and elsewhere'.

148 ORR has reported that Network Rail has taken the recommendation into consideration and is taking action to implement it. ORR also reports at the time of writing that it has yet to be provided with the conclusions of Network Rail's review and a time-bound plan for any remedial actions.

149 To support ORR's implementation of the above recommendation, the RAIB has written to ORR to highlight the non-compliances identified in this investigation as they applied to both Manchester Delivery Unit and elsewhere.

Actions reported that address factors which otherwise would have resulted in a RAIB recommendation

150 Following the accident, AP Webb Plant Hire briefed its staff on the importance of having a clear view of the line ahead when reversing machines, and on complying with any operational restrictions contained in the ECC/EAC for each machine. It also briefed on the importance of complying with these requirements when faced with pressure at site from other staff. It offered staff support from their managers by telephone if they were being pressured to work unsafely or outside the prescribed limitations of machines.

151 AP Webb Plant Hire has enhanced its mentoring arrangements for machine operators as they transition from the training school to working at site. In particular, there is an increased focus on tasks which trainees are unable to undertake at training facilities, such as travelling over long distances. It has introduced enhanced training for its mentors to improve their ability to manage and assess the behaviours of machine operators at site. It has also introduced a system, with dedicated staff, to monitor the ongoing compliant use of plant and the behaviours of machine operators and machine controllers at site. In order to raise the awareness of the importance of good safety behaviours, AP Webb Plant Hire is also trialling a financial incentives scheme rewarding good behaviours and communications and penalising poor performance in these areas.

152 Railability implemented a number of modifications to the ballast distributors, as follows:

- The gearbox software was altered to limit the available gears when driving in reverse in rail mode. This limits the actual top speed in reverse to approximately 6 mph (10 km/h).
- A new speed sensor was fitted to the rail wheels to provide a separate, more clearly readable, rail mode speedometer in the cab. This is separate to the original speedometer, which retains its function in road mode.
- The labelling in the cab has been replaced to indicate the certificated top speed limits in both forwards and reverse.

153 Railability is also updating the Operator's Manual to include the operational limitations specified in the ECC.

Other reported actions

154 Immediately after the accident, Network Rail barred this type of ballast distributor from being used on its infrastructure. However, this bar was lifted on condition that all reverse movements were controlled by a machine controller who was positioned on the ground. This condition reflected the existing requirement specified in the ECC for the ballast distributor and in the Rule Book. ORR challenged the decision to reinstate these machines without requiring additional engineering controls, and is in ongoing discussions with AP Webb Plant Hire in relation to their use. Network Rail has also enhanced its OTP monitoring activities in relation to use of this type of RRV.

155 ORR issued an improvement notice to Network Rail. This was because Network Rail was not able to demonstrate effective management of the risks arising from OTP movements in the possession that is routinely taken between Chester and Crewe, and had failed to ensure, so far as is reasonably practicable, that its employees were not being exposed to risks to their health or safety.

156 Network Rail has continued to discuss the development of issue 7 of RIS-1530-PLT, as well as other relevant standards, with RSSB. The circumstances of this accident have been included in these discussions.

157 Network Rail is continuing with an ongoing project to review the role of the machine controller and the competences that this role requires. This project is intended to review the training requirements for machine controllers, with a view to updating training content and delivery methods to better match those requirements.

Recommendations and learning points

Recommendations

158 The following recommendations are made[17]:

1 *The intent of this recommendation is to prevent those operating and controlling road-rail vehicles from adopting unofficial operating methods during travelling.*

RSSB, in consultation with the industry, and involving due industry process, should review the effectiveness and practicality of the engineering and procedural controls permitted by RIS-1530-PLT to manage the travelling of road-rail vehicles safely, taking into account reasonably foreseeable misuse by machine operators and machine controllers, and make changes to the standard, as necessary. This review should include consideration of the following:

- requirements for visibility of the line ahead, taking into account that road-rail vehicles generally spend as much time travelling in reverse as they do forwards (this will be particularly applicable for conversions of unidirectional road vehicles); and
- requirements for managing speed - in particular whether use of a speedometer is an acceptable means of managing speed where the machine's capability is much greater than its permitted maximum.

2 *The intent of this recommendation is to prevent operational misuse of existing RRVs when travelling.*

Ahead of any changes resulting from recommendation 1, Network Rail should review all road-rail vehicles that are based on unidirectional road vehicles that it permits to operate on its infrastructure, to understand the potential for foreseeable operational misuse when travelling in the reverse direction. It should introduce or amend any mitigations that this review identifies as being necessary to manage the risk of operational misuse. The review should include consideration of the following:

visibility of the line ahead, particularly in the reverse direction; and

potential for operators to exceed prescribed speed limitations.

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

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

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

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.

Learning points

159 The RAIB has identified the following key learning points[18]:

1 It is important that people involved with the movements of OTP at site use safety related communications protocols when instructing and confirming the details of vehicle movements and the locations of personnel.

2 It is important that machine operators and machine controllers recognise when visibility of the line ahead is compromised by the design of the OTP being used, and follow the related requirements of both the railway Rule Book and the operational limitations for the specific machines.

3 It is important that people planning the use of OTP take account of the machines' operational limitations mandated by the ECC, particularly where RRVs based on unidirectional road vehicles are to be used in the reverse direction.

4 It is important that work planners and deliverers consider and apply appropriate additional control measures to reduce and mitigate the risks of collisions when worksites that are not as short as possible are to be used, in accordance with Network Rail standard NR/L2/OPS/202 issue 7.

5 It is important that machine operators are given practical experience in travelling under site-like conditions as part of their training, and that they are, and continue to be, fully knowledgeable about all relevant procedural limitations of the machines for which they have been trained.

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

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed Circuit Television
COSS	Controller Of Site Safety
EAC	Engineering Acceptance Certificate
ECC	Engineering Conformity Certificate
ORR	Office of Rail and Road
OTP	On-Track Plant
PIC	Person In Charge
PICOP	Person In Charge Of Possession
RAIB	Rail Accident Investigation Branch
RRAP	Road-Rail Access Point
RRV	Road-Rail Vehicle
SWP	Safe Work Pack
WON	Weekly Operating Notice

Appendix B - Investigation details

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

- information provided by witnesses;
- documentation related to the work being undertaken on the night;
- design, operational and maintenance documentation for the OTP involved;
- site photographs and measurements;
- testing of the ballast distributor;
- weather reports and observations at the site; and
- a review of previous RAIB investigations that had relevance to this accident.

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