RAIB

Rail Accident Investigation Branch

Rail Accident Report

Collision between on-track machines near to Strood, Kent
16 November 2023

Report 11/2024
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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 on-track machines near to Strood, Kent, 16 November 2023

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Summary

At about 04:15 on 16 November 2023, an on-track machine driver was injured while coupling a multi-purpose vehicle (MPV) to a tamper on the High Speed 1 (HS1) line near Strood, in Kent. The tamper, which had been stationary, moved and struck the driver after a second MPV collided with the other end of it at a speed of about 20 km/h (12 mph). This second MPV was being driven towards the tamper with the intention of coupling all three vehicles together at the end of a night shift.

RAIB's investigation found that it had become normal practice for this coupling operation to be undertaken with another vehicle approaching the other end of the tamper. The established method of working was for the approaching vehicle to come to a stand at a 'holding point' situated around 50 to 100 metres away from the stationary vehicles. The final movement would then be made at very slow speed and under control of the driver responsible for the coupling operation.

However, on this occasion the second MPV did not stop at the holding point. This was because the driver propelling (reversing) the second MPV did not have a view of the railway in the direction of travel of the vehicle and was reliant on radio messages from a machine controller at the rear to know when to slow or stop the vehicle. On the night of the accident, the radio being used by the machine controller had developed an intermittent fault, which led to a breakdown in communication with the driver. Due to the design of the radio, neither the driver nor the machine controller were initially aware that communications had been lost. Although the machine controller subsequently realised that the radio was not working and alerted the driver that they needed to brake by a shouted warning, this occurred too late to avoid the collision.

RAIB found that the type of radios being used during the movement did not transmit a constant 'confidence tone' which would have alerted staff to the loss of communications. It was also not normal practice for machine controllers to communicate constantly on long transit moves. In addition, RAIB found that the type of MPVs used on HS1 were not fitted with any facility for machine controllers riding on the rear deck to brake the vehicle, despite an internal recommendation to fit this facility after a previous similar accident in 2021.

An underlying factor in this accident was that Network Rail High Speed, the infrastructure manager for HS1, did not have safe systems of work for propelling moves or working on track when engineering vehicles were running during a possession. A possible underlying factor was that the strategic safety assurance undertaken by HS1 Ltd, which has the concession to operate HS1, did not identify that the recommendation to fit a braking facility to the rear deck had been closed with no actions being taken.

Since the accident, Network Rail High Speed has fitted its MPV fleet with emergency stop buttons adjacent to the rear deck, secure communications systems and is due to install a rearwards-facing camera, connected to an in-cab monitor.

RAIB has made four recommendations. The first three are addressed to Network Rail High Speed and the fourth to HS1 Ltd. The first recommendation aims to control the risks of engineering vehicle operation on HS1, while the second looks to keep staff working on the line safe by implementing a robust procedural framework. The third recommendation is that Network Rail High Speed ensures that internal recommendations and local actions are reviewed and implemented in a way that reflects their intent, and in a way that can be tracked and used to support safety decision-making. The final recommendation is for HS1 Ltd to exercise more effective strategic safety assurance of its suppliers.

Introduction

Definitions

1 Metric units are used in this report with imperial units provided in brackets to aid understanding, where appropriate.

2 The report contains abbreviations and acronyms, 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 around 04:15 on Thursday 16 November 2023, a multi-purpose vehicle (MPV) struck a stationary tamper while travelling at about 20 km/h (12 mph). The machines were involved in track maintenance work on High Speed 1 (HS1), near Strood in Kent.

4 The tamper moved because of the collision. As it did so, it struck the driver of a second MPV who was coupling their MPV to the other end of the tamper.

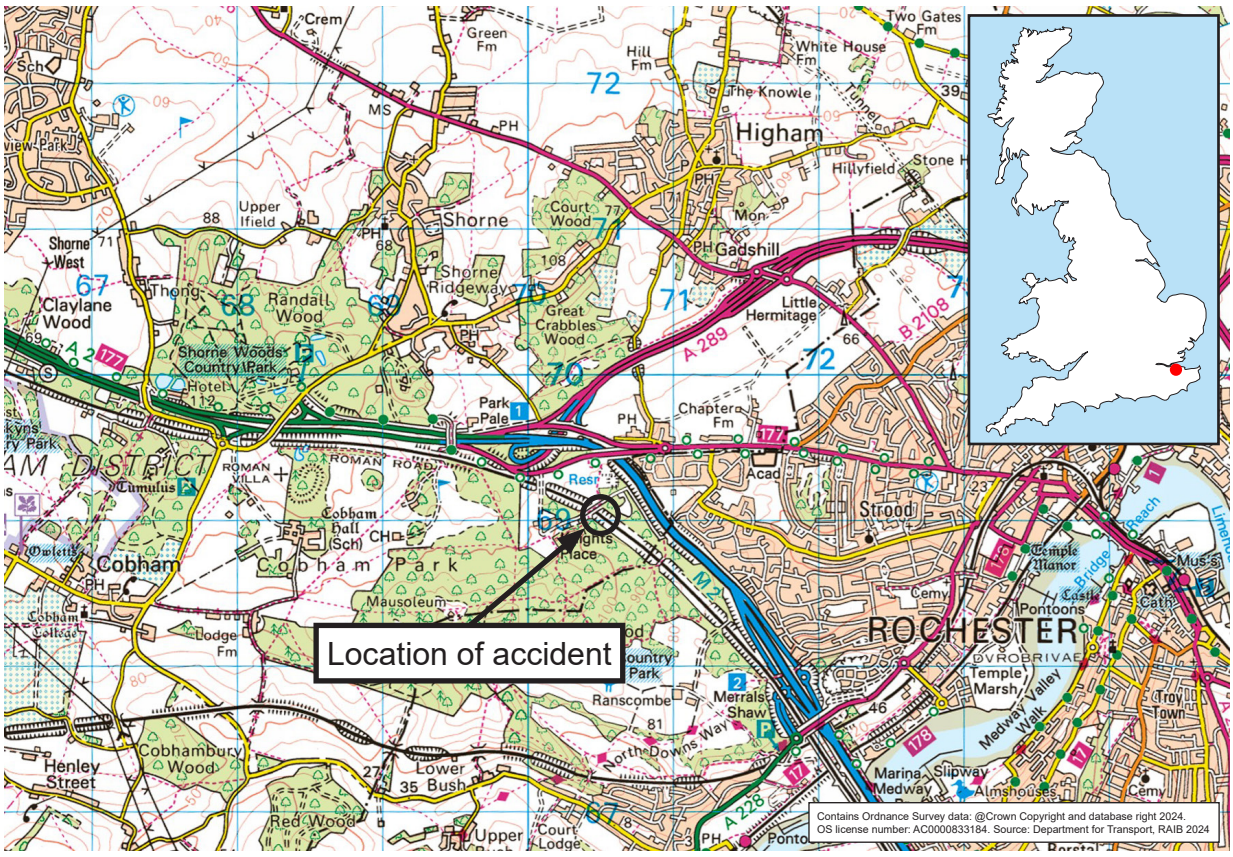

Figure 1: Extract from Ordnance Survey map showing location of accident at Strood.

5 The driver sustained injuries requiring hospital treatment. Although the driver was released from hospital the same day, it was 4 months before they were able to return to work due to the psychological distress resulting from the accident.

6 Minor damage was caused to the MPV which struck the tamper.

Context

Location

7 HS1 is the high-speed rail line which runs between St Pancras International station in London and the Channel Tunnel at Folkestone. It is 109 km long, composed mainly of twin track railway and has maximum permissible speeds of up to 300 km/h (186 mph). Distances on HS1 are measured in kilometres and metres from a datum point located at St. Pancras International station.

8 The accident occurred at 47.67 km, just north of the River Medway, and near to the town of Strood in Kent. Maintenance of HS1 is conducted from Singlewell depot, situated around 43 km from St Pancras (figure 2).

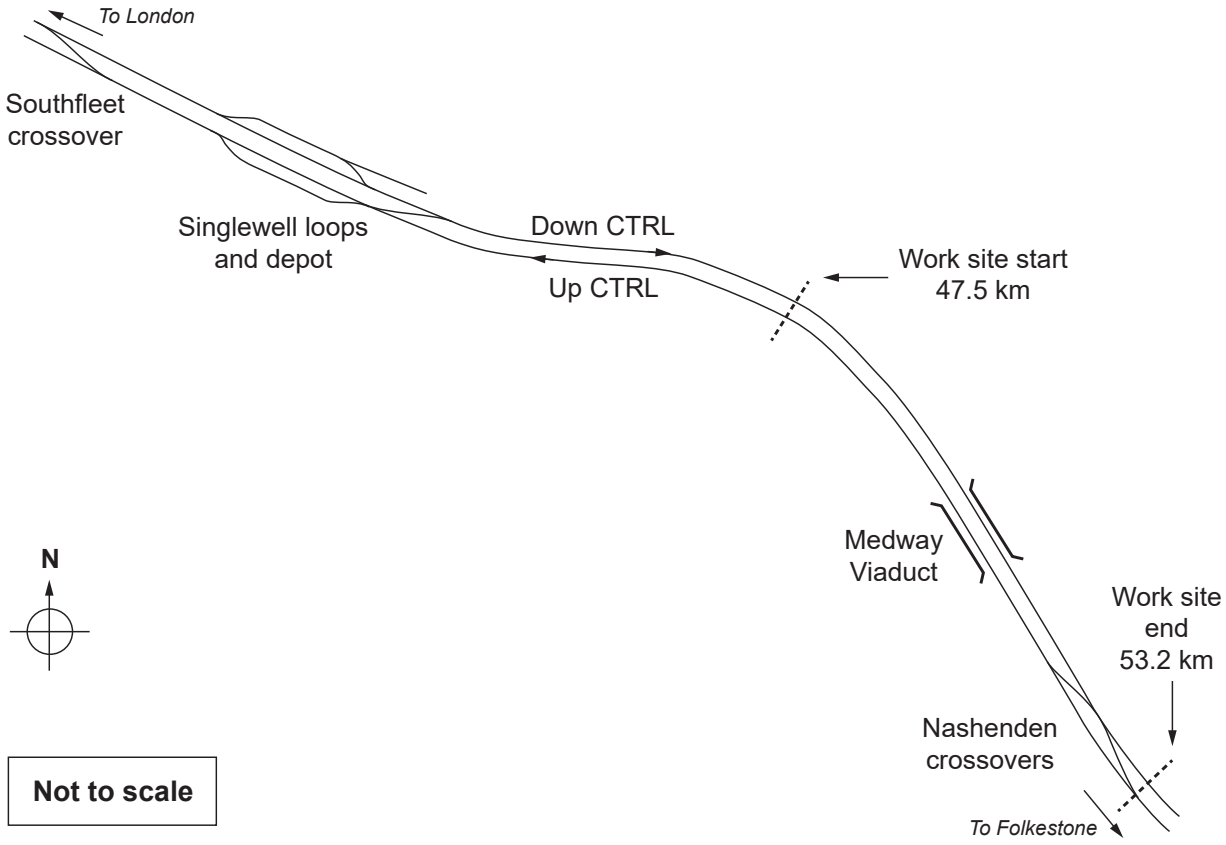

Figure 2: Track layout showing Singlewell depot, the work site limits and the Medway Viaduct.

Organisations involved

9 HS1 Ltd has had a 30-year concession to own, operate and maintain HS1 since 2010. HS1 Ltd is the owner of the two MPVs involved in the accident.

10 Network Rail High Speed (NRHS) is the infrastructure manager for HS1 and is a wholly owned subsidiary of Network Rail Infrastructure Ltd (Network Rail), the infrastructure manager for the remainder of the mainline rail network in Great Britain. NRHS has an agreement with HS1 Ltd and holds the safety authorisation to operate, maintain and renew the route infrastructure. NRHS employs the machine controller.

11 Balfour Beatty Rail is contracted by NRHS to operate and maintain the MPVs. It employs the MPV drivers involved in the accident.

12 Babcock Rail was contracted by NRHS to supply and operate the sprinter tamper which it owns and maintains. It employs the tamper crew involved in the accident.

13 HS1 Ltd, NRHS, Network Rail, Balfour Beatty Rail and Babcock freely co-operated with the investigation.

Vehicles involved

14 Three railway vehicles were involved in the accident. These were:

a. MPV number DR97011 (MPV1), which was stationary before the collision. MPVs are self-propelled on-track machines which can be fitted with a variety of modules to undertake different duties. HS1 owns 4 MPVs (figure 3), built in 2005. These MPVs are configured such that they can be operated singly. They are also fitted with in-cab signalling systems so that they can operate as trains on HS1.

b. Tamper number DR73916, which was also stationary before the collision. This tamper (a self-propelled on-track machine that aligns track and simultaneously compacts the supporting ballast) was manufactured in 2000 (figure 4). It is fitted with equipment and software to undertake short geometry corrections to either, or both, rails, which is known as sprinter tamping. This tamper normally operates outside of HS1 infrastructure and so was not fitted with an in-cab signalling system. This meant that it needed to be accompanied by the MPVs to make any movements outside a work site while on HS1.

c. MPV number DR97012 (MPV2), which was moving when the accident occurred. MPV2 is a similar vehicle to MPV1.

Figure 3: One of the HS1 MPVs involved in the accident (courtesy of NRHS).

Figure 4: The tamper involved in the accident.

15 These 3 vehicles had been involved in track maintenance work during the night before the accident occurred. At the time of the accident, MPV2 was about to be coupled to the tamper. The tamper would then in turn be coupled to MPV1 to form a single train to return to Singlewell.

16 Each of these vehicles was fitted with an on-train data recorder (OTDR) but none were fitted with forward or rear-facing closed-circuit television (CCTV).

Staff involved

17 The driver of MPV1 (driver 1) had been employed by Balfour Beatty Rail for around 3 years at the time of the accident. They held a current competency for this role and had around 34 years' experience of driving trains and on-track machines (OTM, specialist railway vehicles which are self-propelled and operate as railway vehicles outside of possessions) mostly on HS1 and Eurotunnel.

18 The driver of MPV2 (driver 2) had been employed by Balfour Beatty Rail for around 6 years at the time of the accident and held a current competency for that role. Driver 2 had around 15 years' experience of driving trains and OTM on the national rail network, HS1 and Eurotunnel.

19 The machine controller who was controlling the movement of MPV2 had been employed by the NRHS track department for 13 years at the time of the accident. The machine controller had been employed in various track maintenance roles on the railway since 2001. They qualified as a machine controller in 2014, and this competency was current when the accident occurred.

20 Other members of staff were on site at the accident, both on track in the vicinity of the vehicles and on board the tamper. Although some of these staff were knocked over in the accident, they were not injured or otherwise directly involved in the events which led to it occurring.

External circumstances

21 At the time of the accident, it was dark, and the temperature was around 5° C. There was no significant ambient noise present at this time. RAIB has concluded that external influences did not affect the accident.

The sequence of events

Events preceding the accident

22 The night shift on 15 to 16 November 2023 was the last in a series of maintenance activities involving the tamper over the previous 3 weeks. It had been planned and rostered in advance and the staff involved in the activities arrived at Singlewell depot at 21:00 to book on duty.

23 One MPV driver is nominated as the lead driver for each shift. Balfour Beatty Rail stated that the lead driver would be the individual responsible for decisions on the night in the event of an incident, or if recovery was required. This role did not affect which driver drove which vehicle, and the two drivers were in the habit of alternating which end of the train they drove. This alternation arose as driving the train back to Singlewell at the end of the night was the less preferred task.

24 At around 23:30, the two MPV drivers met the tamper operators in the yard where they all prepared and checked their respective vehicles. The vehicles were formed into a train with MPV1 at the London end, the tamper in the middle and MPV2 at the Folkestone end.

25 At approximately 23:55, the train, made up of the three coupled vehicles, was authorised to move by the signaller. The movement was initially towards London along the Down Singlewell Loop and out onto the Down CTRL line, where the train stopped for approximately 4 minutes. At 00:11 on 16 November, the train began to move toward Folkestone, crossing onto the Up CTRL line and proceeding towards the work site.

26 At approximately 00:27, the train reached the London end of the work site (figure 5), at 47.7 km where it came to a stand. Driver 2, who was driving the train at the time, contacted the signaller and stated that the train was in position and ready for the engineering possession (where the lines were blocked to the normal passage of trains) to be taken around it.

Figure 5: The train at the London end of the work site.

27 Once the possession had been taken, the drivers uncoupled the MPVs from the tamper. At 01:35, with authorisation from the senior responsible person on site (SRPOS, the person responsible for train movements in the possession) MPV2 began travelling towards Folkestone. At 01:45, the tamper was also authorised to proceed and followed MPV2. MPV2 reached the southern end of the possession at 01:49 and came to a stand on the Up CTRL line close to the 53 kilometre point (figure 6). Driver 2 and the machine controller waited here, in the cab of MPV2, for further instructions.

Figure 6: The vehicles' positions as the tamper started work.

28 The tamper reached the southern end of the work site at 02:01 and then began heading back towards London, undertaking tamping operations at predetermined locations. At 04:09, the tamper, having completed the planned work, arrived back at the north end of the work site and approached MPV1, which it buffered up to, ready to be coupled to it for the return to Singlewell (figure 7).

Figure 7: The vehicles' positions as MPV2 approached the other vehicles.

29 At 04:01, knowing that the tamper had nearly completed its work, the SRPOS authorised the machine controller to begin moving MPV2 towards the London end of the work site. This movement was undertaken under 'proceed on sight' rules, detailed in module S2 of the HS1 Rule Book, which give the machine controller responsibility for directing it. Under these rules, the machine controller tells the driver when it is safe to move, at speeds of up to 30 km/h (17 mph). The machine controller is positioned to have a view of the line ahead to watch for any obstructions, such as other vehicles or workers.

30 Before this movement, the machine controller spoke to the driver in the cab and agreed that they would communicate by radio. Having moved to the position at the rear of the deck on MPV2, which was now at the leading end, in the direction of travel, the machine controller authorised the driver to begin propelling the MPV towards the other vehicles.

31 During the transit move, the machine controller contacted the driver once or twice a minute to confirm that it was still safe to proceed. At 04:11:48, the machine controller instructed that driver 2 begin to slow down as the rear lights of the tamper were in sight, around 400 metres away. OTDR data and witness evidence show that driver 2 acknowledged the instruction and brought the speed of MPV2 down from 30 km/h (17 mph) to around 20 km/h (12 mph). Driver 2 did not hear any further radio messages from the machine controller after this point.

Events during the accident

32 After the tamper had buffered up to MPV1 (paragraph 28), driver 1 began preparations for the return trip to Singlewell. After checking with the tamper operators that the handbrake was applied on their machine, driver 1 went in between MPV1 and the tamper to couple them together.

33 Although driver 1 knew that MPV2 was transiting towards the stationary vehicles, coupling their MPV to the tamper while MPV2 was approaching was normal practice and driver 1 was confident that it was safe to undertake coupling in these circumstances. This was because the established method of working for this type of move on HS1 was for the approaching MPV2, under the direction of the machine controller, to come to a stand around 50 to 100 metres away from the stationary vehicles. This stop is referred to as the 'holding point' within this report. The machine controller would then hand over control of MPV2 to driver 1, who would direct driver 2 to make any further movements, at very low speed, using a radio or hand signals.

34 Approximately 20 seconds after the first speed reduction (paragraph 31), the machine controller used the radio again to instruct driver 2 to reduce the speed of MPV2. This was to allow it to stop at the intended holding point.

35 The machine controller received no acknowledgement on the radio to this instruction and did not feel the brakes being applied on MPV2. The machine controller then made several attempts to contact the driver using the radio. Still getting no response, and with a collision with the tamper apparently imminent, the machine controller began to shout "Stop, stop" and then braced for impact.

36 Approximately 40 seconds after the last radio communication, driver 2 stated that they heard shouts from outside the cab through the open window and put the traction brake controller, which controls both the power and brakes of MPV2, into the emergency brake position.

37 OTDR data shows that this emergency brake application was made with MPV2 around 16 metres away from the tamper. MPV2 was recorded as travelling at 20 km/h (12 mph) when this brake application was made, leaving insufficient distance to avoid a collision.

38 When MPV2 struck the tamper, driver 1 was in the space between MPV1 and the tamper (figure 8), about to place the tamper's coupling shackle over the hook on MPV1. The impact caused the vehicles to move around 1.4 metres. Driver 1 was hit in the back, knocked to the ground and overrun by the front end of the tamper.

39 Two tamper operators and a machine controller, who were all on the tamper, were knocked over by the impact, but were not injured. The machine controller on MPV2 and driver 2 were uninjured but were shaken by the accident.

Events following the accident

40 A member of NRHS staff who was nearby helped driver 1 out from under the tamper and into the space between the up and down lines. Other members of staff reported the accident to the SRPOS and requested an ambulance, which was reported to have arrived at 04:52. Driver 1 was taken to hospital and released later the same day, having suffered minor physical injuries. Driver 1 continued to suffer from psychological distress due to the accident and began a phased return to work in March 2024 and resumed full duties in August 2024.

41 Staff who were directly involved in the movement and management of the vehicles were tested for the presence of drugs and alcohol in accordance with their companies' procedures. All tests returned negative results.

Figure 8: The space between MPV1 and the tamper in which driver 1 was standing.

42 The vehicles involved were moved back to Singlewell depot and, after checks for damage, the line was reopened to normal traffic at 07:38. The vehicles were checked after arrival at Singlewell depot. Multiple areas of minor damage were identified on MPV2, but no damage was found on the other two vehicles.

Analysis

Identification of the immediate cause

43 The crew of MPV2 did not stop their vehicle short of the tamper as planned.

44 As part of assessing their competence for the driver role, Balfour Beatty Rail required drivers to demonstrate that they had reached a clear understanding with relevant staff that it was safe to couple or uncouple. Balfour Beatty Rail also required staff to demonstrate that they had established that other rail vehicles were secure before undertaking coupling and uncoupling operations.

45 Before setting off to rejoin the other vehicles at 04:01 (paragraph 29), witness evidence indicates that the machine controller and driver 2 agreed that they would communicate by radio, as was their normal practice. They successfully tested the radios while they were both still in the cab of MPV2. They also agreed that they would follow their normal practice and stop MPV2 at the holding point so that driver 2 could put the MPV into creep mode, and control could be passed from the machine controller to driver 1 (paragraph 33).

Identification of causal factors

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

a. Driver 2, driving MPV2 from the cab at the trailing end, did not apply the brakes at the holding point (paragraph 47).

b. The machine controller, riding on the leading end of MPV2, had no facility to apply the brakes at the holding point (paragraph 69).

Each of these factors is now considered in turn.

The actions of the driver

47 Driver 2, driving MPV2 from the cab at the trailing end, did not apply the brakes at the holding point.

48 Analysis of OTDR data and witness evidence show that MPV2 was travelling at approximately 20 km/h (12 mph) when it passed the intended holding point. The OTDR also shows that no braking was used until the MPV was within 20 metres of the tamper, by which time it was too late to avoid the collision (paragraph 37).

49 There was no view to the rear of the vehicle (which was the leading end during the movement) from the MPV's cab which would have permitted driver 2 to see the line ahead during this propelling move. Although driver 2 was in the habit of leaving the cab side window open when making propelling moves and there was a window in the cab door (figure 9), a container on the rear deck of MPV2 on the night of the accident blocked the driver's view of both the line ahead and of the machine controller. This meant that driver 2 was solely reliant on radio instructions from the machine controller to know when to stop the vehicle.

50 Driver 2 stated that they did not brake MPV2 so that it would stop at the holding point because they did not hear any instructions from the machine controller telling them that they needed to apply the brakes.

Figure 9: The rear of an HS1 MPV cab. On the night of the accident a container was mounted on the rear deck.

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

a. Radio communication was lost between the machine controller and driver 2 (paragraph 52).

b. Driver 2 did not know that communication with the machine controller had been lost (paragraph 63).

Each of these factors is now considered in turn.

Radio equipment

52 Radio communication was lost between the machine controller and driver 2.

53 Witness evidence indicates that, when the machine controller and driver 2 discussed the method of working for the return trip (paragraph 44), although it was not specifically agreed, it was understood between them that the machine controller would confirm that it was still safe to proceed from time to time rather than keep in constant communication. This was regarded as normal practice during such movements, which in this case took 10 minutes, but which could be longer.

54 Witness evidence indicates that the machine controller contacted driver 2 once or twice a minute during the transit move to confirm that it was still safe to proceed. At around 04:12, the machine controller instructed driver 2 to slow down. Driver 2 acknowledged this instruction and reduced the speed of MPV2. Driver 2 did not hear any further radio messages from the machine controller after this point (paragraph 31).

55 Approximately 20 seconds later, the machine controller used the radio to instruct driver 2 to begin braking to bring the MPV to a stand at the holding point. However, the machine controller received no response by radio, nor had any feeling that the MPV was slowing (paragraph 35).

56 The machine controller used the radio again, pressing the 'push-to-talk' button and speaking into the radio. After a number of attempts to do this, the machine controller heard the word "*one*" spoken by the radio (see paragraph 60) and recognised this as the spoken confirmation given by the radio that it is on channel 1, which occurs just after it is switched on.

Testing of the radios

57 RAIB tested the radios used on the night of the accident and found that, although driver 2's radio functioned as expected, the machine controller's radio had an intermittent fault, which caused the battery to lose electrical contact with the radio. This removed power from the radio, which would then cease to function.

58 Tests also showed that, after the radio had been switched on for a few seconds, it did not display any indication that it was switched on and ready to transmit. When the push-to-talk button was pressed, the light-emitting diode (LED) indicator on the radio illuminated red to show that a transmission was being made. When receiving a transmission from another handset this LED illuminated green (figure 10). These features are as the radio was designed.

Figure 10: Radio used by the machine controller on the night of the accident, showing LED, channel selector and push-to-talk button.

59 As the radios do not display any visual indication that they are on, other than when transmitting or receiving, it is not possible for a user to tell whether the radio is live and functioning correctly or not without pressing the push-to-talk button and observing the LED indicator illuminate.

60 RAIB's testing also found that, if the battery connection fault corrected itself, and power was restored to the radio, it powered up in the same way as when first switched on, by flashing the green LED, beeping and speaking the channel number '*one*'. If the push-to-talk button was pressed during this startup sequence, the radio would not transmit until the push-to-talk button had been released and then pressed again after the sequence was completed.

61 Given the LED's position on the handset, it is possible that the machine controller would not have noticed whether this LED illuminated or not when the push-to-talk button was pressed, as the radio would have been positioned very close to the machine controller's face to enable them to transmit a clear message to driver 2 (figure 11).

Figure 11: Radio held in a talking position, making the LED difficult to see.

62 This testing of the radio reinforces witness evidence which indicates that, although the machine controller's radio had been working during testing before the transit move and during part of the move, it was not working when the machine controller pressed the push-to-talk button to instruct driver 2 to stop at the holding point. Although the machine controller tried to use the radio again in the seconds after this first failed attempt to communicate, it is probable that, at this point, the radio was either still not powered or that the machine controller had pressed the push-to-talk button while the radio was starting up and then did not release and re-press the button before trying to talk.

Awareness of lost communications

63 Driver 2 did not know that communication with the machine controller had been lost.

64 As there was neither constant communication nor a continual communication tone (known as a 'confidence tone' on other types of radio), driver 2 was not aware that the machine controller's radio had failed after receiving the initial instruction to slow down.

65 Because the accepted method of working was that communication would occur once or twice a minute and because driver 2 had no visibility of the line in the direction of travel, they did not know how far away the tamper was when receiving the initial instruction to slow down. As such, driver 2 was not concerned about the lack of further communication during the 30 seconds after the request to slow down, until hearing shouting from outside the cab (paragraph 36).

66 For many years, Network Rail has had standards which required communications with on-track plant and machines in work sites to use approved duplex radios, either with constant communication or which transmitted a confidence tone, with an obligation for the driver to stop if the tone or communication was broken. This requirement has existed since standard NR/L2/OPS/033, 'Radio Communications for the Control of Trains, On Track Machines and Rail Mounted Plant in Possessions', issue 1, came into force in June 2009. This requirement has also been in the mainline Rule Book GERT8000, including within Module SS2, 'Shunting' since issue 1, dated December 2003, and HB15, 'Duties of the machine controller (MC) and on-track plant operator' since issue 2, dated December 2012.

67 Because NRHS undertakes its functions on HS1, it is not required to follow the mainline Rule Book or the standards used on the infrastructure managed by its parent company, Network Rail. NRHS can choose to adopt such standards and has done so for some disciplines where it considers them suitable.

68 NRHS reported that it had trialled radios with DECT (Digital Enhanced Cordless Telecommunications) headsets, which can provide full duplex secure communication and confidence tones, during 2012. Although the results of these trials were not available to the investigation, NRHS reported that they had identified issues with the transmission of the radio signals through the metal structure of the MPV and therefore the trial was discontinued.

Braking facility at the rear of the MPV

69 The machine controller, riding on the leading end of MPV2, had no facility to apply the brakes at the holding point.

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

a. No brake control was fitted to the rear of the machine as part of the original design (paragraph 71).

b. No brake control was fitted to the rear of the machine following recommendations made after a previous accident in 2021 (paragraph 77).

Each of these factors is now considered in turn.

Brake controls

71 No brake control was fitted to the rear of the machine as part of the original design.

72 Some MPVs in use on other networks, such as infrastructure managed by Network Rail, are configured in trains of semi-permanently coupled vehicles which have a cab at each end of the train. An example of this type of MPV is discussed in RAIB's report into the runaway of a maintenance train near Markinch in October 2017, RAIB report 01/2018.

73 The HS1 MPVs were manufactured with a single cab at the front. Braking controls, in the form of emergency stop buttons, are fitted at several locations along the sides of the vehicle (figure 12), but these were intended for use by personnel working or walking alongside the machine. As the buttons were out of the reach of a machine controller riding on the rear of the load deck, they were not safe to operate while the MPV was moving.

Figure 12: The emergency stop buttons fitted to the sides of HS1 MPVs.

74 When the MPVs in use on HS1 were acquired, they were intended to operate as single vehicles and their main purpose was expected to be for maintenance of the overhead line equipment (OLE). When used for this purpose, they are fitted with an elevated working platform on the rear deck, known as the inspection module, which has driving controls in the basket. When propelling moves are made by HS1 MPVs undertaking OLE work, the vehicle is operated by the machine controller from the basket, from where there is a clear view of the line ahead.

75 The certificate of authority to operate the HS1 MPVs requires that an intercom system is fitted and operational between the driver's cab and the inspection module. It does not make any reference to propelling moves in any other configuration, including operating the machine with a machine controller directing movements from the rear deck.

76 NRHS reported that while it used to be unusual to use the MPVs without an operator in an inspection module, there had been, in recent years, an increase in the number of work sites with multiple machines being used for other tasks. This is likely to be because the infrastructure on HS1 now requires more maintenance than in previous years as it gets older.

Previous recommendation

77 No brake control was fitted to the rear of the machine following recommendations made after a previous accident in 2021.

78 On 15 August 2021, a similar accident occurred in the Thames Tunnel when an HS1 MPV collided with a rail grinding machine. The moving MPV was propelling under the instructions of a machine controller, who was using hand signals with a torch to communicate with the driver, as agreed before the movements started.

79 The driver had no visibility of the grinder due to the gradient and curvature of Thames Tunnel at that point, and either received no instruction from the machine controller as they approached the grinding machine or received it when it was too late to stop. The MPV collided with the grinding machine at about 10 km/h (6 mph). The other MPV was fully coupled at the time of impact and there were no injuries.

80 RAIB was notified of this accident by NRHS. As there was no damage or injury and as the accident had occurred in a work site, it decided to take no further action.

81 NRHS completed an internal investigation which resulted in several safety recommendations. One of the recommendations was that all HS1 MPVs should be fitted with a means for a machine controller, travelling on the rear of an MPV, to apply the brakes and stop the MPV in an emergency.

82 NRHS did not implement this safety recommendation. As such, there was no brake control fitted to any of the MPVs in operation on HS1 at the time of the 2023 accident which could be used by staff on the rear deck. NRHS reported that it had not fitted plungers on the deck of the machines as it did not believe that their availability would have prevented the 2021 accident. NRHS stated that the investigation into the accident had identified that the immediate cause had been operator error, as the machine controller had misjudged the braking time required by the MPV, and consequently found that the design of the MPV had not been a factor in the accident.

83 The recommendation to fit a brake control at a location that would have been safe and accessible in a machine controller's position at the rear deck of the MPVs, for possible use in propelling moves, was closed by NRHS on this basis. The fitment of such a control would almost certainly have avoided the November 2023 accident.

Identification of underlying factors

Safe systems of work

84 NRHS did not have documented safe systems of work in place to manage propelling moves, or to protect staff working on track, when trains were running during possessions.

85 The site documentation that NRHS issued to the staff working in the possession on the night of the accident did not provide any details of protection arrangements for staff working on the track. Neither the actions to be taken when recoupling the sections of the train when other vehicles were still moving, nor any details for the propelling move were included in this documentation.

86 The site documentation did include details of the movements to be made by vehicles during the night (figure 13) but did not include any details of how these would be controlled or how personnel would be kept safe from trains moving through the work site at the maximum permitted speeds of up to 30 km/h (17 mph). When vehicle movements, including propelling movements, within work sites were required, NRHS relied on competent staff applying the rules contained within Module OTP of the HS1 Rule Book (a rule book specific to train movements on HS1).

THE TRAIN WILL ARRIVE FROM:	SIMD
THE TRAIN WILL WAIT ON THE UP CTRL AT:	Km 047.700
POSSESSION TO BE TAKEN AROUND THE TRAIN	
STS TO CONFIRM WITH AFC SIGNALLER THAT THE FOLLOWING POINTS ARE SET CORRECTLY USING FORM SET: 2241 N, 2244 N	
LONDON END MPV TO UNCOUPLE AND PROCEED TOWARDS LONDON END OF WORKSITE	Km 047.700
COUNTRY END MPV TO UNCOUPLE AND PROCEED TOWARDS COUNTRY END OF WORKSITE	Km 053.200
TAMPING TO BE CARRIED OUT AS DIRECTED BETWEEN 49.100 - 53.100 UP CTRL	
ON COMPLETION OF THE WORK THE TAMPER AND MPVS WILL RETURN TO:	Km 047.700
THE POSSESSION WILL BE HANDED BACK AROUND THE TRAIN ON THE UP CTRL AT:	Km 047.700
TRAIN STABLED AT END OF WORK	SIMD

Figure 13: Table from the site documentation detailing the moves of the machinery in the work site.

87 NRHS stated its belief that, historically, this had been a sufficient way of ensuring the safety of staff on the track and movement of machines. This was because there was generally only one machine in operation and staff would have known where this was.

88 Witness evidence suggests that HS1 Ltd and NRHS management were aware of a gradual rise in maintenance activities and an increase of multi-vehicle work sites. Balfour Beatty Rail confirmed that a greater variety of maintenance and renewal trains is being operated, in addition to the long-standing maintenance work. However, NRHS had not identified that the risk to staff, particularly those who are working within the swept path of vehicles, was likely to have increased and that this risk may have required the introduction of additional control measures.

Strategic safety assurance by HS1

89 HS1 Ltd's strategic safety assurance of NRHS did not include a process to review recommendations resulting from safety investigations. This meant that HS1 Ltd was not aware of the recommendation resulting from the previous accident in 2021. This is a possible underlying factor.

90 HS1 is governed by a concession agreement between HS1 Ltd and the Department for Transport. Under this agreement, HS1 Ltd is required to secure the operation and maintenance, renewal and replacement, as well as the planning and management of any upgrades of the HS1 railway infrastructure.

91 HS1 Ltd operates through an outsourced model and contracts NRHS via an operator agreement to undertake the majority of the maintenance, operation and renewal obligations from the concession agreement. NRHS holds a safety authorisation issued by the Office of Rail and Road (ORR), the safety authority for railways in Great Britain, allowing it to act as the infrastructure manager for HS1 under The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended) (ROGS).[1]

92 HS1 Ltd uses the operator agreement to assure itself that NRHS is a competent and safe contractor. HS1 management stated that NRHS's status as a subsidiary of Network Rail provided reassurance to HS1 Ltd concerning the ability of NRHS to undertake its contracted duties safely.

93 The 2021 accident (paragraph 78) was reported to HS1 Ltd's board in September 2021 as part of a safety and security status report briefing. NRHS classified the accident as a 'medium risk operational close call', a category of incident which HS1 Ltd monitors as an indicator of risk. As a consequence of this, HS1 Ltd reviewed its assurance of the NRHS management team, site surveillance processes and its management of contractors, and was satisfied that its assurances processes were robust.

94 NRHS has a recommendations tracker and HS1 Ltd is informed of any outstanding actions relating to recommendations. HS1 Ltd has the right to audit these records should it identify any potential issues. Witness evidence shows that NRHS generally closes recommendations from its internally led investigations without consulting HS1 Ltd, as the relationship is such that HS1 Ltd accepts that NRHS is closing recommendations appropriately, based on its experience, competence and judgement.

95 The recommendation from the 2021 accident relating to additional braking controls at the machine controller position was not shared with or reviewed by HS1 Ltd. As such, HS1 Ltd was not aware that the recommendation had been closed with no actions being taken (paragraph 83).

[1] https://www.legislation.gov.uk/uksi/2006/599/contents.

Role of ORR

96 ORR is the independent economic and safety regulator for the railways in Great Britain including HS1. Monitoring activities of HS1 undertaken by ORR include the annual and 5-year periodic reviews of HS1's performance. Health and safety performance is considered as part of this process.

97 As an infrastructure manager under ROGS (paragraph 91) NRHS has a legal duty to establish and maintain a safety management system, as well as its more general legal duties to manage the risks to health and safety associated with its operations. While HS1 Ltd is the asset steward and client for works on the HS1 network, NRHS is the legal duty holder for the scope of work it undertakes under relevant health and safety law.

98 ORR plans its supervision of HS1 duty holders in accordance with its health and safety regulatory strategy. This supervision comprises a wide range of regulatory activities. ORR allocates its resources according to risk, and where it can have the greatest impact in reducing risk.

99 ORR stated that its approach to the safety supervision of HS1 duty holders takes account of the following:

- the risk profile of HS1 when compared to other major railway infrastructure managers
- the relatively new asset life of HS1 infrastructure. However, ORR is aware that the asset life cycle has continued to progress and has highlighted to HS1 Ltd the importance of having appropriate arrangements for the management of current and future risks. ORR is also reviewing its approach to the regulation of HS1 duty holders
- focusing the resources in the ORR Channel Tunnel team (who hold responsibility within ORR for HS1) on the highest priority matters.

100 ORR's 2022-23 Annual Report on HS1 Ltd[2] highlighted both an increase in workforce injuries, as well as the progress that has been made with both the HS1 Ltd and NRHS approach to the management of contractors.

101 ORR was aware of the accident that occurred on 15 August 2021 in the Thames Tunnel (paragraph 78). However, this accident did not meet either the criteria to be formally reported to ORR under the 'Reporting of Injuries, Deaths and Dangerous Occurrences Regulations 2013 (RIDDOR)' or the requirements of ORR's policy for a mandatory investigation. ORR, therefore, did not make further enquiries into the accident.

102 HS1 Ltd reported to ORR that it was undertaking an assurance audit of its contractors in 2023. ORR, therefore, postponed a planned inspection of its own, which had similar objectives. No actions regarding the assurance programme had been reported to ORR at the time of the accident in November 2023.

[2] https://www.orr.gov.uk/sites/default/files/2023-08/orr-annual-report-on-hs1-2022-23.pdf.

Summary of conclusions

Immediate cause

103 The crew of the MPV did not stop their vehicle short of the tamper as planned (paragraph 43).

Causal factors

104 The causal factors were:

a. Driver 2, driving MPV2 from the cab at the trailing end, did not apply the brakes at the holding point (paragraphs 47 and 107). This causal factor arose due to a combination of the following:

   i. Radio communication was lost between the machine controller and driver 2 (paragraphs 52 and 107b).

   ii. Driver 2 did not know that communication with the machine controller had been lost (paragraphs 63 and 107b).

b. The machine controller, riding on the leading end of MPV2, had no facility to apply the brakes at the holding point (paragraphs 69 and 107). This causal factor arose due to a combination of the following:

   i. No brake control facility was fitted to the rear of the machine as part of the original design (paragraphs 71 and 107a).

   ii. No brake control was fitted to the rear of the machine following recommendations made after a previous accident in 2021 (paragraphs 77 and 107a, **Recommendation 3**).

Underlying factors

105 An underlying factor was that Network Rail High Speed (NRHS) did not have documented safe systems of work in place to manage propelling moves or to protect staff working on track when trains were running during possessions (paragraph 84, **Recommendations 1 and 2**).

106 A possible underlying factor was that HS1 Ltd's strategic safety assurance of NRHS did not include a process to review recommendations resulting from safety investigations. This meant that HS1 Ltd was not aware of the recommendation resulting from the previous accident in 2021 (paragraph 89, **Recommendation 4**).

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

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

107 NRHS has reported that, since the accident, it has:

a. fitted emergency stop and warning horn buttons to the rear deck positions of each MPV (figure 14), which, like the controls on each side of the MPV, apply the vehicle's emergency brakes

b. purchased headsets that enable secure open microphone communication between the cab and the rear standing positions of each MPV

c. updated the HS1 Rule Book with instructions for use of these radios and a requirement for drivers to stop if there is no communication for 10 seconds.

Figure 14: The new emergency stop and horn buttons on HS1 MPVs.

Other reported actions

108 NRHS reported that it is intending to fit recorded CCTV on the fleet of HS1 MPVs, with forward and rear-facing cameras, together with monitors in the driving cab to give drivers rearward visibility during propelling moves.

109 NRHS is developing a standard to protect its workforce. It stated that it intended that this be the equivalent to standard NR/L2/OHS/019, 'Safety of people at work on or near the line' which is used by Network Rail on the mainline railway.

110 HS1 Ltd reported that it has undertaken continuous improvement activities based on the learning from this accident. This has included looking at how it applies its health and safety management system to discharge its responsibilities, including the use of audits, periodic reporting and site visits. It is also seeking to better understand risk, based on evidence, to target assurance activities.

111 The internal review into this accident resulted in HS1 Ltd accepting recommendations to:

- improve its processes to ensure rigour in the acceptance and close-out of audit recommendations/actions between HS1 and NRHS systems, including opportunities for improvement
- introduce a change control process to provide an audit trail of why effectiveness ratings have been changed (and what incident, key performance indicator, or evidence has caused this change)
- include in its audit plan for 2025/26 an audit of recommendation close-out process and effectiveness with particular focus on significant operational and safety incidents in 2023/24.

112 In its Annual Report on HS1 Ltd for 2023 to 2024[3] ORR stated that the key performance indicator for workforce safety had seen improvements and had now returned to within the threshold value.

[3] https://www.orr.gov.uk/annual-report-hs1-ltd-2023-2024.

Recommendations

113 The following recommendations are made:[4]

1 *The intent of this recommendation is that the risks of engineering vehicle operation on High Speed 1 are appropriately controlled.*

Network Rail High Speed, working in conjunction with Balfour Beatty Rail and other relevant suppliers, should undertake a risk-based review of the design of on-track plant and machines, relevant rules, standards, procedures, and training material relating to the movement of on-track plant and on-track machines, including those relating to propelling movements.

Network Rail High Speed should develop a timebound programme for the implementation of any appropriate changes identified (paragraph 105).

2 *The intent of this recommendation is that staff work within a robust procedural framework when on or near the line*.

Network Rail High Speed should undertake a risk-based review of the relevant rules, standards, procedures, and training material to check that they provide an effective framework for staff to work safely during engineering possessions.

Network Rail High Speed should develop a timebound programme for the implementation of any appropriate changes identified (paragraph 105).

[4] 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.

3 *The intent of this recommendation is for Network Rail High Speed to ensure that recommendations and local actions are reviewed and implemented in a way that reflects their intent and that this process can be tracked and used to support safety decision-making.*

Network Rail High Speed should review its procedures for handling recommendations and local actions from internal and external safety investigations. This review should specifically examine how recommendations are considered and implemented, and how the effectiveness of any measures taken to implement recommendations are assessed to ensure that the risk that the recommendation was designed to address has been sufficiently mitigated.

This review should also consider how the implementation of recommendations is recorded and how this can be used to support future decisions concerning safety.

Network Rail High Speed should develop a timebound programme for the implementation of any appropriate changes identified (paragraph 104b.ii).

4 *The intent of this recommendation is for HS1 Ltd to exercise more effective strategic safety assurance of its suppliers.*

HS1 Ltd should review the findings from this investigation to establish if it can make improvements to the strategic safety assurance of its suppliers.

HS1 Ltd should develop a timebound programme for the implementation of any appropriate changes identified (paragraph 106).

Appendices

Appendix A - Glossary of abbreviations and acronyms

Abbreviation / acronym	Term in full
CCTV	Closed-circuit television
DECT	Digital Enhanced Cordless Telecommunications
HS1	High Speed 1
LED	Light-emitting diode
MPV	Multi-purpose vehicle
NRHS	Network Rail High Speed
OLE	Overhead line equipment
ORR	Office of Rail and Road
OTDR	On-train data recorder
OTM	On-track machine
ROGS	The Railways and Other Guided Transport Systems (Safety) Regulations 2006
SRPOS	Senior responsible person on site

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from the train's OTDR
- testing and analysis of the radio equipment
- site photographs and measurements
- weather reports and observations at the site
- a review of previous reported accidents
- a review of previous RAIB investigations that had relevance to this accident.

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