Rail Accident Investigation Branch

# Rail Accident Investigation: Interim Report

## Collision between passenger trains near Talerddig, Powys
## 21 October 2024

Report IR1/2025
April 2025

*Note: This interim report contains information obtained as part of the Rail Accident Investigation Branch's (RAIB) ongoing investigation. Some of the information contained in this report may be refined or changed as the investigation progresses.*

*The purpose of an RAIB investigation is to improve safety by preventing future railway and tramway 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.*

# Collision between passenger trains near Talerddig, Powys, 21 October 2024


## Summary

1 At around 19:26 on Monday 21 October 2024, train reporting number 1J25, the 18:31 passenger service from Shrewsbury to Aberystwyth, collided with train reporting number 1S71, the 19:09 Machynlleth to Shrewsbury passenger service. Both services were operated by Transport for Wales Rail Limited (TfWRL).

2 The collision took place on Network Rail's Cambrian line to the west of the passing loop located at Talerddig, Powys (figure 1). One passenger died and four other people were seriously injured. Neither train derailed in the collision, although significant damage was caused to the leading vehicles of both trains.

3 From each direction, the railway approaching Talerddig passing loop consists of a single line, with the loop allowing trains to pass each other. Train 1J25, travelling west, was due to stop in the loop to allow eastbound train 1S71 to pass it. Train 1J25 was braking as it approached and passed through the loop. Despite this it was unable to stop within the loop as intended. The train subsequently exited the loop, while still braking, and re-entered the single line, heading towards train 1S71. Train 1J25 travelled approximately 1,080 metres beyond its intended stopping point, before colliding with train 1S71.

4 At the time of the collision, train 1J25 was travelling at approximately 39 km/h (24 mph), while train 1S71 was travelling in the opposite direction at approximately 11 km/h (6 mph).


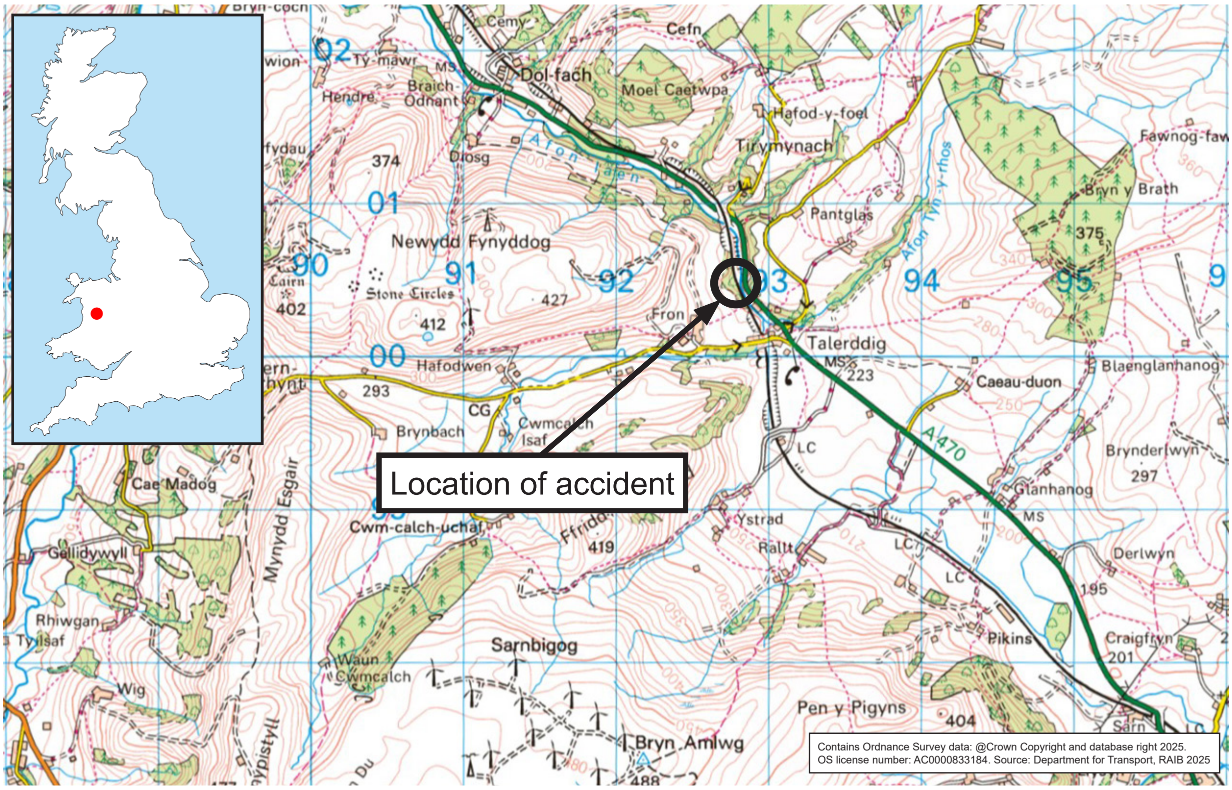


*Figure 1: Extract from Ordnance Survey map showing location of the accident at Talerddig.*

## RAIB's role and the context of this interim report

5 The Rail Accident Investigation Branch (RAIB) is responsible for conducting independent investigations into railway and tramway accidents in the UK. The purpose of its investigations is to improve safety, by establishing the causes of the accident, and making recommendations to reduce the likelihood of similar occurrences in the future or to mitigate their consequences.

6 RAIB does not apportion blame or liability, enforce the law or carry out prosecutions. RAIB investigations are independent of those undertaken by other public bodies, such as the Office of Rail and Road, and the railway industry itself. However, we will work alongside investigations being undertaken by others and may share certain physical evidence with them, where this is appropriate and allowed by the law.

7 A final report will be published by RAIB on completion of its investigation. All RAIB investigation reports are available on RAIB's website. If found necessary, during its investigation, RAIB may also issue urgent safety advice to the rail industry.

8 This interim report is based on the evidence gathered and analysed to date and RAIB's findings should be considered within this context. RAIB's intended future actions for this ongoing investigation are described in paragraph 87. Topics relevant to the accident are likely to be covered in more detail within the final report following this work. This may also cause modifications to the interim findings contained in this report.

## Background

### The train services and passengers

9 Both trains involved in the accident were two-car class 158 diesel multiple units (figure 2).

10 Train 1J25, which was travelling west, was formed of unit number 158841. This comprised vehicle 57841 (leading) and vehicle 52841 (trailing). There were 31 people on board this train, including three TfWRL staff.

11 Train 1S71, which was travelling east, was formed of unit number 158824. This comprised vehicle 57824 (leading) and vehicle 52824 (trailing). There were six people on board this train, including two TfWRL staff.

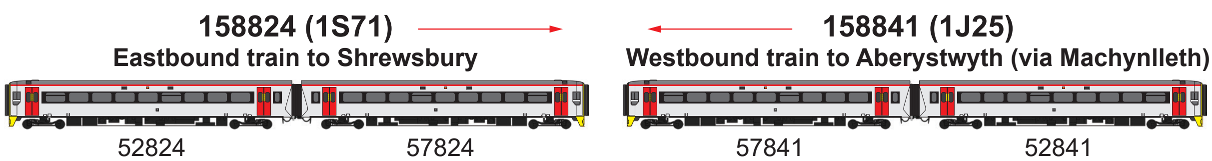


*Figure 2: Formation and direction of travel of trains 1S71 and 1J25.*

### The class 158 trains

12 Class 158 trains were built between 1989 and 1992. This type of train is widely used in the UK by a number of train operators. Constructed predominantly from aluminium extrusions, each vehicle is fitted with a driving cab and a diesel engine.

13 The braking system fitted to class 158 units decelerates the train by supplying air to brake cylinders mounted on the train's bogies. These brake cylinders apply friction pads to brake discs, mounted on each wheelset. A driver can apply three levels of braking in normal service. Step 1 provides the lowest level of braking, while step 3 (known as 'full service braking') provides the maximum braking effort. A driver can also make an emergency brake application. This applies the same level of retardation as step 3 but uses a different control system so the train can still be braked in the event of a service braking system failure. On the class 158 units operated by TfWRL, the on-board signalling system (see paragraph 27) can also apply full service or emergency braking.

14 The TfWRL class 158 units also have auxiliary tread brakes installed on the bogies under each driving cab. Auxiliary tread brakes help to clean the wheel treads, to enhance train detection, and can also improve wheel-rail adhesion.

15 Both trains involved in the accident were fitted with a wheel slide protection (WSP) system. Similar to the anti-lock braking system in a car, the WSP system monitors the rotational speed of a train's wheelsets to detect and prevent wheel slide during braking, or wheel spin during acceleration. If the WSP system detects that wheel slide is occurring, the system automatically reduces the brake force being applied to the wheelsets until the system determines that they are no longer sliding. WSP systems are designed to optimise a train's braking in conditions where there is low adhesion between the wheel and the railhead, while also minimising the potential for the wheels to be damaged by sliding.

16 The class 158 units operated by TfWRL are fitted with two separate and independent sanding systems; these are an automatic sanding system and an emergency one-shot sanding system. When needed to improve wheel-rail adhesion, sand is dispensed from the train and delivered through hoses aimed directly at the wheel-rail interface.

17 The WSP system on the class 158 can activate the automatic sanding system to increase the available wheel-rail adhesion (and hence the available brake force). The sanding systems are discussed further in this interim report at paragraph 67.

## Parties involved

18 The railway infrastructure at Talerddig is owned, managed and maintained by Network Rail.

19 The trains involved were both operated by TfWRL. TfWRL employs the train drivers, the guards of both trains and the on-board host who was travelling on train 1J25.

20 TfWRL carries out all routine maintenance on the trains involved, predominantly at its depot at Machynlleth.

21 The trains involved are owned by Angel Trains and leased to TfWRL.

## Features of the route and accident location

22 The accident occurred on the Cambrian line which runs from Shrewsbury in England to Aberystwyth and Pwllheli, passing over the Cambrian Mountains in central Wales. The route includes long sections of single line railway, with passing loops provided at certain points to allow trains moving in opposite directions to pass each other.

23 The accident occurred near Talerddig passing loop (figure 3). This loop is located at 61 miles and 26 chains, measured from a datum point at Whitchurch via Oswestry.[1] Trains can be signalled into either side of the loop, at the discretion of the signaller located at Machynlleth. The points at each end of the loop are fitted with actuators which allow them to be remotely controlled by the signaller (see paragraph 40).

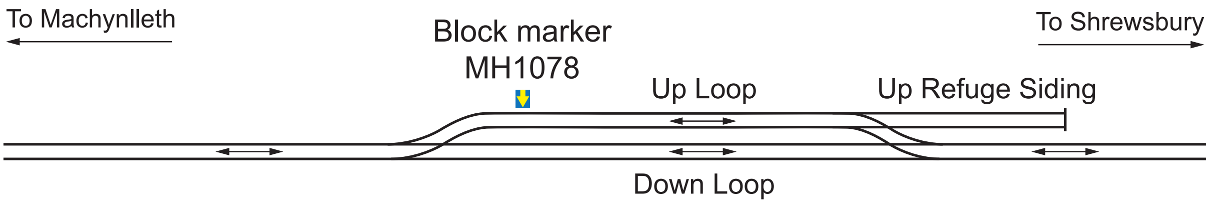


*Figure 3: Talerddig passing loop (image not to scale and not all equipment is shown).*

24 The permissible speed for trains approaching Talerddig in a westbound direction is 130 km/h (81 mph). This reduces on the approach to the passing loop, initially to 115 km/h (71 mph) and then to 95 km/h (59 mph). The permissible speed then further reduces to 50 km/h (31 mph) for trains entering the Up Loop. For trains passing via the Down Loop in a westbound direction, the permissible speed is 95 km/h (59 mph).

25 The permissible speed for trains approaching Talerddig in an eastbound direction is 95 km/h (59 mph) on the approach to the loop. This then reduces to 50 km/h (31 mph) for trains entering the Up Loop. For trains passing via the Down Loop in an eastbound direction, the permissible speed is 95 km/h (59 mph).

26 The loop at Talerddig is located on a summit with an ascending gradient for westbound trains approaching it. The exit from the passing loop for westbound trains descends to the collision point (figure 4).

## Signalling

27 The Cambrian line has operated since 2011 using a pilot installation of the European Rail Traffic Management System (ERTMS). This signalling system replaces traditional lineside signals with 'movement authorities' transmitted by radio to trains. ERTMS movement authorities are provided to the train driver on a display screen in the cab as information about how far the train may travel and the maximum permitted speed of the route the train will take. Equipment on board the train continuously monitors the train operation and will intervene if the train is travelling too fast or is likely to exceed the movement authority.

28 Lineside signage is used to provide additional visual cues for drivers, including marker boards which indicate the end of track sections ('blocks'). Train 1J25 was intending to stop at block marker MH1078 (figure 5).

[1] Via a now-closed railway from Oswestry to Buttington. Talerddig loop is 46 miles and 25 chains from Sutton Bridge Junction, located to the south of Shrewsbury station.

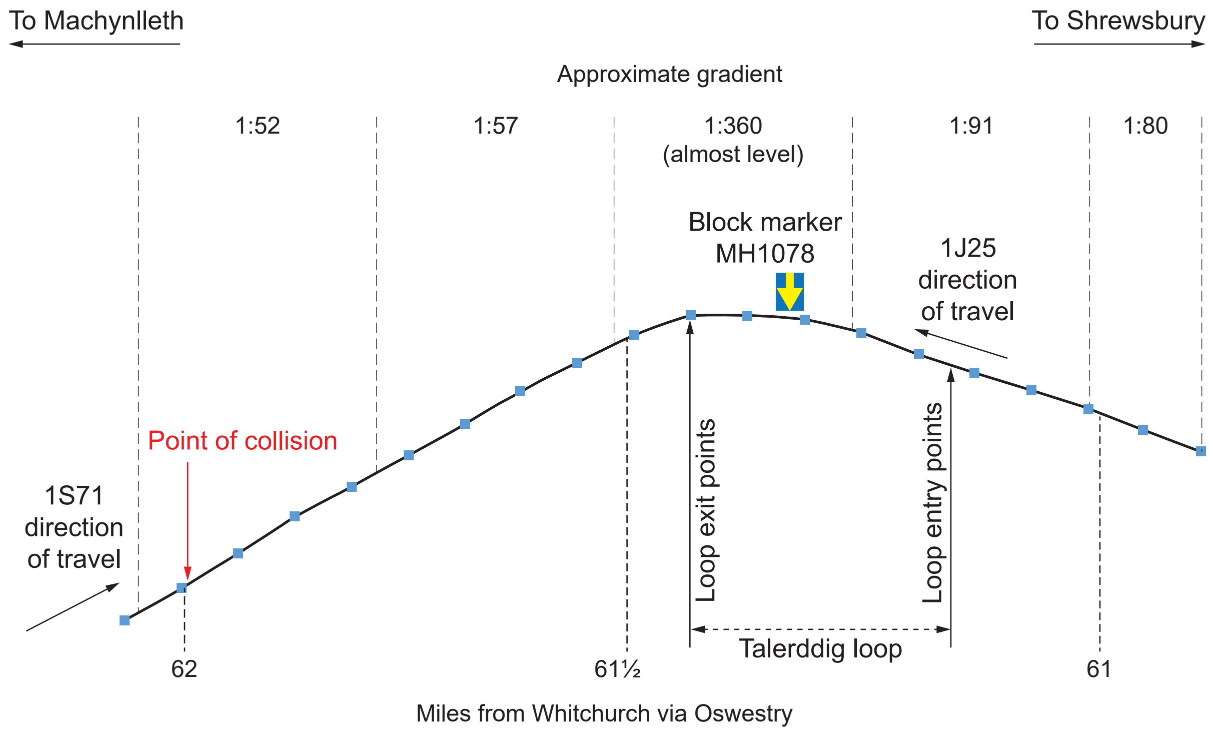


*Figure 4: Track gradient at Talerddig passing loop (gradient detail from an RAIB survey).*


*Figure 5: The intended stopping position for train 1J25, at block marker MH1078 on the Up Loop. A low adhesion warning sign is also visible on the left of the Down Loop.*

## External circumstances

29 On 18 October (3 days before the accident), Storm Ashley was forecast to bring strong winds and heavy rain to the UK on 20 and 21 October 2024. A Met Office weather report issued 3 days after the accident stated that '*Storm Ashley, the first named storm of the 2024/25 season, brought wet and windy weather to the UK in late October with the strongest winds across north-western areas. This was a powerful, although not exceptional, Atlantic autumn storm'*.

30 Network Rail has a contract with a national weather forecast provider, MetDesk Ltd. MetDesk sends weekly and daily weather and adhesion forecasts to each control centre. These include an adhesion index which indicates the likely risk of leaf fall and railhead contamination in wet and dry conditions, along with the possible level of disruption to the rail network which may be caused by this.

31 The adhesion index for 21 October forecast 'Moderate to Poor' adhesion for the Talerddig area. It estimated that there would be 3 to 4% of the season's leaves on the ground in the morning and that more leaves would fall during the day, leading to an increased risk of railhead contamination.

32 Data from a nearby weather station (at Carno, approximately 4 km from the accident location) from the evening of 21 October recorded rain falling between 17:00 and 18:00. This is likely to have created damp railhead conditions.

## The sequence of events

33 During the night of 19 to 20 October 2024, unit 158841 underwent a 'Fuel Point Examination' at Machynlleth depot. This is a routine maintenance activity which is carried out approximately every 1,500 miles (approximately 2,400 km) and includes refuelling the train and carrying out checks on safety equipment, including the train's automatic sanders. To check the automatic sanders, a maintenance technician presses a sander test button and visually observes if sand is ejected from the sand hoses. The sander test button is mounted on the sand hopper, which is on the train's underframe.

34 Before entering service on the morning of 20 October, unit 158841 was prepared by a driver instructor and a trainee driver. This preparation included internal and external inspections of the train, together with further checks of the functionality of safety systems, including the train's automatic sanders.

35 During 20 October, unit 158841 was operated on various routes to Aberystwyth, Shrewsbury, Birmingham and Chester. After the last passenger service finished at Shrewsbury, unit 158841 was planned to be stabled overnight at Crewe maintenance depot. However, due to service disruption, the train was instead driven to Chester station and stabled in a platform, arriving just before midnight.

36 Early on the morning of 21 October, a train driver prepared the train for service. However, the train was positioned adjacent to a platform. This meant that the driver did not have access to equipment on the train's underframe, including the sander test button. Consequently, certain safety systems, including the operation of the automatic sanding system, could not be checked.

37 During 21 October, unit 158841 entered service and was operated on various routes to Aberystwyth, Shrewsbury and Birmingham. Several of these journeys were operated from the cab of vehicle 57841. The train was operated by various drivers, and no faults were reported during this time.

38 The seventh journey for unit 158841 on 21 October was as train 1D16, the 17:08 service from Birmingham International to Shrewsbury and Llandudno. This train was formed of unit 158841 coupled to another TfWRL unit, 158828. The cab of vehicle 57841 was trailing for the first leg of the journey to Shrewsbury. On arrival at Shrewsbury, the train was split, and unit 158841 then formed train 1J25 from Shrewsbury to Aberystwyth. The track layout at Shrewsbury means that the train reversed direction and train 1J25 was operated with the cab of vehicle 57841 leading the train.

39 Train 1J25 departed from Shrewsbury 2 minutes late at 18:33. It called at Welshpool, Newtown and Caersws stations, departing from each on time. The train departed from Caersws at 19:15 with the next scheduled station stop due to be Machynlleth, at 19:45.

40 The signaller's intended operation of the passing loop at Talerddig on this occasion can be summarised in three steps (figure 6):

a. Westbound train 1J25 would arrive first, be signalled into the Up Loop and stop at block marker MH1078.

b. Eastbound train 1S71 would arrive next, be signalled via the Down Loop and pass without stopping.

c. Westbound train 1J25 would then be signalled back onto the single line.

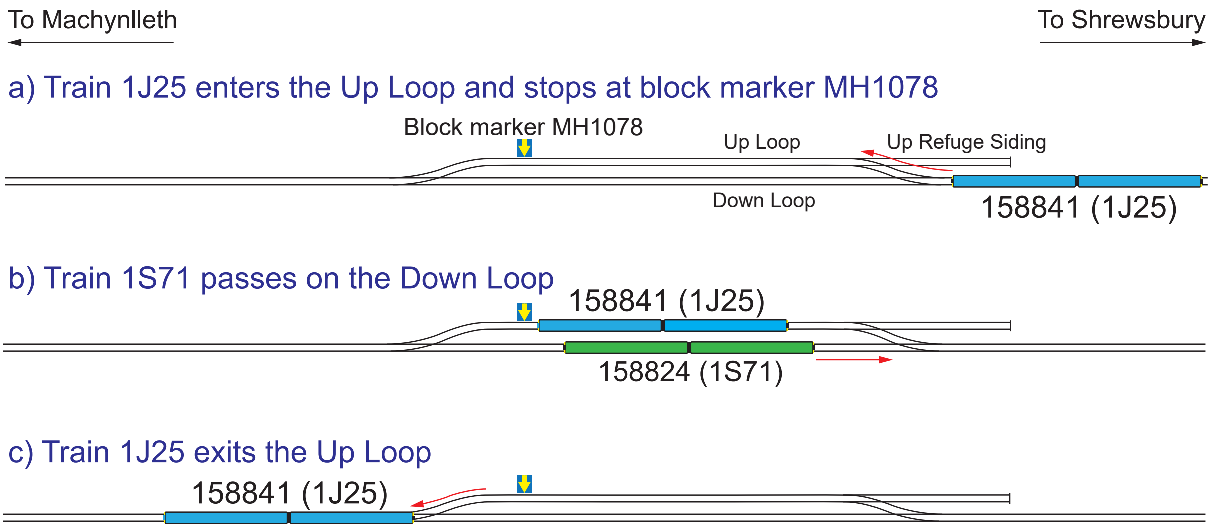


*Figure 6: The intended sequence of events at Talerddig passing loop (not to scale).*

41 The signaller chose this sequence of operations so that the eastbound train (1S71), which was climbing the steeper gradient on the approach to the loop, would pass through the Down Loop, which has a higher permissible speed than the Up Loop.

42 At approximately 19:22, on the approach to Talerddig loop, data from the on-train data recorder (OTDR) of train 1J25 shows that the driver shut off traction power while the train was travelling at 125 km/h (77 mph). At this point, the intended stopping point, at block marker MH1078, was approximately 1,900 metres away. Over the next 39 seconds, the driver made two separate step 1 brake applications to bring the train's speed down to 94 km/h (58 mph).

43 At approximately 19:23, the driver selected step 2 braking. The intended stopping point, at block marker MH1078, was now approximately 730 metres away. Three seconds later, the on-board signalling system automatically intervened and applied full service braking (step 3); block marker MH1078 was now approximately 640 metres away. The driver also stated that they applied full service braking, although the exact point that this occurred cannot be confirmed by OTDR data due to the automatic braking application. RAIB has concluded from its analysis of OTDR data that the train's wheels began to slide approximately 1 second after the automatic braking intervention.

44 After 6 seconds of full service braking, the on-board signalling system intervened with an emergency brake demand. The intended stopping point, at block marker MH1078, was now approximately 500 metres away.

45 The driver of train 1J25 then used the train's GSM-R radio to call the signaller to report that the train was sliding and was probably going to pass the block marker. Approximately twenty seconds after starting the call, the train passed block marker MH1078 at approximately 54 km/h (34 mph). The area beyond block marker MH1078 is a designated low adhesion area (see paragraph 60).

46 At approximately 19:24, the call with the signaller ended, as the train ran through the points and exited Talerddig Up Loop at approximately 33 km/h (20 mph). The train then entered the descending gradient and, although the brakes remained fully applied, its speed increased.

47 The signaller then called the driver of train 1S71. The driver of train 1S71 was told by the signaller that train 1J25 had passed block marker MH1078 and was occupying the loop exit points. The signaller instructed the driver of train 1S71 to stop at block marker MH1081 (figure 7), and the driver mentioned that the train was struggling with low adhesion. At the end of the call, train 1S71 was travelling at 26 km/h (16 mph). The driver then shut off traction power, possibly in response to seeing the approaching headlights of train 1J25. Over the next 9 seconds, the driver of train 1S71 applied service braking and then the emergency brake. The collision occurred 4 seconds after the emergency brake was applied.

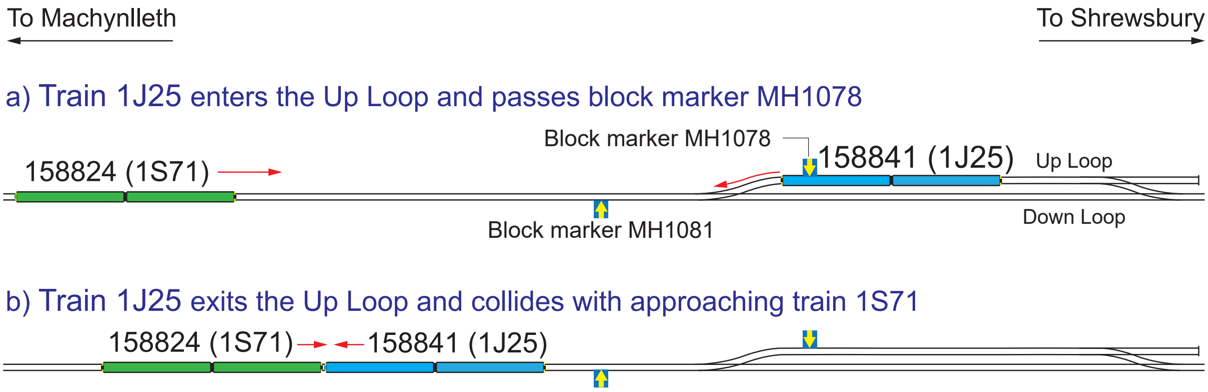


*Figure 7: The simplified sequence of events at Talerddig passing loop (not to scale).*

48 The driver of train 1J25, realising that a collision was imminent, moved into the saloon area of the leading vehicle and provided a warning to nearby passengers.

49 The collision occurred at around 19:26, while train 1J25 was travelling at approximately 39 km/h (24 mph) and train 1S71 was travelling at approximately 11 km/h (6 mph). At the point where the collision occurred, train 1J25 had travelled around 1,080 metres beyond block marker MH1078, and around 360 metres beyond block marker MH1081 (the position that train 1S71 had been instructed to stop at). Train 1S71 was pushed backwards approximately 35 metres by the collision (figure 8).


*Figure 8: The trains involved, showing the approximate location of the collision and the final resting position.*

50 Just over 2 minutes after the collision, the driver of train 1J25, having checked on the passengers and made their way to the back of the train, made a railway emergency call to the signaller from the rear cab to report the collision and to request the emergency services.

## Consequences of the accident

51 There were 31 people on board train 1J25, including the train driver, the guard and one other member of TfWRL staff. One person died and three people were seriously injured. The person who died and all the people with serious injuries were travelling in the rear carriage of train 1J25. This included the train's guard, who was standing up at the time of the accident. RAIB has been able to confirm that a further 18 people received minor injuries. The remaining passengers have either reported suffering no injuries or RAIB has not been able to obtain information from them about any possible injuries.

52 There were six people on board train 1S71, including the train driver and the guard. The driver was in the process of attempting to leave the driving cab when the collision occurred. The driver became trapped during the collision and was seriously injured. The remaining five people on board reported minor injuries.

53 The leading end of each train suffered damage in the collision (figure 9). The driving cab of train 1S71 received the most damage and was significantly deformed. The basic structural integrity of the passenger compartments on each train was maintained although some internal panels became detached, and some internal and external doors became inoperable. Some of the underframe equipment on both trains was displaced but did not become detached.

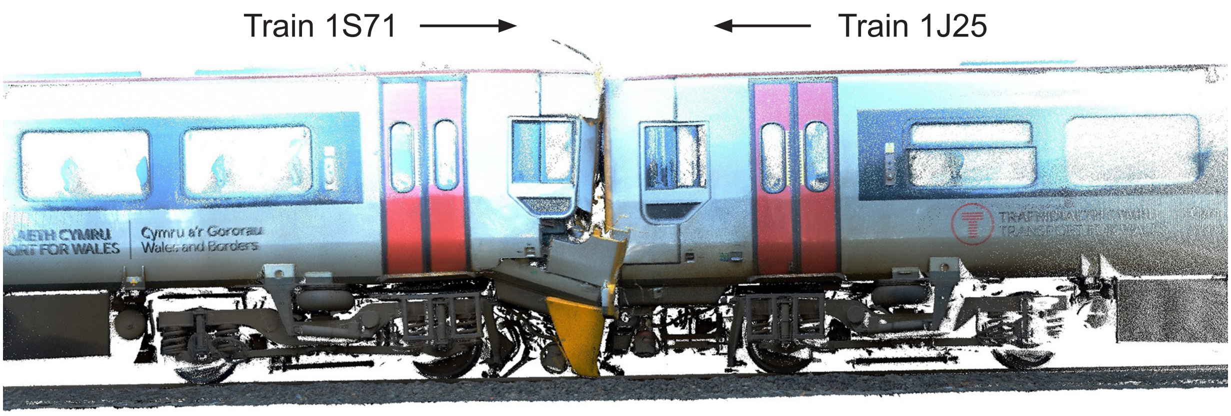


*Figure 9: Side view of the collision (image created from laser scans).*

54 A passenger in the leading vehicle of train 1S71 needed assistance to force open a jammed internal saloon sliding door before they could leave that carriage. The driver of train 1S71 was trapped in the driving cab and needed assistance from the driver of train 1J25 and a passenger to force open the damaged door from the cab into the passenger area. All other passengers had a viable means of escape.

55 During the accident, train 1J25 ran through a set of points, at the exit from Talerddig loop, which were not set for the route which it took. The points were damaged and needed repair. There was no other significant damage caused to the infrastructure. The line was reopened on 28 October 2024, 7 days after the accident.

## The investigation

56 The collision was notified to RAIB by Network Rail around 20 minutes after it happened. RAIB deployed immediately, with inspectors arriving on site just after midnight. While on site, RAIB inspectors identified that train 1J25 had encountered low wheel-rail adhesion and that its sand delivery hoses were blocked.

57 Since the accident, RAIB has:

- inspected and surveyed the accident site for 1.8 km on the approach to the point of collision, including taking railhead samples

- arranged for the damaged trains to be moved to a secure location and conducted an examination of the trains, including the braking, WSP and sanding systems
- commissioned laboratory analysis of the materials found in the sand hose and the samples taken from the railhead
- recovered components from the sanding systems of the vehicles involved, and started further detailed examination and laboratory testing
- completed crashworthiness examinations of both damaged trains
- established the number of people on board each train, and where possible, identified who was injured and how they received their injuries
- obtained evidence from data recorders on both trains involved, together with data from other trains operating the route, signalling and other electronic records
- gathered physical and documentary evidence
- gathered evidence from witnesses.

## Findings to date

### Wheel-rail adhesion and railhead treatment

58 Trains rely on friction between their steel wheels and the railhead to accelerate or decelerate. This means that the level of wheel-rail adhesion is critical to achieving both. Research indicates that adhesion can be significantly reduced by the presence of contamination and moisture on the railhead. When a train encounters a section of track with low adhesion, there may not be enough grip present between the wheels and rails, reducing the braking performance of the train.

59 RAIB undertook an inspection of the rails at Talerddig at around 02:00 on the night of the accident. It rained during this inspection. Some visible contamination was observed on the railhead, which was assessed by RAIB as being relatively light and intermittent. RAIB collected railhead contamination samples on the day after the accident and these are currently being analysed by a laboratory. RAIB also took some sample measurements using a digital tribometer with the data from these measurements indicating the presence of areas of low adhesion. There was no visible contamination on the wheels of the train when these were inspected. For this reason, RAIB did not collect any samples from the train's wheels.

60 Network Rail's sectional appendix identifies an area of known low wheel-rail adhesion starting towards the western end of Talerddig loop. This lies beyond the intended stopping position of train 1J25 at block marker MH1078. This area of known low adhesion is marked with a lineside sign, positioned in the cess of the Down Loop (figure 5), and continues west down the gradient towards Machynlleth for 5.9 km (3.7 miles).

61 Network Rail employs a number of methods to manage low wheel-rail adhesion risks. One such method is railhead cleaning using Rail Head Treatment Trains (RHTT). An RHTT treated the line through Talerddig in accordance with the planned schedule on the evening of 20 October 2024, the night before the accident. This treatment included the single lines around Talerddig and both tracks at the passing loop. At this location, the treatment involves water jetting only. The RHTT can also deposit an adhesion-improving gel, but this was not used on the Cambrian line.

62 Another method used to manage low adhesion risk is the use of Traction Gel Applicators (TGA). A TGA is a track-mounted device which can dispense an adhesion-improving gel onto the railhead. Although the action of passing trains can spread this along the track, the effect is relatively localised. A TGA is installed at Talerddig[2] approximately 280 metres east of the point of collision. This applicator, and other TGAs located to the west of the loop at Talerddig are provided primarily to assist trains climbing the gradient in the eastbound direction. There was no visible evidence of traction gel on the railhead when it was observed on the day after the accident. Network Rail inspected the TGA on 25 October (4 days after the accident) and found that it was not working.

63 TfWRL produces an Autumn Seasonal Risk Guide. This is intended to provide good practice and useful information for train drivers, and notes the low adhesion site at Talerddig identified in the Network Rail sectional appendix. TfWRL also produces a route risk assessment and route competence questions, both of which reference the low adhesion site at Talerddig.

### Trains involved

64 RAIB is undertaking testing of the braking, WSP and sanding systems on unit 158841 (train 1J25). The objective of the testing is to understand the condition and functionality of the train's systems and any role they may have played in the accident. Although testing is ongoing, no defects have been identified so far with the braking or WSP systems of unit 158841. Some defects have been identified with the sanding system on this unit (see paragraph 73).

65 For unit 158824 (train 1S71), no relevant defects or other issues were recorded with the braking, WSP or sanding systems.

66 The maintenance and overhaul history for both trains was compliant with the maintenance plan defined by TfWRL for the class 158 fleet.

### Sanders

67 The application of sand is a well-established mitigation for low wheel-rail adhesion conditions and can help restore braking performance. When needed, sand is dispensed from the train and delivered through hoses aimed directly at the wheel-rail interface. Most passenger trains which operate on GB mainline railways are fitted with an on-board sanding system.

68 Both trains involved at Talerddig were equipped with on-board sanders. Class 158 units operated by TfWRL are fitted with two separate and independent sanding systems. These are:

- an automatic sanding system which, when the train is under braking, is operated by the WSP system and delivers sand to the third wheelset of the train

[2] A second TGA is provided further west, beyond the point of the collision.

- a ‘one-shot’ sanding system (referred to as an ‘emergency sander’), which is manually activated and delivers sand to the first (leading) wheelset of the train.

Although these sanding systems are installed on each vehicle, only the sanders on the leading vehicle are active (figure 10). In the case of train 1J25, the active sanding systems at the time of the accident were therefore fitted to vehicle 57841. RAIB has concluded from the available evidence that neither the automatic sander nor the emergency sander on this vehicle discharged sand in the moments immediately before the collision.

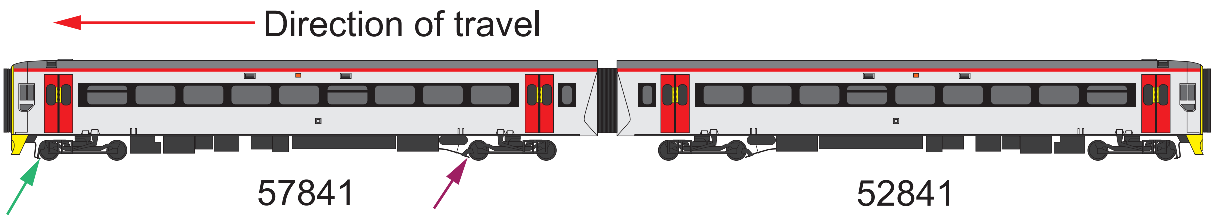


*Figure 10: Automatic sanders at third wheelset (purple arrow) and emergency one-shot sanders at first wheelset (green arrow) are available when vehicle 57841 is leading. The same equipment is also installed on vehicle 52841 but will only be available when this vehicle is leading.*

69 Class 158 trains were built between 1989 and 1992. As was common with trains built at that time, no sanding systems were originally fitted. However, due to problems with the trains’ performance in low wheel-rail adhesion conditions, a need was recognised to fit sanding systems. The emergency one-shot sanding system was therefore developed and fitted to class 158 trains in the late 1990s and was successful in reducing the number of adhesion-related incidents. The emergency sanding system is discussed in paragraph 80.

70 Subsequently, train operators identified a need for sanders which could be used multiple times during a journey and automatic sanders were developed and fitted to class 158 trains around 2001. After installing automatic sanders, some train operators and owners removed the emergency sanders, although they were retained on TfWRL’s class 158 trains.

## The automatic sanding system

71 The automatic sanding system is designed to deliver sand when a prescribed set of conditions are met. These include the detection of wheel slide (by the WSP system), train speed greater than 10 km/h (6 mph) and the brake controller commanding brake step 2 or higher.

72 The automatic sanding system is designed to deliver sand to the third wheelset of the train, at a fixed rate of 2 kg per minute to each wheel.

73 Following the accident, RAIB inspected and tested the automatic sanding system on vehicle 57841. Four defects were identified:

- The sander isolation switch, which provides electrical power to the automatic sanding system, was not allowing current to pass. The switch was found to be physically in the correct position (labelled as ‘Normal’), but when tested electrically it was found to be open circuit. If present at the time of the accident, this fault would have prevented the automatic sander from operating.

- The low-speed relay is a device which inhibits automatic sanding below a threshold speed of 10 km/h (6 mph). This is intended to prevent discharge of sand at low speed, since it could interfere with the railway signalling system. The relay was found to be defective when tested. If present at the time of the accident, this fault would also have prevented the automatic sander from operating.
- The orifice plates, which are part of the sander pneumatic system, were found to be installed incorrectly (both were upside down and one was incorrectly aligned). This fault could lead to a reduced sand delivery rate from the automatic sanders.
- Both sand delivery hoses were found to be blocked (figure 11). This fault would have prevented sand from being ejected from the hoses.

74 No defects relating to the sanders were reported by any drivers of unit 158841 on 20 or 21 October. However, it cannot be determined if the train encountered areas of low wheel-rail adhesion during this period which would have activated these systems and potentially alerted drivers to any defects which may have existed.

75 The blocked sand delivery hoses were identified shortly after the accident while the trains were still on site at Talerddig. The two electrical defects and the incorrectly installed orifice plates were observed by RAIB during subsequent testing in January 2025 (11 weeks after the accident). These electrical faults may have been present at the time of the accident, may have been introduced as a consequence of it, or may have arisen during post-accident recovery and storage.


*Figure 11: The blocked sand delivery hoses on vehicle 57841.*

76 After the accident, RAIB removed the blocked sand hoses for analysis. Although the hoses were blocked at the outlet end, there was no evidence of any significant build-up of sand in the pipe behind the blockage. There was dry sand in the sand hopper, and sand flowed freely from the sand valve under the hopper when the test button was pressed during subsequent testing.

77 A detailed examination of one of the blocked hoses has been undertaken. The blockage consisted of a plug of material which was approximately 30 mm deep in the outlet end of the sand hose. RAIB considers that the material blocking the hose probably originates from a source external to the sanding system. Visual examination of the material with an optical microscope revealed organic matter and very small particles of sand-like material. Preliminary DNA testing of the organic material indicates that it comprises leaves and debris originating from ash, acer and wild cherry trees.

78 RAIB also tested the sanding system on vehicle 52841, which formed the trailing end of train 1J25. One of the sand delivery hoses was almost entirely blocked. None of the electrical faults identified on vehicle 57841 were present on vehicle 52841, and the orifice plates were installed correctly.

79 The maintenance history for the automatic sanding system on unit number 158841 includes:

- As part of preparing for each autumn, an annual test is conducted to measure the sand delivery rate of each sander. For this test, the maintenance technician places bags to catch the sand ejected from each sand delivery hose and presses a sander test button (mounted on the sand hopper) for 30 seconds. The test requires that the amount of sand discharged from each sand hose is between 0.75 kg and 1.0 kg in 30 seconds. The test was recorded as having been completed on 25 September 2024 (26 days before the accident).
- The last routine maintenance test which could have identified either of the electrical faults (with the sander isolation switch or the low-speed relay) was completed on 12 October (9 days before the accident). This was part of a ‘Wheel Slide Protection System Test’, which is included as part of a routine maintenance inspection known as a B exam, which is undertaken approximately every 7,500 miles (approximately 12,000 km). This test was recorded as successfully completed, which suggests that the electrical faults with the sander isolation switch and the low-speed relay were not present at this time.
- A basic check of the sanding system was carried out on 20 October (the day before the accident) as part of a Fuel Point Examination (paragraph 33). This test was recorded as successfully completed, which suggests that the sand hoses were not blocked at this time. However, the testing process used could not have identified either of the electrical faults. This is because the test methodology, which used the sander test button on the hopper, derives an electrical supply from a separate circuit which is not supplied from the sander isolation switch. The sander test button circuit also bypasses the low-speed relay.

### The emergency sanding system

80 The emergency sander is based on fire-extinguisher technology, with cylinders of fine dry sand stored with nitrogen under high pressure. The emergency sander is designed to deliver sand to the first (leading) wheelset of the train. The emergency sander is activated manually by a driver pressing a plunger in the driving cab. Once the emergency sanders are activated, the sand discharge cannot be stopped until the cylinders are empty.

81 The emergency sander system includes in-cab indicators which are illuminated when the system is 'healthy' (one for the left-hand sander and one for the right-hand sander). Train drivers check that these indicators are illuminated as part of train preparation. No defects were reported during the train preparation which was undertaken on the days before the accident (paragraphs 34 and 36).

82 There is no evidence that the emergency sander was activated during the accident.

83 RAIB tested the emergency sanding system after the accident. The sander healthy lights were not illuminated, and this was traced to an open (tripped) circuit breaker which provides current to the emergency sanding system. This circuit breaker is installed in the roof panel above the driving desk, in an area which sustained damage during the collision.

84 After closing the circuit breaker, both sander healthy lights illuminated. Both sand cylinders fired and delivered sand when the emergency sander plunger was pressed. Each sander delivered approximately 4 kg of sand in approximately 30 seconds.

## Actions already taken by industry relevant to the investigation

85 TfWRL raised a National Incident Report on 25 October 2024 (NIR4106) titled 'Class 158 low speed collision'. Such reports are generated for the use of railway industry duty holders. NIR4106 described the risks of blocked sander hoses and described additional checks to be carried out.

86 TfWRL raised a second National Incident Report on 14 January 2025 (NIR4134) titled 'Class 158 sander hidden fault'. This report highlighted the electrical defects identified with the automatic sanding system (paragraph 73) and described additional checks to be carried out.

## RAIB's future actions in the investigation

87 RAIB's objectives for the investigation are to:

- continue to develop an understanding of the sequence of events
- continue to establish, as far as practical, the cause and severity of low wheel-rail adhesion at Talerddig
- complete the testing of the braking, wheel slide protection and sanding systems on train 1J25
- consider the actions of the drivers of both trains and any factors which may have influenced them
- consider the actions of the signaller and any factors which may have influenced them
- consider the actions taken on the day of the accident to manage the risk of low wheel-rail adhesion given the time of year and prevailing weather conditions

- consider Network Rail’s policies and processes relating to low adhesion and how it managed the risk, including vegetation management, the role of TGAs and how they are maintained, and railhead cleaning
- consider TfWRL’s policies and processes relating to operating trains in low adhesion
- consider how the Cambrian ERTMS system was designed and implemented, including how operation in low adhesion was intended to be managed
- consider the behaviour of both trains during and following the collision, and the damage caused to each
- consider any factors which may have affected the severity of the consequences, including the actions of emergency services
- identify any relevant underlying factors, including any actions taken in response to previous safety recommendations and research conducted in relation to managing the risks of low adhesion
- make recommendations, as appropriate, to prevent a recurrence.

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Any enquiries about this publication should be sent to:

RAIB
The Wharf
Stores Road
Derby UK
DE21 4BA

Email: enquiries@raib.gov.uk
Telephone: 01332 253300
Website: www.gov.uk/raib