RAIB

Rail Accident Investigation Branch

Rail Accident Report

Track workers struck by a train at Margam, Neath Port Talbot
3 July 2019

Report 11/2020
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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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Track workers struck by a train at Margam, Neath Port Talbot, 3 July 2019

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Summary

At around 09:52 hrs on Wednesday 3 July 2019, two track workers were struck and fatally injured by a passenger train at Margam East Junction on the South Wales main line. A third track worker came very close to being struck. The three workers, who were part of a group of six staff, were carrying out a maintenance task on a set of points. The driver made an emergency brake application about nine seconds before the accident and continued to sound the train's horn as it approached the three track workers. The train was travelling at about 50 mph (80 km/h) when it struck the track workers.

The accident occurred because the three track workers were working on a line that was open to traffic, without the presence of formally appointed lookouts to warn them of approaching trains. They were carrying out a maintenance activity which they did not know to be unnecessary. All three workers were almost certainly wearing ear defenders, because one of them was using a noisy power tool, and all had become focused on the task they were undertaking. None of them was aware that the train was approaching until it was too late for them to move to a position of safety. Subsequent acoustic measurements have shown that they would not have been able to hear the train's warning horn.

The system of work that the controller of site safety had proposed to implement before the work began was not adopted, and the alternative arrangements became progressively less safe as the work proceeded that morning and created conditions that made an accident much more likely.

RAIB's investigation found several factors which led to this situation, relating to the work itself, the way the safe system of work was planned and authorised, the way in which the plan was implemented on site, and the lack of effective challenge by colleagues on site when the safety of the system of work deteriorated.

The investigation also considered why Network Rail had not created the conditions that were needed to achieve a significant and sustained improvement in track worker safety. Four underlying factors were identified:

- Over a period of many years, Network Rail had not adequately addressed the protection of track workers from moving trains. The major changes required to fully implement significant changes to the standard governing track worker safety were not effectively implemented across Network Rail's maintenance organisation.
- Network Rail had focused on technological solutions and new planning processes, but had not adequately taken account of the variety of human and organisational factors that can affect working practices on site.
- Network Rail's safety management assurance system was not effective in identifying the full extent of procedural non-compliance and unsafe working practices, and did not trigger the management actions needed to address them.
- Although Network Rail had identified the need to take further actions to address track worker safety, these had not led to substantive change prior to the accident at Margam.

RAIB has made eleven recommendations in this report. Nine of these are addressed to Network Rail and cover:

- improving its safe work planning processes and the monitoring and supervision of maintenance staff (three recommendations)
- renewing the focus on developing the safety behaviours of all its front-line track maintenance staff, their supervisors and managers
- establishing an independent expert group to provide continuity of vision, guidance and challenge to its initiatives to improve track worker safety
- improving the safety reporting culture
- improving the assurance processes, the quality of information available to senior management, and processes for assessing the impact of changes to working practices of front-line staff (three recommendations).

A further recommendation is made jointly to Network Rail, in consultation with the Department for Transport, relevant transport authorities, the Office of Rail and Road (ORR) and other railway stakeholders, to investigate ways to optimise the balance between the need to operate train services, and enabling safe track access for routine maintenance tasks.

The final recommendation addresses an observation noted during the investigation and is not related to the cause of the accident. It is addressed to the Rail Delivery Group, in consultation with Network Rail and RSSB, and recommends research into the practicability of enabling train horns to automatically sound when a driver initiates an emergency brake application.

RAIB has also noted two learning points: one reminds staff to only carry out maintenance on insulated rail joints when the relevant line has been closed to traffic, and the other reminds companies to update staff on revised maintenance practices as railway assets are modernised.

Introduction

Definitions

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

2 The report contains abbreviations and technical terms (shown in italics the first time they appear in the report). These are explained in Appendices A and B. Sources of evidence used in the investigation are listed in Appendix C.

The accident

Summary of the accident

3 At around 09:52 hrs on Wednesday 3 July 2019, two track workers were struck and fatally injured by a passenger train at Margam East Junction on the South Wales main line. A third track worker came very close to being struck. These three workers were part of a group of six staff, who were carrying out maintenance work on lines that were open to traffic.

4 The train, which was travelling from Swansea to London Paddington, was approaching Margam on the *up* main line at around 73 mph (117 km/h). Its driver saw three track workers walking in the same direction as his train on the adjacent *down* main line and, beyond them, three more track workers on the line ahead of his train. He sounded the train horn and applied the *emergency brake*. The track workers walking on the down line became aware of the train approaching from behind them and tried to warn their colleagues as the train passed them.

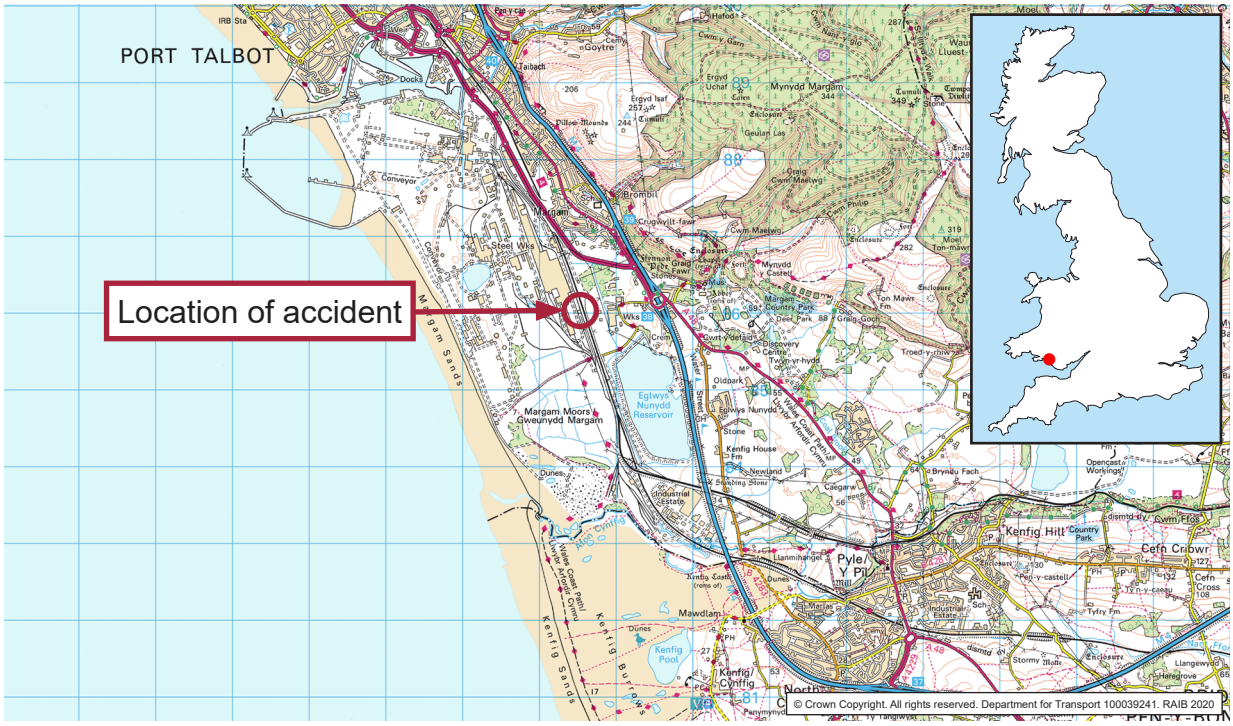

Figure 1: Extract from Ordnance Survey map showing location of accident

5 The three track workers on the up main line were working on a set of *points*, using a powered *impact wrench* for loosening and tightening large-diameter fastenings. Consequently, all three of the workers were almost certainly wearing ear defenders. Closed-circuit television (CCTV) images taken from a camera at the front of the train, and witness evidence, indicate that the workers did not become aware of the train until less than one second before it reached them. By this time, although it was braking, it was still travelling at around 50 mph (80 km/h).

6 Two of the track workers were fatally injured, and the third was severely traumatised.

Context

Location

7 Margam East Junction is on the main line between Swansea and London. The accident occurred at a set of points in the up main line at 200 miles 31 chains[1] from London Paddington, 2.3 miles (3.7 km) east of Port Talbot station and about 30 miles (48 km) west of Cardiff (figure 1). Although the descriptions in this report refer to east and west, reflecting the general direction of the railway route, in the area where the accident took place the tracks run on a north-west to south-east alignment.

8 The points involved, numbered 9577B, form part of a *crossover* between the up and down main lines (figure 2). The crossover forms part of the route between the up *relief line*, which is on the north-east side of the main lines and terminates at Margam East Junction, and the up and down Ogmore Vale Extension (OVE) lines, which are on the south-west side of the main lines and give access to a number of freight destinations including Margam Abbey (Port Talbot) steelworks.

9 The maximum permitted speed for trains on the up and down main lines is 90 mph (145 km/h). Signalling in the area is controlled from Port Talbot signal box.

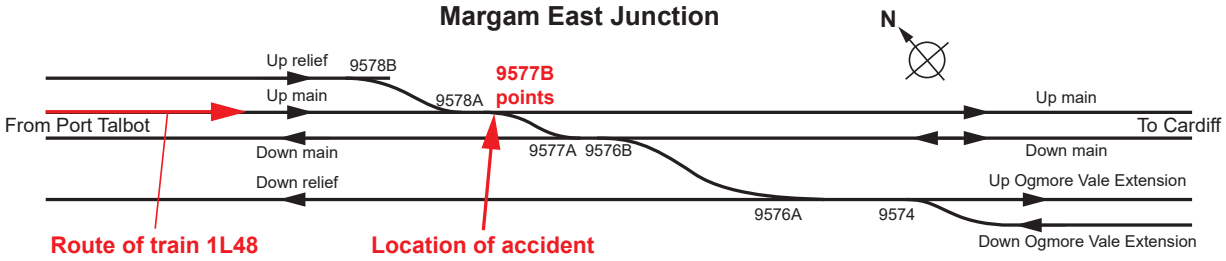

Figure 2: Track layout

Organisations involved

10 Network Rail owns, operates and maintains the infrastructure in the area, and employed all the track workers.

11 First Greater Western Ltd (trading as Great Western Railway (GWR)) operated the train involved in the accident, and employed the driver and other train crew.

12 Network Rail and GWR freely co-operated with the investigation.

Train involved

13 The train involved, reporting number 1L48, formed the 09:29 hrs service from Swansea to London Paddington. It consisted of two five-car, class 800 *bi-mode multiple units*, with unit 800021 leading. There were 184 passengers on board.

Staff involved

14 There were six track workers in the group, three of whom were working at the points when the accident occurred. All six were full-time Network Rail employees based at Port Talbot depot.

[1] Distances are measured from a zero datum at London Paddington. A chain is 22 yards (approximately 20 metres). There are 80 chains in one mile.

15 Track worker 1 (TW1) had over 40 years' railway experience, and for the last six years he had been an acting team leader at Port Talbot depot.

16 Track worker 2 (TW2) was a track technician who had over 40 years' railway experience.

17 Track worker 3 (TW3) was a track technician with around 20 years' experience.

18 Track worker 4 (TW4) was acting in the role of Controller of Site Safety (COSS) for the group on the day of the accident. He was a track technician with over 30 years' experience.

19 Track worker 5 (TW5) was nominated to act as the *site lookout*. He was a track technician with around 15 years' experience.

20 Track worker 6 (TW6) was a track technician with around 40 years' experience.

21 Team Leader 1 (TL1) had been working in the railway industry for about eight years, and had been a team leader at Port Talbot for more than three years.

22 Team Leader 2 (TL2) had railway experience dating from 1997. He became a team leader at Port Talbot in 2013.

23 The train driver had been a driver since 1988 and had been passed as competent to drive class 800 bi-mode multiple units in December 2017. He began his duties on the day of the accident at 06:43 hrs, driving a train from Bristol Temple Meads to Swansea, where it arrived at 08:58 hrs. He then departed from Swansea driving train 1L48 at 09:29 hrs.

External circumstances

24 The weather at the time of the accident was bright and sunny, with good visibility. The wind was very light (around 5 mph (8 km/h)), and the temperature was around 20°C, as recorded by two nearby weather stations.

25 The sun was shining from an angle of about 60 degrees to the left of the direction of travel of the train (figure 2), and would not have affected the track workers' visibility of the train, nor the driver's visibility of the track workers.

The sequence of events

Events preceding the accident

26 Network Rail's track maintenance process requires staff to carry out regular maintenance tasks, as well as remedial work in response to reported faults. On 27 June the planner at Port Talbot depot created a 'safe work pack' (SWP) for work that was to take place on 3 July at Margam East Junction. This listed the planned work activities as vegetation clearance, *boxing-in ballast*,[2] and maintenance of 9577 points. It identified two safe systems of work. The first of these, designated 'working', stated that work on the up main line was to be protected by blockages of that line that were planned to take place between 12:30 hrs and 15:30 hrs (an associated request for a line blockage with the signaller at Port Talbot had been made). The other system of work, designated 'parallel', indicated that work could take place on both main lines, with warning provided by *lookouts*, between 12:30 hrs and 15:30 hrs.

27 Another SWP was also created on 27 June for work to be done on 3 July. This was at a different location on the down main line near 9550 crossover, approximately 1.6 miles (2.6 km) from Margam East Junction towards Cardiff (see paragraph 36). It also contained two safe systems of work within it. The first of these, designated 'working', stated that work on the down main line was to be protected by blockages of that line that were planned to take place between 08:00 hrs and 09:30 hrs. The other system of work, designated 'parallel', indicated that work could take place on both main lines with warning provided by lookouts between 08:00 hrs and 09:30 hrs.

28 On 28 June, one of the local supervisors checked the SWPs for both sites and signed them off as 'authorised'. On 2 July one of the two permanent team leaders at the depot reviewed both SWPs, and signed them off as 'verified'.

29 On the morning of 3 July, maintenance staff arrived at the depot between 07:00 hrs and 07:30 hrs. One of the depot supervisors spoke to the two permanent team leaders about the work to be done at Margam East Junction that day. As well as the tasks listed in the SWP, there was also an emerging need to investigate and attend to *insulated rail joints* (IRJs)[3] in the area, following a report of a failure of a *track circuit* on 1 July. This additional task was not specified in the SWP.

[2] Boxing-in ballast is the task of adding ballast in-between the sleepers and to the sleeper ends to retain the track's stability.

[3] Insulated rail joints are used to separate sections of rail from each other electrically, for signalling purposes. Rail wear, damage and contamination can lead to the insulation becoming ineffective. This can usually be rectified relatively easily by maintenance staff.

30 Witness evidence indicates that although one of the permanent team leaders (TL1) had already signed ('verified') the SWP for the work at Margam East Junction, the supervisor passed the SWP for this work to the other permanent team leader (TL2), because he thought that TL2 would be on site acting as person in charge (PIC) (see paragraph 53). However, TL2 was intending to work at the other site (paragraph 27) and so he passed the SWP on to TW1, an acting team leader, to lead the Margam East Junction group, and both permanent team leaders then briefed TW1 about the work. TW1 then chose TW4 to act as the controller of site safety (COSS) for the work at Margam East Junction and gave him the SWP. TW4 reviewed the pack and found that the first opportunity for a line blockage would be at 12:30 hrs. Noting that the SWP did not cover the work that was proposed to be done during the morning, he gave the pack back to TW1.

31 The group of six track workers (TW1-6) left the depot around 08:00 hrs and arrived at an access point near Margam East Junction around ten minutes later. On arrival at site, TW1 gave the SWP back to TW4 and indicated that they would be working under lookout warning that morning and that he wanted TW4 to be COSS and to complete the paperwork. TW4 did not raise his earlier concern about the plan, and while the group had breakfast, TW4 filled in the various forms in the SWP, signing the sections of the forms dealing with site safety leader roles as both COSS and PIC. He also signed the form to indicate that the work had been completed.

32 Although the SWP had not specified the need for a *distant lookout* (see paragraphs 47 to 50) to give an adequate warning of a train's approach when working at the points, TW4, acting as the COSS, correctly worked out that a distant lookout was in fact required. TW4 briefed the group and scanned their *Sentinel*[4] cards, and nominated two of them, TW2 and TW5, to act as lookouts during the work: TW2 as a distant lookout, and TW5 as a site lookout (see paragraph 49). Both lookouts signed the SWP, indicating that they accepted these roles. Uncorroborated witness evidence indicates that TW1 then decided that a distant lookout was not necessary, and the COSS did not raise any objection.

33 Around 08:50 hrs the six track workers split into two groups. One group, consisting of TW4 and TW6, started the additional task on the IRJs on the down main, up main and down relief crossover lines. The other group, consisting of TW1, TW2, TW3 and TW5, went to work on 9577B points (figure 3). TW5 stood clear of the line and acted as site lookout, with one of the others watching him and acting as *touch lookout* for the person with the power tool. During this period the two groups were around 100 metres apart, with TW4 and TW6 being the Cardiff side of 9577B points. TW4 and TW6 took it in turns to work while the other observed the nominated lookout TW5, who was with the other group at the points, for warning of approaching trains on the up main line.

[4] The Sentinel system is used by the railway industry to record and monitor the competence and fitness of staff who work on or near the track. Each person must carry an identifying smart card which provides access to the database on which this information is held, so that their competences can be checked before the start of work.

Figure 3: Forward-facing CCTV image looking towards Port Talbot from a train on the down main line at approximately 09:24 hrs, showing the two groups working on the open up main line approximately 100 metres apart

34 At around 09:30 hrs the two groups came together again and had a break of about ten minutes. Uncorroborated witness evidence indicates that there was a discussion between TW1 and TW4 about the work. Following this discussion, the group then split again, this time into two groups of three. The site lookout (TW5) went with the COSS (TW4) and TW6 towards Port Talbot to work on the IRJs on the up relief and up main lines.

35 TW4, TW5 and TW6 walked towards Port Talbot in the cess of the up main line and onto the up relief line. Sometime later, the other group, consisting of TW1, TW2 and TW3, went back to working on 9577B points, loosening, lubricating and retightening bolts and nuts using the impact wrench.

Other work in the area

36 On the same morning, the other group of track workers from Port Talbot depot, including the two permanent team leaders (TL1 and TL2), was working on the down main line around 1.6 miles (2.6 km) south-east of the site of the accident, towards Cardiff. They were packing the ballast under a rail crossing, under the protection of a series of planned line blockages on the down main line. The line blockages taken were from 08:51 hrs to 09:19 hrs, and then again from 09:44 hrs to 10:00 hrs, when the work ceased due to the accident. The main lines between the two sites of work are straight, and the two groups were, distantly, in sight of one another.

Events during the accident

37 The COSS (TW4) and the other track worker (TW6), with site lookout warning provided by TW5, inspected a pair of IRJs on the up relief line and then inspected and undertook remedial work on a pair of IRJs on the up main line. These were situated about 170 metres from 9577B points towards Port Talbot.

38 When they had completed their work on the IRJs, they crossed from the up main line to the down main line and walked back along the down main line towards the access point. They were walking facing the direction of traffic on that line, and therefore had no need to look out for trains approaching from behind them on the other line. Train 1L48 approached from behind them on the up main line travelling towards Cardiff. At this time they could see the other three track workers about 100 to 120 metres ahead, and they have stated that they were surprised to see them working on 9577B points on the up main line with a train so close (figures 4 and 5).

Figure 4: Position of workers immediately before the accident

39 Train 1L48 had left Port Talbot station on time at 09:49 hrs. The driver accelerated the train towards the line speed of 90 mph (145 km/h). The train had reached about 70 mph (113 km/h) when it passed under the A4241 (Harbour Way) bridge and the two groups of track workers came into view. The Cardiff side of the bridge is 662 metres (725 yds) from 9577B points.

40 The data recorder on board the train indicates that at 09:51 hrs the train driver sounded the first horn warning, giving a low/high/low tone[5] warning, for around two seconds. At this time, the train was over 600 metres from the group of track workers at 9577B points. Approximately five seconds after the first horn sounding, with the train about 400 metres away from the points, the driver sounded a second, low tone, horn warning continuously for around five seconds. He applied the train's emergency brake approximately four seconds after starting to sound this warning, when the train was about 260 metres away from the group. Around two seconds later, the driver began to sound a third low tone warning, and continued to do so for ten seconds, reaching the points seven seconds after this warning was initially sounded. The train's speed had reduced to around 50 mph (80 km/h) when it reached the group on the up line.

[5] The warning horn on the class 800 trains has two settings, dependent upon the speed at which it is travelling. The low speed setting is applied automatically when the train is travelling at less than 100 mph (160 km/h), and the high speed setting above this speed. The driver is not able to change the setting. The horn also has two tone (pitch) settings, a high note and a low note, which the driver can select when in either speed setting.

Figure 5: Image from forward-facing CCTV from train 1L48 as it was passing the group walking on the down main line

41 The lookout, TW5, who was with the group walking on the down line, stated that as the train passed him, he blew the horn he was carrying. The other two track workers in the group have stated that they began to shout and they all moved faster towards the three working on 9577B points (figure 5).

42 TW3, who was in the space between the up and down main lines, was using the impact wrench to loosen nuts, while one of the other two, both of whom were standing between the rails of the up main line, used a brush to lubricate the thread of the bolt. TW3 finished tightening a nut and was about to stand up when, less than a second later, the train struck TW1 and TW2. TW3 fell backwards out of the way. TW1 and TW2 were fatally injured. TW3 was severely traumatised.

Events following the accident

43 The train came to a stop 182 metres beyond the point of collision.

44 The driver of the train made a *railway emergency call*, using the GSM-R radio in the cab of the train, reporting that the train had struck some track workers. As a result, the Welsh Ambulance Service, South Wales Fire and Rescue Service, South Wales Police and British Transport Police were alerted and attended the scene. Wales Air Ambulance Service also sent rapid response road vehicles to the site.

45 The signaller stopped other trains from approaching the site to make it safe for the emergency responders. Network Rail and GWR also sent staff to the scene.

46 Subsequently, arrangements were made to allow passengers on the train to leave under the supervision of the emergency services and Network Rail staff so that they could continue their journeys by road.

Background information

Protection of workers on the track

47 To protect staff working on the track from being struck by moving trains, the rail industry's preferred approach is to arrange for all train movements to be stopped while the work is taking place. This is by arranging either an engineering *possession* or a line blockage, depending on the circumstances. However, if this is not deemed reasonably practicable, work may have to be done while trains are running. In this situation, the workers need sufficient warning of the approach of trains for them to be able to stop work and move clear of the track, so that they are in a position of safety for at least ten seconds before the train arrives. This requirement, along with others summarised in this section, can be found in the various modules and handbooks which make up the railway Rule Book (GERT8000 series), published by RSSB.[6]

48 The warning of approaching trains can be given by fixed or portable automatic systems, activated by the trains themselves. These give visual and/or audible warnings at the site of the work, which may be supplemented by a touch lookout if the work is noisy. If such systems are not available, unassisted lookout warning may be used. The lookout stands in a position of safety, chosen by a COSS, where they should not be distracted, and watches for approaching trains. When a train comes into view, the lookout uses a whistle or horn to warn the members of the work group, who must immediately move to the designated position of safety. If a work group is using noisy tools or machinery, each member of the group must be warned by a touch lookout. In some cases, a lookout may be able to switch off the power to noisy tools. In all cases the safe system of work should be tested before work begins, but such a test was not carried out on 3 July 2019 at Margam East Junction.

49 The COSS is responsible for arranging and implementing a safe system of work to protect the group from moving trains. If the adopted system uses unassisted lookout working, the COSS will appoint the necessary lookout(s). The COSS uses a table of speeds and sighting distances to calculate the necessary warning time. The COSS must then check that this time can be achieved at the location of the work. If the available sighting distance for a lookout at the location of the work (the site lookout) is insufficient, because of the curvature of the track or other obstruction, a distant lookout, positioned far enough away from the site to be able to give an earlier warning of approaching trains, can be used to relay the warning to the site lookout. The distant lookout uses a blue and white chequered flag to signal to the site lookout that a train is approaching.

50 Any lookout should be appointed solely to that duty and must not take any part in the work. After members of a work group have moved to the position of safety in response to the lookout's warning, they must not return to the track until told to do so by the COSS. Whoever is appointed as COSS must remain with the work group for the duration of the work.

[6] RSSB is a body comprising rail industry members, whose purpose is to make the industry safer.

Network Rail standard 019

51 Network Rail's standard 'Safety of people at work on or near the line', NR/L2/OHS/019 (standard 019), was first issued by Railtrack as 'Protection of people working on or near the line', specification RT/LS/S/019, in April 2002. This introduced the RIMINI (RIsk MINImisation) procedure, which is now referred to as the hierarchy of safe systems of work, and reflected the new role of COSS that had replaced the role of person in charge of work (PICOW) in Section B(ii) of the Rule Book. The version of NR/L2/OHS/019 that was current from 2010 to 2017 was issue 8, issued in September 2010.

52 Compliance with standard 019 is mandatory for staff of Network Rail and its contractors. Issue 9 of standard 019 was published in March 2017. The purpose of this issue of the standard is stated as being:

> *'to control the risk to personnel from site risks, activity risks and train movements by requiring effective planning of work activities "on or near the line", or which could affect the area termed "on or near the line"…The standard requires a focus on the management of the significant risks and improving the quality of the safe work packs (SWP) by providing clear, concise relevant information to the people who need it in order to maintain safety whilst working.'*[7]

53 This revision introduced the role of person in charge (PIC), which is defined in the standard as being:

> *'a person involved in the planning and who is on site where the work is being undertaken and has the overall accountability of supervising and overseeing works. This person will normally be the team leader (or equivalent) and hold COSS competence to make sure planned controls are put in place to keep persons safe from trains, activity and site risks.'*

54 While the PIC must be qualified to act as a COSS, they may appoint someone else to act as COSS to arrange and maintain protection from trains, provided that person is also suitably qualified.

55 The revised standard requires that SWPs be developed by a planner, in conjunction with a PIC who has been nominated by a responsible manager. The plan must then be verified by that PIC before being authorised by the responsible manager. SWPs should be verified and authorised at least one shift before the work is due to take place. Standard 019 issue 9 states that the PIC retains ultimate accountability for safety at a site of work and has the final decision as to whether a SWP is acceptable before it is implemented.

56 Standard 019 also defines a hierarchy of 25 possible protection and warning systems within 8 levels that can be used to manage the risk from trains. Those systems that are higher in the hierarchy are considered to be safer, and therefore preferred, over those listed lower in the hierarchy.

[7] NR/L2/OHS/019 v9, section 1.

57 At the top of the hierarchy are 'protection' systems, the highest of which involves the line being blocked to trains. Below these are 'warning' systems in which the line is open to traffic, and workers are warned of the approach of trains. The preferred warning systems involve equipment (which can be fixed or portable) operated by the approach of trains, giving audible and visual warning of trains. Below these, towards the bottom of the hierarchy, are warning systems operated by lookouts. The very lowest system is warning by unassisted lookouts, using flags and/or horns or whistles, or warning by touch.

58 Planners, working with input from the PIC, should aim for the SWP to specify work to be undertaken under the highest level in the hierarchy available, and move down through the hierarchy only when the higher methods cannot be implemented, or involve a disproportionate effort to implement.

59 If the PIC requires a change to the SWP on site, they may only implement a lower level safe system of work than the one authorised in the SWP if the responsible manager authorises the change and issues an authority reference.[8]

60 Modules published with issue 9 of standard 019 describe the process for creating SWPs. In particular, the PIC is required to verify whether the SWP is '*appropriate and accurate taking into account the location, work to be undertaken and resources available'.* If the PIC intends to delegate the duties of COSS, in respect of protection from moving trains, to someone else, the PIC must ask the COSS to confirm that the arrangements are suitable and sign the verification section, which must also be signed by the PIC.

The Safe System of Work Planning (SSOWP) system

61 Most Network Rail planners, including the planner at Port Talbot depot, use the company's own software, called the SSOWP system, to plan work 'on or near the line'. This software enables the creation of SWPs for issuing to COSSs and PICs. These are predominantly produced in hard-copy paper form, for signature by the planner, PIC and responsible manager, before being used on site. The system guides the planner through a series of screen menus to input the necessary information, including the work task and location, the proposed safe system and who is to be the PIC on site.

62 The SSOWP system allows the planner to choose one of three options (known as components) depending on the type of plan required. Two of these, 'working' and 'walking', allow for separate safe systems to be created for the work itself and for accessing the site of work. The third component is known as 'parallel'. There is currently no guidance documentation available to planners on the use of the parallel component. Briefing material issued by Network Rail for an earlier version of the SSOWP system introduced in 2012 describes the parallel component as:

> *'a specific safe system of work where we are at the same track mileages, at the same time as the previous working component BUT we are using a different safe system (for example alternating between green and red zone[9] working in conjunction with the signaller)'.*

[8] NR/L2/OHS/019 v9 section 6.

[9] Green zone is the former name for the safe system of work now known as 'Protection', where train movements are prevented on the line being worked on. Red zone was the former name for the safe system of work now known as 'Warning', where train movements may occur on the line being worked on.

63 The parallel component option allows the planning of two or more safe systems of work at a single site of work during a defined period. This may, for example, allow the use of lookout warning if and when line blockages are not available for the full duration of the planned work. Witness evidence indicates that Network Rail intended that the times when each system would be used would be defined in the SWP, and not left to the discretion of the safety leader on site. A SWP created via the parallel screen menu, employing a two-component system of work, will include a 'working' component as the first safe system. This section of the SWP specifies the location, the start time and duration of the work. The second safe system, known as 'parallel', specifies the alternative safe system of work, and retains the details of the location, start time and duration from the first safe system.

64 The SSOWP system does not limit the planner to one work task in each SWP, and multiple tasks may be specified.

Port Talbot depot

65 Network Rail's Port Talbot depot is the base for staff responsible for inspection and maintenance of track, signalling and power equipment in the area that it serves. The area covers 21¼ miles (34 km) of the South Wales main line from Llanharan (183¾ miles) to Baglan (205 miles), and associated branch lines. The depot is one of five within the South Wales delivery unit. The section manager (track) at Port Talbot reports to a track maintenance engineer based at Swansea, who in turn reports to one of the two infrastructure maintenance engineers at delivery unit level. These engineers report to the infrastructure maintenance delivery manager for South Wales, based in Cardiff, who reports to the head of maintenance for the Wales route.

66 The track maintenance staff at Port Talbot were organised into two teams, each of around six people, led by team leaders TL1 and TL2. The team leaders report, through two supervisors, to the section manager (track). A third team leader, who is office-based, is responsible for the track inspection team. There is also a planner and an administrator. In addition to TL1 and TL2, TW1 had been acting as a team leader for several years, although he had not been formally appointed to the role.

Maintenance of switches and crossings

67 Maintenance of the parts of the track that make up assemblies such as crossover 9577, technically known as switches and crossings (S&C) but often referred to as 'points', includes a wide variety of tasks. These include removing litter and debris, checking and tightening the fastenings that secure the rails to the sleepers and bearers, and replacing any fastenings that are found to be broken.

68 The process of checking and tightening fastenings in S&C is sometimes referred to as 'fettling', and is described in Network Rail's Track Work Instruction 2S 006 'How to tighten S&C fastenings'. It is often done while the line is open to traffic, because watching the behaviour of the track when a train passes over it is an important part of the process. Maintenance staff use spanners or impact wrenches to tighten loose threaded fastenings, and torque wrenches to check and restore their correct tightness. The process as specified does not involve any lubrication of threaded fastenings.

69 At defined intervals, suitably qualified staff are required to carry out checks on the distance between the rails throughout the S&C and detailed checks on the condition of the rails in the area near the *toes* of the switches where derailments may be caused by wear of the railheads. The track workers at Margam on the day of the accident were not expected to carry out either of these tasks.

Inspection and maintenance of insulated rail joints

70 An insulated rail joint (IRJ), also known as an insulated block joint, is a type of rail joint that uses components that are electrically non-conducting and assembled in such a way as to prevent the flow of electric current between the two adjoining rails (figure 6). Track circuits, which are the basis of the signalling system used in the Margam area, detect whether a train is present or not and control the operation of the lineside signals seen by the train driver. There is a pair of IRJs at each end of each track circuit, one for each rail.

Figure 6: Insulated rail joint

71 It is important that the non-conducting property of an IRJ is maintained. Between the two abutting rail ends is an insulating spacer, and a common failure mode is for the rail ends to become deformed by the impact from passing wheels, leading to damage to the rail ends and the top of this spacer. This rail deformation is referred to as 'lipping'. If it is not checked, the two lipped rail ends may eventually make contact, at which point the electrical insulating property of the joint is lost. This will usually show up as a failure of one or both adjacent track circuits, meaning that the signals cannot be cleared for trains to pass.

72 If inspection of an IRJ shows that lipping is occurring, the joint can often be repaired by grinding away the deformed portion of the rail ends to restore the gap between them, grinding the top of the spacer to reduce its height, then adding a resin to build up the spacer again. The resin is then smoothed off to match the profile of the rails before it hardens. This operation is referred to by track maintenance staff as 'trimming' the IRJ.

73 If inspection of an IRJ shows that trimming is required, it is important that maintenance staff inform the signaller before starting work. This is because the process of grinding the deformed rail ends may bridge the gap between them, leading to a track circuit failure as described in paragraph 71.

74 Network Rail's Track Work Information Sheet 2C027 – 2G032 'How to Maintain Insulated Block Joints' says that this work must be carried out during a possession, meaning that the line must be blocked to trains while the work takes place.

Analysis

Identification of the immediate cause

75 The group of three track workers were all unaware of the approaching train until it was too late to move clear.

76 The forward-facing CCTV from the train, and witness evidence, indicate that the three track workers who were working on the crossover were unaware of the approach of train 1L48 until the moment before it reached them.

Identification of causal factors

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

a. the group of three track workers were on a line that was open to traffic while carrying out a maintenance activity which they did not know to be unnecessary (paragraph 78)

b. the three track workers were working without the presence of formally appointed site and distant lookouts to warn them of approaching trains (paragraph 120)

c. the three track workers did not see or hear any warning of the train's approach (paragraph 145)

d. there was no challenge to the way the work was being done, probably because of the dynamics within the group (paragraph 156).

Each of these factors is now considered in turn.

The work activity

78 The group of three track workers were on a line that was open to traffic while carrying out a maintenance activity which they did not know to be unnecessary.

79 At the time of the accident the track workers were loosening, lubricating and retightening a threaded fastener on a slide baseplate/distance block assembly of the switches of 9577B points, while both the lines connected by the crossover were open to traffic.

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

a. it was custom and practice within the depot to lubricate threaded fastenings, despite the absence of any written procedures requiring it to be done (paragraph 81)

b. the SWP was prepared with no involvement of the person who was expected to take the lead in safely undertaking the work, and was not compliant with procedures (paragraph 88)

c. the planned safe system of work was interpreted to mean that work could be carried out with lookout protection if blockages were not available (paragraph 94), and it included only three of the four tasks required to be undertaken

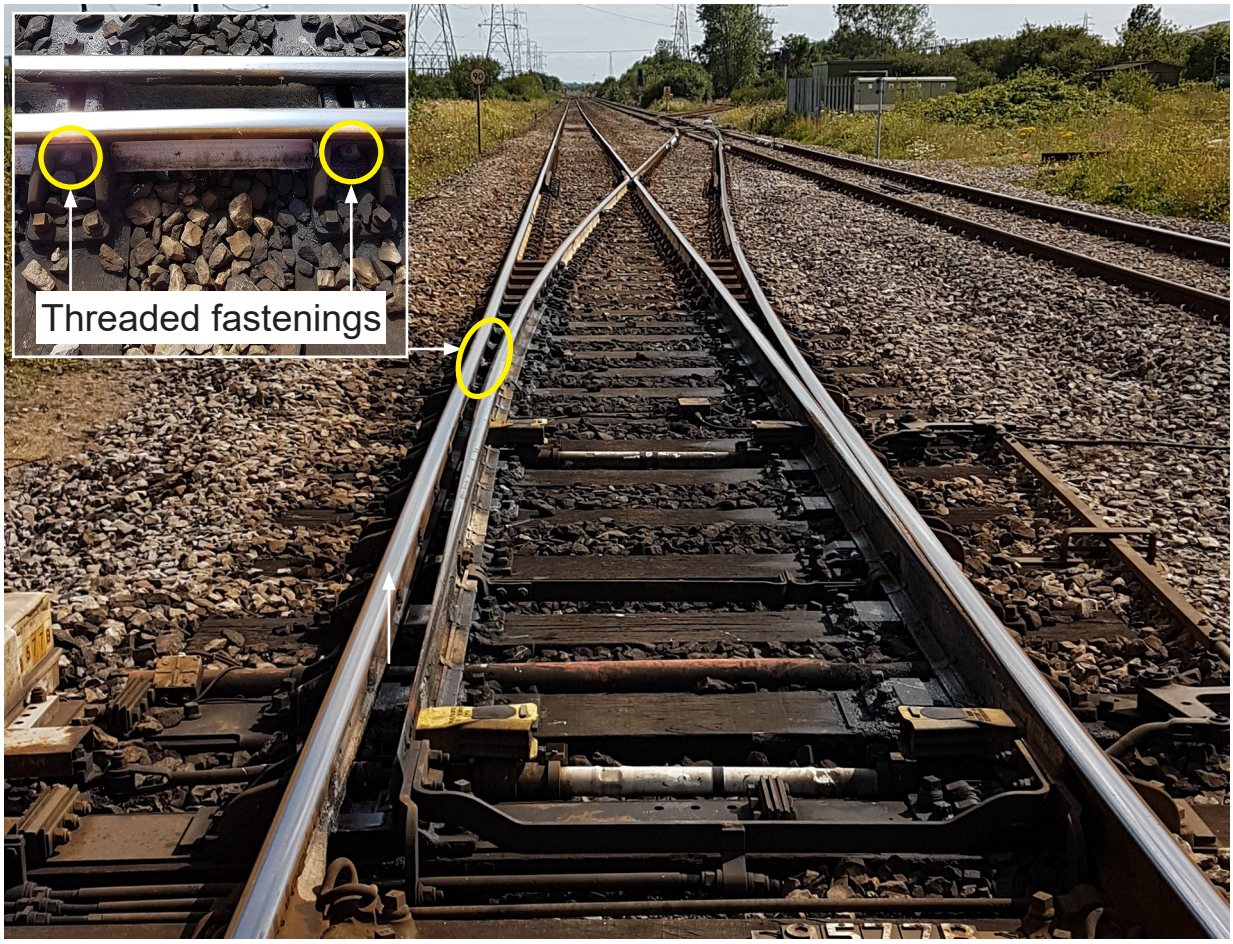

Figure 7: Switch slide baseplate and distance blocks

d. Port Talbot depot's safety planning practices were not compliant with the mandated process. The extent of non-compliance was not detected by the local checks required by standard 019 (paragraph 106), nor by the Network Rail route management team's assurance process

e. the group of three track workers were accustomed to working on lines that were open to traffic (paragraph 117).

Each of these factors is now considered in turn.

Lubricating fastenings

81 The sub-assemblies of track components that make up a crossover are put together under factory conditions. This includes tightening the threaded fastenings to a torque value determined by the designer of the assembly. Network Rail's work instruction NR/L3/TRK/4004 'Switch & Crossing Assemblies', section 6.14, states:

> '*Fastenings … shall be fully tightened on assembly to the required torque. With the exception of fastenings which might require subsequent loosening/removal during the installation process (including rail fastenings, baseplate screws and point operating equipment), all torqued fastenings shall be sprayed in white to indicate correct torque has been applied*'.

82 This means that the bolts and nuts of switch slide baseplates and distance block fastenings are considered to be assembled for life at the factory and should not need to be dismantled while the switches are in service.

83 Network Rail guidance note NR/GN/MTC/011 'Stock Rail Bolt Torque Application' describes a requirement to retighten and check the torque of stock rail bolts which secure the stock rails to the slide baseplates (figure 7) on newly installed switches between 1 and 12 weeks after installation. Crossover 9577 had been in service for several years at the time of the accident, and the guidance note prescribes the use of a calibrated torque wrench, not an impact wrench, to check the tightness of those bolts. The stated procedure does not include disassembly, lubrication and reassembly of any threaded fastener.

84 There are no Network Rail track engineering standards, track work instructions or other guidance notes which require the loosening, lubricating and retightening of these fastenings (figure 7) as a scheduled maintenance activity. Network Rail's professional head of track was unable to think of any reason why this should be carried out as a scheduled task, and other engineers whom RAIB has consulted agree.

85 Witness evidence indicates that the staff at Port Talbot regarded the lubricating of these fastenings as part of the normal routine maintenance of switches and crossings (paragraph 67). The need for this task had never been queried by anyone, in the memory of all those interviewed by RAIB. Local managers were aware that it was being done and believed that it was a technically correct and worthwhile task.

86 Many of the depot staff, due to their long service on the railway, would be familiar with the maintenance of older designs of S&C. These required greater maintenance attention than the more modern types, such as 9577B points. The component parts on older designs, including the rails, were often replaced individually, but the practice with the more modern types is to replace complete sub-assemblies. It was noted that some of the depot managers, also with a long service on the railway and with responsibilities for checking the technical quality of work, viewed the practice of loosening, lubricating and retightening threaded fasteners as normal.

87 This continuation of a former and now redundant practice indicates that technical knowledge and skills were not being refreshed at Port Talbot depot. It also indicates a lack of independent technical supervision and monitoring. RAIB has made a recommendation (paragraph 373) and identified a learning point relating to this issue (paragraph 375).

Preparation of the SWP

88 The SWP was prepared with no involvement of the person who was expected to take the lead in safely undertaking the work, and was not compliant with procedures. If it had been, it would have given the opportunity for the PIC who was to lead the work on site to be involved in deciding the safe systems of work for each of the required tasks and the resources that would be required. It might also have enabled him to challenge why the work was not scheduled to start until 12:30 hrs.

89 Standard 019 modules 3 and 4 define the process for creating a SWP for working, using protection and warning arrangements respectively. In both cases the process requires the planner to create the SWP with input from the PIC (paragraph 53). The PIC is then required to verify the SWP which the planner has produced, following which the responsible manager should authorise the SWP for implementation, and then issue it. This process is intended to ensure that the person in charge of safety for the work on site is involved in the planning, and is able to check and challenge details of the proposed safe system of work.

90 The previous issue of standard 019, issue 8 (paragraph 51), introduced in 2010 and prior to the creation of the PIC role, stated that the COSS, who was then responsible for the safety of a group on site, was required to be involved in the planning process. Witness evidence indicates that this had not been the practice at Port Talbot depot.

91 If the site safety leader is to be involved in the planning process, there must be local arrangements that allow them time to review the proposed SWPs in advance of the work. This can conflict with their need to be working on the railway if not properly managed and organised. Had the depot been complying with the requirement of issue 8 of standard 019, staff would have found it more straightforward to implement the requirement for the PIC to be involved in the planning when standard 019 was revised and reissued in 2017 to issue 9.

92 In the case of the work at Margam on 3 July, the SWP had been prepared by the depot planner with no input from the PIC who would be working on site. It was subsequently authorised by the supervisor, and only then verified by team leader 1 (TL1) acting as the PIC signatory. None of these people were at the work site on the day of the accident. Evidence indicates that TL1 knew it was unlikely that he would be on site to take charge of the work, as he had also verified the pack for the other work site for the same day (paragraph 28). The SWP was returned to the supervisor for issue the next day.

93 On the day of the accident, the supervisor issued the SWP to TL2, who passed it on to TW1, because he wanted TW1 to lead the group that day. TW1 passed the SWP to TW4, telling him to complete the SWP paperwork. Neither TL2, TW1 or TW4 had been involved with the planning or verification of the SWP, contrary to the requirements of standard 019 (paragraph 53).

Parallel working and multiple work tasks within one SWP

Parallel working

94 The three track workers formed part of a group of six that had been tasked by the supervisor to carry out work at Margam East Junction, several hours earlier than the line blockage planned from 12:30 hrs (paragraph 26). One of the supervisors, who was aware of the time of the planned line blockage, has stated that his expectation was that the group would work with lookout warning in the morning, during which time they would only inspect the IRJs (with any follow up rectification to be planned for a later visit), and then carry out the other work under the protection of a line blockage in the afternoon.

95 The SSOWP system allowed the planner to use the parallel component feature in a way which was not intended (paragraph 62). The first safe system of work, stated in the SWP as 'working', specified that the up main and up relief lines would be protected by line blockages from 12:30 hrs for 3 hours. Line blockages were only available from this time because a line blockage had been arranged for the period before 12:30 hrs for the other group working on the site towards Cardiff. Port Talbot signal box instructions state that only one line blockage is allowed at any one time in its controlling area between 06:00 hrs and 22:00 hrs.

96 Standard 019 issue 9 contains a hierarchy of controls for operational risks consisting of three levels of 'protection' and five levels of 'warning' systems (paragraph 57). All three levels of 'protection' systems require a line to be blocked to traffic, and the four highest levels of 'warning' systems require additional equipment. Because a line blockage was not available for that morning, and additional warning equipment was not available, the only option for the planner was to plan the work in the morning under an unassisted lookout warning system. This is the lowest system in the hierarchy and standard 019 states that '*this should always be regarded as the last resort'*.

97 The second safe system stated in the SWP as 'parallel', specified unassisted lookout warning, using only one lookout. However, at this location, a site (touch) lookout should have been specified because of the use of a noisy tool, in addition to a distant lookout (paragraph 32), required because of the limited sighting distance available.

98 When using the parallel feature of the planning system, the start and duration of the work are governed by the time and duration set by the first or 'working' component, so the start time for the second 'parallel' component was also 12:30 hrs. In reality, the group were out on the track and had begun work before 08:30 hrs. Witness evidence indicates that the parallel component option was used by the planner to minimise the amount of paperwork and make production of SWPs easier.

99 Port Talbot depot staff have stated that they understood that producing SWPs with the 'parallel' component gave flexibility for staff on site to work with either system as they chose. Track workers at Port Talbot reported frustrations with a lack of availability of line blockages within the area covered by Port Talbot signal box. Furthermore, witness evidence indicates that parallel working was used widely in South Wales for expediency, as it provided a means of continuing work on the track when line blockages could not be obtained.

100 More widely, there was inconsistency in staff understanding of what 'parallel working' meant. In focus groups conducted by RAIB (paragraph 253), two different 'parallel working' scenarios were described by staff:

- patroller inspections, mainly carried out using lookout warning, but taking line blockages to pass through areas where working under lookout warning is prohibited, such as around bridges and tunnels
- using a line blockage to provide a place of safety on one line while working under lookout warning on the other line.

101 Neither of these scenarios corresponds to the concept of parallel working that was being operated at Port Talbot depot.

102 Senior staff at Network Rail HQ have indicated to RAIB that parallel working is not specified in standard 019 and is not recognised as an official term. The intention of standard 019 is that only one safe system of work should be used at a time. Any change from one system to another should be planned in advance, or be authorised by a supervisor prior to implementation, should a change to a less safe system be required during the work. The risk associated with using the parallel working option in the planning software, to move down the hierarchy of protection systems without authorisation, had not been recognised nor addressed by Network Rail when developing the SSOWP system. Although in this case it gave the group flexibility about which safe system they could use for each task, this way of using the planning system meant that the work was not planned to minimise risk.

Multiple work tasks within the one SWP

103 The SWP for the work was prepared by the planner at Port Talbot depot on 28 June 2019. It included three tasks: vegetation clearance, boxing-in ballast and maintenance of 9577 crossover, all within the one pack. The 'parallel' component option (paragraph 63) within the SSOWP system was chosen for creating the SWP.

104 The SSOWP system allowed the planner to create a SWP with all three tasks on one document, contrary to the principle that separate SWPs should be created for each task. Network Rail's guidance 'Principles for Implementation of NR/L2/OHS/019 - Safety of people at work on or near the line', Route Businesses version 1.2, 14 June 2017, states that:

> '*For every stand-alone activity (i.e. replacing a set of switches, felling a tree, taking an isolation or location inspection), there should be ONE Person in Charge and ONE Safe Work Pack'.*

105 The SWP did not include the required work on the IRJs. The supervisor had asked the team leaders to undertake this on the morning of 3 July, and so it was not included in the previously prepared SWP documents. The work was in response to a track circuit fault affecting the running of trains in the area, which had been reported and repaired two days previously. One of the supervisors then decided that other IRJs in the area should be checked, and trimmed if necessary, on 3 July.

Safety planning processes at Port Talbot depot

106 The SWP covering the work on that day had been prepared in a way that was not compliant with the process specified in standard 019 (paragraphs 51 to 60 and paragraph 88). RAIB's examination of other SWPs from Port Talbot depot showed that it was common for SWPs to be authorised by supervisors before they were verified, and issued with no identified person in the role of PIC, either at the planning stage or on site.

107 RAIB examined 637 SWPs from Port Talbot depot, covering the three-month period from April to July 2019. Of these, 259 related to non-cyclic tasks, similar to the work being done on 3 July. The investigation found that at least 49% of these SWPs (127 of 259) had been authorised by a responsible manager before being verified by a PIC. Additionally, 33% (87 of 259) did not specify the name of a PIC. It was possible for the planner to select the option of 'Your PIC' from a menu instead of nominating a named person. Witness evidence indicates this was a feature of the software that had been created for testing purposes and not removed after the SSOWP system was commissioned. Additionally, about 16% of the non-cyclic SWPs (42 of 259) had been planned with fewer lookouts than were actually needed on site.

108 In 17% (44 of 259) of the SWPs, the person who had been nominated as the PIC, and who had also verified it, did not perform the role on site. It was also the case that 8% (20 of 259) of the SWPs included parallel components (paragraph 62).

109 The frequent practice of not specifying the name of the PIC within the SWPs at the planning stage strongly suggests that the depot did not generally involve the PIC responsible for the work in the planning process.

110 Witness evidence indicates that many of the plans prepared at Port Talbot were based on undertaking multiple tasks at one particular location, rather than planning each task separately. This meant that there was little attempt to consider and minimise the risk associated with each task. The lack of prescriptive and well planned safe systems of work within SWPs, although allowing necessary flexibility to site safety leaders to adapt to changing situations, is likely to have reinforced the view among staff at the depot that the SWPs had little value in supporting safe decision making on site.

111 Section 11 of standard 019 describes the assurance and management activities that should be undertaken as part of the process for delivering safety. As well as continuously monitoring the effectiveness of planning and task delivery during routine management inspections, there is a requirement for responsible managers to review and monitor the SWPs that are produced, to ensure compliance. Checks should be done for every four-week period, on at least 10% of returned SWPs. The review should include identifying and checking that SWPs are being verified and authorised before use (although the standard does not specify in which order this should be done), that the plan is fit for purpose, and that all the sections are completed accurately, including signatures.

112 One of the supervisors involved has stated that he checked around 20% of returned SWPs. However, the reviews carried out were on the basis that the way in which the depot produced SWPs was correct, rather than checking actual compliance with the standard. The non-compliant practices were therefore not detected during these reviews.

113 The SWP covering the work on 3 July 2019 was signed by TW4 in both the PIC and COSS sections, and he also signed to say that the work had been completed before it had actually begun (paragraph 31). Track workers at Port Talbot depot, and elsewhere, told RAIB that there was a culture of making sure that SWPs were fully signed, irrespective of by whom and when, because feedback was often given about missing signatures following managers' reviews of the returned SWPs.

114 SWPs were not perceived by supervisors or track workers at Port Talbot as having much value in keeping people safe. This view is also supported by evidence from RAIB's discussions with wider groups of COSSs (see paragraph 253). SWPs were seen as something that needed to be signed off correctly as complete, rather than documents that guided and assisted staff in undertaking work activities safely. Staff stated that it was necessary to ensure that returned SWPs 'looked right'.

115 There was no independent check on whether the process being used at the depot was compliant with standard 019 when it was first introduced. Neither the section manager nor the supervisors had received any formal training on the checking process, nor was there additional guidance available beyond the text of the standard itself. These managers had either received the same shortened briefing about the revised 019 standard as others in the depot, or were not present when it was given (see paragraph 228).

116 In addition to the local audits by Port Talbot depot staff, activities, including the implementation of the revised standard 019, were periodically reviewed by the workforce health safety and environment advisor on behalf of, and reporting to, the route's infrastructure maintenance delivery manager. The responsibilities included checks that depot safety briefings had been completed, monitoring performance indicators and undertaking unannounced safety visits. One of the advisors has stated that he checked 10% of completed SWPs as part of his responsibilities under the management self-assurance process. He has also stated that he had been given no formal guidance on what a review consisted of, so he was reliant on using his own previous experience in planning when checking the SWPs, and that, unless he was on track with a working group, he could not tell whether the packs were suitable for the work being undertaken.

Working on an open line

117 Witness evidence indicates that all three members of the group were accustomed to, and preferred, working with lookout warning on lines that were open to traffic. Evidence from other track workers also indicates that some prefer to work with lookouts as it gives them flexibility in accessing the track. Furthermore, some prefer to place their trust in a lookout who is part of their group, rather than relying on a signaller arranging a line blockage, who they do not know, and who may be located a long distance from their work site.

118 Staff at Port Talbot gave differing estimates of the amount of routine track maintenance work at the depot that was being done with lookout warning on open lines. RAIB's review of SWPs from Port Talbot, covering the three months preceding the accident, showed that approximately two-thirds were planned to be done under 'protection' (line blockage or a possession). It was not clear whether this value had changed over recent years, or whether the actual method adopted for the work was as planned.

119 Network Rail has for many years had a policy of minimising the amount of work done under unassisted lookout warning. RAIB's class investigation into track worker safety outside possessions (RAIB report 07/2017) found that there were widely differing approaches to this issue across Network Rail. For instance, London and North Eastern route has developed an initiative ('Safe and Effective Working') with the aim of eliminating working under lookout warning for routine maintenance (see paragraph 180), but this has only recently been nationally adopted.

The method of working

120 The three track workers were working without the presence of formally appointed touch and distant lookouts to warn them of approaching trains.

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

a. The COSS and the formally appointed site lookout were not with the group of three in the period leading up to the accident (paragraph 122).

b. There was a breakdown in site safety leadership which led to informal working practices (paragraph 128).

c. Local and route management were not actively monitoring, and had not identified and managed, non-compliant working practices at Port Talbot depot (paragraph 136).

Each of these factors is now considered in turn.

Supervision of the group

122 The COSS for the group of six track workers, and the person who had been appointed to act as site lookout during the work, did not remain with the group of three workers at 9577B points in the period before the accident (paragraph 34).

123 The Rule Book, Handbook 7 'General duties of a controller of site safety (COSS)', section 4.1 states:

'You [the COSS] must stay with your group so that you are able to personally observe and advise everyone until:

- *Work is completed and your group is no longer on or near the line, or*
- *You are replaced by another COSS or an SWL.'*[10]

124 On both occasions when the group had split into two, the COSS was not able to '*personally observe and advise everyone*' as required by the rules. There is no guidance in the rules or published training material about how close the COSS (or Safe Work Leader (SWL)) should be to their group to be able to carry out this duty effectively. In practice, this is a matter for the judgement of the COSS, and evidence indicates that it varies according to the nature of the work, the location, and the environment.

125 CCTV evidence indicates that when the group first started work, they split into two groups to do different tasks, with TW5 looking out for the group working at the points and TW4, in the role of COSS, around 100 metres away (paragraph 33).

126 Shortly before the accident, the team had split into two groups for the second time so that one group could carry out work on the IRJs closer to Port Talbot. The lookout went with that group, as they would be working on the up lines and would need a lookout to warn them of approaching up trains. As the group moved towards Port Talbot, the available sighting distance for up trains reduced because of the presence of the bridge and the curvature of the line, to the point where it was even less adequate to provide the required warning of the approach of trains (paragraph 32).

[10] A safe work leader (SWL) is the role of an employee of Network Rail, a principal contractor who holds a trackside principal contractor licence or a contractor who has gained a railway contractors certificate, who manages the safe delivery of work. As a minimum they hold a valid COSS competence.

127 TW4 did not come to a clear understanding with TW1, who was seen by the others as being the leader of the group (see paragraph 129), about what the three workers who were remaining at the points would be doing while the others were away. TW4 stated that he told the group at the points to stay in the cess while he was away, but this cannot be corroborated. Both track workers who were with TW4 told RAIB that they expected that the other group would wait in the cess, clear of the line, until they returned.

Safety leadership and behaviours

128 During the work on 3 July, neither of the depot's two substantive team leaders were on site at Margam East Junction. TL2, to whom the SWP had been issued, had decided to go to the other site of work, and therefore passed the SWP to TW1 who was an acting team leader (paragraph 93).

129 Documentary evidence indicates that TW1 was not formally appointed as PIC. All the safety leader sections within the SWP (both PIC and COSS) requiring a signature were completed on site by TW4 (paragraph 31). However, all the surviving members of the group stated that they understood that TW1 was in charge of the work on site, even though he had given the SWP to TW4, and they expected to take instructions from TW1 (see paragraph 158).

130 According to the Rule Book, TW4, in the role of the COSS, should have been in control of the arrangements at the work site for protection from trains (paragraph 123), but in practice he acted in accordance with instructions given by TW1. He had previously handed the SWP back to TW1 at the depot, but he was given it again on site and did not raise any further concerns. Witness evidence, and the details entered on the SWP, indicate that TW4 had planned that the morning's tasks would be done under a warning system using a site and a distant lookout. However, the evidence of TW4 is that TW1 told him that they would not be using a distant lookout (paragraph 32).

131 CCTV evidence from trains which passed through the area where the group was working indicates that no distant lookout was used, and that at various times the full group of six separated into smaller groups to carry out specific tasks. Witnesses have stated that when the group first split, this was so that work could be done on the points and the IRJs concurrently. On each of the first IRJs requiring attention, TW4 and TW6 alternated between doing the work and looking out for trains. One of the track workers has stated that when acting in this unofficial 'lookout' role, they were watching the group who were around 100 metres away at the points. The officially appointed site lookout was with the group at the points at that time, and was closer to Port Talbot, and so was able to give the earliest warning should a train approach on the up main line. As all lines were open, one of the two people working on the IRJs and acting as the unofficial 'lookout' would also have been looking out for trains on the down main line when they were working on it.

132 It is likely that a similar method of working was being used by the group working on the points at the time of the accident, with one of the group acting as an unofficial lookout. This could not have been TW3, as he was using the powered impact wrench. Uncorroborated witness evidence indicates that TW1 was the unofficial lookout, and that he was intending to obtain a warning of approaching trains by watching the group working on the IRJs, who had the formally appointed site lookout with them.

133 All six of the group held the competency of lookout. Witness evidence suggests that some, if not all, readily adopted the practice of looking out for others and changing safety roles without formally being appointed. None of the group had any concerns about working in this way (see paragraph 156).

134 At the time of the accident, the group who had finished working on the IRJs were walking back towards the points. They reported that they were surprised to see the other group of three working in the four-foot of the up main line with a train approaching, because they had understood (paragraph 127) that the others would remain at the side of the line while they were away.

135 These events indicate that the group as a whole was not working in accordance with the requirements of the Rule Book and standard 019. The setting aside of the distant lookout arrangements planned on site by TW4 (paragraph 32) demonstrate that informal methods of working had been adopted. However, everyone involved was convinced both that they were working safely and that the senior person on site (TW1) was acting for the best. The working practices and informal arrangements on the site were unlikely to have been isolated occurrences. Such ways of operating had almost certainly become normalised and had not been monitored or addressed by managers.

Local and route management monitoring of safety behaviours

136 Network Rail Standard NR/L2/MTC/SE0117 'Planned Assurance Inspections and Site Surveillance (PAISS)' was first issued in 2006, and the current version is issue 5, September 2018. It defines the process for the planning and reporting of inspection and site surveillance activities as part of the company's assurance regime.

137 The standard states that this should be part of the day to day assurance responsibilities of line managers, and that a minimum of two inspections should be planned for each four-week period, although this can be relaxed if an approved variation is in place. The checks may include subjects such as work planning, staff behaviours and staff technical competencies on site. The inspection plan is reviewed and authorised by senior managers within the route. The number and type of inspections should be based on risk reviews, which may include any close call reports, audit findings, safety conversations and findings from reviews of the self-assurance process (paragraph 265).

138 This standard fulfils the assurance requirement in an associated standard, NR/L2/ASR/036, 'Network Rail Assurance Process', to identify whether formal controls are being implemented correctly, and that any unsafe acts or poor safety controls are managed. This includes quarterly inspections by employee health and safety representatives.

139 The requirement to monitor track staff behaviours at Port Talbot depot was the responsibility of the section manager (track), and the two permanent supervisors, with reporting back to senior managers within the route.

140 RAIB reviewed the South Wales route plan for periods 2 to 13 of 2018/2019. The plan showed that site visits were to be undertaken by the section manager (track) and the two supervisors at Port Talbot depot. Records showed that all three managers had shortfalls in the number of visits completed. Plans for line managers in other depots in the route showed that this was not uncommon. The section manager (track) raised two issues following his visits, although the details of these, and any responses, were not recorded. There were no issues recorded as being raised by either supervisor.

141 The section manager (track) at Port Talbot depot stated that he and the two supervisors made regular visits to sites of work. He believed that the two supervisors at the depot undertook the majority of the management checks on the way that work was being done. One of the supervisors stated that he went out on track 'sometimes'. Other than the existence of a PAISS plan for the visits, RAIB has found no documentary evidence of these visits having taken place.

142 Standard 019 also includes a requirement for continuous review by managers and supervisors of the effectiveness of the planning process, including the behaviours of staff. It states that '*planning and task delivery shall be monitored and managed by the observation of staff at work*.' This shall include '*unsafe behaviours, activities and/or conditions'*, including corrective actions to address them. The standard states that to be effective, supervisors and managers should spend sufficient time with their staff.

143 RAIB considers that managers may have relied on reviewing the returned hard copies of SWPs to inform them of how work was being done, rather than undertaking observations of the way in which the staff were working on site. Witness evidence indicates that the managers had little time available for checks on routine work.

144 Senior managers at Network Rail have told RAIB that there is very little guidance and limited training given to line managers about identifying unsafe behaviours, and how to challenge staff should they find any. A lack of independent checking can result in non-compliant and unsafe practices becoming normalised. There may also be a lack of willingness by line managers to challenge, possibly in part due to conflicted priorities. The evidence suggests that this is likely to have been the case at Port Talbot depot. Witness evidence also indicates that more generally the quarterly employee health and safety representative inspections did not always happen.

The approach of the train

145 The three track workers did not see or hear any warning of the train's approach.

146 The forward-facing CCTV from the train and witness evidence indicate that the group working on 9577B points were unaware of the approach of train 1L48 until the moment before it reached them.

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

a. The group of three track workers were using a noisy machine, and so were unable to hear the horn warnings from the train and the other group (paragraph 148).

b. None of the track workers looked towards the approaching train because they had become distracted by the task they were undertaking (paragraph 154).

Each of these factors is now considered in turn.

Audibility of warnings

148 The train's data recorder shows that the driver sounded the train's warning horn three times on the approach to the group working on 9577B points (paragraph 40, figure 8). The driver sounded these repeated warnings, and applied the emergency brake during the second of them, because he saw no response from the group of three to the initial warning.

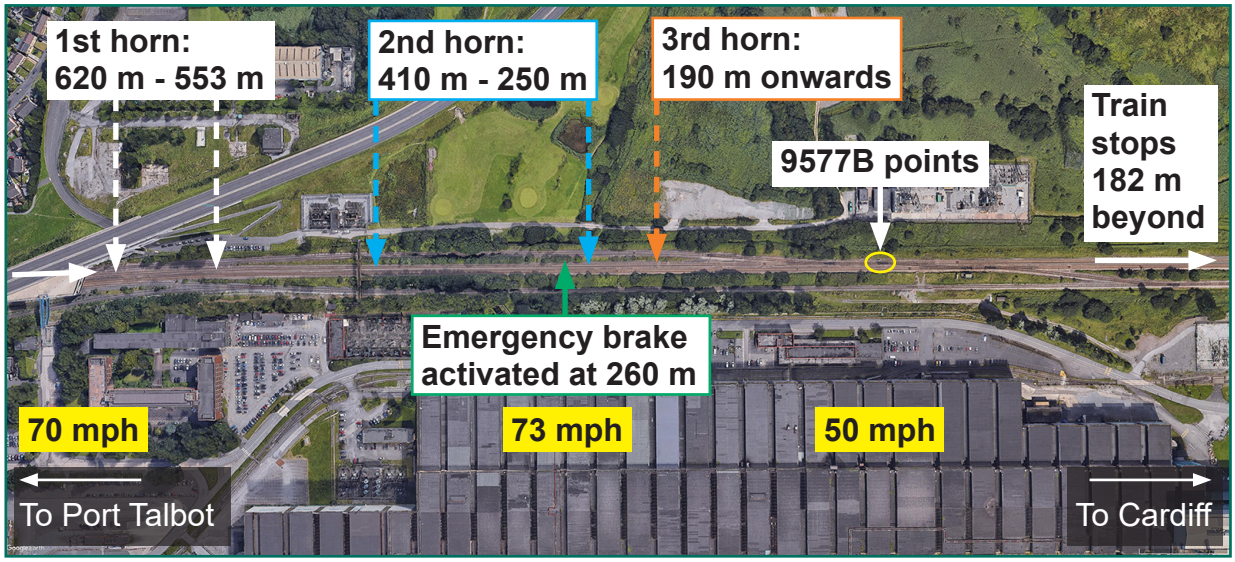

Figure 8: Driver actions and train speeds on the approach to 9577B points

149 The other track workers, who had been working on the IRJs, were walking towards the group working on the points, and were approximately 100 to 120 metres away from them when the train passed. They began to shout, and the lookout (TW5) blew his horn, in an attempt to warn their colleagues. CCTV evidence indicates that the three track workers did not react to any of these warnings.

150 The group at the points were using a petrol-driven impact wrench, which is a noisy machine. Witness evidence indicates that because of this, each person was almost certainly wearing ear defenders.

151 Measurements undertaken by RAIB of the sound pressure levels[11] from the impact wrench (measured in similar conditions to those at the time of the accident, but on a different day) showed that at distances of between 1 and 2 metres it produced a sound pressure level between 105 and 113 dB(C)[12] (figure 9). This was greater than the sound pressure level of the low tone warning from the approaching train horn (paragraph 40), which was measured as 88 dB(C) at 25 metres, the approximate distance the train was from the group around one second before it reached them. The sound pressure level of the lookout's warning horn was measured as 68 dB(A)[13] at a distance of 120 metres, which is the approximate distance that the lookout was from the three track workers at the points.

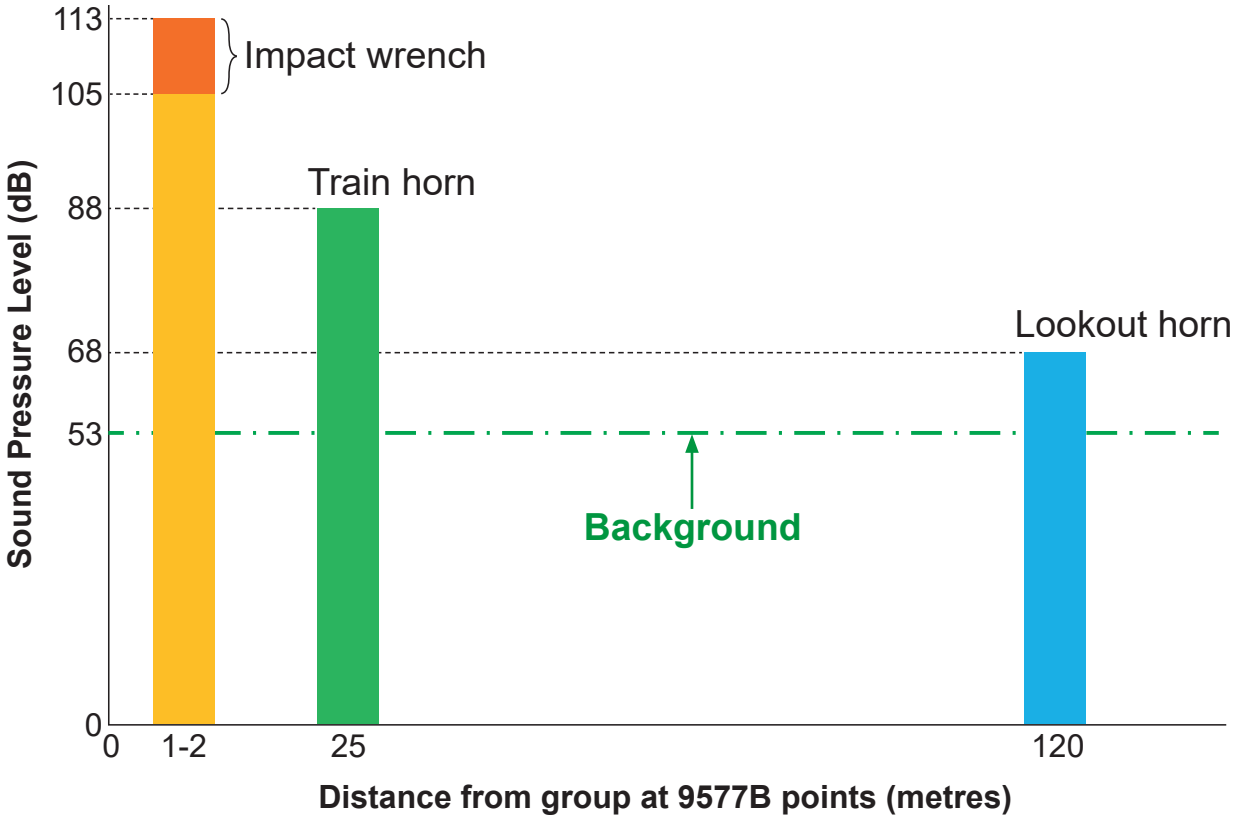

Figure 9: Comparative sound pressure levels of different sources at distances relative to the group working at 9577B points

[11] A logarithmic measure of the effective sound pressure of a sound relative to a reference value. It is measured in decibels (dB) above a standard reference level.

[12] Sound pressure level weighted to simulate the frequency response of human hearing at high sound pressure levels, written as dB(C).

[13] Sound pressure level weighted to simulate the frequency response of human hearing at low to moderate sound pressure levels, written as dB(A).

152 The wearing of ear defenders by the track workers would have reduced the perceived sound pressure level of the impact wrench by around 30 dB.[14] Ear defenders would also have reduced the sound pressure level of all other sounds by approximately the same amount, so the impact wrench would still have been louder than the warnings that were given. Research[15] indicates that the sound of warning devices is reliably discernible, and therefore detectable, when the sound pressure level is between 15 and 25 dB(A) above that of another sound source. The sound pressure level from the impact wrench, and the proximity of the three track workers to it, prevented them from hearing the warnings that were being given.

153 Tests carried out by RAIB also found that the sound pressure levels produced by the train horn in some of its settings were less than the Group Standard requirements (see paragraph 348). The way in which the driver used the horn was not in accordance with the Rule Book (see paragraph 341). However, had both been in accordance with their respective requirements, it would not have affected the outcome.

Distraction

154 Exactly what happened at 9577B points in the ten minutes before the accident cannot be corroborated, because the surviving member of the group, TW3, is the only source of evidence about these events. The equipment that TW3 was using meant he was not looking out for trains, and he believed that TW1 was looking out. However, it is clear from the forward-facing CCTV from the train, that all three were concentrating on the work being undertaken. TW3 has stated that one of the distance block fastening nuts was difficult to undo, and that TW1 gave instructions to TW2 to lubricate the bolt with a brush, while TW3 used the impact wrench.

155 Because of this distraction, none of the track workers were looking towards the approaching train.

Challenging the system of work

156 There was no challenge to the way the work was being done, probably because of the dynamics within the group.

157 At various times during the morning's work, the group acted in a way that was not compliant with the rules (paragraphs 120 to 135). No-one in the group challenged these actions, or the decisions that led to them.

158 Witness evidence strongly suggests that the group members had considerable trust in each other and were familiar with the ways in which the others worked. TW1 was the most senior person in the group (paragraph 15) and frequently acted as team leader. Although TW4 had signed the SWP as COSS and PIC (paragraph 31), witness evidence from members of the group suggests that TW1 was directing the work tasks that day. Many of the staff at Port Talbot depot told RAIB that they considered him to be very safety conscious, capable and knowledgeable, with high standards and pride in his work.

[14] This is in line with current HSE guidance for hearing protection and typical of the ear defenders that were recovered following the accident.

[15] Referred to in RSSB/AEATR-PC&E-2004-002 Issue 3 'Audibility of Warning Horns', AEJ Hardy, 2004, and Catchpole, K. & McKeown, D. (2007). 'A framework for the design of ambulance sirens.' Ergonomics 50(8), 1287 – 1301.

159 Before the group began work on 3 July, there had been some discussion about the SWP and the work that was to be done. The sequence of events is described in paragraphs 30 to 32. At the depot, before work started, the COSS (TW4) had handed the SWP back to TW1 because, having read it, he found that there was no line blockage available before 12:30 hrs. When the group arrived on site, TW1 is reported to have said that the work would be done under lookout protection and handed the SWP back to TW4.

160 Witness and documentary evidence show that TW4 made plans for using site and distant lookouts, based on his assessment of the warning time required and sighting distance available (paragraph 32). He has stated that TW1 then decided that only one lookout was necessary.

161 It is possible that these exchanges affected the working relationship between TW4 and TW1. They moved into separate groups after work started, and although the group came together for a break for about ten minutes from 09:33 hrs, the two men remained, and worked, apart.

162 Witnesses at Port Talbot depot, and from outside it, spoke consistently of a strong sense of pride in the standard to which the track at Port Talbot was maintained, and a strong culture among staff of ownership of the output of the section. Consequently, the depot enjoyed a good reputation for the quality of the track it maintained.

163 The strong sense of group identity, combined with confidence in each other, made it less likely that the decision to work without a distant lookout would be challenged. Despite witness evidence indicating that the group did not feel any external time pressure on the day of the accident, the group split to undertake two separate tasks, again without challenge.

Underlying factors

Background

Historical context

164 There has been a steady improvement in the safety of track workers over the last hundred years, with particular reductions in accidents following the mechanisation of many routine tasks from the 1950s onwards, the introduction of high-visibility clothing in the 1960s, and the application of health and safety legislation from the 1970s.

165 In 2002 Network Rail issued standard NR/L2/OHS/019 (paragraph 51), commonly referred to as ‘standard 019’. This concerned the planning and management of the risk controls to keep people safe when working ‘on or near the line’. At that time, it was solely focused on minimising the risk to people from the movements of trains.

166 Figure 10 shows the number of fatalities as a result of track workers being struck by trains for each year between 1997 and 2020. This suggests a falling trend for most of that period. However, since 2018 there have been three fatal accidents resulting in four fatalities. Following a gradual decline in near misses to around July 2018, there has since been a gradual increase in such incidents, many of which have been judged to have had high potential for causing serious harm to one or more track workers (figure 11).

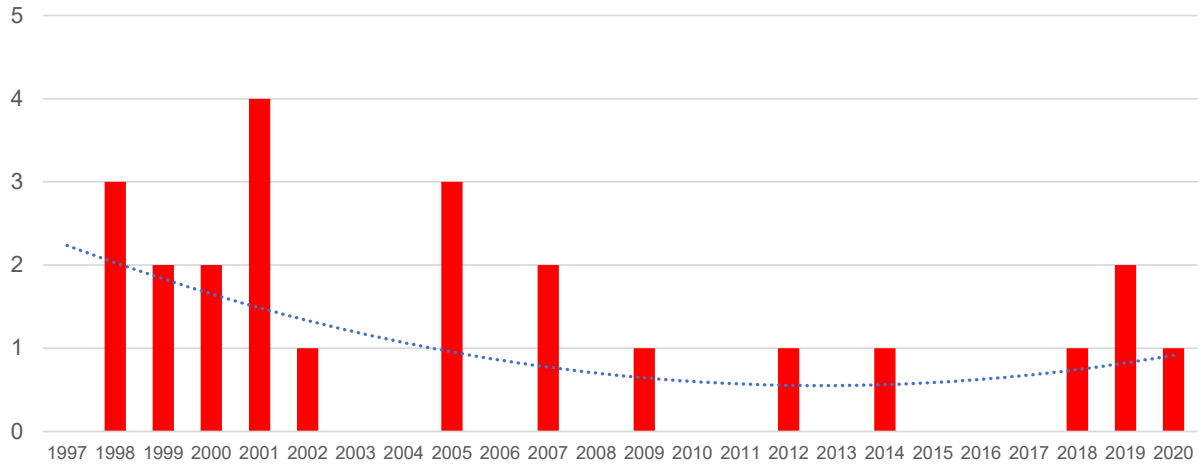

Figure 10: The number of fatalities as a result of track workers being struck by trains for each year from 1997 to the end of October 2020 (source: RAIB)

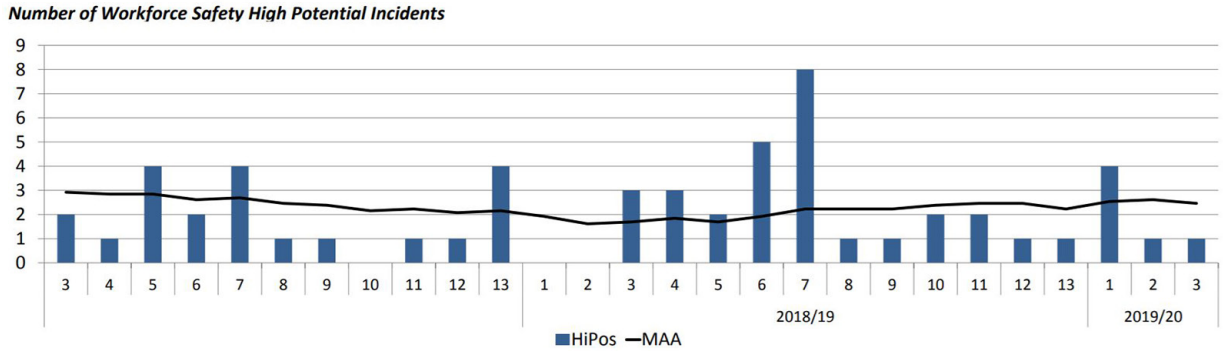

Figure 11: The number of workforce safety high potential incidents over the two years before the Margam accident (extracted from Network Rail's Safety, Health and Environment Performance Report, Period 3, 2019/20)

The role of the Office of Rail and Road (ORR)

167 ORR is the independent safety regulator for Britain's railways. Its main activities include the oversight of the industry's safety performance, high level definition of the required outputs and expectations for Network Rail, the enforcement of health and safety law in the railway industry, and the provision of advice. In support of these activities ORR gathers evidence about the management of risk through regular audits, inspections, investigations of accidents, incidents and complaints, and monitoring of health and safety performance indicators.

168 ORR has several options for enforcing compliance with health and safety law, ranging from verbal and written advice, through improvement and prohibition notices, to prosecution.

169 Each year, ORR selects areas of Network Rail's activities to prioritise using its risk assessment and risk ranking process.

170 ORR has explained to RAIB that when it identifies areas for improvement it will allow the duty holder time to develop and implement changes, and only reinspect when it believes it will be able to identify that a change has taken place.

Overview of Network Rail's senior management health and safety meeting structure

171 Network Rail sets safety policies and direction for the management of the organisation through a structure of formally appointed committees and groups. These meetings were also tasked with monitoring and reviewing safety performance.

172 The structure of senior management safety meetings, documented in Network Rail's 'Health and Safety Management System' (HSMS), is summarised below:

- Network Rail Infrastructure Ltd. board meets monthly and has overall responsibility for corporate governance.
- The safety, health and environment (SHE) committee of the board holds roughly four to five meetings per annum, and is attended by the chair of Network Rail's board, the chief executive officer, directors, non-executive directors (one of whom chairs the meeting), senior managers and subject experts from within Network Rail. The meetings would also include guest speakers and presenters from the routes and other parts of the business. On occasions, ORR's chief inspector and the general secretary of RMT would attend at least part of the meeting.
- Regular meetings of the safety technical and engineering (STE) directorate's national safety, health and environment review group (NSHERG), which was responsible for developing strategic plans for consideration by the executive committee to tackle the risks and opportunities in the area of health, safety and environment (later renamed the health, safety and environment integration review group (HSEIR)). This provided a national forum of safety professionals from across the routes and business units.
- The executive committee: an executive body operating at a strategic level. It is responsible for the day-to-day running of the organisation, but it is also responsible for agreeing the strategy and objectives necessary to deliver Network Rail's safety and sustainability goals. It meets regularly throughout the year, is chaired by the chief executive and is attended by senior managers and nominated directors.

173 The 'technical authority' with the overall responsibility of leading the development of safety policy, and developing national safety initiatives, was the STE directorate. Included in this directorate was a quality, health, safety and environment team which was responsible for leading the development of strategy, and the setting of the safety standards that routes were required to apply.

174 The primary responsibility for the local implementation of Network Rail's safety policy and mandated standards and procedures sat with the managing director of each route and their team. Within each route, the route safety, health and environment team provided support and advice to the route managing director and the chief operating officer.

175 Other national forums that provided an opportunity to review and discuss track worker safety included:

- The periodic business review: a two-day meeting of all the route managing directors, held every 28 days, chaired by Network Rail's managing director of network operations, and supported by various national functions including safety.
- 'Visualisation meetings': the tracking of performance within the maintenance organisation was carried out with the help of 'visualisation boards' (paragraph 276), which were reviewed at meetings held three times every four weeks. The idea of these meetings was to enable a team review of vital statistics that were displayed for all to see, to assess performance against targets and decide on management actions and priorities.

Analysis of underlying factors

176 Despite its stated intention to improve track worker safety, Network Rail did not create the conditions that were needed to achieve a significant and sustained improvement.

177 This inability to create the right conditions arose from a combination of the following:

a) Over a period of many years, Network Rail had not adequately addressed the protection of track workers from moving trains (paragraph 178). In particular, the major changes required to fully implement issue 9 of standard NR/L2/OHS/019 were not effectively implemented across Network Rail's maintenance organisation (paragraph 202).

b) Network Rail had focused on technological solutions and new planning processes, but had not adequately taken account of the variety of human and organisational factors that can affect working practices on site (paragraph 239).

c) Network Rail's safety management assurance system was not effective in identifying the full extent of procedural non-compliance and unsafe working practices, and did not trigger the management actions needed to address them (paragraph 263).

d) Although Network Rail had identified the need to take further actions to address track worker safety, these had not led to substantive change prior to the accident at Margam (paragraph 301).

Each of these is now considered in turn.

Protecting track workers from moving trains

178 Over a period of many years, Network Rail had not adequately addressed the protection of track workers from moving trains.

179 It is self-evident that a key factor that determines the likelihood of a worker being struck by a train is the proximity of workers to moving trains. One way of separating workers from trains is to block the line to trains when maintenance workers need to go on or near the track. However, such temporary blockages are not without risk. Despite the application of rules, miscommunications and/or other human factors can lead to blocks being lifted prematurely or work taking place without the block being in place. Furthermore, temporary blockages of the line to enable maintenance activities can increase the workload for signallers and distract them from other safety critical duties.

180 A more reliable means of separating workers from trains is to schedule work at times when trains are not running, for instance at night or during weekend maintenance possessions. With this in mind, Network Rail's London North Eastern and East Midlands (LNE&EM) route's south maintenance area pioneered a scheme known as 'Safe and Effective Working' (S&EW). This involved the detailed planning of cyclical access across all disciplines, to maximise the use of standardised pre-booked possessions taken throughout the week. A stated aim of the approach was the systematic elimination of any requirement for routine maintenance to be undertaken on lines that were still open to traffic.

181 LNE&EM route started the S&EW project after a track worker fatality in 2014 at Newark (RAIB report 01/2015). The project was supported by the route's senior management team and had a full-time team of seven additional planning staff from around the start of 2018. The project covered eight maintenance delivery units, encompassing more than 700 individual maintenance teams. Its primary focus was on planning and delivering the Route's known routine maintenance workload. It is also claimed to result in greater reliability, efficiency and productivity.

182 When a maintenance section is engaged with the S&EW project, the initial phase was to take the section's known maintenance activities and align as much of this work as possible with engineering possessions. It did this by looking at the access opportunities available in the agreed strategy for pre-programmed cyclical engineering possessions. This process also considered the number of night shifts that the section's maintenance staff could be rostered to work in accordance with their employment terms and conditions. The S&EW project found that this process had promoted collaborative working between different maintenance sections.

183 The wider application of the principles of 'Safe and Effective Working' was the subject of a RAIB recommendation following the investigation into a near miss near Peterborough in 2018 (RAIB report 04/2019) (paragraph 361).

184 A notable absence from the national schemes to enhance track worker safety was any detailed consideration of the ways in which the principles of 'Safe and Effective Working' could be applied more generally. The reasons for this are unclear, but RAIB is aware of a number of perceived barriers to wider implementation of such a scheme. These include reluctance of maintenance staff to work more nights and weekends, a perception that such an approach is unnecessary on lines with lighter traffic (where obtaining more and longer blocks between trains is less of an issue) and the need for significant additional resource to carry out the planning.

185 There is evidence that Network Rail has found it difficult to implement significant changes to long-established working practices relating to track maintenance. In particular, there is a widespread belief among maintenance staff that working between trains under the protection of one or more lookouts is an efficient and safe way of working (paragraph 117). Unlike the alternatives, it enables immediate and short-notice access to the infrastructure without reliance on a signaller, or person in charge of a possession, to block the line to traffic. It gives workers more autonomy and flexibility, allowing them to carry out their tasks at a time of their choosing. Track workers have also reported to RAIB that some signallers can be difficult to work with, and reluctant to arrange blockages of the line, particularly when the intervals between trains are short. It is also the case that some maintenance activities require and benefit from watching a train passing over the track, which is not possible with a line blockage.

186 The absence of widespread planning to reschedule routine maintenance to enable greater separation of trains and the workforce, combined with a widespread preference to work with unassisted lookout warning, has resulted in continued exposure of maintenance staff to moving trains.

187 The changes that are needed to significantly increase the separation of workers from trains, and to engage track workers in the planning process, are likely to require significant organisational change at depot level. Shifts may need to be altered, additional planners appointed, and well-established working practices radically changed. Such changes are difficult to execute on a national basis given the size of the industry, a degree of resistance to change and, at times, difficult industrial relations. Witnesses have also suggested to RAIB that the workforce are becoming tired of the number of changes and new safety initiatives imposed upon them.

Minimising Red Zone working

188 Network Rail and ORR have long considered that work groups working under unassisted lookout warning (a 'warning' safe system of work) are at greater risk than those working under 'protection' arrangements. In 2002 RSSB, on behalf of the railway industry, published a strategy document entitled 'Green Zones – Thinking Strategically'. This was part of an initiative that was established at the end of 2001 '*in order to achieve the target of zero workforce fatalities set in the Railway Group Safety Plan 2002/03.*'

189 The output from the above initiative came under six main headings:

a) encouraging cross industry co-operation

b) automating inspection, and mechanising maintenance

c) designing a reliable and low-maintenance railway with good accessibility

d) providing sufficient engineering access within the timetable

e) maximising work efficiency by improving planning of work and possessions

f) simplifying rules, standards and methods of protection.

190 Examination of this list by RAIB suggests that in the 18 years leading up to the accident at Margam the only areas in which substantive progress had been made related to the automation of inspection and mechanisation of maintenance, and the introduction of new railway equipment with improved reliability (thereby reducing risk exposure). In the other areas progress has been limited. This is evidenced by the proportion of work that is still scheduled to take place with lookout warning (figure 12) and the continued number of potentially serious narrowly avoided accidents (figure 11). RAIB's class investigation into track worker safety (RAIB report 07/2017) presented Network Rail data from 2014/15 and 2015/16 which indicates that nearly 50% of all near misses take place when the only safeguard from trains is looking out for approaching trains (figure 13). A more recent thematic review of track worker accidents undertaken by RAIB (see paragraph 241) paints a similar picture.

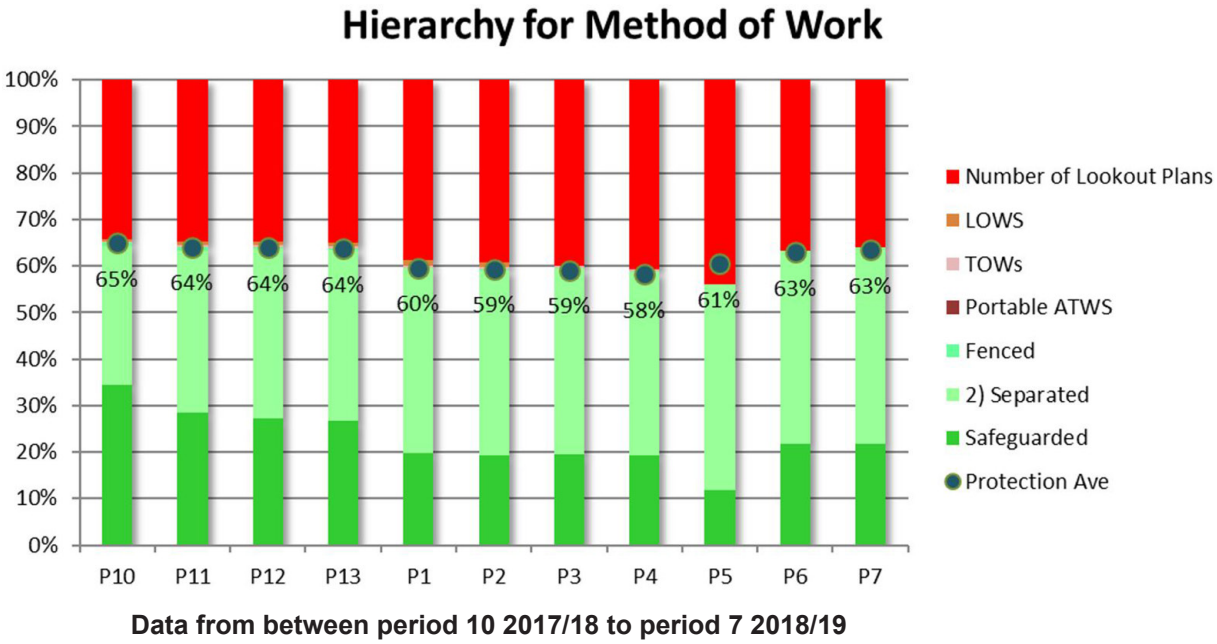

Figure 12: Proportion of work planned to take place with different forms of 'protection' (green columns in figure above) and 'warning' systems (red columns in figure above) (extract from Network Rail paper 31/18 submitted to the Safety, Health and Environment Committee, November 2018)

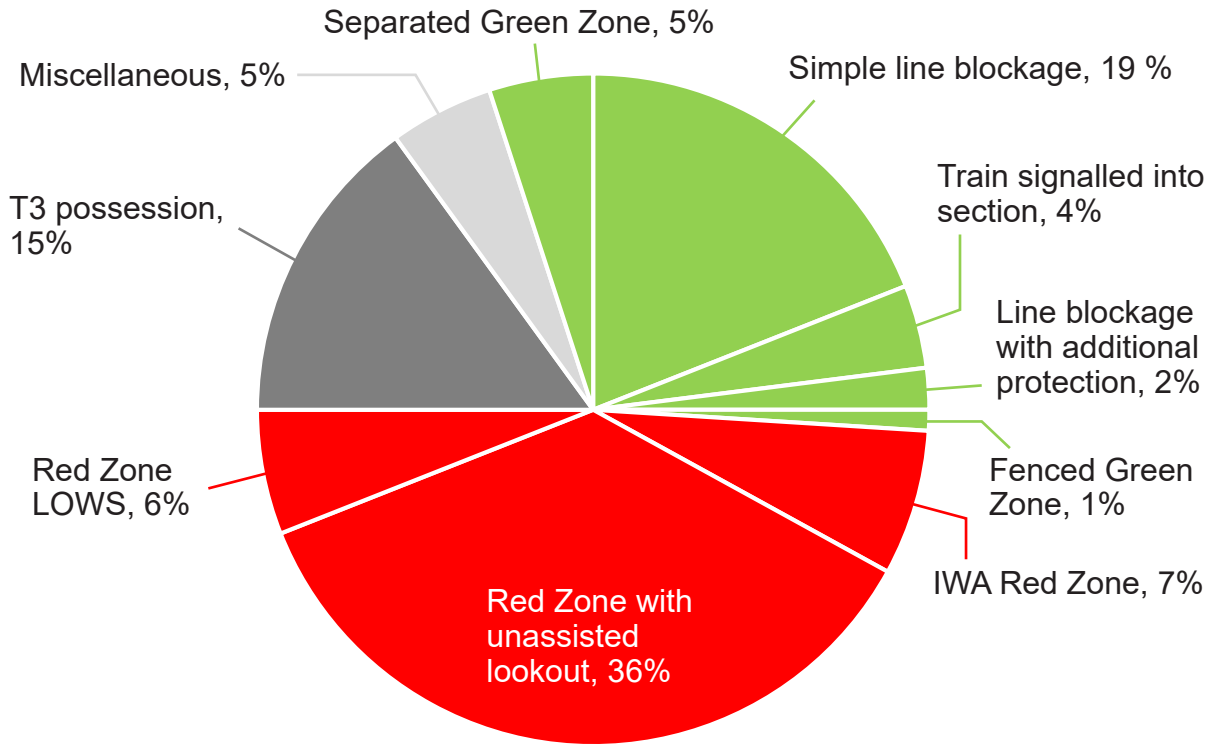

Figure 13: Near misses recorded for work planned using different Safe System of Work types; two years 2014/15- 2015/16 (source: Network Rail). The red coloured sectors show the proportion occurring under the 'warning' safe system of work

191 These figures indicate that the programmes for separating people from trains which have been implemented by Network Rail in recent years have yet to achieve a sustained reduction in the exposure of track workers to the risk of being struck by moving trains.

The PDSW initiative

192 The rail industry has long recognised that the number and seriousness of narrowly avoided fatal accidents is a cause for concern, and there has been a general acceptance that the relatively low levels of fatalities were hiding some systemic problems with the management of track worker safety. Senior leaders in Network Rail and ORR had spoken publicly about the need to improve the management of track worker safety and had committed themselves to finding a solution. In 2014, work started to develop a new scheme known as 'Planning and Delivering Safe Work' (PDSW).

193 The PDSW initiative became established as a formal programme in 2014/15. In 2016, following its pause (see paragraph 199), it was relaunched and was then intended to deliver five basic objectives:

a) the creation of a single controlling mind responsible for the safe delivery of the work and protection from trains

b) involvement of site safety leaders in planning of work activities and protection measures

c) proper risk assessment of the work tasks

d) the provision of simple schematic diagrams of the network that were suitable for use in the planning and delivering of work

e) a formal electronic permit-to-work system.

194 Objective a) was originally planned to be achieved by the creation of a new role, associated with a new formal competency, the safe work leader (SWL), who would be directly involved in planning the protection from trains. It was envisaged that the creation of this new role would enable the selection of a much smaller number of site leaders, all of whom would have the potential to be developed to act as effective safety leaders. However, it was recognised that to achieve this outcome, those selected would require to be trained in the technical and non-technical skills needed to deliver higher standards of safety on site.

195 Objective e) was planned to be delivered by a software system known as Proscient, which had been used in other industries, and would use already available track and signalling data.

196 Witness evidence indicates that the PDSW scheme was strongly supported and actively promoted by the then chief executive and his senior management team. They saw it as a means of significantly reducing the risk to track workers by protecting them both from trains, and from hazards associated with the work task itself. Throughout the development of PDSW, and the subsequent revision of standard 019, there remained strong pressure from the executive team to bring about a step change to risk management on site.

197 The PDSW scheme was initially implemented in the East Midlands route in mid-2015. Within a few weeks, it became apparent that the delivery units were struggling to implement the scheme. The maintenance organisation could not adapt to the process changes, and the technology that had been introduced to support the schematic diagrams and electronic permits-to-work failed to deliver in line with management expectations.

198 Witness and documentary evidence suggests that there were three fundamental problems with the initial PDSW programme:

- the extent of change to existing working practices, and the consequent resource and time pressures on delivery units and depots, was not allowed for. Consequently, the need for major changes to working practices at delivery unit level was not adequately addressed
- delivery of the programme was based on optimistic assumptions about the development and implementation of the associated technology, and the availability of reliable data to support the electronic permit system
- there was a lack of ‘buy-in’ to the new processes from the workforce and trade unions.

199 Given the above, and in the face of strong representations from the trade unions, the roll out of the PDSW programme in the maintenance organisation was paused in 2016 to enable a comprehensive management review to take place.

200 The Network Rail PDSW programme team reviewed its options, and in September 2016 a paper was submitted to Network Rail’s safety, health and environment (SHE) committee. This proposed that the principle of having a ‘single controlling mind’ accountable for operational safety risk and task risk should be adopted as quickly as possible. The paper expressed the view that this should be de-coupled from the introduction of the supporting technology and implemented by means of updating standard 019.

201 The paper's proposals were supported by the SHE committee and the implementation of these changes was subsequently defined as a 'Must Win' high priority project, with a target date of April 2017. The governance arrangements included periodic reviews by the senior management team, weekly reviews by the sponsor (the managing director of network operations) and a specific PDSW board.

The revision of standard 019

202 The major changes required to fully implement issue 9 of standard NR/L2/OHS/019 were not effectively implemented across Network Rail's maintenance organisation.

203 Following the various problems experienced with the initial implementation of the PDSW initiative, Network Rail proceeded with the revision of standard 019 to introduce the principle of a 'single controlling mind' for each worksite. This resulted in the production of issue 9 of the standard. This revision introduced important requirements that are relevant to this accident. These are the provision of a person in charge (PIC) to safely lead the work, and the involvement of the PIC in the planning process to ensure risks both from trains and from the work tasks were managed.

204 The development of the revised standard 019 was led by the STE directorate and overseen by the PDSW programme. The approach taken was collaborative, involving subject experts from delivery units and trade unions. As drafting progressed, it proved difficult to reconcile a range of differing requirements and expectations. Although steady progress was made, the revised document became more complex than had been originally intended.

205 Following on from this, early in 2017, it was agreed between Network Rail and the trade unions that it would be necessary to trial the revised standard to assess the resource implications of the proposed changes. This was principally focused on the role of planners, although the impact of the change on section managers, supervisors and COSSs/PICs was also included. It was agreed that this assessment should be undertaken by an independent body.

206 The trial sites selected were in the Anglia route, on the lines between London Fenchurch Street and Shoeburyness. The trial programme started on 6 March and was concluded on 28 April 2017, with the final report issued on 3 May 2017.

207 The analysis was conducted by PA Consulting under contract to Network Rail. Based on measurements and observations during the trial, and interviews with those involved, it predicted that introduction of the new standard had the potential to increase the workload of planners, and to a lesser extent responsible managers and PICs. In the case of the former, it predicted an increase of 7% in the total work time required to manage the increased input required into SWPs under the revised standard. The critical factor driving this increase in planning effort was the volume of non-cyclical (work arising) packs produced by a section, as additional engagement and information was required. However, the PA Consulting report suggested that this additional work could reduce as those involved became more familiar with the new process, and if various steps were taken to address practical difficulties.

208 The report also observed a number of issues that endangered the successful implementation of the changes to standard 019 nationally. These included:

- difficulties in getting PICs involved in the planning process (a critical element of the PIC role)
- late information about possessions, meaning that planning margins were compressed and the intent for SWPs to be developed in a measured and timely manner, with specialist input and verification more than one shift before implementation, might not be met
- PICs delivering incomplete site briefings because of the volume of material to be briefed, thereby undermining the intent that PICs should be controlling all elements of site safety
- A 'failure' to 'sell' the benefits of the new system to those involved in implementing it, with some seeing it as a 'paper exercise' with no impact on safety - the opposite of the intent of the PDSW initiative. Critically, PA Consulting expressed the view that the required changes in leadership and behaviours were also unlikely to be achieved
- Inconsistent messaging and a lack of clarity over job roles, especially in relation to the PIC's role and what they could and could not do.

209 The PA Consulting report concluded that if the changes to standard 019 were introduced appropriately, and properly planned, managed and delivered, the additional planning effort could be absorbed by the existing team members. A number of recommendations were made to Network Rail on how to introduce the change successfully during the national implementation. Those relating to change management were (in summary form):

'The PDSW Programme Team, STE and the route change management organisation should work together to:

- *set up the change in the sections for success by selling value, supporting the implementation of the desired beliefs, behaviours and ways of working for the key roles and ensuring the design of the SWP supports the desired behaviours*
- *deliver effectively through a clear delivery strategy and an integrated approach that clearly defines the change delivery responsibilities between the different parties involved*
- *manage the engagement of and communication with stakeholders through a clear plan that delivers relevant and timely messages to specific audiences and seeks regular feedback to test whether the intended messages are truly embedded*
- *ensure clear and consistent operational messaging*
- *reinforce the new ways of working by continually monitoring behaviours, recognising and 'rewarding' the correct behaviours.'*

210 While acknowledging that the PDSW Programme and STE were continuing to develop their approach to the national implementation in parallel with the trial, PA Consulting observed that the trial showed there was:

> *'a lack of change management focus to implement these key changes during the trial itself. The impact of this was a disproportionate amount of change effort focused on the planners, section managers and supervisors and a lack of evidence of change on the front line.'*

211 In parallel with the trial, planning for implementation of the revised standard was ongoing. Network Rail has told RAIB that at that time it had a Change Management Office undertaking regular assessments on the delivery of the PDSW programme. It has since stated to RAIB that there was purposely no change management support during the trial as it was agreed that this trial would assess the impact on planners of the new standard based on what they were doing at that time, and not artificially skew the data gathered. However, the evidence presented in this investigation report suggests that most of the PA Consulting recommendations had not been fully implemented by the time that the revised issue of standard 019 came into force.

Validation of the changes to standard 019

212 According to its documented Health and Safety Management System (HSMS), Network Rail operates formal change management arrangements to control the introduction of change and to confirm that all safety risks are identified, systematically addressed and controlled. These apply to changes relating to organisational structure, management systems, operations, infrastructure engineering, traction and rolling stock route compatibility, product acceptance, and any other factors which may affect the safety of the operational railway.

213 Standard NR/L2/HSS/020 'Safety Validation of organisational change' describes the four levels within the process for validating organisation and associated HSMS changes, including arrangements for consulting employees and trade union-appointed health and safety representatives about proposed changes. Validation was intended to affirm that the potential risk associated with a change had been identified, assessed and appropriately controlled, in compliance with the Common Safety Method for Risk Assessment (CSM-RA).[16]

214 In June 2016 Network Rail's standards and controls steering group for safety, health and environment considered the proposed re-write of standard 019 to incorporate the former standard that governed the initial roll-out of PDSW in the East Midlands (standard 0133), and a guidance note (GN908) that replaced standard 0133 when the rollout of PDSW was paused. The steering group was presented with an argument that the potential impact of the proposed changes was 'non-significant' when assessed against the criteria published in the ORR's guidance on application of the CSM-RA. More detail of these criteria, and Network Rail's assessment against each of them, are provided at Appendix G.

[16] The CSM-RA is an EU framework that describes a common mandatory European risk management process for the rail industry (ref: Commission Implementing Regulation (EU) 402/2013).

215 Despite the issues that it had recently encountered when implementing PDSW, Network Rail's assessment of the safety significance of the proposed updating of standard 019 appears not to have taken account of the major changes to existing working practices that would be required if the new process was to become properly embedded within the workforce. The changes were presented as being largely administrative in nature, consisting of the combining of existing standards and a guidance note. However, in reality, the lessons learnt from the 'paused' PDSW initiative had still to be analysed, and the principles underpinning the new standard were still to be decided.

216 Having reviewed the submission, the standards and controls steering group endorsed the argument that the proposed level of change inherent in the revision of standard 019 was not sufficient to warrant formal safety validation above level two as stated in standard NR/L2/HSS/020. Instead, the steering group decided that the changes were 'non-significant', and sufficient validation would be provided as part of the review of the revised document.

217 The absence of formal safety validation was a missed opportunity to identify deep-seated obstacles to implementation of the new working arrangements within delivery units.

Near miss incident at South Hampstead

218 In December 2018 RAIB published a report into a near miss incident at South Hampstead (see paragraph 362). This concluded that '*Network Rail's introduction of the person in charge role in NR/L2/OHS/019 issue 9 did not make the responsibilities of the role sufficiently clear*' and recommended a number of changes to clarify the standards. The report also recommended that:

> *'Network Rail should undertake a review of how the change of NR/L2/OHS/019 from issue 8 to issue 9 was managed, in order to identify any areas for improvement in the management of change'* (Recommendation 6 of RAIB report 20/2018).

219 This recommendation was reviewed by Network Rail's national recommendations review panel. Evidence suggests that it was not brought to the attention of the SHE committee. The status of actions taken in response to this recommendation is reported at paragraph 362.

The trade union view

220 Three trade unions represent significant numbers of people who were directly affected by the PDSW scheme and the subsequent changes to standard 019. These are the National Union of Rail, Maritime and Transport Workers (RMT), the Transport Salaried Staffs' Association (TSSA) and Unite. Between them, they encompass track workers, supervisors and planners. Trade unions have provided evidence to RAIB that they had been supportive of Network Rail's attempts to improve track worker safety and, in particular, the concept of a 'single controlling mind' with responsibility for the safety of the task and protection of the work group from trains. Although the unions had been involved in the PDSW development work, they became concerned about the way that the proposed changes were being developed and implemented, firstly as part of the original roll-out of PDSW, and later when standard 019 was being developed and then reissued.

221 The concerns expressed by the trade unions over the way in which the initial PDSW programme was being developed and implemented were broadly similar to each other. They pointed out that implementation of the new process would require additional planners, and the practical implications of involving the SWL in planning, including the question of what teams should do while the SWL was working with the planner developing the plan. Other issues raised included:

- reconciling the roles and responsibilities of COSS and SWL
- adequacy of the planning paperwork
- poor quality and inconsistent on-site safety briefings.

222 The concerns raised by the trade unions were a major factor in the 'pausing' of PDSW in the East Midlands route and led to a further series of discussions about how to take the initiative forward. At this point the trade unions worked with Network Rail to develop a way of taking forward some elements of the PDSW scheme. This collaboration led to the proposal that standard 019 should be revised to take into account the concept of a single controlling mind. However, as the planned date for implementation of the revised standard 019 approached, the trade unions raised a range of issues about Network Rail's readiness to implement the changes.

223 By May 2017 the RMT's National Executive Committee had adopted a report of its health and safety sub-committee which noted that the trials in Anglia route had taken place. It expressed concern about the resources that would be needed, and other aspects of the details of the new arrangements. The sub-committee felt unable to endorse the proposed changes to standard 019 until it could be assured that the revised process would bring a 'definite improvement' in track safety.

224 The RMT has told RAIB that it then wrote to Network Rail to express the above concerns. Although RMT considered that many of the union's concerns had not been acknowledged, Network Rail stated its intention to press on with implementation of the standard.

Implementation of standard 019 issue 9

225 Witness evidence from a senior manager in a Network Rail route indicates that there was an early realisation that implementation of standard 019 issue 9 would require additional resources. Network Rail has told RAIB that the findings from the workload impact assessment were discussed with all route directors, as it was the responsibility of the routes to adequately resource safe working. The role of the PDSW programme board was to provide guidance.

226 Evidence indicates that nationwide introduction of the changes to standard 019 involved briefing around 70 'delivery unit leads' from the routes in June 2017, who then briefed it to staff locally, including at delivery unit (depot) level. It was intended that they would be able to brief staff and to answer emerging questions and provide support during the implementation phase. To assist in this, the central team created briefing documents and training materials which included presentations and videos. A helpline was also established for a number of weeks, supported by personnel familiar with standard 019 and SWPs.

227 The onward briefings for operational staff (such as track workers and depot managers) were planned to last half a day, with a half-hour briefing session for others who only required an awareness of the revised process.

228 RAIB has been told by staff at Port Talbot depot that not all operational staff were present when the briefings were given, including some managers, and that the planned half-day briefing was delivered in around 40 minutes and there was no opportunity to ask questions for clarification.

229 Several witnesses reported conflicting guidance, and a lack of clarity about the role and responsibilities of the PIC and their expected involvement in the planning process. A review by RAIB of Network Rail's temporary frequently asked questions (FAQ) section on its intranet site, Safety Central, also indicated that there was confusion over these issues. In early 2020 RAIB found that this confusion was still widespread, during meetings with a number of front-line staff in other areas of the network as part of RAIB's study to look into the factors affecting the safety behaviour of COSSs (see paragraph 253).

230 In the months following the roll-out of the revised standard 019, the TSSA health and safety representatives visited a number of depots across the country to talk to its members and other staff about the implementation of the new standard. Feedback included: confusion about roles and responsibilities; the poor quality (and in some cases absence) of training; inadequate compliance checking; overloading of PICs, section managers and planners; and non-responses to earlier concerns that had been raised. The TSSA reports that this feedback was shared with the PDSW Programme team and senior managers including those at executive level. However, the feedback does not feature in the records of the SHE committee or Network Rail board.

231 RAIB has been told that there was pressure from senior managers in Network Rail to revise and reissue the standard quickly. Staff working on the revision of the standard reported that some briefing materials and guidance were being prepared before the final content of the standard was decided. On at least one occasion, the SSOWP system had to be reworked because of a subsequent change to the content of the standard. Because of the short implementation timescales, the training materials were produced in parallel with both the standard and the revised SSOWP system software.

232 One year on from implementation of the updated 019 standard, the PDSW programme team was briefing delivery units on the issues that had been identified and presenting the case for greater compliance with the new working arrangements. As part of this briefing process, the programme team identified a number of issues with the embedding of the revised standard 019. An extract is shown below:

'Feedback has shown that the key themes for non-compliance towards to (sic) the standard include;

- *Lack of understanding of the new process*
- *Lack of understanding of the PIC role and responsibility*
- *Operational challenges making it difficult to always involve the PIC in planning*
- *Planner capability and capacity'.*

Post-implementation reviews of standard 019 issue 9

233 In October 2017 (one month after the adoption of the revised standard 019 by all the routes) Network Rail undertook a review of how the company's central function had designed and implemented the standard. This review principally involved those who had been involved in the development of the standard, the changes to the SSOWP system and the programme management. RAIB observes that none of those taking part were in operational roles (such as section managers, planners and PICs) who would have had direct experience of using standard 019 in their daily work.

234 Some findings from the review indicated that there could have been a clearer understanding between Network Rail's central function and the routes, and the routes could have improved their capability to change working practices. The review also found that the standard could have been written more clearly, and that the effectiveness of the implementation was affected by time constraints.

235 A further review of how the implementation was progressing was planned for around September 2018. This was to include more representation by those in the routes. RAIB has found no evidence that this review was ever conducted.

Outcome of the changes to standard 019

236 RAIB has analysed the evidence relating to the updating and implementation of standard 019 issue 9 and identified a number of the factors that ultimately led to confusion and the poor levels of compliance:

- there was no comprehensive independent safety validation of the changes that were proposed and the implementation programme (paragraph 212)
- a key lesson of the unsuccessful implementation of PDSW by East Midlands maintenance teams was the need to consider the impact of the new processes on existing working practices. Despite this learning, the need for major changes to working practices at delivery unit level had not been properly addressed before standard 019 issue 9 came into force
- planners often had neither the time nor the capability to perform the role assigned to them
- witnesses have stated that it was difficult for routes to acquire the additional resource needed to implement the changes
- while accounts differ, standard 019 issue 9 was drafted on an assumption that routes were working to issue 8, or that any non-compliances were being addressed (paragraph 90). In some maintenance areas this was far from true,[17] and so the changes to pre-existing working practices that were required to implement issue 9 were larger than envisaged
- issues raised by the trade unions in the period leading up to implementation of the revised standard 019 were not fully addressed and so ground level 'buy-in' was lacking

[17] Issue 8 of the 019 standard had introduced the requirement for the COSS to be involved in planning, and for SSOW packs to be available for review by the COSS 24 hours in advance. Previous RAIB and Network Rail investigations reveal that the correct implementation of these working practices was, at best, patchy.

- the role of PIC was not considered to be a formal competency deserving of training. Consequently, the quality of training/briefing was variable, and in many cases poor (as was the case at Port Talbot depot (paragraph 228))
- Network Rail had not established systematic and rigorous processes (paragraph 233) for assessing the effectiveness of standard 019 issue 9 post-implementation.

Development of new track side protection and warning technology

237 In parallel to the PDSW programme, Network Rail's executive committee (Excom) was committed to the development and deployment of new trackside systems capable of preventing trains from approaching sites of work (thereby mitigating the risk of signaller error), or providing reliable warnings of trains approaching. In April 2016 a paper to Excom described the solutions under investigation as follows:

- a 'trackworker protection system', to be deployed with new traffic management technology, and designed to facilitate the taking of line blockages
- remotely operated devices to disconnect signalling equipment or operate track circuits
- automatic warning technology linked to the operation of the signalling system (known as the Lineside Early Warning System).

238 Funds were made available during Control Period 5 (2014-19) for the development of the technology. Consequently, the bulk of investment needed to deploy new equipment nationally was planned for Control Period 6 (2019-2024).

Management of site safety behaviours

239 Network Rail had focused on technological solutions and new planning processes, but had not adequately taken account of the variety of human and organisational factors that can affect working practices on site.

240 Since it became operational in October 2005, RAIB has undertaken 31 full investigations into accidents or incidents involving track workers, and published 14 bulletins and safety digests, and two class investigations. All but two of the incidents occurred on Network Rail infrastructure. RAIB's track worker investigations have resulted in over a hundred recommendations, primarily focused on the improvement of safety for people working on or near the line.

241 During 2019, RAIB undertook a thematic analysis of its investigation reports, bulletins and safety digests covering the period October 2005 to December 2019, to look for overall trends in track worker accident causation over a longer period than the previous class investigations, and to see if there were any gaps in safety learning. A full list of the reports used for the analysis is included at Appendix D.

242 The analysis showed that almost half the accidents and incidents occurred while staff were working under an unassisted lookout warning system (figure 14). In standard 019 this method of work is considered to carry the highest risk, and should only be used as a last resort, being vulnerable to variability in human performance. However, this method of work is often preferred by track worker teams because it offers them greater flexibility and autonomy than using protection arrangements (paragraph 185).

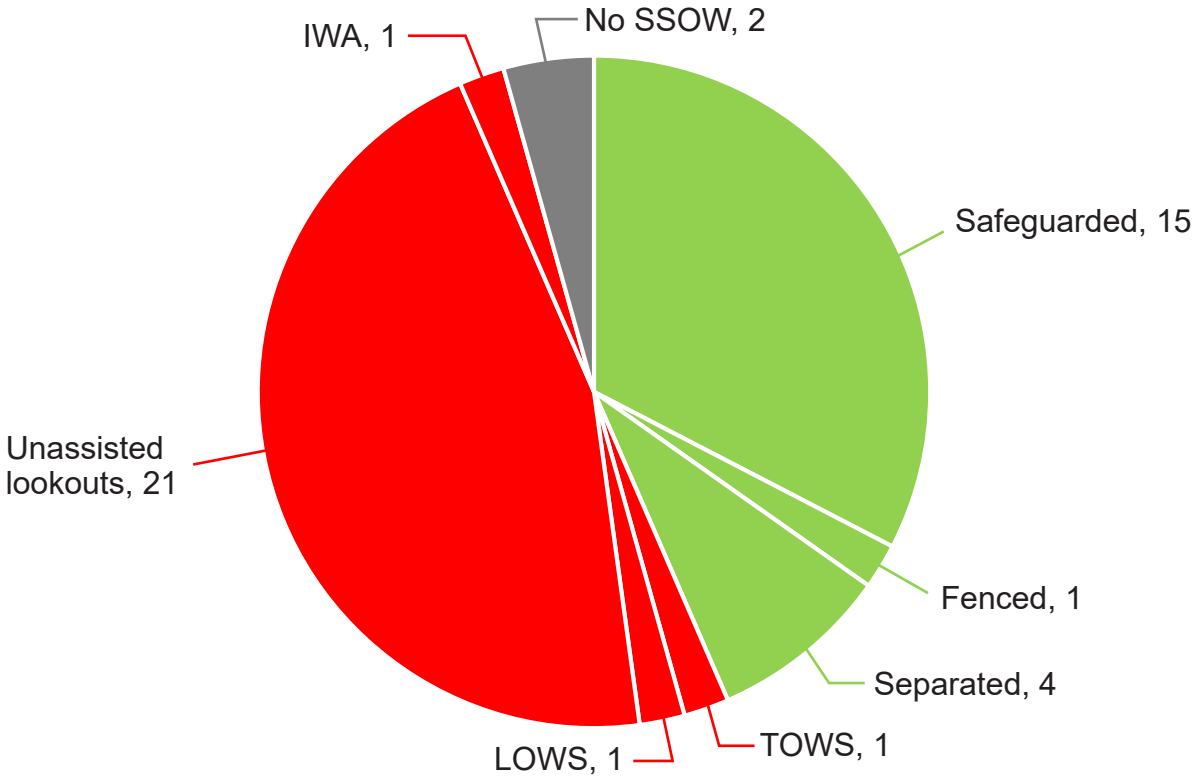

Figure 14: Chart showing the planned Safe Systems of Work of the 45 track worker accidents and incidents for which RAIB has published an investigation, bulletin or safety digest (Note: The data set totals 46 data points. The Heathrow Tunnel investigation is included twice, as it covered two separate events)

243 The chart shows that 43% of accidents and incidents occurred when staff should have been protected from train movements (they were working in what was formerly called 'green' zone). Some of these incidents were due to signallers or site safety leaders making errors when establishing line blockages, but many involved staff working beyond the planned limits of their safe system of work, often due to a lack of local knowledge. In the incidents using line blockages, none utilised 'additional protection' in which the COSS, signaller or signalling technician uses a secondary engineered safeguard to minimise the risk from a signaller error.

244 RAIB's review of the 45 reports listed in Appendix D revealed that there is no dominant cause of track worker accidents and near miss incidents (figure 15). Instead, there is a range of overlapping factors that are found to recur frequently. These include:

- use of unofficial working practices
- perception of risks by experienced staff
- poor safety critical communications
- COSS distraction
- unwillingness to challenge unsafe working or cultural issues.

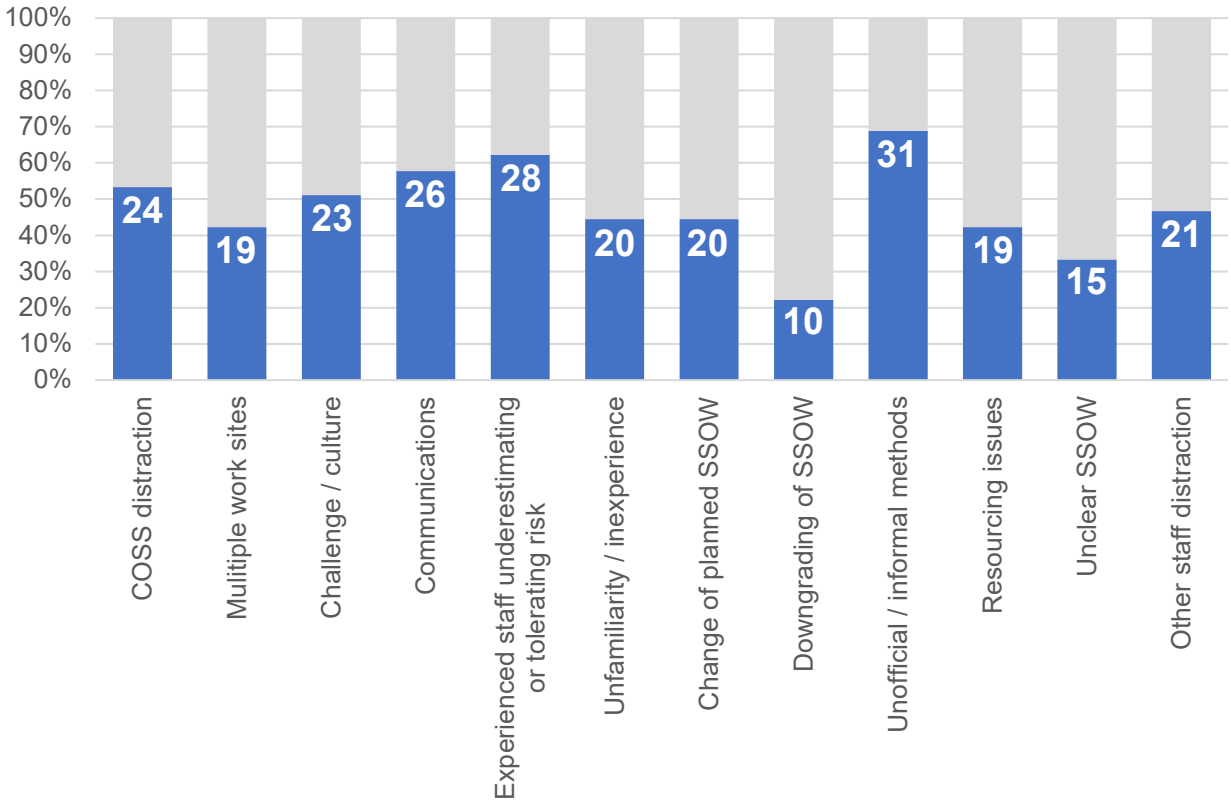

Figure 15: Occurrence of common causal factors in 45 RAIB published track worker reports

245 RAIB's overall conclusion from its analysis of this data is that reliance on compliance with procedures alone is unlikely to achieve the required levels of safety unless steps are taken to separate people from moving trains. However, until this separation is routinely achieved there will continue to be a need to address the quality of procedures, the quality of leadership, and underlying behaviours and attitudes. RAIB also observes that the introduction of new technology to protect track workers, or to warn of approaching trains, will not overcome the need for willing compliance with effective procedures, continued risk awareness by everybody on site, good quality safety leadership and positive working relationships within teams.

Safety leadership and non-technical skills

246 Non-technical skills (NTS) training was first introduced by the aviation industry in response to accidents; it has since been adopted in other safety critical industries including rail. NTS have been defined as '*the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance*'.[18] RSSB states that '*NTS enable safety critical workers to identify, manage, mitigate and recover from errors and other threats to operations by using all available resources - human, informational, procedural, equipment - to achieve a safe and efficient outcome.*'

[18] Flin, R., O'Connor, P. & Crichton, M. (2008). 'Safety at the Sharp End: A Guide to Non-Technical Skills.' Aldershot: Ashgate.

247 Network Rail introduced NTS training following a series of accidents involving track workers, including those at Trafford Park in 2005 (RAIB report 16/2006), Ruscombe in 2007 (RAIB report 04/2008) and Stoats Nest in 2011 (RAIB report 16/2012). This training was originally targeted at staff undertaking the role of COSS, although Network Rail declared its intention to expand the scope to include other roles such as lookouts, signallers, electrical control operators and operations control staff. The aim was to achieve a reduction in incidents where an underlying cause was associated with non-technical skills, and a reduction in the number of accidents and incidents involving individuals performing the role of COSS.

248 Network Rail's core NTS framework included the following:

- conscientiousness*
- attention management
- relationships with people*
- multi task capacity
- controlled under pressure
- planning and decision making*
- communications*
- willingness and ability to learn*.

249 The skills marked with an asterisk were included and assessed as part of a 'development day' that formed part of Network Rail's NTS programme for COSS personnel.

250 NTS training started in 2012 and all individuals employed in the role of COSS by Network Rail were due to have received the training by December 2014; those employed by other companies were to have received it by June 2015. Not attending the development day, or not passing the assessment, resulted in replacement of the individual's COSS competence with a new competence of 'COSS Theory' (the individual would no longer be able to act as a controller of site safety). Some COSSs have told RAIB that they found the development day valuable. Network Rail subsequently suspended the COSS development day training before the cut-off dates were reached because it was then implementing the SWL training, which included some NTS elements. However, the duration and scope of the NTS elements in the SWL training were reduced compared to those in the development day.

251 Currently, some elements of NTS have been incorporated into the e-learning which is now a pre-requisite to attendance at personal track safety (PTS) and lookout training courses. Network Rail has also included NTS elements within its updated Controller of Site Safety Course which began in July 2019.

252 The PDSW project (paragraph 192) was originally conceived as bringing about a fundamental change in the way that site leaders were selected and trained. It had been intended that there would be a limited number of 'Safe Work Leaders' appointed who would be selected on the basis that they had the right personal qualities to exercise safe and effective control of the work site. However, as time passed it became clear that Network Rail was unable to introduce this role in its maintenance organisation and would instead develop the role of PIC. Although the PIC role was not a formally defined competency, those acting as PIC are required to hold the COSS competency. PICs are people who were judged by their line manager to be capable of exercising authority, and were very often already qualified as a COSS. This meant that there was no mechanism in place to develop and assess the non-technical skills of PICs.

Factors affecting the behaviours of site safety leaders

253 As part of this investigation, RAIB commissioned the Transport Safety Research Centre at Loughborough University to conduct research into the factors affecting safety behaviours of COSSs and PICs. The aim of this research was to understand the key factors that can affect safety leadership on site.

254 The research comprised a review of relevant academic literature and an analysis of 47 RAIB investigation reports[19] of track worker incidents, followed by a series of focus groups with COSSs from several Network Rail regions. The analysis of RAIB reports resulted in a list of 47 causal factors in track worker incidents and accidents, which were subsequently rated for frequency and severity by COSSs in the focus groups.

255 The list of factors from RAIB reports is shown in figure 16, ordered by frequency of occurrence. The most frequently occurring factor was 'documentation', and there was also evidence from the COSS focus groups that the increasing volume and complexity of site safety paperwork is becoming overwhelming. Part of this is associated with the experience and capabilities of the planners who produce the paperwork, which can vary between depots. COSSs saw value in planners having experience of being a COSS themselves, as well as knowledge of the location, to produce appropriate and usable paperwork.

256 When the COSSs rated these factors for frequency and severity, three factors stood out as being considered both high frequency and high severity: fatigue, workload/time pressure, and distraction. Comparing these with the findings from previous RAIB reports, fatigue was ranked 25th of 47 in terms of frequency (appearing in six of the 47 reports). In the focus group discussions, COSSs raised concerns about the amount of rest rostered between shifts, as well as variations in shift patterns. Meanwhile, workload/time pressure and distraction ranked sixth and tenth respectively for frequency in RAIB reports (appearing 17 and 13 times, respectively, in the 47 reports).

[19] These comprised 45 accident reports in Appendix D (as used in the thematic analysis), and also included Heathrow Tunnel (RAIB report 20/2015) counted as two separate incidents, and the track worker class investigation report (RAIB report 07/2017).

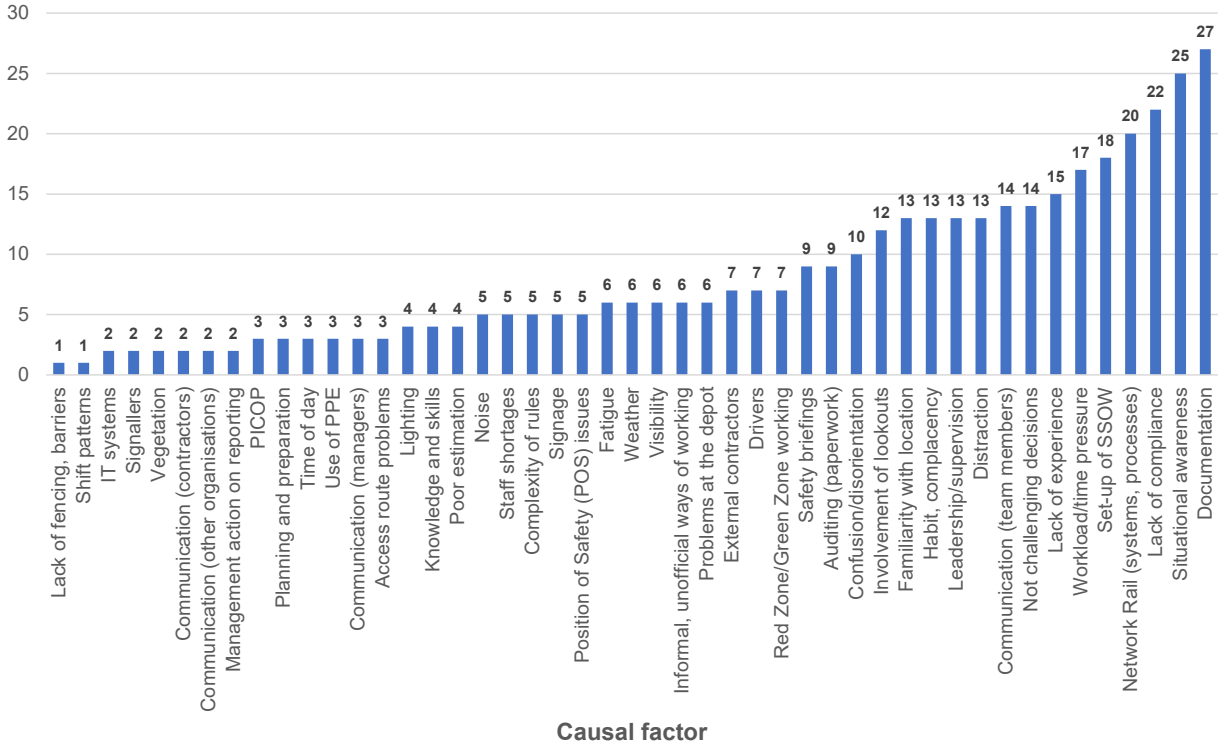

Figure 16: Aggregated causal factors and frequency of occurrence in RAIB reports

257 Collating the findings from RAIB reports with the data from the focus groups and the COSSs' ratings of causal factors, the researchers found that five factors emerged as particularly important:

a) workload and time pressure (due to limited time on track, staff shortages or pressure filtering down from management)

b) distraction (caused by multitasking or workload)

c) situation awareness (being familiar with locations as well as being responsible for less experienced colleagues)

d) unofficial ways of working (adapting rules to real-world constraints where the rules may be unworkable in some circumstances)

e) ability to challenge decisions (confidence in speaking up, which is in turn dependent on working relationships at the depot).

258 The factor concerning unofficial ways of working merits further explanation, particularly as a related factor of lack of compliance is frequently identified in RAIB reports (22 times in 47 reports). The focus groups demonstrated that safety is a top priority for COSSs, and they recognised the importance of following the planned safe system of work. Nevertheless, COSSs also felt that occasionally it is necessary to improvise around the rules or processes, to enable the completion of a task. The literature shows that informal or unofficial practices usually arise where there is a need to adapt rigid rules and procedures to the complexities of the real world, and that was evidenced in this research. Several of the other factors identified may influence the use of such practices, including workload or time pressure, habitual behaviours, peer pressure, supervision and leadership, planning and preparation, complexity of paperwork, or staff shortages. In some cases, track workers may develop informal strategies that contribute to improved safety.

259 Findings from the academic literature review and the focus groups also confirmed the importance of interpersonal dynamics within track worker teams, such as trust and the ability to challenge others. These issues were also highlighted in relationships between track workers and other groups, such as their supervisors and managers, or with signallers.

260 Concerns were also expressed in the focus groups about the adequacy of COSS training, especially around the transition to the new version of standard 019, which in some cases was seen to be insufficient. Some COSSs were aware of training in non-technical skills, but were not particularly knowledgeable about it. Role clarity was also an issue, as COSSs expressed confusion about the roles and responsibilities of COSS and PIC when both are present at a site of work.

261 Finally, the research identified a wide range of individual, group, organisational and external factors that combine to contribute to accidents and incidents involving track workers. Since these are systemic causes, the research concluded that systemic solutions are required, with a focus on organisational factors that influence the behaviours and decisions of all COSSs, rather than individual interventions such as training.

262 Taken together, these findings show that although there are apparent concerns regarding the kind of frontline behaviours and non-technical skills that contributed to the accident at Margam, such problems are a symptom of deeper systemic factors that have been present within Network Rail for several years. Notwithstanding the lack of ongoing commitment by Network Rail to NTS training for staff with site leadership roles, the research commissioned by RAIB showed that such behaviours are also influenced by factors within organisational control, such as workload, role clarity, change management, the complexity of paperwork and the suitability of rules for the complexities of working on track.

Management assurance processes

263 Network Rail's safety management assurance system was not effective in identifying the full extent of procedural non-compliance and unsafe working practices, and did not trigger the management actions needed to address them.

Audits and compliance reporting

264 Network Rail's management assurance processes are set out in company standard NR/L2/ASR/036 and are intended to provide assurance at every level of the organisation that risk management systems are operating as intended. Network Rail has three levels of assurance:

- Level 1: 'Local (route) management controls' including compliance monitoring, inspections, management reviews and self-assurance.
- Level 2: 'Corporate oversight' including engineering verification, deep dive reviews, and functional and management system audits, conducted by persons independent from those with the responsibility of implementing the risk controls.
- Level 3: 'Independent challenge and assurance of risk control policies' consisting of audits undertaken by Network Rail's internal audit team with the findings reported to the Network Rail board. These audits can also be informed by activities undertaken by external bodies such as ORR.

Local (Level 1) audits of compliance with standard 019

265 The Level 1 assurance activities include line management monitoring, competence management, planned assurance inspections, safety conversations and management self-assurance.

266 The management self-assurance process involves participation by all line managers in the route businesses. The process, as described in Network Rail's standard NR/L3/MTC/MG0221 (issue 5, September 2018), is intended for line managers to '*formally check their own compliance with company procedures and standards and allow them to identify and address any issues in a more efficient and cost-effective manner than assurance undertaken by another party*.'

267 The process involves managers providing responses to a series of subject related questions every period. These questions are phrased so that a manager has to consider their own compliance, or that of their staff, including questions relating to compliance with the standard 019 processes. Most are closed questions, requiring only a 'yes 'or 'no' answer. No justification or explanation in support of either answer is sought.

268 There is an option to answer any question as '*not checked on this occasion*', and there is no restriction on how many questions can be answered in this way. Network Rail staff have stated that unless a detailed review of the record of the responses is done, there is nothing to reveal that questions had been answered in this manner. Records will show merely that they had been answered.

269 Responses from the lower levels of management are used to inform the next management tier. An effect of this is that questions answered incorrectly at depot management level may provide a misleading, or incomplete assessment to more senior managers. There is no apparent cross-checking to prevent this, unless a more thorough review, such as a depot visit, can be carried out. Upper management reviews may solely involve checking that an assessment has been completed, and do not have to include reviewing any detail of the responses which have been given.

270 Senior managers within the Wales route have stated that this process lacks integrity and is not robust. One manager reported choosing to have their direct reports go through their self-assurance questions in the manager's presence, to obtain some assurance about the responses that they were being given.

271 The non-compliances at Port Talbot depot with respect to the preparation of SWPs and with standard 019 (paragraphs 106 to 116) went undetected, and the depot was not identified as needing support or guidance in its safety planning processes.

Corporate oversight of Level 1 audits

272 In late 2016 Network Rail's STE directorate (paragraph 173) undertook a 'deep dive' review of the Level 1 assurance process, and a report was issued in February 2017. 'Deep dive' papers were intended to explore particular risk areas in detail, so providing an insight into whether existing measures are effective, and the scope for improvement.

273 The review was commissioned in response to the number of Level 2 functional audits which were raising concerns associated with the understanding and implementation of Level 1 assurance activities at route level, and ORR concerns about the effectiveness of Network Rail's assurance process.

274 In the preamble to the deep dive report STE described the two key functions of Level 1 assurance as providing an overview of risk control and effectiveness at local level while also highlighting the areas to be targeted by Level 2 assurance activities. The report also stressed the increased need for robust Level 1 assurance activities given the moves towards creating a more devolved organisation.

275 The deep dive review was informed by visits to three diverse routes and a combination of structured open interviews, observation of site and depot management activities, and a review of documentation. The interviews were held at all levels of the routes' organisation, ranging from managing director to frontline staff.

276 The findings of the deep dive review of most relevance to this investigation are summarised below:

- Level 1 assurance was not adequately defined or communicated within Network Rail. Staff at all levels of the business had limited or no understanding of their duties as part of the Level 1 assurance process.
- Staff, including senior managers in the routes, frequently referred to self-assurance as a 'tick box exercise' and 'going through the motions' without seeing any added value at operating level. Opinions expressed at delivery unit level included "*Six months of self-assurance with no issues found, but we had four near misses where the investigations found fault with the SSOWPs.*"
- Intelligence gained from safety conversations, self-assurance and technical assurance was neither collated or analysed locally, nor used to feed into route level or national analysis.
- Visualisation, using visualisation boards, is a process where those responsible for a business area regularly discuss the performance data with a more senior colleague. This was widely used within Network Rail to highlight and track key topics throughout the business. Progress against plan for some Level 1 assurance activities such as safety tours and safety conversations was included on visualisation boards seen in Anglia, LNE/EM and Western routes. However, they were generally recorded as simple, quantitative values and did not assess the quality and therefore the value of the activities.
- There was no consistently applied process to monitor or improve compliance in areas of weakness identified by the Level 1 assurance process.
- Assurance staff at route level, such as the compliance and assurance advisors, relied heavily on Level 2 functional audits to provide them with assurance for topics that should be covered by Level 1 assurance activities.
- The verification of safe system of work packs (SWPs) was part of the Level 1 self-assurance process. However, when Level 2 functional audits were carried out, issues with the quality of the packs were often found.

277 The deep dive review included six recommendations for the improvement of the Level 1 assurance process. These covered the need for improved documentation describing the process, more effectively linking the Level 1 assurance process to the management of locally monitored risks, and various process improvements, including a greater focus on tracking the quality of tasks undertaken. Finally, there was a recommendation that the Level 2 assurance process should be reviewed and revised where appropriate so that it adequately focused on the quality and completeness of Level 1 assurance activities.

278 In September 2017, the SHE Committee discussed the adequacy of Network Rail's management assurance framework and noted that the primary weakness was the 'labour intensive' analysis in reviewing the outcomes from assurance activities, and that improvements were required. However, RAIB has found no evidence that the subsequent review of the assurance framework led to significant improvements to Network Rail's understanding of the risk to track workers.

279 In December 2017, Network Rail issued version 5 of standard NR/L2/ASR/036 'Network Rail Assurance Framework', which included details of which bodies would review audit findings. Level 2 assurance reports (which were consistently identifying ongoing problems with the Level 1 assurance process) were to be reviewed by the quarterly national health, safety and environment review group (NHSERG). The board and the SHE committee were to consider Level 3 assurance reports (which considered the effectiveness of the Level 2 assurance regime, but not the Level 1 assurance regime).

280 The deep dive review resulted in the development of an action plan, the last update of which was in April 2018. At that time, only 3 of the 11 actions identified had been completed. It is unclear which Network Rail group or committee took responsibility for monitoring progress with the action plan and closing the remaining actions.

281 Assurance activities were monitored by NHSERG, in accordance with the HSMS, with an assurance report being prepared for each meeting. RAIB sampled reports from 2017, 2018 and 2019, and noted the following in relation to the findings of Level 2 audits:

- *Q3 2017/2018 - 'Key findings for Delivery Unit audits continue to be related to self-assurance and deficiencies in the planning and documenting of safe systems of work.'*
- *Q2 2018/2019 - 'General concerns and patterns within audits show that several subjects need attention. Track Worker Safety insofar as the implementation of Safe Work Packs is still a concern and has been for quite some time, however this is mainly the correct completion of the RT9909 Safe System of Work plan.'*
- *Q1 2019/2020 - 'The Track Worker Safety process identified in NR/L2/OHS/019 which covers the planning, checking and implementation of the Safe Work Pack remains a problem nationally.'*

282 The reports suggest that actions taken in response to the deep-dive review of 2017 had not yielded a significant change in the robustness of the Level 1 assurance process.

283 The chair of the NSHERG also attended the SHE committee, but not the board. The concerns over the Level 1 assurance regime identified in the 2017 deep dive review, and the ongoing problems identified in the subsequent quarterly assurance reports, do not feature in board minutes of the period and there is only a single passing reference to it in SHE committee meetings at that time.

Summary of the issues with Level 1 audits

284 The evidence obtained by RAIB suggests that the underlying weaknesses in the design of the Level 1 audit processes were as follows:

- since managers in Network Rail are often judged on the level of compliance with process, there is an obvious disincentive to assess their part of the organisation as non-compliant
- once a manager has judged their part of the organisation to be non-compliant, there is an implied responsibility to take action; this may mean challenging well established work processes, or risk unwanted confrontation with those in the team
- route level audits tend to be focused on areas considered to be high risk or where self-assurance checks have revealed particular problems. If there are no reports of non-compliances and no significant issues are raised in self-assurance returns, it is easy for particular delivery units or depots to avoid route level audits (as was the case for Port Talbot)
- local managers were not sufficiently trained to apply the process and so did not properly understand what was required of them (paragraph 115).

285 Although the outcomes of the Level 1 audits were not discussed in detail at senior management forums, witnesses have told RAIB that the weakness of Network Rail's management process had been recognised by the senior management team. Despite this, no fundamental changes to the mandated process were implemented prior to the accident at Margam.

Level 2 (Functional) audits of compliance with standard 019

286 Each financial year, a Level 2 Functional Audit programme is prepared by the corporate investigation and assurance manager. It takes into account the results of previous audits and the risk of failure of control measures, and includes compliance with technical standards and specifications. Network Rail also sponsors specific topic audits, where organisational and rail industry-wide concerns have been identified. Audits are undertaken by trained auditors from Network Rail's STE directorate in accordance with the requirements of Network Rail standard NR/L2/ASR/036 'Network Rail Assurance Framework', and are intended to provide an independent assessment of compliance at a functional level. Each finding of a level 2 audit is recorded in a national audit database, and categorised as one of the following types:

- non-compliance report (NCR)
- observation
- repeat of a previously recorded non-compliance (repeat NCR)
- good practice.

287 Between June 2016 and July 2019, 30 level 2 audits included the implementation of standard 019 in their scope. These led to the raising of 36 NCRs, 8 repeat NCRs, 8 observations and 3 examples of good practice (for details see Appendix F).

288 RAIB has analysed Network Rail's level 2 audit findings and reached the following conclusions:

a) In the three years before the Margam accident, Network Rail had in place processes for the independent audit of key activities, including those related to track worker safety. Audits were conducted at delivery units and depots throughout the country, although none in this period took place in Wales.

b) Although the auditors detected numerous examples of non-compliance with track worker safety arrangements, the NCRs provided little or no indication as to why the underlying management system failures were occurring.

c) Most NCRs contained multiple examples of non-compliance with correct process. Paperwork errors included: miscalculations of lookout distances (by up to 250 metres); unauthorised changes to systems of work lower down the safety hierarchy; no safe system of work identified; no granting authority for line blockages; and, in almost all cases, incomplete SWPs. The number of SWPs with errors/omissions varied from very few to an instance at Peterborough depot where 47 out of 72 checked (65%) had been incorrectly completed. Similar types and numbers of issues were found in audits that were conducted in Reading, Plymouth, Croydon and York.

d) Ten NCRs (encompassing 5 delivery units) recorded non-compliances that were considered by the auditor to be 'systemic' in nature, suggesting that delivery units did not have the management systems in place to deliver compliance.

e) The number of repeat NCRs (8 in total) suggests that some delivery units were incapable of embedding compliance with standard 019 and that senior managers in the routes had allowed the situation to persist.

f) The NCRs confirm evidence presented earlier in this report (paragraphs 265 to 271) that 'management self-assurance' (the process by which managers assess and report their own team's compliance with mandated processes) was an unreliable mechanism. The NCRs also indicated that significant numbers of managers were either unable to complete the required numbers of checks on completed track safety paperwork, or did so in a perfunctory manner.

289 Although the level 2 audits appear to have been reasonably thorough, they were heavily based on a review of paperwork, in particular completed SWPs. For this reason, the NCRs and observations provided limited information for managers to judge the extent of problems with the operation of the track worker safety arrangements. However, had this audit data been reviewed in conjunction with the findings of numerous previous accident and near miss investigations, the full extent of non-compliance with standard 019 could have been better appreciated.

RAIB's examination of Safe Work Packs

290 As part of its investigation, RAIB examined a sample of 288 SWPs from five different maintenance depots (other than Port Talbot). This analysis revealed that irregular completion of safety planning paperwork was not uncommon in the period leading to the accident at Margam, consistent with the results of Network Rail's own Level 2 audits. Non-compliances with the documented 019 process included:

- multiple systems of work in one pack (31% of SWPs examined)
- multiple tasks in the same SWP, or vaguely described work descriptions that probably involved more than one task (15%)
- SWPs that were verified on the same day as the work task (12%)
- use of parallel working (paragraph 62) (5%).

There were no instances found in these packs where the option of 'your PIC' had been selected within the SSOWP system rather than a named person (paragraph 107).

Management information provided to senior management forums

291 Within the maintenance organisation, the routine tracking of performance was carried out with the help of 'visualisation boards', which were reviewed at periodic 'visualisation meetings' (paragraph 175). However, measures of safety performance were heavily focused on lagging indicators, such as the number of lost time accidents.

292 A primary source of safety performance data for Network Rail's senior management team was the STE directorate's Safety, Health and Environment Performance (SHEP) report. The four-weekly report, which included data relating to a number of key performance indicators and supporting information, was intended to communicate safety performance against agreed targets, with commentary to explain over- and under-achievement, and to explain what was being done to address adverse trends. The report was primarily for leaders across the rail industry but was also shared with the regulator and RAIB, and placed in the public domain.

293 RAIB's review of meeting minutes reveals that the senior management team at Network Rail discussed workforce safety issues on a number of occasions. It was a topic for discussion at about half of the SHE committee meetings, but much less often at the board. These discussions included reviews of significant accidents, and concerns expressed about the numbers of narrowly avoided accidents involving track workers. However, the SHEP report and other corporate reports available to senior managers did not facilitate a full understanding of the extent of problems with track safety processes in many of the routes' delivery units.

294 Network Rail's measurement of workforce safety was primarily focused on lagging indicators of safety performance (such as measuring the number of accidents) and the achievement of targets. The relevant sections of the SHEP report contained very few leading indicators[20] of safety performance, and limited explanation of adverse trends. This meant that the report was providing copious data on Network Rail's safety performance in terms of outcome, but limited intelligence on how its safety management arrangements were working in practice (see Appendix H for details).

295 A review of the various papers presented to the SHE committee in the period up to July 2019, shows that the number of potentially high risk near miss incidents involving track workers was regularly reported. However, until the launch of the near miss reduction programme in late 2018 (see paragraph 307), the primary focus of the reporting was the number of lost time injuries, many of which are relatively minor in nature. This focus on lost time injuries appeared to have been driven by a desire to drive down the total harm to the work force (measured in 'fatalities and weighted injuries', known as FWI). Although important in itself, this may have led to a reduced focus on the actual risk of fatal accidents to track workers and why it remained significant.

Higher level reporting of findings from the assurance processes

296 The SHEP report sometimes contained a short summary of the findings of level 2 audits carried out on delivery units (DUs). An example with relevance to track worker safety is:

> *'019 process compliance was measured during the Reading DU audit and significant issues were identified relating to the completion and implementation of Safe Work packs by the Person in Charge (PIC) and Controllers of Site Safety (COSS). Areas of importance on 019 packs such as Positions of Safety, Methods of Warning, RT3181 Line Blockage and COSS Verification forms were found to be missing from some packs showing a general lack of attention to detail. Briefings on 019 version 9 had been given to operational staff, however there was no identifiable improvement in 019 pack quality observed during the audit (audit carried out in Period 7 2017/18).'*

297 Although such summaries did not present all the detailed findings of the audits, they indicated that there were some serious issues with track worker safety at delivery unit level, and that the hoped-for improvements with issue 9 of standard 019 were not being realised at working level.

298 RAIB could find no evidence that these level 2 audit reports were discussed at the board or SHE committee, or that the findings were subject to detailed analysis by the STE directorate. Nevertheless, the senior management reports and minutes reveal a prevalent expectation that all that was needed to deliver the desired safety improvements was for routes and delivery units to encourage and enforce compliance with the revised standard. RAIB found no evidence that these reports led to substantive discussions about the suitability of the revised standard 019, or the way that it had been implemented.

[20] A 'leading indicator' is a measurement which provides an insight into possible future safety performance: for example, the percentage of work carried out in accordance with safety procedures.

299 By the beginning of 2019, the PDSW programme was no longer mentioned in the SHEP reports and the SHE committee was no longer tracking the extent of compliance with PDSW or the standard 019 process.

300 At a management level, the papers to the SHE committee, including those from route directors, rarely challenged the corporate policy, but instead emphasised the progress towards implementation of the mandated changes. In general, papers to the SHE committee up to the middle of 2018 tended to emphasise good news and areas of new initiatives, with very little hint of the compliance problems that were being encountered in maintenance depots.

Network Rail's plans to address track worker near misses

301 Although Network Rail had identified the need to take further actions to address track worker safety, these had not led to substantive change prior to the accident at Margam.

302 The number and severity of near miss incidents involving track workers and trains did not reduce following roll-out of standard 019 issue 9. In October 2017, three months after the revised standard came into force and one month after the standard should have been adopted by all of the routes, a group of track workers was very nearly struck by an express train at Egmanton on the East Coast main line (RAIB report 11/2018).

303 By the summer of 2018, the number of serious near miss incidents appeared to be rising, and the chief executive was becoming concerned about the adequacy of safety planning and work processes following visits to a number of maintenance depots, where he had observed levels of dissatisfaction with recent changes to the planning processes and working practices. He was also told by people he met at maintenance depots that the processes had become too bureaucratic and cumbersome to use. These concerns caused him to commission a paper to examine the reasons underlying the near misses and to propose a way forward.

304 On 6 November 2018 a track worker was struck and killed by a train at Stoats Nest Junction in south London (RAIB report 07/2019). Later that morning the SHE committee met for one of its routine meetings.

305 The 'deep dive' paper on track worker near misses that had been requested by the chief executive was presented to the SHE committee (Network Rail paper 31/18). It confirmed that 2018 had seen a substantial increase in near miss incidents and concluded that a major event was likely to occur if the causes of near misses were not addressed. It also commented on one aspect of compliance with the standard, the requirement to produce the SWP at least 24 hours before the work takes place. This requirement is intended to ensure that the packs can be reviewed at least one shift beforehand. The paper noted that 8% of packs were not meeting this requirement, and that the pressure on the verification and authorisation process resulting from this late planning was leading to errors not being identified and a failure to include the PIC in the planning of the work.

306 The paper also pointed out that analysis of data from the updated Safe System of Work Planning System had identified an increase in the use of unassisted lookouts, and that around 37% of all the work done was completed using unassisted lookouts. The exception to this was in Scotland route, where the use of unassisted lookouts had almost been eliminated.

307 Paper 31/18 also proposed a range of actions designed to reduce the number of near misses involving track workers. These included:

- increased site surveillance
- analysis of the near miss events to identify further trends, taking into account the outputs of previous investigations
- trials of simplified Safe System of Work packs
- development of an integrated planning solution (including improved visibility of line blockage availability)
- steps to improve the competence of PICs and planners.

308 The minutes of the meeting on 6 November 2018 show that there was a discussion of the issues raised and concerns expressed about the delivery dates for the various actions that were proposed. The committee was assured by the STE directorate of the intention to deliver a single programme with clearly defined milestones and dates, which would be discussed at other senior management forums, including the executive leadership team meeting (this meeting was chaired by the chief executive and attended by his direct reports).

309 Another of these forums was the quality, health, safety and environment framework committee held on 19 December 2018. This meeting was attended by senior staff from STE and three route directors. The chief inspectors of ORR and RAIB were also invited to attend part of the meeting, with colleagues, to discuss the issue of track worker safety. During the meeting, both ORR and RAIB presented their concerns about the number and seriousness of near miss incidents involving track workers and trains. ORR reminded Network Rail that PDSW had emerged from investigations into the death of a track worker at Saxilby in 2012 (RAIB report 21/2013), and reiterated the factors that PDSW was meant to address, namely:

- reducing reliance on labour-only supply agency staff
- a drastic reduction in the number of protection staff
- clarifying site leadership roles
- improving non-technical skills
- introducing electronic permits to work
- involving end-users in the planning of work
- making the responsible manager's role explicit.

310 ORR's chief inspector expressed concern that the original intentions of PDSW were not being delivered and that the 'paused' introduction of the scheme had created confusion at route, delivery unit and depot levels. He stated that he was frustrated by the lack of progress and looking to see more detail on Network Rail's near miss reduction programme. He also stated that in the absence of a timebound programme that addressed the issues, ORR was minded to take enforcement action.

311 RAIB's chief inspector presented some key learning from its recent investigations. This included the need to address the selection, training and development of site leaders with the right qualities, and equipping them to make safe decisions, especially when required to work with lookouts or short-term line blockages.

312 At the close of the discussion on track worker safety, Network Rail's STE directorate presented nine new work streams which it was proposing to implement as part of the near miss programme. These were presented in rough order of priority as follows:

Short term

- *Further data analysis*
- *Safety briefing material for all front-line personnel*
- *Routes to develop near-miss management plans*

Medium term

- *Increased site surveillance*
- *Improved rulebook blockage form*
- *Improved competence of PICs and planners*
- *Removal of the use of unassisted lookouts, as far as possible*

Long term

- *Development of trackside safety technology*
- *Designing the railway to avoid the need for workers to go onto the track*

313 During the subsequent discussions, it became clear that the route directors at the meeting had still to fully understand and accept the STE proposals, and that another meeting was required for Network Rail to develop a more detailed programme with the necessary 'buy-in' across the organisation.

314 In February 2019, the SHE committee discussed the near miss action plan that had first been proposed in November 2018. The accompanying paper referred to a national survey on the application of standard 019 which had highlighted that 20% of PICs did not fully understand their role.

315 The paper included details of a 'near miss reduction programme' to be delivered jointly by Network Rail's STE directorate, the routes and the PDSW programme. This featured: additional staff briefings (based on a newly prepared Safety Hour pack); the roll out of a remotely operated Track Circuit Operating Device (ZKL); improved green zone planning tools; simplified SWPs for specified low risk activities; a target for reduced use of unassisted lookout protection; increased assurance activities by the routes; and increased visibility of senior leaders on site discussing track safety issues. It was also proposed to implement a new governance group, the 'Trackworker Safety Improvement Group'. This group was intended to oversee the effectiveness of the programme, and was proposed to include the representatives of the national safety programmes, ORR, RAIB, RSSB, trade unions and the Infrastructure Safety Liaison Group (ISLG).

316 The near miss reduction programme also included commitments by each route to undertake various activities to improve track worker safety. Wales route undertook to increase on-site assurance checks by November 2019, and to achieve a reduction in open line working and increase the use of track side technology to provide automatic protection/warnings by November 2020.

317 For its part, the PDSW programme was committed to developing a formal competence for the role of PIC, creating advanced schematics for use when planning work and developing an electronic SWP (accessible via a new app).

318 RAIB observes that the paper was largely focused on process, technological change and formal competences. Although behavioural change was identified as an area to be addressed, there was no detail on the steps that were planned. This suggests that Network Rail saw non-compliant behaviour as a cause of near misses, but was no longer committed to address the underlying behaviours, attitudes and systemic organisational factors.

319 In May 2019, the SHE committee again discussed Network Rail's proposals to address track worker near misses, and requested verification that the levels of staff engagement were adequate. At this meeting the action related to track worker near misses was minuted as closed. However, the committee asked to be kept informed by the programme board that had been established to implement the near miss reduction programme. This was the last SHE committee meeting before the accident at Margam.

Actions of the regulator

320 ORR has told RAIB of its concerns about track worker safety, going back to the period between 2013 and 2015. At this time, ORR was not seeing the expected improvements from Network Rail's initiatives which were intended to reduce the number of occasions track workers needed to be on or near the line while trains were running. In its 2013/14 annual health and safety report of performance on Britain's railway, ORR stated that '*progress to introduce new technologies that would help remove or reduce risk to infrastructure workers had been too slow and needed improvement'.* In its 2014/15 report it stated that '*the big challenge for the industry was culture and behavioural change for infrastructure workers to help implement planned safety improvement initiatives'*, and that Network Rail was expecting the introduction of its safe work initiatives would '*secure long-term cultural change'.*

321 In its 2015/16 report, the ORR stated that the pausing of the PDSW initiative was frustrating, and the industry's challenge was to implement and embed planned safety improvement initiatives and continue with cultural and behavioural change.

322 In June 2016, ORR's chief inspector wrote to the chief executive of Network Rail. This letter expressed ORR's view that:

> *'there has been better safety leadership and governance at a senior level within Network Rail, but this often fails to translate into implemented improvement on the front line',* and
>
> *'there is a great variation across the network in levels of management maturity, with assessments ranging from 'ad hoc' to 'excellent'. This threatens the sustainability of improving safety performance.'*

323 The letter also identified a concern about the effectiveness of Network Rail's Level 1 management assurance processes.

324 At a meeting in July 2016 ORR presented to Network Rail concerns it had regarding the effectiveness of Network Rail's assurance regime and its ability to support delivery of repeatable consistent compliance with safety critical elements of standards and processes, particularly at an operational level. Following this, Network Rail put in place measures intended to address those concerns by improving its assurance process at route level.

325 Between April 2018 and March 2019, ORR decided to address its concerns about track worker safety by undertaking a programme of inspections across every Network Rail route (this was done as part of its 2018/2019 inspection plan). The results of that work were available around the end of March 2019 and provided the evidence ORR felt it needed to support Improvement Notices (paragraph 331). Additionally, between October 2018 and October 2019, ORR carried out a project to examine Network Rail's assurance regime. That project was split into two phases: a high-level review of assurance process at route level; and a detailed review of Level 1 assurance activities at an operational level. Its findings were reported in late March 2020.

326 ORR's assurance regime report identified some key findings relevant to this investigation:

- Routes had not taken ownership of the targeting, delivery and review of Level 1 assurance, resulting in a lack of focus on critical and vulnerable tasks/systems. This led ORR to conclude that priority issues were overlooked or that they received only superficial checks.
- ORR identified that numeric targets set by NR company standards in respect of inspections had typically led to a focus on getting checks done rather than recognising the purpose of the checks and obtaining useful reports. It reported that '*outcomes from assurance activities were frequently largely trivial in nature, with the focus often being on missing documents and signatures rather than substantive health and safety risks'*.
- ORR reported concerns with the quality of the outcomes of Level 1 assurance activity, which was described as being very variable. It found the management self-assurance questionnaires often led to yes/no answers without further detail or explanation.
- The quality of the assurance activity was also noted to be heavily dependent on the capability of the individuals doing it. Although ORR found that actions raised were reviewed, tracked and completed locally, little of the detail on the corrective actions was recorded. ORR's reviews of Network Rail's assurance work found that Network Rail seemed to focus on the numbers of assurance activities completed rather than the intelligence gathered.

RAIB has identified many of the same issues during the course of this investigation (paragraph 263).

327 RAIB has asked ORR why enforcement action, such as the serving of improvement notices,[21] was not taken earlier. ORR explained that its 'health and safety regulatory strategy' recognises that the primary responsibility of managing risk sits with the duty holder. Legal enforcement of safety improvements is seen as a last resort, when other means of influencing the duty holder have proved ineffective. ORR had seen the original PDSW scheme as a positive development with the potential to address many of its own concerns, along with many of RAIB's track worker safety recommendations. ORR was also encouraged by the ongoing development of new technology to improve the protection available to track workers (the 'Safer Trackside Working' programme).

[21] An improvement notice is one of ORR's formal enforcement means by which it can request a duty holder to make a specific improvement within a set timescale.

328 When the PDSW scheme failed to deliver, ORR had been persuaded that Network Rail's proposed revision of standard 019 was an acceptable first step towards achieving all of the same aims. ORR has pointed out that improvement notices can only be issued if it can be shown that an existing situation is a breach of health and safety law. Since Network Rail was taking substantive actions aiming to reduce the risk to track workers, broadly in line with its legal duties to seek to reduce risk to as low as reasonably practicable, ORR felt that there was no immediate legal justification for issuing a notice and had little choice but to allow Network Rail to address the issue.

329 However, by the second half of 2018 ORR's concerns were increasing when it became apparent that the changes to standard 019 had not improved safety, and that other elements of the PDSW concept and the Safer Trackside Working programme, were not progressing as expected. In December 2018, the ORR's chief inspector informed Network Rail that he was minded to serve an improvement notice (paragraph 310).

330 In April 2019 ORR's chief inspector met with the trade union general secretaries to discuss track worker safety. During the meeting he issued a short discussion document which raised a number of high level concerns. Relevant extracts are shown below:

'In reality there is no clear overall leadership or direction. 019+ has failed to deliver improvements because the perceived focus is on improving the integrity of safe systems of work (where it has created some confusion and extra paperwork) rather than safer planning. We see some good initiatives (safe & effective working, technological warning & protection devices) but patchy adoption and progress. We also see missed opportunities to learn the real lessons from near-misses.

In our experience NR's initiatives tend to be overly-complex and insufficiently targeted on key issues. We therefore have limited confidence in NR's ability to deliver appreciable and sustained change.'

331 On 24 April 2019 ORR held a discussion with a senior safety manager at Network Rail regarding the emerging findings of its examination of Network Rail's assurance regime. On 15 May 2019 ORR had another meeting with Network Rail at which the serving of improvement notices was discussed.

332 To obtain input from the trade unions, ORR held a workshop on 20 June with the RMT and TSSA, and agreed a two-week period for them to make written contributions. That consultation period ended on 4 July, the day after the accident at Margam.

Observations

Maintenance work on insulated rail joints (IRJs)

333 The work attending to the IRJs should have been done with the lines closed to traffic.

334 At the time the accident occurred, the group working on IRJs had attended to a few of them, using a small electric grinder to trim the rail ends. This work should have been done with the line closed to traffic, and should not have been done without contacting the signaller, because it might have affected the operation of track circuits causing the aspect shown by signals to change (paragraph 73).

335 Witness evidence indicates that there were multiple and conflicting understandings among the depot staff about when trimming of IRJs should be done. However, no-one in the group contacted the signaller before doing the work.

Access to the track for maintenance

336 On many busy railway lines there are limited opportunities for maintenance staff to access the track when the line is closed to traffic.

337 On many parts of the mainline network the gaps between scheduled services are too short to enable planners to arrange blockages of the line. Similarly, requests to signallers to block the line to provide safe access for maintenance staff may be refused for fear of delaying the next train, or because of limits on the numbers of line blockages that signallers can grant in a single shift (due to concerns over signallers' workload). This lack of opportunity to block the line means that many track workers have become habituated to working on open lines with warnings provided by lookouts.

338 Some railway networks, such as the London Underground and the Docklands Light Railway, impose strict separation between people and trains. Neither has ever featured in an RAIB investigation in which track workers were at risk from moving trains. Other European railway systems, such as in France, timetable 'white periods' in the daytime off-peak hours during which no trains are scheduled to run, so enabling safe access for inspection and maintenance purposes. In other cases, reduced train services are operated using a single line, or diverted onto alternative routes, to enable access in daylight hours.

339 Some of these measures are difficult to adopt on the national network. Almost all lines operate seven days a week. While some have a short period with no traffic overnight, a few are operational for 24 hours on most days of the week. Train operators running passenger services are contracted by the Department for Transport (DfT) or transport authorities in the devolved administrations to operate services. For instance, DfT has specified one train per hour between Swansea and Paddington on the stretch of line that the accident occurred on. The remaining train paths are available for local services contracted by Transport for Wales or freight services (which are agreed between Network Rail, ORR, and the freight operators). Strict separation between people and trains has therefore been difficult for Network Rail to adopt, given its obligations to all parties.

340 If an operator wants to run additional trains on the UK's national rail network, it must seek the ORR's approval for a track access agreement with Network Rail (as required by sections 17 to 22A of the Railways Act 1993). When considering any such request, ORR is required to consider whether it is consistent with the efficient use of capacity and the impact on the railway network's overall performance. ORR's guidance on the criteria it uses when considering such a request to operate additional trains identifies Network Rail's ability to obtain access to the network for inspection and maintenance activity as a factor for consideration (among many others).

The operation of the train's warning horn

341 Although it did not affect the outcome of the accident, the driver did not use a series of short blasts of the train horn on approach to the track workers.

342 The Rule Book, GERT8000 module TW1 section 45.3, requires train drivers to give a series of short, urgent danger warnings to anyone who is on, or dangerously near the line, who does not:

- '*acknowledge your warning by raising one arm above the head, or*
- *appear to move clear out of the way of the train.*'

343 It also states that for an urgent warning, the high tone in the loud setting should be used. If the horn does not have manually available soft and loud settings, the setting which is provided must be used.

344 The horn on the train involved has both soft and loud settings. However, the soft setting is enabled automatically when the train is travelling at less than 100 mph (160 km/h) as it was in this case (paragraph 39), and the loud setting is enabled above this speed. The driver is not able to change the setting, and therefore in this case, could have only sounded a warning in the soft setting. When in either setting, the horn is capable of allowing the driver to sound a high or a low tone warning.

345 The data recorder shows that the driver sounded the horn three times on the approach to 9577B points (paragraph 40). Following the first low-high-low tone warning, a long duration low tone was given twice when the train was closer to the track workers. Although the Rule Book requirement is to use the high tone to give an urgent warning, tests conducted by RAIB showed that the low tone horn had a slightly greater sound pressure level than that of the high tone.

346 Further tests conducted by RAIB on the audibility of the horn when operating the impact wrench (paragraph 151) have shown that it would have made no difference to the outcome whether the high tone, or a series of short, urgent danger warnings were sounded. Similarly, the outcome would not have been different had the loud setting been available to the driver and it had been fully compliant with the current standard, and also with that which was current at the time of the train's introduction into service. This is because there would have been an insufficient margin in sound pressure level above that of the sound from the impact wrench for the horn to have been reliably discernible.[22]

[22] Referred to in RSSB/AEATR-PC&E-2004-002 Issue 3 'Audibility of Warning Horns', AEJ Hardy, 2004, and Catchpole, K. & McKeown, D. (2007). 'A framework for the design of ambulance sirens.' Ergonomics 50(8), 1287 – 1301.

347 It is also accepted that under such stressful circumstances, it is optimistic to expect drivers to always operate the horn control to sound short duration warnings, as required by the Rule Book. RAIB notes that some UK tram systems, although operating in a different environment to the main line network, have made changes to their vehicles' audible warnings to automatically sound when an emergency brake application is made by the driver. This offers the best opportunity of one or more audible warnings being discernible, while taking away the responsibility from the driver for sounding warnings during stressful situations.

The sound pressure level of the train's warning horn

348 The sound pressure levels of some modes of the horn of the train involved in the accident, when tested, were found to be marginally less than those specified by current standards.

349 RAIB undertook tests on the warning horn of unit 800021 following the accident, which indicated that it was not fully compliant with the requirements of current standards (set out in GM/RT2131 Issue 1, 2015 and EN15153-2:2013) in three of its four modes. The findings were:

- Speeds less than 100 mph (160 km/h):
  - Requirement: high and low tones: 86-94 dB(C)
  - Measured: high tone: 85-86 dB(C), low tone 88-89 dB(C)
- Speeds greater than 100 mph (160 km/h) (not relevant to this accident):
  - Requirement: high and low tones: 101-109 dB(C)
  - Measured: high tone: 96-98 dB(C), low tone 98-99 dB(C)

However, the lower sound pressure levels found during these measurements did not affect the outcome of the accident (paragraph 153).

350 RAIB passed this information to Hitachi Rail Europe Ltd (HRE). HRE explained that the Class 800 horn was approved against the requirements of the previous Railway Group Standard GM/RT2484 Issue 2, 2007, which was replaced by the current standard GM/RT2131 in 2015. Although there is no requirement to retrospectively apply the new standard to existing trains, the sound pressure levels specified in each of the two standards, although expressed differently due to the differences in measurement methods used for each, are technically equivalent.

351 HRE also advised RAIB that it undertook tests in July 2018 to check the compliance of its horn in the low speed mode (less than 100 mph (160 km/h)) to the current standard GM/RT2131. This was in response to a notification from Network Rail that staff working on or near the track were experiencing difficulty hearing the train's warning horn in the low speed mode. HRE reported to RAIB that the tests confirmed that the Class 800 horn complied with the low speed requirements of GM/RT2131.

352 HRE reports that it is planning to carry out a trial with the Class 800 horn so that the higher speed mode is activated at 20 mph (32 km/h) instead of 100 mph (160 km/h), to improve the horn's audibility at lower speeds.

353 RSSB is currently undertaking project T1205 'Relationship between train horn test measurements and perceived sound levels on the track'. This project was started in response to senior industry stakeholders and trade unions in 2019 receiving numerous comments from track workers raising concerns about the audibility of the horns on more modern trains. The scope of the project includes a literature review, static sound pressure level measurements, and dynamic measurement in operational environments. The forecast date for completion is April 2021.

Previous occurrences of a similar character

354 Between October 2005 and the accident at Margam in July 2019, RAIB had published 31 investigation reports, two class investigation reports and 14 safety bulletins/digests relating to track worker safety. Taken together, these evidence a range of the factors that have contributed to track worker accidents and near misses over this period. RAIB's own analysis of the findings of factors has enabled it to map the key themes that need to be addressed if track worker safety is to be improved, as shown in figure 17.

Figure 17: Key track worker safety themes identified by RAIB 2005-20

355 RAIB has investigated 21 accidents and incidents involving fatalities and near misses involving track workers working under the lookout warning safe system of work. A full list is given in Appendix E.

Summary of conclusions

Immediate cause

356 The group of three track workers were all unaware of the approaching train until it was too late to move clear (paragraph 75).

Causal factors

357 The causal factors were:

a. The group of three track workers were on a line that was open to traffic while carrying out a maintenance activity which they did not know to be unnecessary (paragraph 78). This causal factor arose due to a combination of the following:

   i. It was custom and practice within the depot to lubricate threaded fastenings, despite the absence of any written process requiring it to be done (paragraph 81, **Recommendation 1**).

   ii. The SWP was prepared with no involvement of the person who was expected to take the lead in safely undertaking the work, and was not compliant with procedures (paragraph 88, **Recommendation 2**).

   iii. The planned safe system of work was interpreted to mean that work could be carried out with lookout protection if blockages were not available, and it included only three of the four tasks required to be undertaken (paragraph 94, **Recommendations 2 and 3**).

   iv. Port Talbot depot's safety planning practices were not compliant with the mandated process. The extent of non-compliance was not detected by the local checks required by Network Rail standard NR/L2/OHS/019 issue 9, nor by the Network Rail route management team's assurance process (paragraph 106, **Recommendations 2 and 7**).

   v. The group of three track workers were accustomed to working on lines that were open to traffic (paragraph 117, **Recommendation 2**).

b. The three track workers were working without the presence of formally appointed touch and distant lookouts to warn them of approaching trains (paragraph 120). This causal factor arose due to a combination of the following:

   i. The COSS and the formally appointed site lookout were not with the group of three in the period leading up to the accident (paragraph 122, **Recommendation 4**).

   ii. There was a breakdown in site safety leadership which led to informal working practices (paragraph 128, **Recommendations 2 and 4**).

   iii. Local and route management were not actively monitoring, and had not identified and managed, non-compliant safety behaviours at Port Talbot depot (paragraph 136, **Recommendations 2 and 7**).

c. The three track workers did not see or hear any warning of the train's approach (paragraph 145). This causal factor arose due to a combination of the following:

   i. The group of three track workers were using a noisy machine, and so were unable to hear the audible warnings from the train and the other group (paragraph 148).

   ii. None of the track workers looked towards the approaching train because they had become distracted by the task they were undertaking (paragraph 154, **Recommendation 2**).

d. There was no challenge to the way the work was being done, probably because of the dynamics within the group (paragraph 156, **Recommendation 4**).

Underlying factors

358 Despite its stated intention to improve track worker safety, Network Rail did not create the conditions that were needed to achieve a significant and sustained improvement. This inability to create the right conditions arose from a combination of the following:

a. Over a period of many years, Network Rail had not adequately addressed the protection of track workers from moving trains (paragraph 178, **Recommendation 5**). In particular, the major changes required to fully implement issue 9 of Network Rail standard NR/L2/OHS/019 were not effectively implemented across Network Rail's maintenance organisation (paragraph 202, **Recommendation 9**).

b. Network Rail had focused on technological solutions and new planning processes, but had not adequately taken account of the variety of human and organisational factors that can affect working practices on site (paragraph 239, **Recommendation 4**).

c. Network Rail's safety management assurance system was not effective in identifying the full extent of procedural non-compliance and unsafe working practices, and did not trigger the management actions needed to address them (paragraph 263, **Recommendations 6, 7 and 8**).

d. Although Network Rail had identified the need to take further actions to address track worker safety, these did not lead to substantive change prior to the accident at Margam (paragraph 301).

Additional observations

359 Although not linked to the causes of the accident on 3 July 2019, RAIB observes that:

a. the work attending to the IRJs should have been done with the lines closed to traffic (paragraph 333, **Learning point 1**).

b. on many busy railway lines, there are limited opportunities for maintenance staff to access the track when the line is closed to traffic (paragraph 336, **Recommendation 10**).

c. although it did not affect the outcome of the accident, the driver did not use a series of short blasts of the train horn on approach to the track workers (paragraph 341, **Recommendation 11**).

d. the sound pressure levels of some modes of the horn of the train involved in the accident, when tested, were found to be marginally less than those specified by current standards (paragraph 348).

Previous RAIB recommendations relevant to this investigation

360 RAIB has carried out several investigations into accidents and incidents involving track workers (see Appendix D) and some of the recommendations it has previously made relate to issues found in this investigation. The following recommendations have particular relevance to this investigation.

Near miss between a train and a track worker at Peterborough, 20 July 2018, RAIB report 04/2019

361 Recommendation 5 read as follows:

Network Rail should:

a. reduce the number of cyclic maintenance tasks that are undertaken with lookout warning by establishing improved planning processes to substantially decrease the reliance on lookout warning by enabling more pre-planned activities to take place in planned possessions, or using line blockages protection systems; and

b. implement effective arrangements for the monitoring, audit and review of these revised planning processes.

ORR informed RAIB on 15 April 2020 that Network Rail was undertaking a number of initiatives in response to this recommendation which should help to reduce the number of routine maintenance tasks undertaken with lookout warning. The planned completion date for this work is 30 September 2021.

Near miss with trackworkers and trolleys at South Hampstead, London, 11 March 2018, RAIB report 20/2018

362 Recommendation 5 read as follows:

Network Rail should carry out a detailed audit of how standard NR/L2/OHS/019 Issue 9 has been implemented across the network, including in its supply chain. The purpose of this audit is to determine how the standard has been interpreted and understood, and areas of good and bad practice. Network Rail should take appropriate actions to address any issues found.

ORR informed RAIB on 18 December 2019 that Network Rail had not yet done a detailed audit across the network of the application of standard 019 and that so far a comprehensive audit had only been done in South Wales. Network Rail had committed, through its 'safety task force' to making improvements as a result of the ORR enforcement notices issued on 8 July 2019. ORR advised that its own inspections uncovered shortcomings in how standard 019 had been implemented and therefore it considered there was little benefit in Network Rail doing its own audit. ORR advised RAIB that it considered this recommendation had been implemented by alternative means. RAIB expressed concern about this in its annual report covering 2019.

Network Rail has stated that it has completed the work to address this recommendation 5, and its response is currently being considered by ORR.

363 Recommendation 6 read as follows:

Network Rail should undertake a review of how the change of NR/L2/OHS/019 from issue 8 to issue 9 was managed, in order to identify any areas for improvement in the management of change.

ORR informed RAIB on 19 October 2020 that Network Rail had implemented this recommendation, having carried out the review of how the change of NR/L2/OHS/019 from issue 8 to issue 9 was managed and having identified a number of corrective actions.

Near miss with a group of track workers at Egmanton level crossing, Nottinghamshire, 5 October 2017, RAIB report 11/2018

364 Recommendation 1 read as follows:

Network Rail should review its processes for monitoring and managing the safety leadership of its staff in COSS, SWL or PIC roles, in order to identify improvements such that only those who exhibit satisfactory safety attitude, leadership and compliance with safety rules and procedures, undertake these roles. The review should include consideration of the following:

a) risk based analysis of the non-technical skills required for different work scenarios (ie under protection and warning systems of work);

b) evaluation of the effectiveness of non-technical skills training since its initial introduction;

c) assessment tools (eg COSS pre-course workbook, 360 degree feedback) to assist managers with monitoring the ongoing suitability of staff for safety leadership roles; and

d) using re-certification training and assessments, independent of line managers, to reinforce good safety leadership and the importance of compliance with the rules.

Network Rail should then implement the identified improvements to relevant working practices and procedures.

ORR informed RAIB on 12 June 2020 that Network Rail had reviewed its processes for managing and monitoring safety leadership for track workers, taking into account each of the areas identified in the recommendation and that it had taken actions to implement the recommendation by means of improvements to its training programmes.

Class investigation into accidents and near misses involving trains and track workers outside possessions, RAIB report 07/2017

365 Recommendation 2 read as follows:

Network Rail should review the effectiveness of its existing arrangements for developing the leadership, people management and risk perception abilities of staff who lead work on the track, as well as the ability of other staff to effectively challenge unsafe decisions. This review should take account of any proposed revisions to the arrangements for the safety of people working on or near the line. A time-bound plan should be prepared for any improvements to the training in non-technical skills identified by the review.

ORR informed RAIB on 4 December 2018 that Network Rail had reviewed existing arrangements for non-technical skills provision for track workers, and put in place a time bound plan for delivering improvement. Network Rail has since informed RAIB that it has included non-technical skills elements within the revised COSS training and also within the PTS (personal track safety) training currently being piloted.

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

ORR's Improvement Notices

366 On 8 July 2019, ORR served two improvement notices (IN/TW/20190708/1 and 2) on Network Rail.[23] In its accompanying letter to Network Rail, ORR explained that despite Network Rail's commitment to reducing risk to track workers, improvements to safe systems of work and developments in warning and protection systems, ORR continued to be concerned at the number and frequency of deaths and injuries and near misses involving track workers.

367 ORR originally proposed a compliance date of 7 July 2021 for both improvement notices. Subsequently Network Rail argued, and obtained agreement with ORR, for a later compliance date of 31 July 2022, based on the following reasons:

- A critical constraint on compliance timescales was the alignment of the improvement work Network Rail had to do with the industry's timetable development cycle. Network Rail believed there was insufficient time to effectively plan the changes that were needed to comply with the notices into the December 2020 timetable, because of the lead time needed for system-wide changes.
- The company needed more time to implement an improved safe access planning tool, development of an improved signaller workload tool and to engage with relevant trade unions and adapt working practices.

368 ORR had concluded that Network Rail had reached the limits of protection that could be provided by improving safe systems of work, and it now needed to focus on working in possessions and line blockages. The objective of the improvement notices was to significantly reduce the amount of working with unassisted lookouts by:

- identifying track access opportunities and matching them with access requirements, so that as much work as possible is done in possessions and line blockages
- using technological means of protection warning when line blockages are not possible
- only allowing unassisted lookouts when necessary to prevent other risks.

369 ORR has told RAIB that it believes Network Rail has achieved all it can in terms of improving staff behaviours and safety leadership, and therefore the improvement notices do not contain any instruction to improve these aspects. ORR's view, based on its experience and understanding of legal requirements, is that action taken by Network Rail should be based on the hierarchy of risk control as set out in schedule 1 to the Management of Health and Safety at Work Regulations 1999. Staff behaviours and safety leadership are at the bottom of that hierarchy and to base enforcement on those matters would have been legally questionable, as well as running contrary to accepted good practice of controlling risks at source. ORR considers the duty is on the employer to protect the employee, and employees cannot be relied upon to get things right all the time.

[23] https://orr.gov.uk/rail/publications/enforcement-publications/improvement-notices/improvement-notices-2019

370 Although ORR took enforcement action following the accident at Margam, it has had long-standing concerns about Network Rail's approach to reducing the exposure of track workers to risk from moving trains (paragraphs 320 to 331).

Network Rail's actions

371 Network Rail has reported to RAIB that since the accident it is:

a) Planning to undertake a sampling exercise to assess the planning, verification, communication, application and adequacy of protection arrangements for work undertaken by its maintenance function. This includes reviewing whether safe system of work plans are in accordance with standard 019, robustness of safety communication, adequacy of protection arrangements, the effectiveness of the Level 1 Management Self Assurance (MSA) process and whether the responsible manager has the relevant competencies. The target timescale for completion was 31 October 2020.

b) Considering advisory recommendations following its own internal review of the effectiveness of the arrangements within standard 019 issue 9, which was completed in July 2020. This review found that:

- the initial 019 briefings were poor, and there was no provision for refresher training and no process in place to confirm whether staff had understood the briefings
- there is a lack of clarity on the roles of COSS and PIC
- there remain issues in respect of administration and resourcing
- non-compliances with the standard's requirements are due to pressure from performance and late notice changes to the plan
- there are issues around the production and verification of SWPs
- there is a lack of an effective assurance feedback to identify where staff cannot, will not, or do not know how to comply with the requirements of the standard.

c) Evaluating the extent of similar latent factors to those found in its investigation into this accident, in routes other than South Wales, with the intention of identifying systemic safety issues, and making recommendations to reduce related risks. The assessment will include the adequacy of the SWPs, the ability to report compliance to KPIs, readiness to deviate from the plan, the ability of staff to understand and accept a new standard, level of compliance with the Rule Book and whether standard 019 promotes taking line blockages, rather than encouraging more work under unassisted lookout warning. The forecast completion date is 31 December 2020.

d) Implementing a thorough review of the Level 1 Management Self Assurance arrangements to understand its effectiveness as a means of reporting, and whether NR staff have sufficient training, knowledge and experience to be able to report deficiencies under their control. The forecast completion date was 31 October 2020.

e) Seeking technical advice from RSSB on the appropriateness of hearing protection for track workers so that Network Rail can assess designs to provide the best opportunity to hear all current train warning horns. The forecast completion date is March 2022.

f) Conducting a review to determine whether a prescribed competency is required that includes technical and non-technical skills for the person in charge (PIC), given that persons acting in this role are part of the briefing arrangements and have responsibilities on site. This was in response to an issue raised by the Wales route following the accident. The forecast completion date is December 2021.

g) Reviewing the feature of 'parallel components' within the SSOWP system and either removing it or providing effective instruction to clarify when and how it should be used. The forecast completion date is December 2020.

h) Reviewing the role of the planner to make any necessary improvements to training, skills and involvement of this role in planning safe systems of work.

i) Considering whether a maximum distance between the COSS and all members of their workgroup should be specified.

j) Reviewing the effectiveness of the system (known as Annual Capability Conversations, or ACC) by which it assesses its staff's competency and safe behaviours. The findings are to be compared against those results from the formal re-certification training which is the usual means by which non-NR personnel maintain their competencies. There is no forecast completion date for this work currently.

k) Reviewing the Wales Route's safety culture. This is to include consideration of the impact of workload and KPIs on team dynamics and the authority of safety leaders, and whether teams understand assurance activities and the purpose of supervision. The forecast completion date was 30 September 2020.

l) Setting up a national 'Safety Task Force' during August 2020 with a 36-month programme aimed at significantly reducing the risk of track staff being struck by a train whilst working. It plans to develop specific improvement areas in response to the ORR's improvement notices served in August 2019 and has three key targets:

   - 0% unassisted lookout working, so that all work is carried out in planned line blockages or possessions (when no trains are running) or with technology to assist lookouts when trains are running.
   - 100% additional protection (technology to protect and warn track workers when working in a line block, in the event of human error resulting in a train being sent into the blocked section).
   - 100% compliance to standard 019.

m) Applying the 'Safe and Effective Work' methodology (paragraph 119) within all routes, increasing the use of additional protection in line blockages, and assessing signaller workload to identify less busy times to create opportunities for more line blockages.

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

372 Network Rail has reported to RAIB that since 2014 it has continued its programme of modernising the way in which it inspects and maintains its assets in order to reduce the time that front-line staff are exposed to the risks from moving trains. It has reported the following progress to date:

- its fleet of monitoring trains currently eliminates manual inspections on 9,500 miles of its 15,000 miles of plain line railway and a further 4,800 miles has been identified for automated inspections
- 68% of the 17,500 miles of its railway which used to be manually inspected for rail defects, is now inspected by its monitoring trains
- 53% of its 12,500 electrical overhead line assets identified as eligible for the application of Risk Based Maintenance, have had this maintenance regime implemented
- 67% of its 245,000 signalling assets identified as eligible for the application of Risk Based Maintenance, have had this maintenance regime implemented
- it has continued to develop risk based maintenance and new techniques for both its plain line and switch and crossing (S&C) assets
- it has installed remote monitoring on 25,000 track circuits, 14,500 sets of points, 3,250 points heating power supplies and 1,500 power supply units
- it has continued to develop its aerial surveying capability.

Recommendations and learning points

Recommendations

373 The following recommendations are made:[24]

1 *The intent of this recommendation is that staff should only carry out maintenance activities that are strictly necessary*.

Network Rail should undertake a thorough review of the types of routine maintenance activities undertaken on or near the track by its depots to check that all such activities are necessary for the reliable and safe operation of the railway and identify any that are not.

The findings of this review should then be used to inform the development of clear instructions to maintenance staff to prevent any unnecessary activities, and to develop a process for updating staff on new maintenance practices as new assets are introduced in the future (paragraph 357a.i).

2 *The intent of this recommendation is to improve the level of monitoring and supervision of planners and track workers so that safe planning and site behaviours are cultivated and maintained.*

Network Rail should carry out a detailed investigation at delivery units and depots of how management is monitoring and supervising section planners and staff working on or near the track, to check that safe work plans are being generated, and implemented safely on the ground. It should then use the findings to develop and implement improved procedures on monitoring and supervision, and assess and address any related staff resource requirements (paragraph 357a.ii-v, 357b.ii, 357b.iii, 357c.ii).

[24] 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 to prevent future confusion and misuse of the 'parallel working' facility in the SSOWP system.*

Network Rail should define the term 'parallel working' in the SSOWP system and undertake a thorough review of how it is being used in the planning and implementation of SWPs on its network and decide whether to retain the facility in the SSOWP system. If the function is to be retained, Network Rail should train relevant staff on how to use the facility correctly and consider measures to prevent its misuse (paragraph 357a.iii).

4 *The intent of this recommendation is that Network Rail has a renewed and sustained focus on improving the non-technical skills of all its track maintenance teams, including their supervisors and managers, in those areas most closely associated with site safety. When addressing this recommendation, Network Rail should take into account actions taken in response to Recommendation 1 of RAIB's Egmanton investigation (RAIB report 11/2018) and Recommendation 2 of RAIB's track worker class investigation (RAIB report 07/2017).*

Network Rail should review its processes and programme for developing the social, cognitive and personal 'non-technical skills' of those working on or near the track, with a particular focus on those areas that are linked to effective communication, cooperation, leadership and positive team dynamics. By means of this review Network Rail should ensure that it has in place all that is necessary for the timely provision of an ongoing and sustained programme of suitable, relevant and targeted training and mentoring that will influence the mindset and attitudes of everybody involved with planning and delivery of work activities, including managers, supervisors, site leaders and team members. Network Rail should also issue practical guidance on:

a) ways of assessing non-technical skills and development potential when selecting future site leaders

b) methods for evaluating and developing the non-technical skills of those already undertaking leadership roles

c) how to intervene when concerned about the performance of a safety leader.

(paragraphs 357b.i, 357b.ii, 357d, 358b).

5 *The intent of this recommendation is that Network Rail's future work on improving track worker safety is overseen and guided by an independent expert group at a sufficiently senior level, that provides continuity of vision over many years, peer review and an effective challenge function. When addressing this recommendation Network Rail might choose to expand the terms of reference for its newly formed 'Safety Task Force Programme Board' to enable it to perform all of the functions envisaged by RAIB*.

Network Rail, in consultation with its main contractors and Trade Union representatives, should establish a permanent expert group, which comprises representatives from across the rail industry with sufficient seniority and recent front-line experience, together with external experts with relevant qualifications or background (including a behavioural scientist), to provide oversight of all track worker safety improvement programmes. Its scope, which should be formally documented, should include:

a) providing independent advice, guidance and challenge to the Network Rail board and the SHE committee on matters related to the delivery of safety improvements (including those identified by the ORR improvement notices)

b) checking that parallel and interdependent work streams are being properly co-ordinated

c) monitoring the development and implementation of new or revised procedures and management processes

d) ensuring that the need to address the impact on front-line track workers is not overlooked when implementing new technologies and work management processes

e) checking that recommendations and lessons from accident investigations are being learned and fed into improvement processes

f) providing a source of ongoing corporate memory and continuity of vision (particularly during times of organisational and personnel change).

(paragraph 358a).

6 *The intent of this recommendation is that Network Rail has a proactive safety leadership and a culture which promotes an open and objective approach to the reporting and improvement of safety performance.*

Network Rail should investigate different ways of promoting proactive safety leadership at every level of the organisation, to develop a culture that values and actively promotes the open and honest reporting of safety performance, the early identification of any weaknesses in management processes and open debate. The output of the investigation should be an active cultural change programme which is the subject of consultation with employees and stakeholders, and then widely disseminated (paragraph 358c).

7 *The intent of this recommendation is to improve the effectiveness of Network Rail's management assurance processes related to the safety of staff working on or near the track, so that it provides a more realistic assessment of the extent to which track worker safety arrangements are embedded, and being correctly applied, in practice.*

Network Rail, in consultation with its main contractors and staff representatives, should commission a project to improve the way its management assurance system operates in areas directly affecting the safety of track workers. The review should include each of the following:

a) the identification of improved systems for collecting reliable data on how mandated processes are being applied in maintenance depots, and within track worker teams (to supplement or replace the existing Level 1 management self-assurance)

b) improved mechanisms for collating, analysing, tracking, and presenting the findings of audits, investigations and other management assurance activities.

The project should also consider ways of expanding the scope of management assurance activities to provide better intelligence on the underlying reasons for the non-compliances that are identified during audits, including consideration of the views of auditors and other relevant staff. The improved management assurance arrangements that are identified should be endorsed by the Network Rail board before implementation in accordance with a structured and validated programme for change (paragraphs 357a.iv, 357b.iii, 358c).

This recommendation may apply to other Network Rail management assurance processes.

8 *The intent of this recommendation is to improve the quality of information being provided to senior management, relating to the safety performance of staff working on or near the track, to enable better monitoring and decision making.*

Network Rail should extend the review undertaken in response to recommendation 7 to include the following:

a) a more structured process for senior management review of safety assurance data

b) mechanisms to ensure that the senior management team is provided with suitably independent and specialist advice when reviewing the outputs of the safety management assurance system, particularly when considering significant change

c) identification of additional leading indicators of safety performance designed to better inform senior managers on the underlying health of the safety management systems.

(paragraph 358c).

This recommendation may apply to other Network Rail management assurance processes.

9 *The intent of this recommendation is to improve the robustness of Network Rail's processes for assessing the impact of changes to working practices which affect safety of track staff.*

Network Rail should review and strengthen its process for the safety assessment of significant changes to working practices that have the potential to affect the safety of railway staff. This review should identify the extent to which the existing process promotes an adequate consideration of:

a) the conditions that apply before the proposed change (such as the ways of working and how these compare to mandated processes);

b) the impact on resource and staff workload

c) any organisational changes, working practices or work force behaviours that are needed for the changes to be fully effective

d) safety risk and identification of control measures to mitigate or eliminate that risk.

(paragraph 358a)

This recommendation may be best addressed in conjunction with Network Rail's response to recommendation 6 of RAIB's report into the near miss with track workers and trolleys at South Hampstead (RAIB report 20/2018).

374 The following recommendations relate to RAIB observations:

10 *The intent of this recommendation is to explore ways of reducing the risk to staff who work on or near the track by creating more opportunity for safe access to the track when trains are not running.*

Network Rail, in consultation with the Department for Transport, relevant transport authorities, ORR and other railway stakeholders, should investigate ways of optimising the balance between the need to operate train services and the need to enable safe access to the track for routine maintenance tasks. Options for consideration should include:

a) the provision of gaps in the train service, during daylight off-peak hours, to enable timely and safe access for maintenance staff

b) greater use of alternative routes or bidirectional lines to achieve the above

c) increased availability and utilisation of weekend and night time possessions for cyclical maintenance tasks.

Any reasonably practicable measures that are identified should then be implemented in accordance with a timebound plan (paragraph 359b).

11 *The intent of this recommendation is to better understand the practicability of providing an automatic means of improving the discernibility of audible warnings provided by trains when the driver applies emergency braking.*

The Rail Delivery Group (RDG), in conjunction with Network Rail and RSSB, should commission research into reasonably practicable ways of enabling a train's horn to automatically sound when a driver initiated emergency brake application is made on a moving train (as is already done on some UK tram systems). The objective of any such change would be to offer the best opportunity of the audible warning to be discernible, while taking the responsibility from the driver for sounding the horn during situations that are stressful (paragraph 359c).

Learning points

375 RAIB has identified the following two important learning points:[25]

1 Maintenance staff, when attending to IRJs to maintain and restore their insulating properties, are reminded of the importance of working in accordance with the applicable rules on lines not open to traffic (paragraph 333).

2 Duty Holders are reminded that, following changes to modernise assets, it is important that staff are made aware of up-to-date requirements and best practice for maintaining those assets (paragraph 87).

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

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed-circuit television
COSS	Controller of Site Safety
GSM-R	Global System for Mobile Communications – Railways
GWR	Great Western Railway (the trading name of First Greater Western Ltd)
HSMS	Health and Safety Management System
IRJ	Insulated rail joint
IWA	Individual Working Alone
LOWS	Lookout Operated Warning System
NTS	Non-technical skills
ORR	Office of Rail and Road
RAIB	Rail Accident Investigation Branch
RSSB	Rail Safety and Standards Board
PDSW	Planning and Delivery of Safe Work
PIC	Person in charge
RMT	The National Union of Rail, Maritime and Transport Workers
S&C	Switches and crossings
SHE	Network Rail safety, health and environment committee
SHEP	Network Rail safety, health and environment performance report
STE	Network Rail safety, technical and engineering directorate
SWL	Safe Work Leader
SWP	Safe work pack also known as a Safe System of Work (SSoW) pack
SSOWP system	Safe System of Work planning system
TSSA	The Transport Salaried Staffs' Association
TOWS	Train Operated Warning System

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis. http://iainellis.com/.

Ballast	Crushed angular stone used under and around the sleepers, timbers or bearers to support them.
Bi-mode multiple unit	A train which obtains its motive power from either an on-board diesel engine or an external electrical supply.
Controller of Site Safety	A person certified as competent and appointed to provide a safe system of work to protect a group of people from the risks of moving trains on Network Rail infrastructure.*
Crossover	An arrangement of switches and crossings (S&C) that permits movements between parallel tracks.
Distant lookout	A lookout positioned on the approach to a worksite to give additional warning time to the working party. The distant lookout signals to the site lookout by waving a blue and white chequered flag when they see a train approaching.
Down (line)	In a direction towards Port Talbot (away from London).
Emergency brake	A brake which applies full application of all available braking effort more rapidly than that used in normal service.
Fenced	A system of protection from moving trains by using a fence or other physical barrier.
GSM-R	Global System for Mobile Communications – Railways. A radio system for data and speech transmission to and from trains
Impact wrench	A powered hand held rotary device used to drive and remove threaded items, which uses a hammer action to apply a pre-set tightening torque.
Insulated rail joint	A joint which electrically insulates two abutting running rails.
Lookout	A competent person whose duties are to watch for and to give an appropriate warning of approaching trains by means of whistle, horn or lookout operated warning system.*
Points	An assembly of two movable rails called the switch rails, and two fixed rails called the stock rails. It is used to divert vehicles from one track to another and is also known as a set of switches.
Possession	A section of line (delimited by detonator protection) that is blocked for the normal running of trains to allow engineering work to be carried out.

Railway emergency call	The emergency call function of the GSM-R system, which is transmitted to all trains in a signalling area.*
Relief line	A name for an additional running line.
Safeguarded	A system for protecting people from moving trains by the prevention of train movements on all lines.
Sentinel	The competency control system operated by Network Rail, and also adopted by Transport for London. The system records details of medical fitness and railway related competencies.
Separated	A system of protection from moving trains using a minimum allowable distance of persons from lines which are open to train movements.
Site lookout	Where one or more distant lookouts are provided, the person actually giving the warning to the working group is the site lookout.*
Toes (of switches)	The moveable ends of the switch rails.
Touch lookout	A lookout positioned close to the working group who warns them of an approaching train by touch. Used in situations where the work is noisy.
Track circuit	An electrical or electronic device used to detect the absence of a train on a defined section of track using the running rails in an electric circuit.*
Up (line)	In a direction towards Cardiff (towards London).

Appendix C - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from the train's on-train data recorder (OTDR)
- closed-circuit television (CCTV) recordings taken from the train involved in the accident and other trains passing the area prior to the accident
- site photographs and measurements
- weather reports and observations at the site
- an expert report on acoustic measurements recorded as part of this investigation commissioned by RAIB
- an expert human factors report by Loughborough University Transport Safety Research Centre commissioned by RAIB
- Network Rail documents and records of its track worker initiatives and programmes
- a thematic analysis of RAIB investigation reports, bulletins and safety digests covering the period October 2005 to December 2019
- a review of previous RAIB investigations that had relevance to this accident.

Appendix D - List of RAIB track worker reports

The following published RAIB investigations were included in the thematic analysis:

16/2006 – Trafford Park
26/2007 – Manor Park
43/2007 – Tinsley Green
04/2008 – Ruscombe
19/2008 – Leatherhead
19/2009 – Grosvenor Bridge
21/2008 – Reading
29/2009 – Kennington
15/2009 – Acton West
23/2009 – Stevenage
30/2009 – Dalston
15/2010 – Whitehall West
06/2011 – Cheshunt Junction
03/2012 – Clapham/Earlsfield
16/2012 – Stoats Nest (1)
07/2013 – Roydon
20/2013 – Bulwell
21/2013 – Saxilby
25/2014 – Bridgeway
01/2015 – Newark
06/2015 – Redhill
08/2015 – Hest Bank
20/2015 – Heathrow Tunnel
05/2017 – Shawford
16/2017 – Camden
11/2018 – Egmanton
13/2018 – Pelaw*
20/2018 – South Hampstead
04/2019 – Peterborough
07/2019 – Stoats Nest (2)
12/2019 – Gatwick Airport

* Note: the incident at Pelaw took place on the Tyne and Wear Metro network, as opposed to all the others which occurred on Network Rail infrastructure. It is included for completeness, and the people involved are considered to have similar responsibilities to their equivalent role on Network Rail infrastructure.

The following bulletins (B) and safety digests (D) were included:

B01/2012 – North Kent East Junction
B05/2013 – West Drayton
B04/2013 – Poole
D04/2016 – Maesyfelin Bridge
D06/2017 – Surbiton
D09/2017 – Ascot
D12/2017 – Gt Chesterford
D19/2017 – Wimbledon (Raynes Park)
D16/2017 – Clapham (N. Yorks)
D18/2017 – Dutton Viaduct
D02/2018 – Clapham Junction
D11/2018 – Dundee
D05/2019 – Sundon
D06/2019 – Ynys Hir

The following class investigations were also used as reference:

14/2015 – Irregularities with protection arrangements during infrastructure engineering work

07/2017 – Accidents and near misses involving trains and track workers outside possessions

At the time of writing RAIB is conducting an investigation into a trackworker fatality which occurred on 8 April 2020 on the West Coast main line, near to the village of Roade, Northamptonshire.

Appendix E - Previous accidents and incidents involving the lookout warning safe system of work

Date	Location	Description	RAIB publication
Planned safe system of work: Lookout warning			
17/03/2007	Tinsley Green Junction	A near miss between a train and a track worker due to the poor implementation of the system of work. The COSS was inexperienced and did not take into account all of the possible ways that trains could be routed towards the site of work.	Report 43/2007
29/04/2007	Ruscombe Junction	A track worker was struck and fatally injured by a train because he continued to work and did not move to a position of safety. The track worker was given a touch and verbal warning by the site lookout so was aware of the approaching train but possibly assumed that it was not routed towards him.	Report 04/2008
29/08/2007	Leatherhead	A track worker was struck and seriously injured by a train due to a poorly implemented system of work. Factors found included inadequate warning times, poor placement of lookouts and staff not always stopping work when warned of an approaching train.	Report 19/2008
13/11/2007	Grosvenor Bridge	The COSS was struck and seriously injured by a train when he moved away from the line covered by the system of work and went onto an adjacent line. The COSS did not tell the lookout when he moved to the adjacent line. Other factors included an incomplete COSS briefing and staff not challenging the behaviour of the COSS.	Report 19/2009
23/05/2008	Kennington Junction	A track worker was struck and seriously injured by a train when he failed to move to a position of safety after being given a warning by the site lookout. Deficiencies found with the system of work included the COSS not reviewing it when it became dark and staff not moving to a position of safety when trains approached on an adjacent line.	Report 29/2009
30/03/2009	Dalston Junction	A distant lookout was struck by a train, but was not seriously injured, when he walked into the path of the train at a junction. As he walked with his back to the approaching train, he did not react to the warnings it sounded. Factors found included staff who were unfamiliar with the area, deficiencies in how the group were working with each other, and the condition of the area alongside the track causing the lookout to walk on the line.	Report 30/2009

Date	Location	Description	RAIB publication
02/12/2009	Whitehall West Junction	A distant lookout was struck and fatally injured by a train. The lookout had moved a short distance from his allocated position of safety and was standing too close to the adjacent line. He was standing with his back to the approaching train and was possibly unaware of it.	Report 15/2010
30/03/2010	Cheshunt Junction	A track worker was struck and seriously injured by a train when he failed to move to a position of safety after being given a warning by the site lookout. The track worker was not expecting the train to be routed towards where he was working. Factors found included an unsatisfactory system of work being implemented and staff not always moving to a position of safety when warned by the lookout.	Report 06/2011
02/02/2012	North Kent East Junction	A train struck equipment being carried by a lookout causing him minor injuries. A group of track workers had become distracted when the work was complete, so while they were standing in the cess, the safe system of work was not maintained. The lookout had ceased to look out for approaching trains and, although clear of the adjacent line, no one in the group was standing in a position of safety when the train approached.	Bulletin B01/2012
16/07/2012	Roydon	A near miss occurred between a train and two track workers due to the lookout being unable to give a sufficiently early warning for the approaching train. The implemented system of work was found to be inappropriate given the task and the location of the site of work.	Report 07/2013
22/03/2013	West Drayton	An intermediate lookout was struck and seriously injured by a train. The lookout was distracted and was not standing in a position of safety. He was standing with his back to the approaching train, too close to the adjacent line.	Bulletin B05/2013
12/07/2013	Poole	A track worker was struck a glancing blow by a train and suffered minor injuries. A system of work had been implemented when the group were walking to the site of work at the start of the work. The track worker was struck while walking alone to join the group at the site of work some time later. There was no lookout in place to warn him of the train approaching behind him when he stepped out of the cess to avoid an obstruction.	Bulletin B04/2013

Date	Location	Description	RAIB publication
22/01/2014	Newark North Gate	A track worker was struck and fatally injured by a train after walking out of his position of safety. He most probably moved to look for trains approaching from the opposite direction when he was struck by a train that approached from behind him. Factors found included a breakdown in safety discipline and vigilance at the site of work.	Report 01/2015
24/06/2014	Redhill	A track worker was struck and seriously injured by a train as he was walking alongside the line with his back to the approaching train. The track worker's position of safety was not adequate as there was no level place to stand clear of the adjacent line. Deficiencies were found in the planning, choice and implementation of the system of work. The investigation observed that the distant lookouts were using unofficial flag signals to indicate to the site lookout and COSS when their view of approaching trains was blocked by trains going away from the site of work. The COSS used these flag signals to decide when it was safe for the group to resume working on the track.	Report 06/2015
08/04/2016	Maesyfelin Bridge	A near miss occurred between a train and a group of track workers due to the use of an unauthorised system of work. The lookout was told to warn the group of approaching trains using hand-held radios. The planned safe system of work was not implemented by the COSS and no-one in the group challenged this.	Safety Digest D04/2016
24/06/2016	Shawford	A near miss occurred between a train and a track worker who crossed three open lines and then became distracted, while standing on the middle line, when a train approached. The track worker went onto the open lines without implementing the planned safe system of work. Factors found included a breakdown in safety discipline and vigilance at the site of work.	Report 05/2017
02/11/2016	Surbiton	A near miss occurred when a distant lookout was caught between two trains travelling in the same direction on adjacent lines. The distant lookout was unfamiliar with the area so he had walked too far and into an unsafe area. The distant lookout was briefed by the COSS when the system of work was set up but this did not adequately explain to him where his position of safety was.	Safety Digest D06/2017

Date	Location	Description	RAIB publication
21/04/2017	Between Audley End and Great Chesterford	A near miss occurred between a train and a group of track workers due to the system of work not being implemented in accordance with the rules. As the group moved along the track, the achieved warning times became inadequate. The COSS then varied the planned system of work by getting the distant lookout to give warnings to the site lookout by using a horn instead of waving a flag. The site lookout was then told to listen out for the horn while looking out for trains coming the other way. The site lookout did not hear the distant lookout's horn warning when the train approached from behind him.	Safety Digest D12/2017
22/08/2017	Between Wimbledon and Raynes Park	A distant lookout was struck a glancing blow by a train and suffered minor injuries. The system of work required the distant lookout to walk ahead of the group. While walking, with his back to the approaching train, the distant lookout moved from his position of safety so that he was too close to the adjacent line when he was struck.	Safety Digest D19/2017
20/07/2018	Peterborough	A track worker acting as a site lookout for another track worker who was carrying out an inspection, narrowly avoided being struck by a train near Peterborough station. The train involved had just passed through the station and was travelling at 102 mph (164 km/h) when its driver saw the lookout standing on the same line ahead. The driver immediately sounded the train's warning horn and applied the brakes. The lookout responded to the train's horn and moved out of its path about 2.5 seconds before the train reached him.	Report 04/2019
02/04/2019	Ynys Hir	A track worker narrowly avoided being struck by a train at Ynys Hir, near Dovey Junction station. He was one of a group of eight that had just completed fishplate lubricating work on a single line that runs towards Aberystwyth. The group became separated as they were walking back to an access point. The line was open to traffic and a lookout who had been appointed to provide the group with a warning of approaching trains while working and walking did not see the train. The track worker did not hear the horn from the approaching train until it was virtually upon him and he then immediately moved clear.	Report 06/2019

Appendix F - Summary of Network Rail level 2 audits relevant to compliance with standards 019 (NR/L2/OHS/019) and 0221 (NR/L3/MTC/MG0221)

Date	Delivery unit	No. of locations	Audit focus	Issues found	Comment
28/06/16	Peterborough	6	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	30 out of 52 documents were non-compliant
				Deficiencies in paperwork checked by manager	17 out of 20 documents were non-compliant
28/06/16	Peterborough	6	NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies	
				Failure to recognise deficiencies that existed	
30/06/16	Derby	4	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
				Missing paperwork	
07/11/16	London Euston	2	NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies	
				Manager checks not taking place	
07/11/16	London Euston	6	NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order Systemic failing	Repeat NCRs
06/03/17	Swindon	7	NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies	
				Failure to recognise some deficiencies that existed	
06/03/17	Swindon	7	NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order	'Most' checked documents were non-compliant
09/03/17	Perth	1	NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies	
14/04/17	Edinburgh	3	NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order	
				Concern over control of docs used to base paperwork on	
18/05/17	Sheffield	2	NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order	7 out of 23 documents were non-compliant Repeat NCRs
18/05/17	Sheffield	2	NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies	

Date	Delivery unit	No. of locations	Audit focus	Issues found	Comment
23/05/17	Ipswich	5	NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies Failure to recognise some deficiencies that existed Systemic failing	All checked documents were non-compliant
23/05/17	Ipswich	5	NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order Systemic failing	
30/05/17	Brighton		NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies Failure to record some deficiencies that existed Systemic failing	All checked documents were non-compliant
30/05/17	Brighton		NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order Systemic failing	
01/06/17	London Bridge		NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies Failure to record some deficiencies that existed Systemic failing	Repeat NCR from 2014 Repeat NCRs
01/06/17	London Bridge		NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order Systemic failing	Repeat NCR from 2014 Repeat NCRs
15/06/17	Clapham	6	NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies Failure to record some deficiencies that existed	
15/06/17	Clapham	6	NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order	Repeat NCRs
04/07/17	Brighton		NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order Deficiencies in paperwork checked by manager	Only five weeks after last audit
15/09/17	Stafford		NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
17/10/17	Croydon	3	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order Manager checks not taking place Systemic failing	Repeat NCR

Date	Delivery unit	No. of locations	Audit focus	Issues found	Comment
17/10/17	Croydon	4	NR/L3/MTC/MG0221 (L1 self-assurance)	Absence of corrective actions for deficiencies Failure to record some deficiencies that existed Systemic failing	Repeat NCR
08/11/17	Reading	3	NR/L3/MTC/MG0221 (L1 self-assurance)	Some checks not taking place Absence of corrective actions for deficiencies Failure to record some deficiencies that existed	
08/11/17	Reading	6	NR/L2/OHS/019 SSOW (recording of SSOW)	Paperwork not in order	15 out of 59 documents were non-compliant
20/11/17	York	1	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
27/11/17	Plymouth	1	NR/L3/MTC/MG0221 (L1 self-assurance)	Not enough checks taking place	
27/11/17	Plymouth	4	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
24/01/18	Birmingham		NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	8 out of 40 documents were non-compliant
21/02/18	Orpington		NR/L3/MTC/MG0221 (L1 self-assurance)	Actions not being closed Some checks not taking place	
21/02/18	Orpington		NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
13/04/18	Glasgow		NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
19/04/18	Shrewsbury		NR/L3/MTC/MG0221 (L1 self-assurance)	Actions not being closed	
19/04/18	Shrewsbury	2	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
27/04/18	Eastleigh	3	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	Repeat NCRs
24/05/18	Bristol		NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
24/05/18	Bristol	3	NR/L3/MTC/MG0221 (L1 self-assurance)	Not recording identified issues	
15/10/18	London Euston	1	NR/L3/MTC/MG0221 (L1 self-assurance)	Lack of evidence that checks are taking place	

Date	Delivery unit	No. of locations	Audit focus	Issues found	Comment
15/10/18	London Euston	2	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order Manager checks not taking place Systemic failing	
12/11/18	Tottenham		NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	5 out of 14 documents were non-compliant
21/11/18	Leeds	2	NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
19/12/18	Romford		NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
19/04/19	Derby		NR/L2/OHS/019 SSOW (planning)	Paperwork not in order	
20/05/19	Perth		NR/L2/OHS/019 SSOW (planning)	Electronic 'paperwork' not in order	

Appendix G - Safety validation of change, and how this was applied to the proposed revisions of Network Rail's standard 019

G1 ORR's guidance on application of the Common Safety Method for Risk Assessment (CSM-RA) describes the following assessment criteria:

- additionality: assessment of the significance of the change taking into account all recent safety-related modifications to the system under assessment and which were not judged as significant
- novelty used in implementing the change: this concerns both what is innovative in the railway sector, and what is new just for the organisation implementing the change
- complexity of the change
- failure consequence: credible worst-case scenario in the event of failure of the system under assessment, taking into account the existence of safety barriers outside the system
- monitoring: the inability to monitor the implemented change throughout the system life-cycle and take appropriate interventions
- reversibility: the inability to revert to the system before the change.

G2 According to the ORR guidance a change should only be considered to be non-significant if the proposer:

- is confident that it has identified all significant hazards (i.e. those that give rise to non-negligible risk); and either
- knows how it will control the associated risk to an acceptable level; or
- is confident that it will be straightforward to identify and implement the measures required to control the associated risk to an acceptable level.

G3 Table G1 shows how proposed revisions to the 019 standard were assessed against the CSM-RA criteria by Network Rail in the paper that was submitted to the standards and controls steering group in June 2016.

CSM-RA criterion	Network Rail's assessment question	Network Rail's assessment (as presented to the standards and controls steering group for safety health and environment in June 2016)	
		Answer	Justification
Additionality	Are there any other changes being introduced simultaneously which may increase risk?	**No**	"There are no other changes to this process that have been identified. However, the working group are aware of previous changes made in this area."
Novelty	Is the change being introduced unique and/ or complex?	**No**	"This is a simple change to rewrite the existing GN908, 019 and 133 standards into the standards format under 019"
Complexity			

CSM-RA criterion	Network Rail's assessment question	Network Rail's assessment (as presented to the standards and controls steering group for safety health and environment in June 2016)	
		Answer	Justification
Failure consequence	Will there be a significant impact if the change fails?	**No**	"Existing working practices are in place under GN908, 019 and 133"
Monitoring	Can the change be tracked and returned to the previous state, prior to the change?	**Yes**	The change is reversible to GN908, 019 and 133
Reversibility			
Potential scale of a change with respect to safety	Combined uncertainty of outcome and consequence of failure	**Marginal consequence, very low uncertainty**	"The worst case scenario is that we will be unable to change the standards, but we are confident that this will not happen due to the importance being placed on this from Excom and within the routes/regions"
Overall assessment	**Non-significant change**		

Table G1: Table showing how Network Rail assessed the change to standard 019 against the CSM-RA criteria in the paper that was submitted to the standards and controls steering group in June 2016

G4 The proposed changes to standard 019 were presented as being 'simple', and the 'worst case' consequence of a failure in the process was predicted to be reversion to the existing standards and the guidance note. The analysis recognised neither the possibility that the revised standard would encounter many of the same problems as those found when implementing PDSW in the East Midlands, nor the safety implications if the changes were not properly embedded in the workforce.

G5 The analysis presented to the standards and controls steering group was heavily focused on the risk that the process would fail to deliver a revised standard, rather than the potential risk of not delivering the transition from issue 8 to issue 9 of standard 019 in a safe and timely manner.

Appendix H - Management information provided to senior management forums

H1 A primary source of safety performance data for Network Rail's senior management team was the safety technical and engineering directorate's Safety, Health and Environment Performance (SHEP) report. The report was intended to communicate safety performance against agreed targets, with commentary to explain over- and under-achievement, and to explain what was being done to address adverse trends. The report was primarily for leaders across the railway industry but was also shared with the regulator and RAIB, and placed in the public domain.

H2 The SHEP report was issued every reporting period (there are 13 periods in each year). This report included data relating to a number of Key Performance Indicators and supporting information. Those with relevance to track worker safety, extracted from the SHEP report for 2019/20 period 3, are shown in Table H1.

H3 A 'leading indicator' is a measurement which provides an insight into possible future safety performance: for example, the percentage of work carried out in accordance with safety procedures. A 'lagging indicator' is an output measurement: for example, the number of accidents over a given period (it thus reflects actual historical performance). Typically, lagging indicators are easy to measure but will lead to reactive safety management, whereas leading indicators tend to provide better intelligence about the actions that are needed to address poor safety performance before the occurrence of an incident or accident.

H4 An examination of Table H1 reveals that Network Rail's measurement of workforce safety was primarily focused on lagging indicators of safety performance (such as measuring the number of accidents) and the achievement of targets. The relevant sections of the SHEP report contained very few leading indicators of safety performance, and limited explanation of adverse trends. This meant that the report was providing copious data on Network Rail's safety performance, but limited intelligence on how its safety management arrangements were working in practice.

H5 Until March 2019, the SHEP report included a statistical analysis of injury rates across the Network Rail routes and Infrastructure Projects division before and after the implementation of PDSW. This showed that the implementation of PDSW had made little difference to the rate of injuries across the routes. However, the analysis did suggest a significant drop in the number of accidents within Infrastructure Projects following the implementation of PDSW.

Key performance indicator/data source	Definition	Comment	Lagging or leading indicator of safety performance
High potential workforce events	The number of workforce safety incidents rated as high potential.		Lagging (although this data also provides a leading indication of potential accidents)
Workforce fatalities	The number of fatalities recorded for Network Rail staff and contractors, working on behalf of Network Rail.		Lagging
Number of specified injuries	The number of specified injuries recorded for Network Rail staff and contractors, working on behalf of Network Rail.		Lagging
Number of lost time injuries	The number of lost time injuries recorded for Network Rail staff and contractors, working on behalf of Network Rail.		Lagging
Injury rate before and after implementation of PDSW	Statistical analysis of injury rates across all Network Rail Routes and Infrastructure Projects pre and post PDSW implementation	Reporting in the SHEP report ceased from 31 March 2019	Lagging
Lost time injury frequency rate (per 100,000 hours worked)	The number of personal injuries which have resulted in lost time for Network Rail staff and contractors, working on behalf of Network Rail, normalised per 100,000 hours worked.		Lagging
Workforce fatalities and weighted injuries	The weighted number of workforce injuries that are reported for all Network Rail staff and contractors, working on behalf of Network Rail, normalised per million hours worked.	Reporting started at the beginning of 2019/20	Lagging
RM3 milestones completed	The achievement (either as a percentage or number) of the top 10 milestones for health and safety risk management, as assessed using the ORR's Risk Management Maturity Model.	Reporting started in previous period (ie 2019/20 period 2)	Leading
Safe systems of work utilising unassisted lookout warnings	Reporting did not start until period 6 of 2019/20		Leading
Additional protection for line blockages	Reporting did not start until period 6 of 2019/20		Leading
Number of close-call reports	The number of close calls raised by Network Rail Staff and contractors.	Network Rail's stated objective was to increase the number of close-call reports (ie to enhance safety reporting)	Leading (measure of safety reporting)
Close out of close-call reports	% of close-call reports closed out within 30 days		Leading (measure of how quickly close-calls are investigated and addressed)

Table H1: Summary of key performance indicators presented in Network Rail's Safety and Environment Performance (SHEP) report

H6 A review of the various papers presented to the SHE committee in the period up to July 2019 shows that the number of potentially high risk near miss accidents involving track workers was regularly reported. However, until the launch of the near miss reduction programme in late 2018 (see paragraph 307), the primary focus of the reporting was the number of lost time injuries, many of which are relatively minor in nature. This focus on lost time injuries appeared to have been driven by a desire to drive down the total harm to the work force (measured in 'fatalities and weighted injuries', known as FWI).

H7 In September 2017, the chart shown in figure H1 was presented in a paper to the SHE committee. It showed that the biggest risk of harm to track workers was 'slips, trips and falls', with an FWI[26] of 3.8 per year, followed by 'contact with an object or person' with an FWI of 2.4 per year. The FWI for 'struck by train' was 1.6 per year. However, the chart also showed that the biggest risk of fatal accidents involving track workers on or about the line was being struck by a train (the data excluded road traffic accidents).

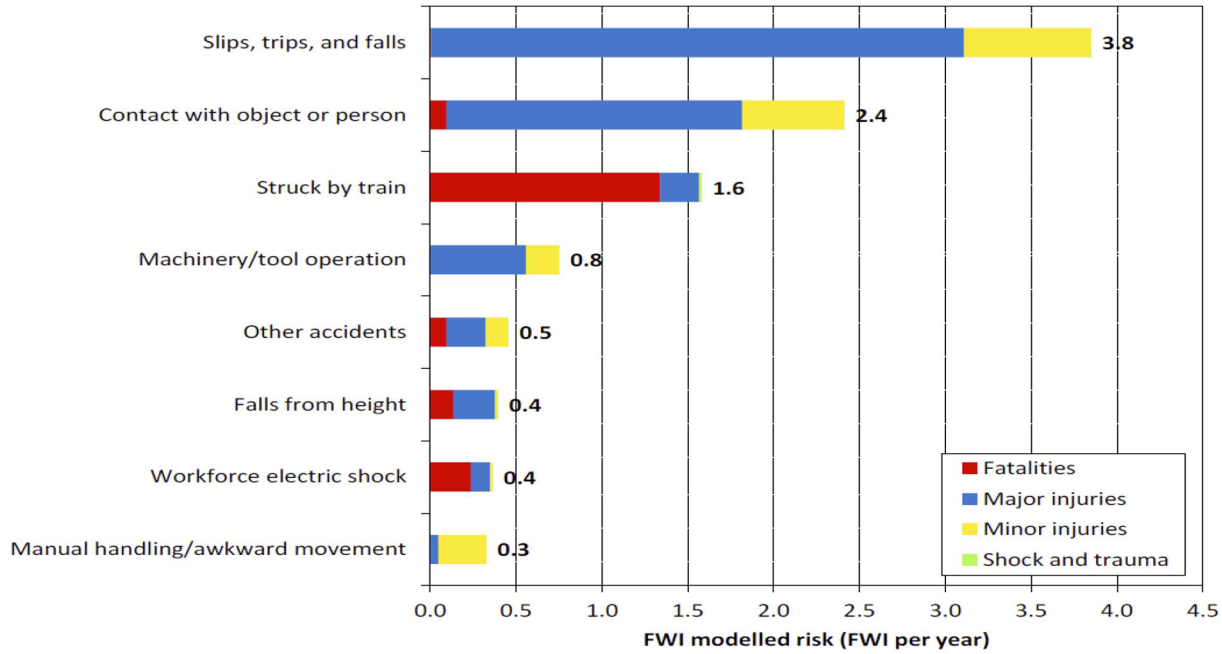

Figure H1: Chart presented in a paper to the SHE committee on 6 September 2017 (based on data in the RSSB Safety Risk Model)

H8 On 6 November 2018, a SHEP report for 2018-19 periods 1-7 was presented to the SHE committee. This report included information concerning 8 high potential near miss incidents involving track workers in period 7 (out of a total of 16 in period 1 to 7). However, the executive summary made no mention of the near miss incidents, but noted an improvement in workforce safety performance compared to the corresponding period the year before. It mentioned slips and trips in autumn conditions, and the hazards of driving in darkness, but did not refer to moving train risk.

[26] Fatality and weighted injury (a measure of overall harm based on 'equivalent fatality' ratios to assess risk and carry out cost-benefit analysis).

H9 The SHEP reports contained very little information concerning the levels of compliance with track safety processes and the level of analysis of close call reporting statistics was extremely limited. However, until the end of 2018/19, data was provided showing the extent to which each route was reporting implementation of the new track safety management arrangements in standard 019 issue 9.

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