Strategy for regulation of health and safety risks - chapter 5: Interface system safety

ORR strategy for interface system safety

Interface system safety risks are those that arise at physical and organisational interface between parties or systems on railways, such as:

- between track or platform and train;
- different departments within the same organisation (e.g. operating department and the maintenance department);
- between different duty holders with responsibilities for different systems, such as the infrastructure manager (track, signalling and structures) and train operating companies (drivers and rolling stock);
- between duty holders and other parties (e.g. passengers).

Areas of concern

Due to the importance of certain interface issues we consider them separately as a risk area within their own right. We therefore cover these in separate chapters within our strategy:

- Chapter 4:   Level crossings;
- Chapter 8:   Workforce safety; and
- Chapter 11: Train movements and signalling

Our priorities for interface system safety risks addressed in this chapter are:

- Platform train interface (PTI)
- Station crowding / control of passenger congestion
- Passenger slips, trips and falls
- Trespass and vandalism including suicides
- Electrical
- Road Vehicle Incursion (not at level crossings)
- Low adhesion
- Freight system interfaces
- Emergency preparedness

Platform train interface, station crowding and passenger slip trip and fall: These closely interact with each other. PTI remains a significant source of fatality risk to passengers. However, there is currently no evidence that station crowding by itself gives rise to significant harm - the main consequence is increased levels of slips and trips on stairs and escalators. Crowding has not been linked to incidences of people being struck by trains at the platform edge.

Trespass and vandalism, including suicides: ORR understands that the industry faces criminal activity from trespassers and we consider that duty holders should be proportionate in their response. Nevertheless, we expect duty holders to take reasonably practicable precautions to install, maintain and improve security on the network.

Electrical: Electricity kills or seriously injures someone every year on the railway. Key areas of prevention include, but are not limited to: prevention of unauthorised access to the railway; safety by design; 'test before touch' to ensure electrical equipment is de-energised; and correct issuing of permits to work on or near railway electrified equipment.

Road Vehicle Incursion (not at level crossings): We have agreement with the Health and Safety Executive (HSE) and the Department for Transport (DfT) that ORR is the enforcing authority in situations where there is a road vehicle incursion risk to the safe operation of the railway. We are actively looking for evidence of risk assessment and the implementation of risk mitigation because of the potentially serious outcome of these events.

Low adhesion: Both the infrastructure managers and train operators have made substantial efforts to prevent and mitigate low adhesion. We continue our challenge of the industry to continue to innovate and find better and more efficient ways of identifying low adhesion and mitigating the risks.

Freight system interfaces: A system approach is necessary to ensure the components of the railway system can interact with each other effectively and safely (wagon load, wagon maintenance and track).

Emergency preparedness: Emergency preparedness is an important area as we believe there is an increasing level of risk caused by passenger and network growth. This should include consideration of the human factors that influence the ability of staff to take control of emergency situations, and where it is reasonably practicable, the design stage should facilitate emergency response and system recovery.

How ORR will address this topic:

- influence the industry to address the importance of interface system safety, ensuring a common approach to risk identification;
- work with the industry, trade unions and other relevant stakeholders to help them identify best practice that can be implemented throughout the industry;
- promote collaborative working (e.g. working groups to tackle specific interface risks);
- where necessary, identify and promote the need for research in any specific area;
- sample/validate the key elements of the SMS to give us confidence in duty holders' overall management capability and collaboration, including on interface risks;
- use the full-range of our influence and powers to give assurance to the travelling public and the workforce that interface risks are being adequately managed by duty holders; and
- ensure the competence of our own regulatory team in the area of interface risks.

Index of issues discussed

Introduction

System safety

1.   ORR promotes a system approach to managing health and safety. A system is an amalgamation of organised parts that work together to achieve a common objective, such as a railway system. The aim of the system safety approach is to have a system that consistently performs in a safe way.

2.   The management of interfaces and interactions between the parts of the railway system, the organisations responsible for those parts of the railway system and the influences of its surrounding environment are therefore important to control risk.

Interface risks

3.   The consequences of failures at the interface can be severe. The Rail Safety and Standards Board's (RSSB) Precursor Indicator Model (PIM) estimates, on the mainline, that the largest proportion of serious injuries and fatalities to individual passengers occur at the Platform Train Interface (PTI), representing over 48% of passenger fatality risk. On London Underground (LU) this is also an important topic as PTI accounts for a lesser but still significant risk. For trams the biggest interface system safety risks is the road-rail interface where trams can collide with people, cyclists or road vehicles. The greatest source of risk to members of the public (except for suicide), anywhere on the railway, is trespass.

4.   Due to the importance of certain interface issues we consider them separately as a risk area within their own right. We therefore cover these in separate chapters within our strategy:

- Chapter 4:   Level crossings;
- Chapter 8:   Workforce safety; and
- Chapter 11: Train movements and signalling.

5.   On 9 November 2016, there was a serious tram derailment and overturning incident at Sandilands junction, near Addington Village, where 7 people died. The Railway Accident and Investigation Branch (RAIB) report concluded that the tram overturned because it was travelling too fast to negotiate the curve. The control measures at the time relied on timely human intervention to control the speed of the tram (operation 'system') to react to route topography, obstructions or other features (infrastructure 'system'). The causal factors that may have contributed to the incident are discussed throughout the strategic risk chapters, but specifically in:

- Chapter 1:   Health and safety management systems
- Chapter 2:   Industry staff competence and human failure; and
- Chapter 12: Health and safety by design.

6.   Our priorities for interface system safety risks addressed in this chapter are:

- Station crowding / control of passenger congestion
- Passenger slips, trips and falls
- Platform train interface (PTI)
- Trespass and vandalism including suicides
- Electrical
- Road Vehicle Incursion (not at level crossings)
- Low adhesion
- Emergency preparedness

7.   The highest risk to passengers arises from slips, trips and falls followed by incidents at the platform train interface (PTI). PTI also includes incidents when no train is present, such as falls from the platform edge. There is also a causal link between the two. Crowding is a focus of public concern, however, there is currently no evidence that station crowding by itself gives rise to significant harm.

8.   Metro railways have similar interface risks to those of the mainline railway. Management of the interfaces between different systems is a key risk area especially where infrastructure management and operations management is carried out by different organisations. The interface between metro systems and Network Rail is also a risk area e.g. compatibility of rolling stock, signalling systems and rail vehicle design. Collaboration between the parties is therefore important in managing the interface risks.

Organisational Interfaces

9.   Organisational interface system safety risks are those that arise at the interface between parties on railways, such as between:

- different departments within one organisation (e.g. the operating department and the maintenance department)
- different duty-holders (such as the risks associated with low adhesion between Network Rail for rail head condition controls and train operating companies (TOC) for driver behaviour and rolling stock equipment);
- duty-holders and their contractors and suppliers;
- duty-holders and passengers;
- duty-holders and other third parties (such as, adjacent businesses and properties).

10.   Interface system safety risks are challenging for railway duty-holders to manage. Generally, no single duty holder has control over the whole risk or may not have the complete picture about incident causation. However, they are required to collaborate and cooperate with each other or outside agencies in order to effectively manage shared interface risks and to comply with their legal duties.

11.   Individual risks to passengers or members of the public are not entirely within the control of the industry, as they often need the cooperation of those people to act in a safe way.

12.   Duty-holders that are good at managing health and safety create an effective framework to manage the health and safety relationships internally and externally to their organisation. These shared risks can be managed collaboratively between duty holders to identify, assess and control the risks. This is a very broad topic area ranging from risks of train derailment and collisions, to situations where passengers are exposed to hazards when getting on and off trains, or members of the public who trespass on the railway.

13.   In May 2017, the mainline sector relaunched its strategy *Leading health and safety on British railways – a strategy for working together.* This has been developed by leaders of the rail industry to provide a framework for the collaborative improvement of health and safety performance on the railway. See: https://www.raildeliverygroup.com/about-us/publications.html?task=file.download&id=469772283. The ORR recognises this document as good practice and refers to it during its inspection activities.

Heritage railways

14.   Interface system safety risks are generally less complex for the heritage sector as most heritage lines operate in isolation. However, there are some interfaces with the mainline network where facilities are shared. Collaboration between the parties is therefore important in managing the interface risks.

Tramways and light railways

15.   Where trams run along roads, the greatest proportion of interface risk arises from incidents with pedestrians, cyclists and road vehicles. With the relatively low speeds involved in built-up areas, fatalities arising from such incidents are rare and trams have effective magnetic track brakes, which can stop the tram very quickly. The predominant causes of accidents are other road users running red lights at road-tram intersections or failing to comply with road signs, lines on the road and pedestrians failing to look both ways before crossing roads.

16. Wheels on bicycles can be caught in the rail grooves of the tramways causing cyclists to fall from their bikes. The fall can cause serious injuries and the cyclist could then be hit by a moving road vehicle. The extent of such incidents is unknown as it does not come within scope of RIDDOR[1] reporting.

17. To reduce the risk of such incidents we promote the provision of cycle lanes away from tramlines and effective maintenance of the carriageway around embedded tram rails.

18. Following the fatal derailment at Sandilands Junction and the publication of RAIB's report, industry will be taking forward a range of recommendations around tram safety, some of which will be relevant to the interface system safety risks covered in this chapter; for example, recommendation 2 advocates a systematic review of operational risks and control measures associated with the design, maintenance and operation of tramways.

19. Generally, in relation to the interface risks of tram operations, control measures rely on ensuring compatibility and cooperation with road traffic control authorities. Precautions include:

- consideration of optimum positioning of lines when designing new or extended tramways, ensuring inter-visibility (between pedestrians and drivers);
- design of tram stops and crossings to minimise risk of pedestrians crossing in front of trams
- tram design:
- signage to warn road users and pedestrians about the presence of trams;
- tram driver competence, including defensive driving techniques; and
- educational and promotional material to raise awareness amongst the general public.

20. The Highway Code also contains specific advice for road users on tramways.

Tramway overhead line electrification (OLE)

21. Tramway OLE shares many of the same issues as the mainline railway system. There are additional risks in the tramway context given that they run in streets to which the public have access and run close to and under buildings. This can give increased risk of contact with road vehicles and construction work.

Legal context

22. Employers, employees, directors, suppliers, owners of premises and others have duties under the Health & Safety at Work etc. Act 1974 to ensure, so far as is reasonably practicable, the safety and health of those at work in, or who enter, their premises, or who are otherwise affected by their activities.

23. ORR's role, as the health and safety regulator for railways, is to encourage compliance with the law.

24. Relevant health and safety regulations include, but are not limited to:

- Health and Safety at Work etc. Act 1974 (HASWA), particularly section: 3 and 4.

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[1] RIDDOR - Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013

- Railways and Other Guided Transport Systems Regulations 2006 (ROGS), particularly regulations 19 and 22.
- Railway safety (miscellaneous provisions) Regulations 1997, particularly regulation 3.
- The Construction (Design and Management) Regulations 2015 (CDM), particularly regulation 8.

HASWA

25.   Section 3 defines the general duty employers and the self-employed have to persons other than their employees, this should include engaging with users, neighbours and subcontractors.

26.   Section 4 defines the general duty of occupiers of premises; towards persons other than their employees, this includes passengers and other station users etc.

ROGS

27.   This gives transport operators a specific duty to carry out a 'suitable and sufficient' assessment of the safety risks involved in running the transport system. The purpose of this assessment is to identify the measures needed to make sure the transport system runs safely. However, there are risk areas where this will require a joint approach between organisations to ensure that interface risks are adequately controlled. This will require transport undertakings, infrastructure managers and their contractors to have arrangements in place to cooperate and manage the organisational interfaces.

Miscellaneous provisions

28.   Regulation 3 defines the requirements to prevent unauthorised access to the track and other railway infrastructure.

CDM

29.   Regulation 8 requires projects to co-ordinate their CDM activities with others to understand how different aspects of their activities interact and influence each other to ensure that all health and safety risks are adequately managed.

RSSB

30.   RSSB plays a central and significant role in helping the mainline industry identify and manage risks at the interfaces. Much of its guidance and research is equally applicable to other sectors of the railway. RSSB activity on interface system safety issues includes:

- managing the process for and owning the industry interface standards, including facilitating committees that take decisions;
- gathering data into the industry's Safety Management Information System (SMIS) and analysing it through the Annual Safety Performance Report (ASPR), special topic reports and other safety risk models to give intelligence on interface risks;
- conducting and publishing research on relevant interface issues;

- establishing and maintaining the Industry Shared Risk Database that gives information on interface risk identification and evaluation, identifying the parties that need to cooperate to manage the risks;

- publishing guidance, for example on the Duty of Cooperation; and

- facilitating cross-industry working groups that focus on identifying and sharing best practice on interface issues, for example the Operations Focus Group, Community Safety Steering Group and the industry Safety Interface Committees. Some of these groups include members from other industry sectors, such as trams and Transport for London (TfL).

Risk areas

Platform train interface (PTI)

Summary

PTI remains a significant source of fatality risk to passengers. In 2016/17, there have been four passenger fatalities at the platform edge (only one of which involved boarding/alighting, the other three involved a fall at a vacant platform and being struck by an approaching train).

The industry takes PTI risk seriously and has arrangements in place to reduce the risks. Despite this, deaths on platforms continue to occur and we continue to treat this as a priority issue.

We support a system approach to managing PTI risk and recognise that a blame culture towards the individual passengers undermines efforts to improve controls and learn lessons.

We believe that with the correct equipment, procedures and competent staff, train dispatch arrangements can meet legal requirements and achieve safe train dispatch.

Driver Controlled Operation (DCO) must be risk assessed to identify the controls needed to ensure drivers have good visibility, which may need to be assisted with aids such as in cab CCTV and monitors or mirrors.

With rising passenger numbers, the industry needs to maintain its focus on managing and reducing PTI risk.

We note the work at RSSB on station safety, which is taking into account passenger behaviour and how it can be influenced.

We continue to urge the industry to identify further opportunities to eliminate or reduce risks at the platform edge by looking at station and rolling stock design.

31.   Five passenger fatalities occurred in 2016/17 of which four of them occurred at the PTI, according to version 8.1 of the RSSB Safety Risk Model (SRM). PTI being the second highest risk to passengers (12.1 FWI/yr). The highest passenger risk coming from slips, trips and falls (27.2 FWI/yr).

32.   PTI incidents arise as a result of passengers:

- falling on to the track and being struck by a train
- falling on to the track and coming into contact with the electric contact rail;
- falls from the platform edge without a train being present;
- being struck by the train whilst standing at the platform edge;
- falls between the train and the platform;
- being trapped in train doors and dragged along as the train departs; or
- falls getting on and off trains.

33.   PTI risk can be managed through a combination of:

- platform design (e.g. visible warnings such as clear demarcation of the platform edge),
- right side door enabling equipment (which controls the risk of doors being opened on the side not adjacent to a platform),
- platform edge doors and barriers (which are aligned with the train doors and only open when a train is in the platform),
- platform heights,
- platform / door gap,
- good platform surfaces,
- tactile edges/surfaces,
- appropriate lighting;
- door closure alarms on rolling stock doors,
- CCTV on the platform with monitors,
- mirrors on platforms to help the driver see the outside of the train;
- train CCTV with in-cab driver monitors,
- signage,
- train dispatch arrangements,
- platform staff to encourage sensible passenger behaviour,
- announcements,
- controlling passenger numbers on the station, and.
- the ability for passengers with reduced mobility to pre-plan their journeys.

34.   All systems of train dispatch need to be risk assessed and risk control measures implemented depending on the particular circumstances. Driver Controlled Operation (DCO) - Drivers must have good visibility of the PTI, this may mean using additional aids such as in cab CCTV and monitors or mirrors to assist them. This area has become more high profile in recent years as train operators have looked to increase the use of DCO as more trains become available with cameras mounted on the train body side.

35.   In the heritage sector, much of the rolling stock has slam-doors and the role of the dispatcher is particularly important in preventing risk as the train departs.

Industry activity

36.   Working with industry, RSSB has developed a PTI strategy for the main line industry. The intention is to make the 'corridor' between the platform and the train safer, and to ensure that growing numbers of passengers can continue to enjoy safe and efficient train services in the future.

37.   The strategy employs a whole-system, safety by design risk-based approach, which includes human factors, operations, engineering, and data analysis with the aim to reduce PTI incidents and improve performance. Following workshops that ORR ran with industry in 2016/17, the working group has agreed to update guidance around train dispatch.

38.   The industry has updated RIS (3703-TOM) Rail Industry Standard for passenger train dispatch and platform safety measures and GERT8000-SS1 Station duties and train dispatch. The RIS provides principles for the development of passenger train dispatch processes and additional measures to encourage and manage the safe behaviour of passengers and the public on platforms; this will inform dispatch arrangements enabling staff to carry out dispatch tasks in SS1.

39.   Additionally, RSSB project T1118 'Optimising the design and position of platform markings designed to keep people away from the platform edge' is a review of platform edge markings with the aim of providing good practice guidance to help station operators determine the design and position of markings to discourage people from becoming too close to the edge. This project aligns with the PTI strategy, which can be found at: https://www.rssb.co.uk/pticontent/pti041-2015-01-platform-train-interface-strategy.pdf

ORR activity

40.   ORR assesses duty holder compliance with their legal obligations by conducting inspections of the management arrangements for risk control at the platform edge and investigating incidents and complaints to establish causal factors.

41.   In April 2017, ORR produced its Railway Safety Principles on Driver Controlled Operation (DCO). These principles are there to ensure that duty holders have the necessary information to hand to ensure their trains are dispatched safely and that all train operators have a guide for continuous improvement. This can be found at: http://orr.gov.uk/rail/health-and-safety/health-and-safety-strategy/driver-controlled-operation-dco

Station crowding / control of passenger congestion

Summary

The evidence shows that station crowding by itself does not give rise to significant harm. The main consequence is increased levels of slips and trips on stairs and escalators and can compromise the effective management of the platform train interface (PTI).

Incidents of people being struck by trains at the platform edge have not been linked to crowding issues.

As the industry is embarking on a programme of station refurbishment and upgrades, we continue to emphasise the importance of being proactive in identifying how large numbers of passengers can lead to congestion and risks around stairs and escalators, where passenger flows can come into conflict, and on platforms.

We expect to see effective contingency arrangements for foreseeable emergency situations relating to crowding.

ORR will inspect and monitor congestion management and seek the introduction of further crowding mitigation measures through improved station design and operating procedures.

42.   Crowding at stations tends to be cyclical, typically morning and evening peaks. However, most passenger harm occurs outside of the 7-10am morning and 4-7pm afternoon peaks. Significant crowding may also occur during specific events (e.g. football matches or other special events) or during service delays as well as abnormal or degraded working. At these times, the potential for accidents increase, particularly for slips, trips and falls on stairs and escalators.

43.   Additional risks may also occur when stations are undergoing refurbishment which often results in restricted passenger capacity including on platforms or in passageways; passengers gathering around information screens can exacerbate this.

44.   Crowding can also contribute to other risks such as unacceptable passenger behaviour directed at others, including station staff.

45.   The provision of clear passenger information such as signage and announcements is important to keep the passenger flow moving to their intended destination at appropriate times to avoid people trying to walk against the general flow, or run to change platforms.

46.   Understanding the flow of people around stations is an important precursor to risk assessment, for example identifying conflicting passenger flows, including detrainment onto crowded platforms. Sometimes even simple modifications to access and egress arrangements can mitigate crowding and prevent risk.

47.   An emergency evacuation of a station will be more complex when the station is crowded as passengers may panic causing extreme pressure at certain points such as stairs and escalators and gate lines. Experiences of other locations, such as football grounds, graphically demonstrate the risks that arise when control of crowds is lost in an emergency.

Industry activity

48.   Station operators have arrangements in place to identify and trigger additional control arrangements to manage the numbers of passengers allowed on platforms before concerning levels of crowding are reached. Passenger levels during peak hours are generally predictable. However, abnormal and degraded working can cause problems at any time and these should be anticipated as part of station risk assessments.

49.   In many locations, CCTV control centre staff can monitor congestion on platforms and initiate additional control measures. Staff on platforms are also well placed to assess when platforms are becoming unacceptably congested.

50.   Railway undertakings have congestion control and emergency plans, which are regularly reviewed, as well as after incidents and changes to station layout and staffing levels.

51.   Dedicated congestion and crowd management plans for events can aid crowd management.

52.   The safe design of changes to station layouts (both temporary and permanent) takes account of passenger flows and includes the use of computer models and monitoring the effectiveness of the controls, post change. Management of change is discussed in chapter 3.

53.   Increased system resilience through planned introduction of new signalling systems and rolling stock should help to relieve some of the issues around degraded working. On-going upgrade work will also help increase capacity at some stations.

54.   To assist in making good crowd management arrangements the RSSB has published guidance entitled 'Crowd management at stations – A good practice guide'.[2]

ORR activity

55.   We inspect activities at stations and specifically focus on congestion control arrangements, and emergency preparedness. We also inspect train dispatch to ensure the risk at busy times is being managed.

56.   We will continue to monitor the existing controls to ensure they remain effective, in light of rising passenger numbers. We will also seek the introduction of further crowding mitigation measures through improved station design and operating procedures.

Passenger slips, trips and falls

Summary

Passenger slips, trips and falls represent the highest frequency event to which passengers are exposed. Risk from these incidents has continued to increase over recent years, but this is in line with normalised ongoing passenger growth.

Falls on escalators and stairs account for the largest proportion of risk and we look for specific controls to manage this risk.

57.   Slips are the result of too little friction or a lack of traction between footwear and the floor surface. A trip is the result of a foot striking or colliding with an object. Both of which can cause a loss in balance and may cause someone to fall.

58.   The main causes of slips, trips and falls are:
*   uneven floor surfaces;
*   unsuitable floor coverings;
*   wet floors;
*   changes in levels (steps and escalators);
*   objects;
*   poor lighting; and
*   poor housekeeping

59.   Passenger slips, trips and falls represent the highest frequency event to which passengers are exposed. Risk from these incidents has continued to increase over recent years, but this is in line with normalised ongoing passenger growth.

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[2] Available on RSSB's Spark website.

60.   The consequences of such incidents vary widely from loss of dignity to loss of life. Slips, trips and falls in stations represent half of passenger FWI risk and up to 20% of total passenger fatality and major injury risk (SRM v8.1). Over the last five years, there have been two passenger deaths in falls at stations. When considered alongside the 1.73 billion passenger journeys, the incidence rate is low.

61.   Falls on escalators and stairs account for the largest proportion of risk and we look for specific controls to manage this risk, such as:
- effective maintenance and lighting;
- audible and visual warnings; and
- directing passengers of reduced mobility and those with luggage to use lifts, where available.

62.   Although these measures can reduce this risk, a significant proportion of incidents are passenger-generated, but even this is reasonably foreseeable. Typically, this would result from persons rushing to catch trains or being under the influence of alcohol.

ORR activity

63.   ORR investigates serious accidents and complaints in order to assess the adequacy of risk controls and we have taken formal enforcement action to require improvements. However, most incidents are relatively low consequence.

64.   ORR believes that we can make the most impact by requiring the industry to ensure the design of stations adequately manages these risks. Nevertheless, we do monitor the incidence of slips trips and falls and will take proactive action where we have evidence that risk management may be inadequate. On the mainline railway, we have monitored delivery of improved design through inspection of National Station Improvement Programme projects.

Trespass and vandalism including suicides

Summary

ORR understands that the industry faces criminal activity from trespassers and we consider that duty holders should be proportionate in their response. Nevertheless, we expect duty holders to take reasonably practicable precautions to install, maintain and improve security on the network.

65.   Trespass: A trespasser is someone who goes where they are not authorised to be. This usually means the track itself, but also includes trains (when not in service) and/or buildings etc. Some trespassers cause damage to property and equipment, and jeopardise the safety of workers and passengers, as well as putting themselves at risk.

66.   Over recent years there were on average around 30 trespass fatalities on Britain's railways annually, of which about 70% were caused by electrocution or being struck by moving trains, the rest involved falls from height or from the train.

67.   Excluding suicides, RSSB's Safety Risk Model v8.1 (SRM) estimates that around 80% of the total fatality risk to members of the public on the mainline results from trespass incidents.

68.   Trespass and vandalism are criminal acts on the part of the individual rather than necessarily from specific industry failings. However, the industry has a duty to control risks arising from them so far as is reasonably practicable, often focused on infrastructure access control.

69.   Suicides: numbers increased in 2013-14 and 2014-15 but have decreased in recent years. There are an average of 260-280 fatalities reported on the mainline annually. Over the last decade, seven involved road vehicle drivers in incidents believed to be suicides. Around 20% of railway suicide attempts result in non-fatal but often severe, life- changing injuries.

70.   The Rail Industry Suicide Stakeholder Group (RISSG), which is formed of Network Rail, the train operating companies, trades unions, BTP, Samaritans and RSSB; have been working together since 2010 to reduce suicide on the railway and to support those involved or who witness such an event. In 2015 the contractual partnership agreement between Samaritans and Network Rail on behalf of the rail industry was renewed until 2020.

71.   During 2016/17, BTP recorded a total of 1,593 interventions in suicide attempts on the mainline railway. This compares to 1,137 made in 2015/16, a 40% increase.

Industry activity

72.   Most trespass and vandalism prevention activities come from the infrastructure manager in terms of 'target hardening the asset' (i.e. burying cables, improving fences etc.). Much effort has been put into educating young people in recent years through visits to schools, advertising campaigns to alert parents to the risks and also arranging distraction and risk prevention activities during school holidays.

73.   During enhancements and renewals, materials and equipment may be stored at the side of the railway, which can be used by vandals to obstruct the track or be attractive to thieves. Industry standards now require small items to be either secured in a safe place or bound together to prevent them being moved.

74.   The police services responsible for railways (e.g. BTP) have a key operational role in dealing with trespass and vandalism incidents. The overall control of these risks is difficult, given the ready accessibility of railway property from stations and level crossings.

75.   Suicide represents the single largest source of fatalities on Britain's mainline railway. In July 2014, the Samaritans announced a further five-year extension (2015-20) to its partnership with Network Rail to reduce suicides on the railways. Since the original 2010 partnership Samaritan-trained railway staff and Transport Police officers have approached and potentially saved hundreds of lives. In 2016-17 over a thousand suicide prevention interventions were made and around 7,000 railway-related employees have been trained to proactively take such actions. Engineering controls now installed to reduce suicide risk, include mid-platform fencing at 50-stations, platform-end barriers and new 'smart' technology cameras to help spot people in difficulty.

ORR activity

76.   We receive reports of deaths on the railway, where suicide is suspected, via RIDDOR reporting and also from reports provided by BTP. It is our policy that we do not generally investigate incidents of suicide except where the circumstances suggest that there may be a failure of a HASWA S3 duty.

77.   ORR has an active role in the Community Safety Partnership Group (CSPG) where we engage with local schools to educate on the consequences of trespass and vandalism. We also have a similar role in Route Crime Groups.

78.   We mandate investigation of any fatality or serious injury involving a young person (under 18 years of age) trespassing on the railway. We also investigate complaints from members of the public about inadequate site boundaries. We focus our activities in those areas where young people are most likely to congregate for example, near school premises and sporting facilities where we expect higher standards of precautions.

79.   We also scrutinise safety management system procedures for the inspection and repair of security arrangements around the infrastructure.

Electrical risks

Summary

Every year someone is killed or seriously injured as a result of coming into contact with the electrified rail network.

Key areas of prevention include but not limited to:

- prevention of unauthorised access to the railway;
- safety by design;
- 'test before touch' to ensure electrical equipment is de-energised; and
- correct issuing of permits to work on or near railway electrified equipment.

80.   As of 31st March 2017, there was one infrastructure worker fatality and one depot worker fatality over the last five years, due to electric shock. There was also an average of four public trespass fatalities per year, over the last five years due to electric shock.

81.   Regulation 3 of the Railway safety (miscellaneous provisions) regulations 1997 requires the prevention of unauthorised access to the track and any other railway infrastructure, such as 25kV railway overhead line equipment, so far as is reasonably practicable. This duty covers the initial provision and the maintenance of fencing and other measures.

82.   The Rail Safety Standards Board (RSSB) document *Research Programme Engineering Investigating the economics of the 3rd rail DC system compared to other electrification systems* states at 12.2.5 '*Electrical safety: The fatality rate per DC track kilometre is about ten times that for the AC system.*

83. We believe the unmodified extension of a top rail conductor system would increase the risk of death or serious injury when compared to other options and would not meet the full requirements of the Electricity at Work Regulations 1989.

Industry Activity

84. Network Rail's Electricity Safety Delivery Group (ESDG) is committed to continuous improvement and supports the routes through the publication of standards and support for innovative improvements made by the routes. To support this commitment a support tool has been developed to help quantify safety and efficiency savings in order to prioritise improvements and to help secure funding.

85. New electrification projects are assessed to ensure they can be operated, maintained and safely integrated into the existing network. This includes the application of meaningful and consistent risk assessments to inform decisions to manage system and identified risk gaps (desired and actual levels of health & safety performance) supported with cost benefit analysis. A holistic approach should be taken.

86. Network Rail is currently reviewing its safe systems of work for electrical installations to improved compliance with the electricity at work regulations 1989.

87. London Underground has been reviewing implementation of Electricity at Work Regulations since 2015 and has significantly reduced live working at depots and for track maintenance and signals.

ORR Activity

88. We have published two policies relating to electrical safety on our website:

- Electrical clearances to standing surfaces for 25kV overhead electrification;
- Third Rail DC Electrification Systems; and
- Safety principles for train servicing work in conductor rail premises.

These can be found at: http://orr.gov.uk/rail/publications/policies-and-statements/health-and-safety:

89. We support better signage at high risk areas such as sidings to align with the Electrical Supply, Safety and Continuity Regulations 2002. Although not applicable to the rail network they are considered as good practice.

90. We support, where it is reasonably practicable to do so, the move to increase electrical clearances to meet the 'protective provisions against electric shock' of BS EN 50122-1.

91. We support the work of the train operating companies (TOC's) to mitigate the risk of maintenance and cleaning activities in 3rd rail depots. We will also continue to monitor Network Rails landlord's duty to provide a safe workplace so far as is reasonably practicable.

92. We support the move to raise wire heights at level crossings to as high as is reasonably practicable with a minimum height of 5.8m where possible. Vehicles contacting

overhead power lines can become stranded or damage the rail infrastructure and this can lead to a catastrophic incident.

93.   We will continue to monitor the interface between 3rd parties on the rail network to ensure cooperation and coordination of activities to prevent electrical injury. Including isolation activities and issuing of electrical permits and other safety documentation.

94.   We support Network Rail's initiative to:

- adequately identify safe work areas,
- positively identify residual hazards (parts that may remain live within or close to an isolation), and
- record this information on the permit to work on or near railway overhead line equipment (Form C) with adequate precautions mandated to prevent injury.

95.   We acknowledge the work being done by the industry towards improved compliance with the Electricity at Work Regulations 1989. We actively monitor the application of Network Rail's working with electricity lifesaving rules:

- Always test before applying earths or straps;
- Never assume equipment is isolated – always test before touch; and
- Correct issuing of permits to work on or near railway electrified equipment

Road Vehicle Incursion (not at level crossings)

Summary

We have agreements with the Health and Safety Executive (HSE) and the Department for Transport (DfT) that ORR is the enforcing authority in situations where there is a road vehicle incursion risk to the safe operation of the railway.

We are actively looking for evidence of risk assessment and the implementation of risk mitigation because of the potentially serious outcome of these events.

Where necessary, we use our influencing skills to promote cooperation and action between all parties.

96.   Road vehicle incursions involve incidents where a vehicle leaves a road or private land and comes to rest on the railway infrastructure. Most incursions occur at boundary fences and at some bridges. Incursions also occur from private land and industrial premises. Some incident also occur where engineering vehicles at lineside worksites foul the operational line.

97.   The most notable incidents include the derailment of a train in 2001 at Great Heck, near Selby, where a vehicle left the highway and entered the railway before being struck by a train. This resulted in the death of 10 train passengers. In 2010 a cement mixer lorry breached the parapet of a road-over-rail bridge and fell onto a passing passenger train at Oxshott, in Surrey. The lorry driver and six passengers suffered injuries. Road vehicle incursions have the potential to cause a train derailment with multi-fatality consequences.

98.   Around 50% of road vehicle incursions come to rest foul of the line.

Industry activity

99.   Following the road vehicle incursion that caused a derailment at Great Heck in 2001 and the review of safety at the road rail interface undertaken by DfT, Network Rail has worked jointly with Highways Authorities to conduct risk assessments to identify any necessary mitigation measures.

100.   To date, much work has been completed, however, there are locations where the necessary remedial work is still to be done.

101.   Following the road vehicle incursion at North Rode in 2008, RAIB recommended that Network Rail should establish a method for assessing its infrastructure to identify the sites where the risk of incursion from private land is highest and secure the improvement of the identified sites by those responsible for them. This work is ongoing and is being monitored by ORR.

ORR activity

102.   Historically there has been a lack of clarity regarding the enforcement arrangements for the management of road vehicle incursion risk. Following agreement with HSE and DfT, we clarified that ORR is the enforcing authority in situations where there is a road vehicle incursion risk to the safe operation of the railway. The practical arrangements supporting this agreement have been included in our Memorandum of Understanding with HSE and we now believe that these arrangements are working well in practice.[3]

103.   We monitor the implementation of mitigation measures arising from joint risk assessment by Network Rail and Highways Authorities according to the DfT protocols, and we have intervened as necessary to ensure engagement by all parties. We also liaise with HSE where potential vehicle incursion from private industrial premises is revealed. We are monitoring progress in the identification of new potential vehicle incursion sites, both on public highways and from private land. We have contributed significantly to the drafting of Network Rail protocols for dealing with the issue of road vehicle incursion.

Low adhesion

Summary

Both the infrastructure managers and train operators have made substantial efforts to prevent and mitigate low adhesion. Vehicles now have sanding equipment, the maintenance of which is well managed across the industry. We monitor low adhesion management issues especially in relation to lineside vegetation, particularly in the autumn. Network Rail's 'Intelligent Infrastructure' programme makes greater use of a wide range of data from trains in service to identify low adhesion areas on the network in real time

We also challenge the industry to continue to innovate and find better and more efficient ways of identifying low adhesion and mitigating the risks. We recognise that this is a

[3] Available at http://orr.gov.uk/__data/assets/pdf_file/0006/1698/279.pdf

> complex area and that further research may be needed to increase our understanding of the causes of low adhesion and mitigation methods.

104.   Low adhesion occurs at the wheel/rail interface where a reduced coefficient of friction results in loss of grip between the wheel and the rail reducing braking performance. There is a strong bias towards the autumn months which coincides with the leaf fall season and also the onset of cold and damp weather. However, the distribution is not uniform or necessarily easy to predict. It is primarily an issue for heavy rail, but contamination with organic matter from vegetation can also affect light rail.

105.   Low adhesion and resulting wheel-slide can give rise to safety related events such as:

- signals passed at danger (SPADs);
- collision with another train;
- collision with buffer-stop;
- other collision (obstruction on the track, vehicle at a level crossing);
- run through of facing points and derailing; and
- station / platform over-run.

106.   Additionally, wrong-side track circuit failures (WSTCF) occur due to leaf litter contamination insulating the track circuit. This leads to failure of train detection and may result in a train being signalled into a section that is already occupied.

107.   Low adhesion is an important interface system safety risk where risk control is a shared responsibility between both the infrastructure manager and train operators. The infrastructure manager has a responsibility to provide rails in appropriate condition and train operators put in place measures to mitigate the impact of poor railhead conditions e.g. sanding equipment.

108.   Information on low adhesion incidents is not directly recorded in SMIS and therefore there are no published estimates of risk. Station overruns and SPADs may be a result of low adhesion but can also be a consequence of driver error. This aspect is discussed in chapter 2 'industry staff competence'.

Controls

109.   The industry employs a 'predict, prevent and control' strategy to manage the risks. Local knowledge helps identify likely low adhesion areas and weather monitoring can help predict leaf fall and when the railhead dew point will be reached, which creates railhead low adhesion conditions.

110.   Vegetation control, railhead cleaning and treatment by the application of adhesion modifiers all form part of Network Rail's strategy to improve adhesion in high-risk areas. London underground similarly operates a 'Rail Adhesion Train' during the leaf fall period and adjusts train timings to accommodate slower operating conditions.

111.   Poor railhead conditions are improved if sand is applied, and many trains are fitted with a sanding system. The majority of Great Britain's trains are fitted with systems to

prevent the wheels sliding, known as wheel slide protection (WSP), which prevents damage to the wheels and railhead. Many WSP systems automatically activate sand deposition. Train operators ensure that train drivers are aware of low adhesion 'hot spots' via daily briefs. Where drivers are also able to recognise low adhesion they can use defensive driving techniques to mitigate the effects.

Industry activity

112.   Low adhesion is seen as a significant risk by all industry duty holders. The Rail Accident Investigation Branch (RAIB)[4] carried out a class investigation into 'autumn adhesion incidents' and have subsequently published reports of other low adhesion incidents.

113.   Notable improvements have been achieved through cooperation of duty holders. These include:

Network Rail:

- carrying out better vegetation management;
- providing funding to fit sanders to all rolling stock;
- fitting treadles on vulnerable track circuits to prevent WSTCFs;
- Network Rail's 'Intelligent Infrastructure' programme makes greater use of a wide range of real time data from on-board train technology to improve information intelligence – using GPS to identify low adhesion hotspots to inform drivers and feedback to Network Rail;
- more use of rail head treatment trains; and
- daily monitoring of weather conditions.

TOCs have also made progress through:

- modifications to sanding equipment to improve sanding rates and accuracy of deposition;
- improved procedures to keep equipment maintained and sand replenished;
- better information - keeping annual results thus giving a better understanding of system performance;
- fitment of sanding units to rolling stock previously exempted from the railway group standard;
- improved braking capability – which has reduced low adhesion related overruns;
- provision of scrubber blocks on Class 158 units to help wheel conditioning; and
- daily monitoring of weather conditions.

114.   RSSB has carried out research into low adhesion issues including:

- T1077 - The effect of water on the transmission of forces between wheels & rails
- T060 -   Overview of magnetic brakes
- T054 -   Independent review of 'Laserthor' railhead cleaner

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[4] https://www.gov.uk/government/organisations/rail-accident-investigation-branch

- T1046 - Optimising the ability of industry to deal with low wheel-rail adhesion and the use of sanders on trains.

ORR activity

115.   We monitor industry activity arising from recommendations in the RAIB low adhesion class investigation report which was published in 2007[5]. In the first 1 – 2 years following publication, activity and progress were slow from the train operating community.

116.   As of November 2015, all of the recommendations had been implemented, apart from two that were related to improving the accuracy of WSP simulation, which was not considered reasonably practicable, as there was no clear safety benefit.

Freight system interfaces

Summary

A system approach is necessary to ensure the components of a railway system can interact with each other effectively and safely.

Recently there have been several incidences where derailments have occurred due to the synergistic effects of wagon load, wagon condition and track condition. Whilst the individual risk for each component or activity is within tolerance, the combined effect of these may result in an unsafe outcome.

Supervision is undertaken by ORR's Freight Team, supported by specialist engineers. This includes inspections at strategic and tactical levels with industry bodies, including reviewing design changes, so that ORR gains assurance of continuous improvements in safety performance.

117.   The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) requires all 'freight wagons' (non-self-propelled vehicles designed for the purpose of transporting freight or other) registered on the National Vehicle Register (NVR) to be allocated an Entity in Charge of Maintenance (ECM).

118.   ECMs are responsible for managing the maintenance of railway freight vehicles and are also required to be certified either by an accredited body or the Safety Authority.

119.   ORR, as the National Safety Authority (NSA) for GB, will undertake certification activities in relation to ECMs until 2018. ORR also currently carries out supervision of all ECMs for vehicles operating on the GB network.

120.   A system approach is necessary to ensure the components of a railway system can interact with each other effectively and safely. The certification process validates the maintenance functions of an entity in charge of maintenance (maintenance development,

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[5] The recommendations relate to: Wheel-slide and sanding equipment - Train operating guidance - Prediction, treatment of and research into low adhesion conditions - Industry investigation of low adhesion events - Performance criteria and simulation of trains Research and testing of magnetic track brakes – see: http://www.raib.gov.uk/latest_news/news_archive/news_archives_2007/070108_pn_autumn_adhesion.cfm.

fleet maintenance management, maintenance delivery) to ensure that the wagon is capable of being maintained and integrated into the network to a safe level.

121.   Recently there have been several incidences where derailments have occurred due to the synergistic effects of wagon load, wagon condition and track condition. Whilst the individual risk for each component or activity is within tolerance, the combined effect of these may result in an unsafe outcome, such as a derailment. An example of this is the derailment of a freight train near Angerstein Junction, 3 June 2015.

The RAIB investigation concluded that: *'The wagons derailed because the leading right-hand wheel on one of them was carrying insufficient load to prevent the wheel climbing up the outer rail on a curved section of track. The insufficient load was due to a combination of the suspension on that wheel being locked in one position, a twisted bogie frame and an intended twist in the track.'* The RAIB report can be found at https://www.gov.uk/raib-reports/derailment-near-angerstein-junction

122.   The RSSB currently has two projects looking at system safety between the load, wagon and track

- Project T1112 - Quantify the distribution of unevenly loaded containers carried by road and rail
- Project T1119 Specification for research project Quantifying Offset Loading of Container Wagons

ORR activity

123.   ORR supervision of ECMs is vital to ensure ongoing compliance with legal requirements and ensure good engineering management is practised. This will include ensuring ECMs consider recommendations made by the Rail Accident Investigation Branch (RAIB), the Freight Technical Committee (FTC) and cross industry working groups. So they have a joined up and sound engineering approach embracing multiple stakeholders.

124.   Supervision is undertaken by ORR's Freight Team supported by specialist engineers. This includes inspections at strategic and tactical levels with industry bodies, including reviewing design changes, so that ORR gains assurance of continuous improvements in safety performance.

Emergency preparedness

Summary

Emergency preparedness is an important area as we believe there is an increasing level of risk caused by passenger and network growth.

We urge the industry to consider during the design stage of infrastructure enhancements and renewals, system resilience and ease of system recovery from an incident.

This should include consideration of the human factors that influence the ability of staff to take control of emergency situations, and where it is reasonably practicable, the design should facilitate emergency responses.

> We continue to monitor the activities of duty holders with respect to emergency planning to ensure that they act on the findings of our interventions. We stress the value of table-top and practical exercises to test emergency plans as these are an excellent way to test the communications between emergency services and railway staff.

125.   Emergency preparedness is a series of risk mitigation measures that make sure a duty holder has arrangements in place to deal with major incidents and degraded working that can give rise to significant risks to staff, passengers or the public. These could include:

- serious incidents involving one or more trains;
- fire in a tunnel;
- large fire elsewhere on or adjacent to the infrastructure;
- failed train;
- stranded train e.g. due to cable theft;
- crowding at stations encountered during normal daily peak flows, degraded working or during significant public events; or
- terrorist attack

126.   A key element is understanding the role of other parties, which could include: BTP, RAIB, Network Rail, TOCs, LUL, local authorities and emergency services, and having robust arrangements for co-operating with them and testing them through exercises. The largest exercise in Europe was held in the UK over 4 days in 2016, which simulated a tower block collapse onto a major London Underground station.

127.   For the purposes of this document, emergencies involving the carriage of dangerous goods are not considered, as there are specific measures, involving a range of public bodies, in place to help manage such activities. When we analysed the level of risk, the carriage of dangerous goods was not a high-ranking priority risk area. That said, station emergency plans should address likely instances involving dangerous goods that pass through a station where this is relevant.

128.   We believe that there is increasing potential for risk from mishandling emergency situations, as the level of rail traffic and numbers of travelling passengers rise. This makes the recovery from an emergency situation more complicated and accelerates the need to take effective remedial steps to recover from a degraded situation before it becomes serious.

129.   The industry is prone to high levels of criminal activity which can lead to degraded working and potentially large number of stranded trains. There have been a number of incidents where passengers have let themselves out of a stranded train into a place of danger on or near the line. This is particularly a problem in hot weather in trains with inadequate ventilation, when passengers will be less tolerant of waiting for rescue. The Rail Delivery Group has published a good practice guide[6] for the mainline industry on how to design systems to manage situations where passengers are stranded in failed trains.

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[6] Good Practice Guide - Meeting the Needs of Passengers when Trains are Stranded: ATOC/Network Rail Good Practice Guide

130.   On London Underground, a Senior Operating Officer (SOO) with extensive system operational experience is present at all times while the underground is operating. The SOO has authority to vary operational rules on the basis of assessed risk in order to minimise service delay stranding passengers and leading to self-detrainment.

131.   Emergency preparedness is a key element of a Safety Management System (SMS) and is the 'last layer of protection' in preventing escalation of an already unfolding incident.

132.   The ROGS safety certificate and authorisation regime requires demonstration of adequate emergency planning based around a robust process that establishes; means of communication and arrangements for cooperation with emergency services, provision of information to staff and passengers and means of safe evacuation.

133.   Non-mainline railways including several heritage railways (as they operate above 40 km/h) have 'non-mainline safety certificates' requiring them to describe particulars of their emergency arrangements. However, as the majority of heritage railways operate below 40 km/h, and therefore do not require a safety certificate, still require to have emergency planning as part of their safety management system.

134.   Fire in stations is included as an interface risk. In addition to the general requirements of ROGS, some stations on the mainline are classified as subsurface and are therefore subject to the special provisions of The Fire Precautions (Subsurface Railway Stations) (England) Regulations 2009 in England and Wales. These regulations adopt a risk assessment approach (outlined in the Regulatory Reform (Fire Safety) Order 2005) which is more in line with health and safety law. The Fire Precautions (Sub- surface Railway Stations) Regulations 1989, as amended remain in force in Scotland. These have specific requirements relating to minimum staffing levels and other fire precautions. However, the regulations are not enforced by ORR and are an example of where we interface with other enforcing authorities. Separate guidance has been published by the Department for Communities and Local Government on fire safety risk assessments at transport premises and facilities.[7]

Heritage railways

135.   The Heritage Railway Association (HRA) has published specific emergency planning guidance which is freely available from its website[8].

Our view of the industry position

136.   The industry is well aware of the importance of emergency preparedness procedures that give a swift joined-up approach to managing serious situations. Our own inspection and investigations have shown that in practice, implementation of these plans can, however, be patchy and even vary between stations on a route.

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[7] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/14894/fsra-transport.pdf.
[8] http://www.heritagerailways.com/ (ref no: HGR-A0020)

ORR activity

137.   Inspection and audit of a duty holders' emergency planning arrangements are a significant part of our proactive inspections, along with our reactive investigation work.

138.   We evaluate the adequacy of emergency planning arrangements using the Risk Management Maturity Model (RM3) criterion RCS5: Emergency Planning.

139.   Where we find serious deficiencies, we use our influence and if necessary enforcement powers to require improvements.

Glossary of terms	
Acronym	**Definition**
ASPR	Annual Safety Performance Report
ATOC	Association of Train Operating Companies
BTP	British Transport Police
CCTV	Closed circuit television
CDM	The Construction (Design and Management) Regulations 2015
CSPG	Community Safety Partnership Group
CSSG	Community Safety Steering Group
DfT	Department for Transport
DCO	Driver Controlled Operation
ECM	Entity in Charge of Maintenance
ESDG	Electricity Safety Deliver Group
FTC	Freight Technical committee
FWI	Fatalities and weighted injuries
GPS	Global Positioning System
HSE	Health & Safety Executive
HRA	Heritage Rail Association
HSWA	Health and Safety at Work etc. Act 1974
LU	London Underground
NSA	National Safety Authority
NVR	National Vehicles Register
OFG	Operations Focus Group
OLE	Overhead Line Electrification
ORR	Office of Rail and Road
PIM	Precursor Indicator Model
PTI	Platform Train Interface
RAIB	Railway Accident Investigation Branch
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013
RIS	Rail Industry Standard
RISSG	Rail Industry Stake-holder Suicide Group
RM3	Risk Management Maturity Model
ROGS	The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended)
RSSB	Rail Safety and Standards Board
SIC	Safety Interface Committee
SMIS	Safety Management Information System

SMS	Safety Management System
SOO	Senior Operating Officer
SPAD	Signal Passed At Danger
SRM	Safety Risk Model
TfL	Transport for London
TOC	Train operating company
WSP	Wheel slide protection
WSTCF	Wrong-side track circuit failure