The Railway Strategic Safety Plan 2005

Supporting Document

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Introduction

This document is designed to be read in conjunction with the 2005 Strategic Safety Plan and is intended to assist safety professionals within railway industry companies to draw up business cases to support safety expenditure. Such a business case should contain:

- an explanation of the objective, that is, risk that we are seeking to reduce;
- a description of the actions that we will take; and
- an estimate of the outcomes including the costs of the actions and the benefits that we expect to emerge, both safety benefits and contributions to the commercial and operational health of the railway.

Wherever possible, the objectives should support the industry's six key challenges set out on pages four and five of the Strategic Safety Plan.

This is a qualitatively different approach to planning for safety improvements from earlier safety plans. It recognises implicitly that safety is one of the consequences of a well run railway, not something that we "bolt on" to our operations. We seek to reduce or eliminate the causes of failure that lead risk, both safety risk and commercial and operational risk. By defining and presenting our plans as outline business cases, we are building a framework that recognises that we must deliver the best railway that we can within our finite budgets.

This document contains only outline business cases; this approach to safety planning is new for the industry and we are developing the process necessary to cast our plans in this form. We have been able only to make approximate estimates of some of the outcomes here, but even approximate estimates are a great advance on previous thinking and we are committed to presenting more detailed business cases in future Railway Safety Plans.

Please note that this document uses data taken from version 3 of the Safety Risk Model.

Risk associated with train accidents

Scope and level of risk

There are several reasons to attach a high priority to our plans to continue to drive down the risk from train accidents. Train accidents represent a significant fraction of the total railway risk. The main contributions to risk are derailment, collisions with obstacles and collisions between trains as a result of a SPAD. SRM estimates[1] the level of risk after TPWS has been fully deployed to be:

Risk – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	3.2	8.7	40	0.7	2.9	55	1.1	1.4	3

There are two further reasons to attach special weight to efforts to reduce the risk from train accidents. When a train accident occurs in which one or more people are killed, it is seen as a catastrophe and attracts extensive press and political comment. The societal concerns are greater than for other causes of death or injury on the railway. Also, the Safety Directive calls for Member States to give "priority to the prevention of serious accidents" and we will need to establish measures to reduce the risk from train accidents as this Directive starts to have an effect on UK policy.

There is an extensive programme of activities within the rail industry to understand the causes of train accidents and to put in place measures to reduce their frequency and seriousness. These activities fall into three broad classes:

- transfer of good practice, both within the rail industry and from other industries;
- doing more of what is already known to be effective, such as more frequent checking or more refresher courses for safety-critical employees;
- supporting duty holders to comply with standards, by training to improve understanding and to ensure that all duty holders understand the need to comply even when it appears unnecessary, and by reviewing standards to ensure that they are appropriate.

[1] SRM codes HET 01, 02, 03, 04, 05, 12, 13

Level crossings

Scope and level of risk

Level crossings accidents are responsible for more than 6% of all railway risk. Although the greatest risk is to pedestrians, trains that strike road vehicles can be derailed and this can result in multi-fatality train accidents.

Level Crossings Risk without TPWS					Passenger Risk			Staff Risk			Members of Public Risk		
H. E.	No.	Hazardous Event description	Frequency	Total Risk	Fatalities / year	Major Injuries/ year	Minor Injuries/ year	Fatalities/ year	Major Injuries/ year	Minor Injuries/ year	Fatalities/ year	Major Injuries/ year	Minor Injuries/ year
HET	10	Passenger train collision with road vehicle on level crossings	18.46	3.929	1.21	3.17	20.20	0.20	0.16	14.97	1.78	1.98	4.15
HET	11	Non-passenger train collision with road vehicle on level crossings	3.809	0.4927	3.24	6.31	0.03	0.03	4.25	2.93	0.39	0.45	0.94
HEM	11	Passenger struck while crossing track at station on crossing	0.4289	0.1706	0.14	0.28	0.00	0.00	0.00	0.07	0.00	0.00	0.00
HEM	27	MOP pedestrian struck/crushed by train on level crossing	10.00	5.542	0.00	0.00	0.00	0.00	0.00	6.00	5.33	1.67	3.00
HEM	28	MOP pedestrian struck/crushed by train on footpath crossing	1.667	1.372	0.00	0.00	0.00	0.00	0.00	1.00	1.33	0.33	0.00
HEN	44	MOP struck / trapped by level crossing equipment	15.0	0.337	0	0	0	0	0	0	0.00	2.67	14.00
HEN	46	MOP slip, trip or fall on level crossing	21.0	0.485	0	0	0	0	0	0	0.00	4.01	17.01
HEN	47	MOP slip, trip or fall on footpath	0.200	0.0200	0	0	0	0	0	0	0.00	0.20	0.00
Total					4.59	9.76	20.23	0.23	4.41	24.97	8.83	11.31	39.10
		Total Fatalities	**13.65**										
		Total major Injuries	**25.48**										
		Total Minor Injuries	**84.29**										

Risk – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	4.59	9.8	20	0.23	4.4	25	8.83	11.3	39

The term ‘level crossing’ is used for any location where pedestrians, animals or vehicles may cross the railway, on the level, legitimately; there are over 8,000 level crossings on Network Rail infrastructure of which 69% are vehicular crossings. It is estimated that there are 680 million vehicle traverses, 66 million pedestrian traverses and 109 million train traverses each year. The simplest level crossings consist only of a stile either side of the line with a sign exhorting users to beware of trains. At the other extreme, crossings have full-skirted lifting barriers and are monitored by CCTV systems.

The risk of collision with road vehicles has been broken down by type of crossing:

Train collision with road vehicle on level crossing	Risk – EF per year	% of population
Automatic Open Crossing Locally Monitored	1.16	2
Automatic Half Barrier Crossings	1.00	6
User Worked Crossing Protected with Telephone	0.99	19
User Worked Crossing	0.54	27
Manual Gate / Barrier Crossing	0.29	9
Occupational Crossing	0.20	1
User Worked Crossing Protected by Miniature Warning Lights	0.11	2
Automatic Barrier Crossings Locally Monitored	0.09	1

Footpath Crossings	0.04	30

Although AOCLs are only 2% of all level crossings, and are generally on less used lines, they are the highest risk. Unlike other types of crossing, there is no physical barrier between the roadway and the railway when a train approaches. It is however possible that the lack of trains inspires complacency.

The risk associated with a particular crossing may change over time. New housing estates, schools, workplaces, farm practices and leisure facilities can all change the pattern of usage of a crossing. There may also be seasonal variations. For example, a crossing that gives access to a beach is likely to be much busier in summer than during the rest of the year.

Actions to mitigate risk

Two members of the railway industry have the central roles in managing the risk of level crossings. Network Rail has primary responsibility, working with other organisations including local authorities, highway authorities and driving schools. RSSB is managing a substantial research programme to inform Network Rail's actions. We have also established a national initiative, the National Level Crossing Safety Group (NLCSG), to coordinate actions on misuse of level crossings and road/rail incursions.

Network Rail's actions

Network Rail has a strategy[2] to reduce level crossing risk to reduce level crossing risk, based on five themes: closures, improved maintenance, improved risk assessments, consistency and improved communication. The policy is summarised here and is available in full from Network Rail. It will be kept under review to ensure that it remains relevant and to improve the engagement of external stakeholders.

Closure: Level crossing risk can be entirely eliminated by closing the crossing. However, there are only a relatively limited number of situations where this is a reasonably practicable approach. Footpaths can sometimes be closed or diverted where there is a bridge, or a safer crossing, nearby. Nevertheless, changing footpaths is a bureaucratic procedure and can be politically very difficult. Even where a footpath is rarely used, there may be vociferous opposition to closure. In some cases, footbridges can be built but this is only likely to be reasonable in a relatively small number of cases – where, for example, there is heavy pedestrian use such as access to a school, or where line speeds are increased. Nevertheless, Network Rail has closed 30 level crossings as part of the West Coast Route Modernisation project.

Maintenance: Much can be done with routine maintenance, and Network Rail will apply its Level Crossing (Inspection and Maintenance) Handbook that defines current good practice. A crossing that gives the appearance of being neglected is likely to be less respected by its users than one where paintwork is fresh and signs are not

[2] "Level crossing policy and strategy", Network Rail, 25 April 2004

obscured. It is also, of course, important to ensure that equipment remains in working order and that the crossing surface is in good condition.

Risk assessment: Risk assessments of each level crossing will be made to determine what investment is reasonably practicable. If the case for eliminating the crossing cannot be made, risk may be mitigated by means of engineering solutions such as upgrading the crossing to a type with a lower level of risk, for example, by replacing an AOCL with a CCTV monitored full barrier crossing. Novel technologies may also help, for example by installing active rumble strip or median strips (flexible lane separator devices) on the approach to AOCLs to stop car drivers attempting to zig-zag round the barriers.

Consistency: Network Rail has prepared a national template for managing level crossings and trained its staff across the network to adopt standard practices and decision criteria. This element of the strategy is largely completed but it will need to be continuously applied, for example by new staff.

Communication: Safety on level crossings cannot be achieved by the railway alone. It needs the cooperation of many other organisations to promote safe behaviour. Network Rail will continue to develop educational material and work with external stakeholders to reduce level crossing misuse.

RSSB's actions

RSSB is managing a research programme that complements the Network Rail strategy. The programme includes work to:

- improve the risk assessments of level crossings
- investigate new types of train horns and rules for their use that accommodate concerns about the impact of the noise on local residents
- evaluate technologies such as median strips
- evaluate enforcement cameras that can both allow vehicles to be identified so that offending drivers may be prosecuted and act as a deterrent
- investigate human factors such as responses to warning signs.

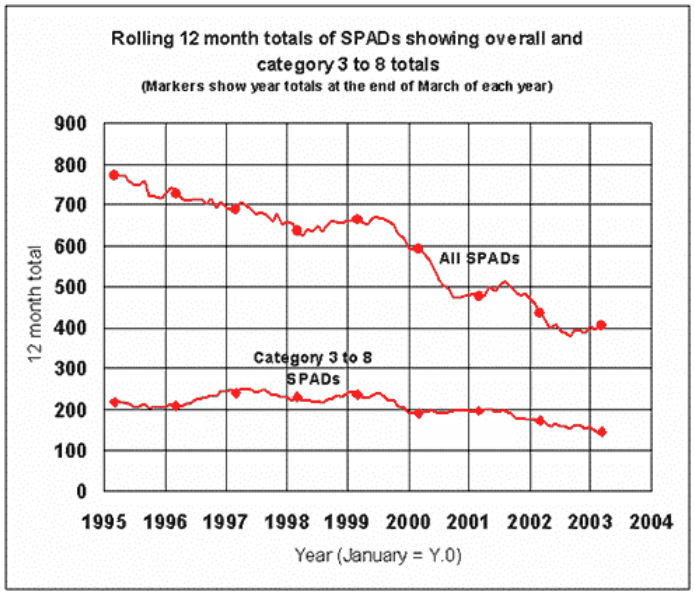
Costs and benefits

As well as work that falls within Network Rail's " business as usual", a special budget of around £50M over three years has been established to fund the level crossing strategy. It is likely that the expenditure in 2005 will be around £18M, although the exact figure will depend on the timing of contracts. RSSB has a research budget of £1M to £1.5M per year dedicated to level crossings.

Network Rail has planned its actions to achieve a 15% reduction in level crossing risk during the period 2004 – 2006, corresponding to 5% per year. Assuming that the risk is reduced uniformly across all groups, the risk reduction will be:

Risk reduction in 2005 – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.23	0.5	1	0.01	0.2	1	0.44	0.6	2

SPAD reduction



Signals passed at danger (SPADs) have the potential to cause multi-fatality accidents such as train collisions and derailments and we remain committed to reducing the risk due to SPADs by 70% from its 2001 level by the end of 2006.

There are several hundred SPADs each year. Most of these have little or no potential to cause harm because they are the result of minor misjudgements of distance or braking capability, or they occur at low speed during shunting operations. In the majority of cases the trains stop within the safety overlap provided at the signal (this is the distance specifically provided after signals as a safety margin in case drivers misjudge their braking). The incidents with the most potential for injury or damage are those when trains run past this safety overlap, and there is a possibility of a collision with another train. These incidents are categorised as 'Severity Category 3 - 8' by the HSE and the rail industry.

The chart shows the number of SPADs on the Network Rail infrastructure since 1996. It uses a rolling 12 month total of SPAD numbers, which removes seasonal variation and reduces statistical variability due to small numbers.

SRM's estimates (codes HET 01, 02 and 03) of the level of risk after TPWS is fully deployed are summarised in the table below.

Risk – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
With TPWS	0.74	2.75	8.04	0.22	1.20	1.17	0.06	0.13	0.25

Actions to mitigate risk

Our actions to mitigate the risk from SPADs are coordinated by the National SPAD Focus Group (NSFG), a cross industry group, which includes representatives from, train operators, Network Rail, HMRI, trades unions, the Association of Train Operating Companies (ATOC), contractors and the wider industry, and which is chaired by RSSB. It facilitates the progressive improvement of SPAD management through the identification, discussion, development and promotion of justifiable and potentially effective measures. It is an independent focus group, with no statutory responsibilities.

NSFG has continued to evolve since Ladbroke Grove and has successfully led and facilitated initiatives to reduce the incidence of and the risk associated with SPADs often by identifying and spreading good practice in SPAD management. In 2001 it developed five key priorities for the industry to focus on to reduce SPAD risk, which were revised and re-launched in March 2004, taking into account the progress that has been achieved in improving SPAD management:

- 100% Professionalism
- Joint approach to improving the infrastructure, operations and traction & rolling stock
- Safety critical communications
- SAS (Start Against Signal) and SOY (Start On Yellow) SPAD prevention through human factors awareness
- 21st Century route knowledge

These key priorities were developed to help the industry continue to focus on actions to minimise, through good practice, the SPADs that will not be eventually prevented by Automatic Train Protection (ATP) systems. Continued SPAD risk reduction will only be achieved through further improvement in the management of the issues that lie behind the passing of signals at danger. Accordingly, many NSFG activities have a ‘human factors’ focus; NSFG is committed to reducing error and influencing behaviour.

We do not exclude technical measures. Railway Group Standard GM/RT2461 now mandates the provision of automatic sanders on new multiple unit trains that operate automatically when a slide is first detected or gives the driver the ability to apply sand quickly in an emergency situation. As more of these systems are introduced this should help to further reduce SPADs arising from poor adhesion and reduce wheel and hence track damage.

Costs and benefits

Network Rail has budgeted approximately £15M over the next three years to assess all signals on the network and to make improvements where justified. The other actions intended to reduce SPAD risk fall within the normal business of a well run railway and should need no additional funding.

We estimate that our programme will lead to a 20% reduction in SPAD risk, after TPWS has been fully deployed. This would reduce risk in each year by:

Risk reduction – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.04	0.2	1	0.01	0.08	0	0.00	0.0	0

Infrastructure and Vehicles assurance : Broken rails

Broken rails have been selected as an example to illustrate infrastructure and vehicle issues.

Scope and level of risk

The following table lists the number of broken rails per year for the last 5 years. It has been falling by over 20% per year for the last three years.

1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
952	919	706	536	444	335

This is as a result of a sustained initiative by Network Rail (and Railtrack before it). As well as locating damaged rails and replacing them before they break, the programme of inspection and monitoring detects other track faults. The risk contributions that are being addressed by this work can be estimated by summing all of the risk that arises from broken or buckled rails and from other track defects that might be expected to be detected and corrected as a result of the initiative.

The relevant precursor codes in SRM are listed below.

HET-12	TBKR----PF	Broken rail leading to PT derailment - D
HET-12	TSPG----PF	Gauge spread (assumed always slow speed) leading to PT derailment - D
HET-12	TFSH----PF	Broken fishplate leading to PT derailment - E
HET-12	TBCK----PF	Buckled rail leading to PT derailment - E
HET-12	TTUNBKR-PF	Broken rail in tunnel leading to PT derailment - D
HET-12	TTWS----PF	Track twist leading to PT derailment - D
HET-13	TSPG----FF	Gauge spread leading to FT derailment on Pass. lines - D
HET-13	TTWS----FF	Track twist leading to FT derailment on Pass. lines - D
HET-13	TBCK----FF	Buckled rail leading to FT derailment on Pass. lines - D
HET-13	TBKR----FF	Broken rail leading to FT derailment on Pass. lines - D
HET-13	TFSH----FF	Broken fishplate leading to FT derailment on Pass. lines - D
HET-13	TTUNBKR-FF	Broken rail in tunnel leading to FT derailment on Pass. lines - D
HET-13	TMSC----FF	Misc. track faults leading to FT derailment on Pass. lines - D
HET-13	TSPG----NF	Gauge spread leading to FT derailment on freight only lines - D
HET-13	TTWS----NF	Track twist leading to FT derailment on freight only lines - D
HET-13	TFSH----NF	Broken fishplate leading to FT derailment on freight only lines - D
HET-13	TBCK----NF	Buckled rail leading to FT derailment on freight only lines - D
HET-13	TTUNBKR-NF	Broken rail in tunnel leading to FT derailment on freight only lines - D
HET-13	TBKR----NF	Broken rail leading to FT derailment on freight only lines - D
HET-13	TMSC----NF	Misc. track faults leading to FT derailment on freight only lines - D

HET-13	TSPG----CF	Gauge spread leading to ECS or PCLS derailment - D
HET-13	TMSC----CF	Misc. track faults leading to ECS or PCLS derailment - D
HET-13	TFSH----CF	Broken fishplate leading to ECS or PCLS derailment - D
HET-13	TBKR----CF	Broken rail leading to ECS or PCLS derailment - E
HET-13	TBCK----CF	Buckled rail leading to ECS or PCLS derailment - E
HET-13	TTUNBKR-CF	Broken rail in tunnel leading to ECS or PCLS derailment - E
HET-13	TTWS----CF	Track twist leading to ECS or PCLS derailment - E

Risk – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
broken rail	0.12	0.36	1.54	0.015	0.071	0.53	0.0042	0.0055	0.0067
others	0.35	0.76	4.06	0.12	0.34	2.18	0.1459	0.40	0.56
total	0.47	1.12	5.59	0.13	0.41	2.71	0.15	0.40	0.57

Actions to mitigate risk

Network Rail's action is part of its overall programme of work to maintain and improve the quality on the network. It is based on developing a much better understanding of the status of all of the company's assets, using new technology such as test vehicles. This allows more frequent and more objective inspection, which is backed up by staff walking the track to examine those areas that the automatic test procedures have identified as suspect. More accurate location of faults, using differential GPS and improved maps, and a risk-based policy for prioritising actions, has allowed the faults to be characterised and dealt with efficiently and before they develop into serious hazards.

An example of the new thinking is the use of video cameras mounted on inspection trains to film the state of the track at normal line speeds. This generates vast amounts of data and therefore an automatic system is needed to reliably identify possible faults. For example, it is technically possible to automatically detect missing clips using pattern recognition software. Even if fault detection cannot be fully automatic, a system that draws the attention of an expert to a suspect section greatly increases productivity and hence improves the probability that faults are located before they become serious.

The work includes a wide range of activities:

- Changes to existing and issue of new standards for the minimum actions to be taken on the discovery of defects and the management of rolling contact fatigue.
- Changes in the frequency of inspection for rails in high risk areas such as level crossings, tunnels etc.
- Increased volumes of rerailing.
- Increased volumes of defect removal.
- Targeted rerailing particularly for specific rolling contact fatigue sites.
- Analysis of trends in broken rails both from type and cluster analysis to identify high risk components and sites.

- Increased inspection frequencies, where appropriate.
- Introduction of improved ultrasonic inspection equipment and techniques, use of the Sperry ultrasonic walking stick and Ultrasonic Test Vehicle offering near full rail head coverage as well as web of the rail.
- Introduction of rail grinding to better manage the wheel rail interface.
- Introduction of improved alumino thermic welding processes to reduce number of broken and defective new welds being installed.
- Improved and controlled welder competency initiatives.
- Introduction of new weld techniques such as mobile flash butt welding in track.
- Improved rail defect and broken rail reporting and understanding.
- Laboratory examination of large numbers of broken and defective rails to improve understanding of defects and root causes of breaks.
- Improved track quality.

Costs and benefits

The broken rail initiative is justified and funded on commercial grounds. Better knowledge of the state of the track assets leads to more efficient maintenance that may be scheduled rather than as an emergency response. ESRs are rare and disruptions to operations are greatly reduced. As well as reducing maintenance costs, the initiative reduces the probability of a broken rail occurring. That too has commercial benefits because of the damage to train operations caused by a broken rail and the reputation damage that would follow from even a minor incident. The initiative is part of "business as usual" for Network Rail and is budgeted through the next control period.

Even though the primary objective is commercial, there is clearly a significant safety benefit. In the absence of any other evidence, we assume that the impact of the broken rail initiative in 2005 will be similar to the last three years, so we estimate that the number of broken rails will fall by 20%, and the risk will be reduced by the same amount. This may be an overestimate of the programme has concentrated in the past on the rails that would present the greatest risk if broken, but new technology may offset this by improving the effectiveness of the initiative.

Risk reduction – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.09	0.2	1	0.03	0.1	1	0.03	0.1	0

Safety critical communications

Scope and level of risk

The Safety Critical Communications Focus Group (SCCFG)[3] has found that many accidents and incidents involve some sort of miscommunication. At least 5% of SPADs were principally caused by miscommunication last year[4] and at least 65% of possession irregularities could have been prevented if there had been accurate and clear communications[5]. Miscommunication often occurs when the usual pattern of service is disrupted. For example, weather related problems could result in a driver needing to contact the signaller and what starts as a routine communication could end up as an incident due to miscommunication.

We do not yet have sufficient information to calculate the level of all of the risk that may be in part attributed to poor communications, other than for SPADs. SRM includes six relevant precursors[6] for each of passenger train accidents and non-passenger train accidents.

Risk – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
passenger train	0.16	0.59	1.84	0.04	0.20	0.24	0.00	0.01	0.02
non-passenger train	0.05	0.15	0.25	0.02	0.15	0.08	0.02	0.03	0.07
total	0.20	0.7	2	0.06	0.4	0	0.02	0.0	0

This is approximately one third of the total SPAD risk after TPWS is fully deployed and all Mark 1 rolling stock replaced. The role communications plays in incidents and accidents is often underestimated because it is never an end in itself; it is always a way of achieving something else. For example:

- a decision on when to grant a T(ii) possession
- implementing a safe system of work, such as single line working
- managing last minute changes to agreed plans

Even though we cannot measure the exact contribution of poor communications, it is not difficult to see the potential scale of the safety and business risk. For example, a derailment arising from a miscommunication between a signaller and a PICOP as to the state of the infrastructure being handed back after a possession results in:

[3] SCCFG includes representatives of ATOC, Carillion, EWS, First Engineering, London Lines, Network Rail (HQ and East Anglia) and RSSB
[4] RSSB intelligence data collected for SPAD reports through SMIS
[5] "The role of communications failures in engineering work", Phillipa Murphy, 2002
[6] Ambiguous or incomplete information given by driver/signaller, Correct information given but misunderstood by driver/signaller, Information not given by driver/signaller, Signaller communication errors, Wrong information given by driver/signaller

- service disruption to affected and surrounding area
- incident response including the time spent by control, infrastructure incident response and operational incident response staff
- breakdown and recovery
- repair to infrastructure
- managers' time to investigate the incident
- investigation panel activities
- review of the incident and implementation of recommendations.

Actions to mitigate risk

SCCFG's aim is to direct and lead the progressive improvement of frontline operational communications. In order to do this it has adopted as its framework a model of culture change. This forms the basis for 8 key areas for action to improve communications. Objectives and action plans will be developed with industry parties to address each action area.

Step in changing culture	**Description**
Selection	*Identifying the right people with the appropriate attributes*
Competence	*Providing the appropriate knowledge and skills and opportunities for good practice so skills can be retained*
Assurance	*Ensuring systems are in place that assess and monitor the standard of communications*
Leadership	*Setting an example so that everyone is clear about the standards that are expected and their roles and responsibilities*
Awareness	*Implementing arrangements to ensure appropriate parties are aware of the initiatives being undertaken and resources available to improve frontline communications and to share good practice*
Rules and protocols	*Providing communications protocols and associated rules that are fit for purpose and which encourage structured communications including reminders and checklist that support real-time communications*
Equipment	*Providing the appropriate equipment that supports effective communications*
Investigation	*Ensuring the investigation processes accurately identify the frequency and nature of the communications risk and thus improve the intelligence available to the industry to effectively target the key issues.*

SCCFG will build on this action plan:

- an interactive CD-ROM is being developed to train and support assessors in assessing safety critical communications with a wider cross-industry focus
- a follow up to the 'Be First' training video titled 'Bat it Back' is being developed
- promotion of SCCFG, the video and CD-ROM, along with SCC Forums will coincide with the release of this Plan.

Costs and benefits

Most of the activities intended to improve safety-critical communications also fall within the scope of "business as usual", although Network Rail has proposed to target an extra £4M over the next three years. We estimate that this should reduce the risk from signaller error by 25%. This should reduce SPAD risk by around 8% per year, as well as reducing other risk contributions that we are not yet able to quantify. We also expect it to reduce service disruption and the costs of dealing with accidents that result from poor communications.

Risk reduction – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.02	0.1	0	0.00	0.0	0	0.00	0.0	0

Risk to the workforce

Scope and level of risk

We are committed to improving the safety of our workforce, not only because of our duties under HSWA but also because the employees of a well run railway should not experience the level of risk that we have at present. Improving the safety of our workers is an essential if we are to attract and retain competent people. As well as safety on railway premises, we are concerned about the safety of our workers when working away or travelling to other premises, both in the short and long term.

There are four groups of workers at the greatest risk: train drivers, train crew, station staff and track workers.

The risk to train drivers from train accidents is estimated by SRM to be 1.39 fatalities, 8 major injuries and 89 minor injuries per year without TPWS, falling to 1.06 fatalities, 6.5 major injuries and 87 minor injuries per year once TPWS is fully deployed.

Train crew are subject to the risk from on-train incidents and assaults. On-train incidents other than assaults[7] account for 9.6 major injuries and 1206 minor injuries, and assaults result in 4 major injuries and 800 minor injuries.

The main risk to station staff is assaults. The total risk from assaults to workers other than train crew gives rise to a risk of 14.4 major injuries and 874 minor injuries).

We include in the term “track workers” all those who build or maintain track, tunnels, bridges or signalling infrastructure. The total risk to track workers is estimated by SRM[8] to be 3.87 fatalities, 141.1 major injuries and 1711 minor injuries. We are very concerned that several track workers have been killed in the last two years. More than half of the risk is attributable to slips, trips and falls and a further quarter results from workers being struck by trains. The next most important group of risks all concern electrocution, accounting for around 0.5 fatalities.

Risk – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
train drivers	-	-	-	1.08	6.5	87	-	-	-
train crew	-	-	-	0	9.6	1206	-	-	-
station staff	-	-	-	0	14.4	874	-	-	-
track workers	-	-	-	3.87	110.6	1711	-	-	-
total	-	-	-	4.95	141.1	3878	-	-	-

[7] HEM 23 and HEM 34
[8] HEM 19 to 22 inclusive, HEM 24, HEN 21 to HEN 35 inclusive, HEN 60

Actions to mitigate risk

Train accidents and assaults are considered in other outline business cases. This one addresses the risk to track workers. The trackside is a difficult and irregular environment and we believe that the best way to reduce this type of incident is to reduce the amount of trackside work and the time pressure of short possessions. We have therefore identified the Green Zone Thinking Strategically initiative as an example to illustrate workforce safety issues.

However, slips, trips and falls are the most important component of the risk and we are working to reduce their incidence by improved authorised walking routes and better signage. During 2005 we will be developing plans to address the risk that our staff will be involved in road traffic accidents.

Green zone working

The rail industry has been cooperating since 2001 on the Green Zone Thinking Strategically initiative. The original remit was to explore ways of separating track workers from trains but the work broadened into a wider consideration of the management of track work. A six point strategy emerged that has been successfully tested in three pilot trials:

- automate inspection and mechanise maintenance
- design a reliable and low maintenance railway with good accessibility
- provide sufficient engineering access within the timetable
- maximise work efficiency by improving planning of work and possessions
- simplify Rules, Standards and methods of protection
- develop processes to start and finish possessions on time.

An example of the GZTS thinking is in the second point, on design. Trackside equipment should be modular so maintainers can rapidly change-out defective modules and replace them off track, it should be positioned off the track and facing away from the running line and the track and should use repeatable standard blocks allowing standard work methods.

The core of GZTS is cooperation. All those involved in arranging access for engineering works need to focus on whole industry benefit – not just industry.

We are committed to implementing the lessons of GZTS. The short paper “Green Zone Thinking Strategically” lists a programme of 37 recommended actions. Network Rail has stated that it will absorb the recommendations arising from the GZTS project into the way that it carries out its business and will monitor progress at its periodic review meetings with its maintenance and route directors. All other members of the rail industry will work with NR to achieve the benefits that GZTS offers.

Costs and benefits

The outcome was summarised by the Managing Director of one of the companies that took part in the pilots:

The process not only gave us a safer working environment for trackside workers, but also delivered improved productivity, better utilisation of existing possessions and improved train performance as emergency speed restrictions became non-existent.

We see GZTS as reducing our costs and improving the quality of service, independently of its safety benefits. We are confident that, if the lessons of GZTS were adopted throughout the UK by all members of the rail industry, we should be able to reduce the risk to track workers by at least 50%. This will take time to achieve, but we can see no reason why we should not reduce risk by at least 10% per year as the programme of actions is rolled out.

Risk reduction in 2005 – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	-	-	-	0.39	11.0	171	-	-	-

Risk to passenger

On-station hazards

Scope and level of risk

This framework for action is concerned with on-station hazards, which are primarily various types of fall. Assaults and train accidents are the subject of other frameworks.

The dominant source of risk to passengers when on stations is falling, either because they slip or trip on the platform or stairs or when boarding or alighting from a train. The Safety Risk Model (SRM) estimates of the level of risk from the five most important categories[9] are summarised in the table.

Event	SRM code	Events per year	Fatalities per year	Major injuries per year	Minor injuries per year
Passenger slips, trips and falls	HEN-14	2397	2.0	152	2283
Passenger falls when boarding or alighting train	HEM-9	472	0.5	24	459
Passenger falls from platform and struck by train	HEM-8	7.3	4.3	2	1
Passenger falls between train and platform	HEM-6	244	1.3	9	241
Passenger falls from platform – no train present	HEN-13	69	0.2	6	62
			8.3	**193**	**3046**

This is over half of the total risk from passenger fatalities and around 80% of the risk from major injuries. 32% of passenger fatality risk arises from falls from platforms. A further 20% arises from slips, trips and falls on railway premises and from accidents when boarding or alighting.

There are many causes of passenger falls. SMIS identifies some precursors, such as where the accident occurred (stairs, escalators etc) and contributory factors such as ill health (including the effects of alcohol) but this breakdown hides the true picture. Scanning the narrative reports in SMIS, and interviewing experienced safety staff show that there are often several contributory causes to one accident. Certain words appear repeatedly when reading the narratives – “rushing”; “alcohol”; “unsuitable shoes” or “high heels”; “pothole” or “rough pavement”; “heavy luggage”; and “wet

[9] Passenger slips, trips and falls; Passenger falls when boarding or alighting train; Passenger falls from platform and struck by train; Passenger falls between train and platform; Passenger falls from platform – no train present

platform", "food debris" or "pigeon droppings". In many cases it appears that the accident arose because of an unfortunate combination of these.

Actions to mitigate risk

It is not simple to find measures to mitigate the risk. Station managers exhort cleaners to better performance after someone slips on a discarded sandwich, but the victim might not have fallen if she had not been rushing to her train in high-heeled shoes. A leaking roof can be repaired to prevent a wet platform, but the surface might be adequately safe for a sober passenger.

We need to go back to the root causes and identify those that are under the control of the railway, why they exist, what the railway can do to mitigate them, and what are their other commercial implications. For example:

- rushing can be caused by a late platform change, driven by commercial priorities to keep to timetable. However, platform changes annoy passengers and can lead to knock-on effects on subsequent train movements. The need to rush can be reduced, and therefore the risk mitigated, by earlier platform announcements, good real-time signage, or even the introduction of ticket barriers that, as well as protecting revenue, restrict the rate at which passengers flow onto the platform;
- a "zero tolerance" policy on roof leaks or potholes would be very expensive and hard to justify. However, a policy of targeting known hazards could be very cost-effective. This is only possible if there is a mechanism to identify the locations or circumstances where accidents have been most frequent;
- infirm passengers or those with heavy luggage or children may be reluctant to use the lift rather than an escalator, even if recommended to use the lift by station staff, because the lift is poorly signed, slow and possibly seen as dangerous if security is in doubt.

The circumstances under which passenger fall accidents do or do not occur can be surprising. Very busy commuter stations, with considerable crowding, have relatively low rates of accident. This is believed to be because commuters travel regularly and are aware of the hazards. Less busy stations with a large fraction of tourist or casual travellers have a higher incidence of falls. Even simple hazards can be misleading. For example, the wide gap between the train and a curved platform at several London Underground stations causes relatively few falls, probably because of the frequent warnings and experienced passengers. Compare this with the carefully aligned train floor and platform height on newer services that can present higher levels of risk, possibly because the passengers stepping across the gap do not receive a visual cue from the movements of the passenger walking in front of them.

This indicates that there is no panacea to reduce the risk from passenger falls. The causes vary greatly between locations and types of service and passenger. A striking illustration emerges from the Case Studies, where the mitigation measure in one case is to remove barriers dividing stairs and in another case is to install similar barriers. Any systematic action to reduce this risk must rely on helping local managers and staff to identify the causes of risk and the measures to mitigate it, not telling them what to do.

There is also little point in collecting centrally (in SMIS) the very detailed site-specific information need to locate hazards. Rather, the central action should be to equip the local managers and staff with the tools to identify specific hazards and to determine the appropriate mitigation measure.

Case Studies

In these cases studies the safety benefits have been expressed in Equivalent Fatalities. The effect in terms of actual harm

Case study 1:Falls from train footboard

Several accidents had occurred when passengers had stumbled on the edge of the footboard when boarding or alighting at night, because it was hard to see where the footboard ended. The mitigation measure was to paint a 10mm wide strip of bright colour along the edge of the footboard.

Cost: The work was done over a period of a few weeks, while each carriage was undergoing scheduled maintenance. There are 1200 steps in the fleet, and if it is assumed that each step needed a total of 30 minutes labour at £20 per hour, the total cost was £12,000.

Benefit: There are no separate records of the number of falls from footboards, but it is estimated that there were around 10 passenger falls per year, as well as several falls by railway staff (including at least one major accident). Falls from footboards no longer occur. Assuming that each fall resulted in a minor accident, the benefit was at least 10 minor accidents avoided per year.

Case study 2:Removal of barriers

A wide flight of stairs into Slough station was divided by three handrails to make four separate lanes. The lanes were so narrow that one could be blocked by a passenger carrying a bicycle, and there had been several falls on these steps. The mitigation measure was to remove two of the handrails. At the same time, the ticket barrier was moved about 3m back from the stairs, which also reduced the risk from accidents.

Cost: The cost of the works to remove the handrails was around £5000, including the management time to oversee the work.

Benefit: The number of falls was estimated to be 18 per year before the modifications and around 8 per year afterwards. It seems reasonable to attribute half of the saving to the removal of the handrails and around half to moving the ticket barrier, so around 5 minor accidents per year were avoided as a result of removing the handrails.

Case study 3:Trolleys on escalators

There are four escalators between the Eurostar platforms and the arrivals hall. One of these (the D Ramp) is longer and steeper than the others and presents a risk for

passengers with loaded trolleys. The mitigation measure was to prevent trolleys entering the D Ramp, so that passengers with trolleys would have to use the other ramps that had a much better safety record.

Cost: A steel bollard was erected in front of the entrance to the D Ramp. The direct cost of this, including the design work needed for the modification, was estimated to be £12500.

Benefit: SMIS shows that there were 5 minor accidents due to trolleys in the year before the bollards were installed and none in the following year.

Case study 4:Lighting

There is a bridge at Ealing station where there have been several falls on the stairs. Both the natural and artificial lighting are poor. Thames Trains has estimated that good artificial lighting would significantly reduce the risk from falls on these stairs.

Cost: The cost of installing adequate lighting is estimated to be around £10,000.

Benefit: The safety staff estimate that around 6 falls per year are due to poor lighting, each of which results in a minor accident. Better lighting should eliminate these.

Case study 5: Camden Boulevard Project

This is an example from outside the railway. Camden Council set out to improve some of its streets by a campaign that included a “zero tolerance” approach to defective pavements, as well as many other enhancements such as removing flyposting and graffiti. It developed a special paving slab to tolerate more effective and frequent cleaning and laid these throughout the Boulevard area.

The campaign has been a great success. There was initial scepticism and even hostility from the local Press but, after 18 months, complaints were from the wards and streets that were not initially included. The Council Members have backed their officials to change the culture and to empower front-line staff and contractors who do much of the work to use initiative, not merely to comply with rules.

Cost: There are many elements to the Boulevard Project. The improvements to the pavements are the most expensive part, and have cost around £18M over the three years that the project has been running. Improving safety is only one of the objectives and it is reasonable to argue that only half of the cost should be attributed to safety. The cost is therefore estimated to be £9M, less any financial benefits of the improvements.

Benefit: Camden Council paid compensation for 189 pavement accidents in area covered by the Boulevard Project during the three years before the project started. There have been 5 claims in the same area in the subsequent three years. Payments for pavement accident claims have fallen from around £400K per year to zero, and the Council has reduced its insurance cover for contingent liabilities from £1.9M to

£800K (and expects to reduce it further). If it I assumed that the reduction in claims reflects a matching reduction in accidents, the benefits are 60 minor injuries per year avoided and around £500K per year saved from accident claims, including the cost of processing those claims and insurance premium. The Council has agreed to capitalise those savings over the life of the enhancements, estimated to be 15 to 20 years. Their Net Present Value, assuming a life of 15 years and discounting at 6%, is £5.1M.

Case study 6: Installation of barriers

There are two curved wide staircases up to each end of the main passenger footbridge at York station. Passengers tend to cut the corner to take the shortest route across the curve. This is believed to be the cause of many falls and minor accidents, and major injuries might occur. The compensation payments are small, averaging around £1500 per year, but might be much greater if there were a serious injury.

The recommended mitigation measure is to fit a central handrail, both to provide support for passengers and to stop them walking across the stairs. The building is Grade 2* listed and there are tenant businesses located under the stairs, but a feasible design has been prepared that has been accepted by HMRI (although the resulting aisles are slightly narrower than the recommended minimum).

Cost: The work has been designed and costed at £80,000.

Benefits: There are typically around 11 reported falls per year. Safety staff estimate that around half of these would be not occur if the handrails were installed, and that all reported falls have caused a minor accident. The saving would therefore be around 5 minor injuries per year, or 0.025EF per year.

Case study 7: Roof repair

There were many falls on wet terrazzo pavement on Newcastle station. The roof was repaired and the terrazzo replaced during 1999. There are many benefits from ensuring that the roof does not leak, but one important consequence for safety was that the terrazzo surface on the platform stayed dry.

Cost: The total cost of the roof repair is estimated to be £200K and that of the terrazzo replacement to be £100K. It is reasonable to attribute half of the cost of the roof repair to generally making the station a more pleasant place, so bringing other commercial benefits. The cost attributable to reducing falls is therefore around £200K

Benefit: Passenger slips, trips and falls on the terrazzo on Newcastle station were:

1997	1998	1999	2000	2001	2002
19	19	10	10	12	5

The number of STF accidents fell by around 10 per year. Assuming that half of these can be attributed to the drier platform and that each would have resulted in a minor

injury, because it was at least severe enough to be reported, the repair resulted in a reduction of 5 minor accidents per year.

Cost-effectiveness summary

The cost-effectiveness values of the seven Case Studies are:

Case study	Cost	EF reduction per year	total EF reduction (10 year life)	Cost-Effectiveness (£ per EF avoided over 10 years)
1	£12,000	0.05	0.5	£24,000
2	£5000	0.025	0.25	£20,000
3	£12,500	0.025	0.25	£50,000
4	£10.000	0.03	0.3	£30,000
5	£3.9M	0.3	4.5*	£870,000*
6	£80,000	0.025	0.25	£320,000
7	£200,000	0.05	0.5	£400,000

* over 15 years, which is the lower estimate of the life of the investment

Although there is a wide range in cost-effectiveness, it is clear that well-targeted investments to reduce the risk from passenger falls can reduce the risk by between around 0.1 and 5 EF per year for every £1M invested. We will assume that the typical figure for future investments is likely to be around 0.5 EF per year for every £1M. If we further assume that the effective life of the investments will on average be 10 years, the overall cost-effectiveness of those investments will be around £200K per EF prevented. Even allowing for the approximate nature of these calculations, this is well within the nominal VPF of £1.36M.

The Case Studies listed here are typical of the opportunities that exist throughout the railway to make targeted investments to counter specific hazards. We are confident that there are many more such hazards where investments like these could yield significant reductions in risk. In addition, there are two other benefits to the company carrying out the targeted investment:

- a reduction in the cost of processing and settling claims;
- improved operational efficiency.

Actions

Many of the measures needed to reduce the incidence of passenger falls lie well within the scope of the "well run railway". Good signage, accurate and early announcements of platforms, watertight roofs, clean platforms with no loose surfaces or potholes, and fast, reliable lifts all make the station operate more smoothly and contribute to punctuality and passenger satisfaction. Systematically improving the quality of stations and the reliability and consistency of operations should go a long way to reducing passenger falls and should pay for itself.

However, we believe that we can do more than this. Responsibility for identifying the hazards and selecting the mitigation measures lies with the station management. They would be greatly aided by a toolkit that brought together the considerable body of research into the causes and prevention of falls, both on the railway and

elsewhere. Having identified possible improvements, they have to get funding from their management to implement them.

RSSB will lead the development of a toolkit (analogous to the anti-SPAD toolkit) to help station managers identify areas or circumstances of particular hazard and to select the appropriate mitigation measure. This might include a simple map of the station, on which all falls are recorded together with details of the circumstances under which they occurred. The map could be backed up with a procedure - maybe a flow chart or simple computer programme - that takes the station manager through a systematic set of questions to identify the problem areas and the best measures for that station. The menu of measures should be based on a synthesis of the research and field experience of what has been shown to work.

We will encourage all station staff to use the toolkit as well as their common sense and everyday experience to identify opportunities to reduce the risk from falls on stations and to propose solutions to their managers. We will analyse each opportunity to estimate their contribution to safety and to the goal of a well run railway. We will strive to fund all those opportunities where we can show a good business case on grounds of safety or performance, and especially all those that contribute to safety and performance.

Costs and benefits

The preparation of the toolkit lies within the scope of RSSB's normal work, possibly with additional tasks that lie within the Rail Safety Research Programme. No new funding is needed for this.

The case studies show that well-targeted investments can reduce the risk by between around 0.1 and 5 Equivalent Fatalities per year for every £1M invested. We believe that there are many opportunities to make investments with an average cost-effectiveness of around 0.5 EF per year for every £1M. Our target of £5M per year should reduce the risk from falls by passengers by 2.5 EF per year. If the benefits of these investments are distributed in proportion to the current risk, the risk reduction is:

Risk reduction – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.48	11.3	178	-	-	-	-	-	-

On-train hazards

Scope and level of risk

There are several different types of harm that passengers are exposed to when on the train. The risk arising from crime (either route crime or assault) and from train accidents are not considered here because they are being addressed in a different

business case. The estimates given by SRM of the other on-train risk contributions are summarised below, together with the estimates of their frequency (including only to those events that lead to injuries). The risk is overwhelmingly to passengers; less than 1% of the risk is to staff and members of the public.

Event	SRM code	Events per year	Fatalities per year	Major injuries per year	Minor injuries per year
Evacuation following a stopped train	HEM01	0.40	0.00	0.1	0
Passenger falls from train in running	HEM02	10.67	1.66	1.0	6
Passenger struck while leaning out of train	HEM03	9.33	0.31	2.3	7
Train overcrowding	HEM13	6.33	0.00	0.7	6
Passenger on-train incident	HEM33	701	0.00	11.7	787
			1.97	**15.8**	**806**

It is clear that three types of event dominate the risk: on-train incidents, falls from trains in running and passengers leaning out of trains.

Seven types of on-train incidents contribute 98% of the risk from this type of incident:

- on-train slips, trips and falls (22%)
- defect on the train (21%)
- caught by internal doors (17%)
- struck against object eg fixed seating (15%)
- struck by falling or displaced luggage (10%)
- scalds or burns (7%)
- caught on sharp object (6%)

99% of the risk from falls from trains in running occurs with slam door rolling stock.

Actions to mitigate risk

Almost all of the fatality risk and much of the risk from on-train incidents will be removed when the last of the slam door rolling stock is taken out of service and replaced by new trains that have automatic doors, sealed windows and better internal design, including improved internal doors and luggage racks and fewer projections. We therefore do not propose to take any further action to mitigate the on-train risk to passengers.

We will of course continue to monitor the risk after the slam door trains have been removed and will, if necessary, introduce measures in future plans.

Costs and benefits

All of the costs of removing the slam door rolling stock have now been incurred or committed so we do not foresee any additional costs.

This will eliminate the risk from falls from trains in running and of passengers leaning out of trains, and we estimate that it will halve the risk from on-train incidents. However, most of the slam door trains have been replaced since the current edition of SRM was published (February 2003). We estimate that 75% of this safety benefit has already occurred, so the improvement in 2005 will be only 25% of the current risk. We do not anticipate any increase in risk. In principle new rolling stock might be less reliable increase the number of train faults leading to stopped train and evacuation, but the new rolling stock is all of classes that we have already used so many of the teething troubles have already been identified and eliminated.

Risk reduction – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.49	2.3	102	0	0	0	0	0	0

Summary of costs and benefits

Our plans to reduce risk on stations are expected to cost up to £5M per year and to reduce risk by 0.5 fatalities, 12 major injuries and 200 minor injuries, as well as bring unquantified operational benefits. Our existing programme to replace slam door trains is expected to reduce on train risk by around 2 fatalities per year and a further 3 EF per year from the reduction in injuries (major and minor injury breakdown not available).

Risk reduction – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
on station	0.48	11.3	178	-	-	-	-	-	-
on train	0.49	2.3	102	0	0	0	0	0	0
total	0.97	13.6	280	0	0	0	0	0	0

Risk associated with public behaviour

Public behaviour is a generic term that covers route crime (formerly referred to as trespass and vandalism), personal security and suicides. These have been brought together in this outline business case because the causes are often related, and because the actions that can be taken to mitigate the risk are often the same, or at least form part of a suite of measures.

We work closely with the police and security authorities to play our part in countering terrorism. It would not be appropriate in this document to describe the counter-terrorism measures that we will implement, or their expected costs and effectiveness.

Route crime

Scope and level of risk

Route crime includes a wide range of criminal activity that is specific to the railway environment. It ranges from anti-social behaviour to activities with the potential to cause a large-scale loss of life that can result in convictions for manslaughter. The railway industry has a significant role in reducing route crime which it is pursuing vigorously, but this element of the Railway Strategic Safety Plan requires a greater degree of input from outside agencies than any other.

The scale of route crime is very significant. It is estimated, for example, that around 640,000 objects are placed on tracks each year. Passengers in most urban areas can hardly fail to be aware of graffiti which disfigures buildings, bridges and retaining walls, signalling equipment, signs and rolling stock; it is often obvious that the perpetrators must have put themselves at significant risk to get it there. In 2002/03 there were 12,786 recorded acts of vandalism, the great majority of which affected the line of route.

SRM identifies five precursors involving vandalism: Passengers struck by objects thrown by vandals through train window, Train crew struck by objects thrown by vandals through train window, Train derailment cause by vandalism, Train collisions caused by objects placed on the line by vandals, and Train fires caused by arson/vandalism. SRM's estimate of the risk is:

Risk – vandalism -events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.11	3.0	135	0.05	1.3	158	0.13	0.1	0

Trespass is the most prevalent form of route crime. Trespass on the railway is an offence under section 16 of the Railway Regulation Act 1840, section 23 of the Regulation of Railways Act 1868, section 55 of the British Transport Commission Act 1949 and railway byelaws. The requirement to ensure that fencing is provided and maintained goes back to the Railways Regulation Act 1842. Nevertheless, in spite of

the antiquity of these laws, there is a widespread perception that it is acceptable, or at least not serious, to trespass on the railway. In fact, 52 deaths resulted from trespass in 2003, which excludes suicides and suspected suicides. Fatalities and major injuries result from being struck by trains or electrocution. Electrocution is most common in areas with third rail electrification; although most people will understand the purpose of overhead wires, it cannot be assumed that the public generally realises that rails can be electrified. It is reasonable to assume that railway trespassers must suffer a significant number of slips, trips and falls, although most of these events probably go unreported.

Child trespass is a particular concern. Although the proportion of child trespassers suffering a fatality is smaller than for adults – possibly because children are more agile – we recognise that we must make greater efforts to protect children. Whereas adult trespassers generally use the railway as a shortcut, children often see the railway as an exciting playground. There are frequent reports from drivers of children playing 'chicken', where children dare each other to be last to cross in front of a train, and whilst this does not usually result in a fatality, it can be very distressing for the driver. Children are of course less likely to be aware of the consequences of their actions.

SRM[10] estimates the total risk to be:

Risk – trespass – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	-	-	-	-	-	-	45.33	23.0	12

Much route crime is relatively low level and can be classified as anti-social behaviour (ASB). This includes graffiti, groups of young people hanging around stations in the evening and bad behaviour on trains. Although ASB does not of itself create a safety risk, preventing it is an important part of dealing with route crime and preventing violent crime such as assaults, arson and robbery. At a minimum, ASB deters people from using the railway. There is also extensive evidence that early intervention to deal with minor offences can prevent the perpetrators moving on to more serious crime, including violence and criminal damage. The "broken windows" model of policing has successfully reduced serious crime by creating an environment in which even minor faults – graffiti, litter and literally broken windows – are not acceptable. The so-called "zero tolerance" policy in New York is a good example, although that term has come to imply a harsh and oppressive policing regime rather than a constructive process to ensure that the environment is not conducive to crime.

There were 2,679 recorded instances of missiles striking trains in 2003. Typically, the perpetrators are children and it is not always necessary for them to gain access to the infrastructure. Missiles thrown from the lineside are most likely to break train windows causing cuts and eye injuries to passengers. Objects dropped from bridges

[10] HEM 25 and HEM 26

may smash cab windows, potentially injuring the driver. The risks are estimated by SRM[11] are shown in the table.

Risk – missiles – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0	2.0	133	0	1.0	147	-	-	-

Trespassers also vandalise the signalling system. This is unlikely to lead to safety risk because of the fail safe nature of the equipment, although it can cause serious service delays. There have been isolated reports of attempts to obscure signals or smash signal lenses but these are not easy and drivers would stop at obscured signals. More disturbing are the attempts to derail trains by placing concrete blocks, sleepers or even motor vehicles across the line, and train fuel tanks can be ruptured by striking objects.

The main risks that have been quantified here are summarised below.

Risk – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
vandalism	0.51	2.8	61	0.51	2.8	61	-	-	-
trespass	-	-	-	-	-	-	45.33	23.0	12
missiles	0	2.0	133	0	1.0	147	-	-	-
total	0.51	4.8	194	0.51	3.8	208	45.33	23.0	12

There are also substantial financial costs. The annual cost to the industry of route crime has been estimated to be £233 million[12]. For example, the cost of objects placed on the line includes repairs to equipment, recovery, accident investigation and delays and cancellations. Trespass, including train surfing, causes delay and cancellation costs.

INCIDENT TYPE	**ANNUAL COST £million**
Object on the line	77.4
Throwing missiles	35.6
Trespass	74.3
Fire at station	0.8
Train fire	3.3
Line-side fire	1.4
Damage to power systems	10.2

[11] HEM 04, HEM 18, HEN 36 to 43 inclusive
[12] Vandalism Cost Model – Project Report, RSSB, March 2004

Damage to signalling systems	11.1
Damage to structures and fencing	16.3
Damage to telecommunication equipment	2.8
Total	**233.2**

Route crime causes approximately 775,000 minutes delay per year, making almost £40M at an average cost of £50 per minute.

There may be costs arising from criminal prosecutions and civil proceedings where it is alleged that railway companies have failed to ensure the security of the lineside. In one recent case the infrastructure controller and an infrastructure contractor were fined a total of £300,000 following the death of a four year old boy. The child had been electrocuted after gaining access to a live rail. As well as the tragedy and the direct financial loss, the companies' reputations are damaged.

Actions to mitigate risk

The National Route Crime Group (NRCG) has been established with wide representation including BTP, SRA, ATOC, HSE, RPC, Network Rail and the trade unions to develop a new strategy. NRCG takes an overview of national and regional trends, and plans and coordinates national initiatives.

In developing initiatives to deal with route crime, it is essential to involve outside agencies and NRCG provides an industry point of contact for engaging central agencies such as the CPS and the DfT. NRCG also promotes good practice and coordinates research. Drawing all these strands together, the NRCG now publishes an annual plan that sets out the initiatives it intends to pursue over the forthcoming year.

NRCG will base its initiatives on four strands: enabling, education, engineering and enforcement.

Enabling

We have established the Community Safety Support Unit for a trial period of two years. This will provide a focus for all our efforts to deal with route crime.

Community Safety Support Unit

CSSU's main role is to serve as a cost-effective rail industry resource developing, facilitating and supporting stakeholder partnership activities to mitigate the risks posed by inappropriate community behaviour. CSSU will act as a focal point that helps stakeholders achieve consistency of approach and economies of scale across a range of related community safety initiatives.

CSSU is funded directly by RSSB's research and development programme for a two-year trial period from May 2004 to May 2006. The progress and performance of the CSSU will be regularly monitored by a senior level stakeholder review panel.

Network Rail has recently revised its standard RT/CE/S/072 on the "Management of Unauthorised Access to the Lineside". Network Rail has developed a route crime tool designed to inform the process of lineside security risk assessment. This involves logging route crime activity, using SMIS data and other sources, in order to identify significant clusters of activity (this includes suicides away

from stations). A risk assessment is carried out to determine whether a location should be identified as a hotspot; a proforma is used which asks such question as whether there are signs of regular unauthorised access, and what evidence there is for lineside activity by children, such as dens and rope swings. This information is then used to develop and deliver route crime education programmes targeted at schools and youth groups in areas of high risk, and therefore to improve the effectiveness of the existing programme. The information is also passed on to trackside workers and contractors to ensure that the area is kept clear of redundant materials at all times.

Education

Education remains a significant element in the effort to reduce route crime. The recent accreditation of the *Trackoff* website has provide the opportunity for the schools education programme to be developed, backed up by a national rail crime campaign.

We will develop accreditation and training for those giving classroom presentations. It is essential that the success of the industry's website is backed up by the ability to provide quality speakers. A Managing Trespass Symposium has been held during 2004 providing the opportunity to learn from international experience.

We will also educate our workforce, so that infrastructure workers, in particular, are aware of the risk from route crime and the part they can play in reducing it, for example by ensuring that access gates are secured after use. We place emphasis on community partnerships eg with Youth Offending Teams and Crime Reduction Partnerships.

In the long-term, we will campaign to change public perceptions about behaviour affecting the railway. Changing public perception is difficult but not impossible. The rail industry will work with wider government crime initiatives. The success over several decades of campaigns against drink-driving illustrates what can be done. Changed attitudes towards smoking is another example of how public perception may change over time. This represents the best hope of a significant permanent reduction in the risk from route crime.

The railway industry will implement the NRCG National Plan comprising*:*
MAKE SURE THAT THIS IS CURRENT VERSION

- Development of community partnership initiatives
- Initiation of a long-term campaign to change public perceptions
- Establishment of a national route crime support unit
- Accreditation of classroom presenters
- Education of the industry's own workforce to become more aware of the potential implications of their actions on route crime
- Continuation of the policy of erecting robust lineside fencing where justified by the risk
- Pursuit of tidy linesides including demolition of redundant buildings
- Exploitation of the opportunities for complementary policing (accredited railway staff, special constables etc)
- National roll out of dedicated route crime police officers initiative

Engineering

There are several engineering solutions to route crime. The most visible is lineside fencing, and Network Rail has invested heavily over recent years in robust fencing. The highest priority for this will be at locations with a history of child trespass.

A tidy lineside is also important. Not only does new equipment, scrap materials and rubbish tipped by neighbours offer miscreants the ammunition they need, it also gives the impression of a neglected environment which tends to encourage vandals. Similarly, derelict buildings spoil the appearance of the railway and are an attraction for young people.

Enforcement

The Railway Safety Accreditation Scheme Regulations, which became law in 2004, give certain enforcement powers to accredited railway staff. This, together with the recruitment of special constables and the potential use of Community Support Officers, offer the opportunity to provide significant back-up to traditional policing operations. Anti-social behaviour orders (ASBOs), which have already had success in dealing with persistent offenders, are another new development in enforcing the law on railway premises. ASBOs have proved particularly successful in tackling graffiti.

BTP will work with the railway industry to use the latest ASB legal powers to reduce fear of crime and to prevent crime hotspots emerging.

One experiment has been to dedicate two police officers based in North West England to dealing with route crime issues. Their duties include staking out known hotspots, checking on the security of access points (for example, making sure that gates are locked), liaising with the local community, visiting offenders and their parents and issuing police cautions. They are not used for other routine policing duties such as escorting football supporters. The intention is that the effort is primarily proactive – crime prevention rather than dealing with the aftermath of an incident. We will assess the success of this experiment and consider extending this scheme nationwide.

British Transport Police will continue to build up a national graffiti database. Graffiti vandals use personal tags to show where they have been – the object being to achieve the greatest exposure of their personal tag. This helps the police because they are able to build up a case against an individual and demonstrate a pattern of offending. The database has shown that offenders sometimes travel substantial distances to spread graffiti.

Costs and benefits

Although some of the measures to reduce route crime such as improving lineside fencing do incur capital cost, much can be done by improving day-to-day

management. This means, for example, proper maintenance of existing fencing, staff vigilance including ensuring that incidents are reported, and good housekeeping.

The cost of the BTP initiative is that of employing two police constables, around £100k per year. If the scheme were to be rolled out nationally, the cost would be around £1million per year. We believe that it is reasonable to expect the work of each officer to prevent one crime per week, leading to a total reduction of around 1000 crimes per year if the scheme were national. If half of these crimes are acts of vandalism and the scheme takes 4 years to become established nationally, it would reduce vandalism by around 2% in 2005.

We estimate that the other initiatives that we are taking would lead to a similar reduction, so we estimate that route crime would fall by around 4% in 2005. This is expected to save the industry around £9M per year in 2005. The savings in delay costs alone amount to £1.6M, and the effect on safety risk is summarised below.

Risk reduction – route crime -events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.02	0.2	8	0.02	0.2	8	1.81	0.9	0

Personal security - assaults and other violent crime

Scope and level of risk

Surveys of public concern about safety on the railways often highlight personal security as a significant issue. Over 9,200 violent offences relating to the mainline railway were reported to the British Transport Police in 2003 – a 15% increase on 2002. Assaults constituted 70% of this figure, which includes robbery and sexual offences. Although the risk for an individual of becoming the victim of a violent crime when using the railway is very small, nevertheless the problem is significant, and it is growing. Perceptions of this type of crime are also important because they deter potential customers – 5% of non-rail users cite personal security as a reason not to travel by train. Surveys indicate that around 20% of passengers report cause for concern during their current or previous journey. In general, train operators whose services include local journeys in urban areas have a higher level of concern than, for example, long distance operators.

The statistical data of the risks of assault is inconsistent. SRM uses the data available to the railway, primarily SMIS. This will include almost all incidents where the victim is a member of railway staff, but many passenger victims will report an incident directly to the police, usually by dialling 999. Like all police forces, BTP maintains a crime recording system. BTP's system (called PINS) records all of the reported crimes that any police database would record and also the incidents that are crimes on the railway but not elsewhere, such as trespass.

The result is that SRM estimates the risk of assault to be predominately to railway staff, whereas experienced BTP officers estimate that between 80% and 90% of the victims are passengers or members of the public. We will use the SRM figures for risk but recognise that these may underestimate passenger harm by a factor of 10 or more.

Risk – assault and violent crime events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.66	9.7	183	0	18.4	1667	-	-	-

Revenue protection staff and others who carry, or who have access to, cash are particularly vulnerable but anyone in uniform is a potential target. The cause may be frustration at journey delays, an attempt to avoid paying a fare or a general grudge against anyone perceived to be in authority.

We have carried out extensive research into assaults on the railway. This has identified several hotspot stations, where the number of recorded assaults represents a relatively high proportion of the number of passengers. Although a high proportion of these are in inner city areas where this problem might be anticipated, a significant number are in suburban or even rural locations, perhaps associated with particular local circumstances. Hotspots do change over time, however. The research has also built up a typical profile of victims that shows that young males are most likely to suffer assaults.

As well as a safety risk, the total cost to the railway industry of assaults is around £12.4 million per year[13]. Because of the 'hotspot' nature of assaults, this cost falls disproportionately on different train operators. The total cost to society as a whole of assaults on railway premises (taking into account, for example, medical costs) is estimated at £168 million.

The principal element of cost to the railway industry resulting from assaults is delay. Data from TRUST indicate that the 50% of those physical assaults that caused any train delay caused less than 8 minutes, while 10% result in 40 or more delay minutes. The figures for verbal abuse are 5 minutes and 21 minutes respectively. The average cost per minute delay is £50[14]. The other principal cost in the case of staff assaults is sickness absence. Analysis of SMIS data suggests that about 17% of staff who suffer physical abuse take time off work. Around 5% of staff subject to verbal abuse take time off. There are other costs, including - in the case of passenger assaults - lost revenue from the victim. Assaults serious enough to attract media attention will also

[13] Assessing the Costs of Assaults, RSSB, May 2003
[14] Made up of direct compensation to passengers, lost revenue due to passengers choosing other modes of transport, and performance penalties levied by the SRA.

result in lost revenue as potential passengers opt for other modes of transport, although this is difficult to quantify.

The cost of an individual assault incident to the industry will depend on who was assaulted, where and when it took place, and the severity of any injuries. A fracas requiring police attention on a peak period train at a busy point on the network is likely to result in a very high cost whereas the cost of an assault on a passenger at a station may be negligible. A single on-train physical assault on a member of staff is estimated to cost an average of £1,761 and £372 for a physical assault on a member of staff elsewhere.

Actions to mitigate risk

Violent crime on railway premises is part of a general law and order problem in a local community, and the issue should not be seen in isolation. There is no reason to believe that violent criminals target the railway specifically, except in so far as stations are a natural local focus, although the frustrations associated with travel and late night drunkenness may also be factors. The fear of violent crime on the walk to and from stations can be a deterrent to using rail services – one which the industry can do very little about.

We have established the Rail Personal Security Group (RPSG) covering violence towards staff and customers. Like other national initiatives, it brings together stakeholders to ensure a coherent and consistent approach. The actions that we will pursue to mitigate the risk include some which should also reduce minor vandalism. For example, graffiti creates an environment that both encourages crime generally and increases the fear of crime, so we will pursue offenders and remove their work as quickly as possible.

Station design is also important in improving actual and perceived personal security. Clear sightlines and good lighting and visibility help to create an environment in which it is more difficult for criminals to operate. This is not easy in older premises that seem almost to have been designed to achieve the opposite. Engineering solutions, such as CCTV and help points, can deter offenders and some train and station operators employ security personnel to give a high profile presence.

We will continue to install CCTV cameras on trains, particularly those that have few train crew such as commuter and DOO trains. This normally allows for the coverage of the entire seating area within a coach and can act as a deterrent for incidents such as arson, vandalism and assaults to passengers and staff. The evidence collected from the cameras can also be used in prosecutions and there is now widespread acceptance that this information can be used to secure convictions.

Costs and benefits

One TOC's experience of installing CCTV at most of its stations shows how effective such measures can be. The initial costs included installation of the cameras and communication links, and project management. Ongoing costs were rental and

maintenance costs for communication links, reactive maintenance and ongoing replacement costs. The total costs were estimated to be £5.8 million. The TOC estimated that the direct cost savings amounted to £3M. In addition, there are indirect commercial benefits because passengers are more confident that they may safely use the service.

Estimating the outcome for violent crime is difficult because changes in the Home Office crime reporting standard. The current BTP target is to achieve a 7.5% reduction in reported violent crime by December 2005, although it looks unlikely that this will be achieved in full, mainly due to the changes in the reporting standard. However, a 2.5% reduction over one year appears to be an achievable aim, and based on the 2003 figure of 6,468 assaults this would mean about 162 fewer assaults, resulting in a saving to the industry of around £300, 000[15]. The corresponding reduction is safety risk is:

Risk – assault and violent crime events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
	0.02	0.2	5	0	0.5	42	0	0	0

Suicides

Scope and level of risk

Suicides on the railway are a serious concern, principally because of the traumatic effects on drivers and other staff, but also because of their impact on performance. There were 179 suicides and suspected railway suicides in 2003, a reduction of 12.7% from 2002. The long term trend in the number of suicides is falling in the UK, and it is likely that many of the initiatives we have taken to deter trespass also deter suicides. There is, however, evidence that the risk has shifted to stations, where access to the railway is generally easiest. These now represent over 40% of the total.

It is estimated that each suicide event costs the industry £52, 642, totalling £9.4M in 2003. This includes a monetary estimate of the effects of trauma suffered by those who witness the event and its aftermath and the costs of staff sickness absence and train delays.

Actions to mitigate risk

Although suicide hotspots have been identified, generally in the vicinity of major mental health facilities, suicide is its unpredictable. There is evidence that the

[15] Based on annul cost of assaults that is estimated at £12.4m.

enhanced lineside fencing now installed in many urban locations has deterred suicides at those sites, but the proportion of suicides at stations is increasing. It has also been suggested that some features of station design, such as island platforms, may make them more prone to suicides, but research into these factors is still at an early stage.

To determine whether railway suicides have particular characteristics that might beneficially be addressed, the then Safety and Standards Directorate of Railtrack PLC co-sponsored with the National Health Service in Yorkshire a three-year project called Suicides and Open Verdicts on the Railway Network (SOVRN). The research phase of the project concluded in September 2002. A research project then identified emerging findings and indicated how they could be applied as mitigation measures. The Rail Fatality Management Group is a national initiative to coordinate efforts to counter suicide on the railway.

We will build on SOVRN's conclusion that the key to reducing railway suicides is local intelligence. Local liaison, with police and mental health units, in particular to identify the level of risk on a continuous basis, will allow preventive measures to be taken against a known threat. The measures will range from permanent barriers, which hinder access to railway property, to additional police or station staff at identified hotspots.

We are very concerned by the impact that the suicide has on our staff. We will always assume that the train driver will suffer a degree of trauma. Other railway staff, and passengers who may have witnessed the event from a station platform, need to be monitored. Train and station operating companies will have specialist medical advice on call. In addition, RSSB will conduct research into the possible application of 'buddy-buddy' counselling systems to support train drivers; this approach is already being applied successfully by foreign railway administrations, notably Deutsche Bahn which suffers around 1000 suicides per year, over 5 times our total.

Costs and Benefits

The cost of the measures implemented as a result of SOVRN is estimated to be £0.5M per year, assuming that 20 staff members are involved across the industry, each spends one half of his/her time on suicide issues and the cost of employment is around £50K per person year.

Although the number of suicides fell by 12.7% in 2005, the trends in suicides are not sufficiently well understood to assume that this will continue, possibly because the mitigation measures taken so far have prevented those events that were easiest to deter. A reasonable expectation is that the number of suicides will fall by 5% during 2005, a risk reduction of approximately 10 fatalities to a member of the public. The economic benefit to the railway is estimated to be around £0.5M, similar to the cost of the measures used. We have included the psychological injury to our staff within the estimate of financial costs. We do not include suicide victims within the total risk of the railway so it is not appropriate to include this estimate of the reduction in risk.

Summary of costs and benefits

Risk reduction – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
route crime	0.02	0.2	8	0.02	0.2	8	1.81	0.9	0
assaults	0.02	0.2	5	0	0.5	42	0	0	0
total	0.04	0.4	13	0.02	0.7	50	1.81	0.9	0

Enabling Safety Improvement

Competence

Competence is defined in the Railway Safety Strategy as 'the ability to undertake responsibilities and to perform activities to a recognised standard on a regular basis.' There can be no commitment to doing things in safe ways if the recognised standard is not understood in the first place. Competence applies to both to individuals – at all levels – and to organisations. This means that although an organisation may employ competent individuals, as a whole it may fail to demonstrate competent behaviour; however, no organisation can behave competently if its employees do not have the competency to carry out their jobs.

Competence consists of attitudes, behaviour, confidence and cultural environment for risk making decisions alongside skills and experience. Traditionally, employment on the railway was seen as a 'job for life', where most staff joined at a young age with a gradual promotional structure. Today, employees tend to be recruited for specific positions and stay for a few years. Furthermore, since privatisation it is more difficult to gain a holistic overview of how the industry works. It is therefore not surprising that the changing employment pattern and fundamental changes in organisations structure results in loss of competence.

Competence means the ability to undertake responsibilities and to perform activities to a recognised standard on a regular basis. Competence is a product of practical and thinking skills, experience and knowledge, which is influenced by personal attributes such as attitudes, beliefs and values. The precise combination required depends on what needs to be done, in what circumstances and how well. A person, a team of people or an organisation is competent when they work consistently to an expected level of performance. Expected levels of performance change over time

The industry's safety leadership programme has been developed to address these issues. This is directed at giving senior managers the competency to be able to lead by example. Importantly, it also brings to together leaders from the disparate parts of the industry in an environment where safety is the topic for discussion.

National Context

The context must be set at the national level. This is why the National Safety Task Force (NSTF) developed a set of core safety values to be applied across the industry. These values are:

- Commitment - Safety is the first consideration in everything we do - if it isn't safe we don't do it
- Leadership - Safety begins at the top - we walk the talk and set a visible example
- Openness - Safety is openness – information is shared and investigation conclusions are open to all parties

- Reporting - Safety is knowledge – we report every incident and take immediate remedial action
- Responsibility - Safety is everyone's responsibility - we learn from mistakes and we will not tolerate negligence
- Measurement - Safety needs a common measure - we shall use Lost Time Accidents and other appropriate measures

These values are supported by a set of rules developed by Network Rail, constituting a code of practice to influence behaviour that is intended to apply across the industry.

Commitment and Leadership

One proven way in which senior managers can demonstrate safety leadership is to undertake joint safety tours. This is now a well-established practice within the industry and RSSB publishes a good practice guide setting out how best to undertake these tours. The tours provide an opportunity for the manager to learn what is really going on whilst also demonstrating his personal commitment to the values listed above. Employees see the manager actively setting an example. Ideally, safety tours should be seen as one aspect of a broader based 'back to the floor' initiative. Other activities might include attending local safety committee meetings and a personal involvement with accident investigations. Middle and junior managers see this as reinforcing their own efforts and employees see that senior management cares for their interests. It is also the opportunity for senior managers to really understand how well their safety management system works in practice.

However, it is not enough for the senior manager to just demonstrate his or her commitment; that commitment needs to percolate down to middle and junior management. Senior management safety tours are inevitably only an occasional event, whereas management at more junior levels is regularly seen 'on the shop floor'. Personal safety objectives are an effective method of cascading core safety values. Too often, however, these have been set as a 'bolt-on' to other personal objectives that a manager might receive. This sends out the wrong message and it is essential that safety objectives are both meaningful and integrate with the normal work of the manager. This applies equally to individuals who might not have direct safety responsibilities – all parts of an organisation need to be involved.

Case Study

Derailment at Kings Cross, September 2003

On 16 September 2003 the 0700 London Kings Cross to Glasgow Central derailed on the pointwork in the throat of Kings Cross station. Although there were no injuries, the incident received a great deal of attention in the media and services were severely disrupted for several days. The formal inquiry revealed a number of underlying causes including non-compliance with existing rules and a series of management failures in the planning of possessions at Kings Cross.

On departure from Kings Cross, the train became derailed because it was signalled over a route with incomplete track, following engineering work that had taken place during the night. This happened because signals had not been disconnected, nor had the preceding points been secured with clips and scotches, in such a way as to prevent access to the incomplete route.

The inquiry found that there had been insufficient time to properly prepare the overnight work because of strict compliance with a track standard which required a defect to be removed within 36 hours. This led to the failure to complete a method statement. In addition, last-minute work was undertaken within the possession, which turned out to be excessive for the time available. Furthermore, the inquiry discovered that a key rule book requirement, governing signal disconnections, was never complied with at Kings Cross because the layout was perceived to be too complicated. There were also significant failures to communicate between the engineers on the ground, between the engineers and the signallers and between signallers.

A derailment in similar circumstances that took place at Aldwarke, South Yorkshire, less than a year previously, held many lessons that were applicable in this case. Although evidence existed that these lessons were included in the cascade briefings held both by the infrastructure controller and the contractor, it was found that not everyone had received the briefing and where it had been briefed, recollection of the contents were sketchy.

Two features of this incident are relevant. Firstly, time constraints led to hasty and inadequate planning and mandatory requirements were overlooked. Secondly, there seems to have been a prevalent attitude that Kings Cross was a special case; generic requirements could not be applied there and lessons learnt elsewhere were not relevant.

Opportunity investment

Scope and level of risk

Opportunities arise to achieve safety improvements as part of other investments in the railway. If these opportunities are grasped when they arise, the cost can be much less than if they were undertaken in isolation. For example, tactile surfaces at the edge of platforms are relatively inexpensive if installed as part of a general upgrade to the platform but might not be reasonably practicable if the full cost of replacing the surface had to be justified on safety grounds alone.

This approach was taken for the MKIV "Mallard" refurbishment, where several safety features were incorporated that took account of lessons learnt from recent accidents but which could not have been justified other than as part of a wider upgrade. The features include: "Anti-missile plates" above the bogies to prevent fragments of broken wheel from penetrating (Sandy); self contained emergency escape guidelighting (Great Heck), Laminated sidelights that also improve the picking up the interior ambience (Potters Bar) and "K-Tex" window breakers (Ladbroke Grove).

The objective of this outline business case is to ensure that opportunities to make safety improvements at modest additional cost are not overlooked.

Actions to mitigate risk

We will seek opportunities to make safety investments whenever we are planning a major project. Opportunity investments are best identified early in the lifecycle of a project so that they may be planned into the work. We will encourage all of our staff, especially but not only those who are responsible for planning and design, to look for opportunities to include worthwhile safety enhancements within their projects. We will also encourage front-line operational staff to suggest safety enhancements that could be carried out as part of a major project.

When an opportunity arises, we will subject it to the same rigorous assessment of value for money as any other proposal, but we will be looking for opportunities that would not satisfy our investment criteria were it not for the opportunity offered by the project. In all projects funded by SRA, a business case will have to be submitted for the benefits of additional investment and SRA will make a transparent decision on accepting it.

Costs and benefits

We have deliberately chosen a modest level because an increment of this proportion is well below the uncertainty of costing major projects. Although we do not suggest that this makes its cost negligible, we believe that the margins of error in the costing process are such that an increment of risk proportions would be acceptable to the funding authorities.

We estimate that viable opportunities would exist in around 1 in 5 major projects, with a total annual budget of £1B, so the total value of the opportunity investments will be around £10M.

We expect that that the average cost per fatality avoided will be around the VPF, so £10M per year should reduce risk across the railway by around 6 Equivalent Fatalities per year. The total risk arising from all types of incident is around 200 EF per year, so the opportunity investment on the scale proposed should reduce risks by, on average, around 3% per year.

If this reduction occurs equally in all groups and in proportion to the current total levels of risk on the railway, we can estimate the reduction in fatalities and injuries for each group.

Risk reduction in 2005 – events per year	Passenger			Workforce			Member of public		
	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries	fatalities	major injuries	minor injuries
Current risk (with TPWS and all Mark 1 replaced)	17.63	256.1	5119	5.21	171.2	6355	72.88	73.3	120
Reduction (3%)	0.52	7.5	151	0.15	5.0	187	2.15	2.2	4