Taking Safe Decisions -
how Britain's railways take decisions that affect safety

This document has been superseded. Please go to -
## Contents

Overview ......................................................................................................................... 3  
Glossary of terms ........................................................................................................... 5  

### PART 1

1. Principles ......................................................................................................................... 8  
   1.1 Background ............................................................................................................... 9  
   1.2 Duty holder principles ............................................................................................. 10  

### PART 2

2. The Decision taking framework ..................................................................................... 14  
   2.1 Overview ................................................................................................................... 15  
   2.2 The Decision taking framework ............................................................................... 17  

### PART 3

3. Worked examples ......................................................................................................... 40  
   3.1 Introduction .............................................................................................................. 41  
   3.2 Removal of fire extinguishers ................................................................................ 41  
   3.3 Fitment of sanders .................................................................................................... 43  
   3.4 Adoption of GSM-R and removal of Signal Post Telephones ......................... 46  
   3.5 Track circuits or axle counters ............................................................................... 48  
   3.6 The length of driver walkways ................................................................................ 51  

4. Abbreviations ............................................................................................................... 53  

5. References .................................................................................................................... 54  

This document has been superseded. Please go to - [http://www.rssb.co.uk/risk-analysis-and-safety-reporting/risk-analysis/taking-safe-decisions](http://www.rssb.co.uk/risk-analysis-and-safety-reporting/risk-analysis/taking-safe-decisions)
Overview

Almost every policy, investment or operational decision taken by the GB railway industry has an impact on safety. It is therefore vital that safety considerations are embedded effectively into the decision-taking process.

Taking safe decisions follows an extensive programme of research, analysis and consultation, which RSSB carried out to clarify how this balance is achieved. It describes the industry consensus view of how decisions should be taken that properly protect the safety of rail industry staff, passengers and others, satisfy the law and respect the interests of stakeholders, whilst remaining commercially sound. The document was developed by a Think Tank of industry experts, and has been endorsed by the industry through the Safety Policy Group and RSSB Board. It has also been developed in tandem with internal guidance on cost-benefit analysis (CBA) in support of safety-related investment decisions produced by the ORR for its own inspectors.

Taking safe decisions states that in the GB railway industry duty holder decisions which impact on safety are taken:

• In order to meet legal requirements.
• Because they are sensible from a commercial perspective.

These different decision types have different implications and involve different considerations; all are clarified in this document. The understanding and clarity that the document brings may result in changes to what has previously been done in some parts of industry. Key clarifications are:

• Societal concern about risk impacts on government decision taking. The document states that societal concern should not be taken into account by duty holders when deciding whether a measure is necessary to ensure safety so far as is reasonably practicable (SFAIRP). However, the impact of societal concern on a company’s reputation might mean that the company takes account of it optionally for business reasons.

• A judgement about whether a measure is required to ensure safety so far as is reasonably practicable might be supported in some circumstances by a cost-benefit analysis (CBA). Specific guidance about how to construct a CBA for this purpose is included in section 2.2.3.

• This document clarifies that application of the tolerability of risk (TOR) framework presented by the HSE in Reducing Risks, Protecting People is not a requirement of the Health and Safety at Work Act etc 1974 (section 1.2.3). The TOR framework is a conceptual guide for regulators that may help duty holders manage and prioritise safety activity by providing an alternative perspective on risk.

Taking safe decisions describes these key principles in full and provides guidance on what they mean in practice for those taking decisions that impact upon safety. The hierarchy of documents forming and supporting Taking safe decisions is outlined in the diagram below.
Taking safe decisions consists of three parts:

Part 1
A statement of principles.

Part 2
The decision taking framework, which describes how the principles can be put into practice.

Part 3
A set of worked examples to show how the decision taking framework should be applied.

The route to Taking safe decisions is a record of the logical, practical and legal arguments behind the industry consensus set out in this document. It is a useful reference for anyone wishing to understand the basis of the industry consensus position described in Taking safe decisions in more detail. For more information, visit the following page on the RSSB website: http://www.rssb.co.uk/safety/safety_strategies/sdmoukr.asp

NB: Taking safe decisions presents the industry’s considered response to questions raised by How safe is safe enough? (2005). How safe is safe enough? has therefore now been withdrawn.

Part 1 of the document should be of interest to both senior managers and safety practitioners. Parts 2 and 3 provide guidance targeted at safety practitioners.


This document has been superseded. Please go to -
Glossary of terms

ALARP/SFAIRP

The Health and Safety at Work etc Act 1974 places duties on employers in the UK to ensure safety ‘so far as is reasonably practicable’ (SFAIRP). When these duties are considered in relation to risk management, the duty is sometimes described as a requirement to reduce risk to a level that is ‘as low as is reasonably practicable’ (ALARP). These terms therefore express the same concept in different contexts and for all practical purposes should be considered synonymous.

Collective risk

The collective risk is the aggregate risk, possibly to a range of different exposed groups, associated with a particular scenario, control measure or hazardous event. Collective risk can be quantified as the average number of fatalities, or fatalities and weighted injuries, per year that would be expected to occur. When undertaking an assessment of whether or not a measure is necessary to reduce risk to a level that is ALARP, the change in risk associated with the measure is a collective risk estimate.

Safety consequences

The number of fatalities, major injuries and minor injuries, including those due to shock/trauma, resulting from the occurrence of a particular hazardous event outcome.

Duty holder

A railway undertaking, infrastructure manager or other railway industry entity to which duties under the Health and Safety at Work etc Act 1974 apply.

Fatalities and weighted injuries (FWI)

For the purpose of assigning monetary value to risk, major and minor injuries are weighted in recognition of their relatively less serious outcome in comparison to a fatality. The weightings at the time of publication are:

<table>
<thead>
<tr>
<th>Unit of loss</th>
<th>Fatalities</th>
<th>Major Injuries</th>
<th>Reportable Minor Injuries</th>
<th>Non-Reportable Minor Injuries</th>
<th>Class 1 Shock/trauma</th>
<th>Class 2 Shock/trauma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighting</td>
<td>1</td>
<td>10</td>
<td>200</td>
<td>1000</td>
<td>200</td>
<td>1000</td>
</tr>
</tbody>
</table>

where:

- A fatality is defined as death within one year of the causal accident.
- A major injury is defined as injury to a passenger, staff or member of the public as defined in schedule 1 of RIDDOR 1995, or where the injury resulted in hospital attendance for more than 24 hours.
- Reportable minor injuries are physical injuries to passengers, staff or members of the public that are not major injuries and are reportable under RIDDOR 1995.
- Non-reportable minor injuries are physical injuries to passengers, staff or members of the public that are not major injuries and are not reportable under RIDDOR 1995.

Class 1 Shock/trauma injuries relate to witnessing fatality incidents and train accidents (collisions, derailments and fires).

Class 2 Shock/trauma injuries relate to all other causes of shock/trauma such as verbal assaults, witnessing physical assaults, witnessing non-fatal incidents and near misses.

Frequency

The frequency of an event is the number of times it occurs over a specified period of time (eg the number of events per year).
Hazardous event

A hazardous event is an event that has the potential to lead directly to death or injury (e.g., derailment, collision, or fire).

Individual risk

Individual risk relates to the probability of fatality per year to which an individual is exposed from the operation of the railway. Individual risk is a useful notion when organisations are seeking to understand their risk profile and to prioritise and target safety management effort. The Office of Rail Regulation (ORR) categorises individual risk as 'unacceptable', 'tolerable', and 'broadly acceptable' for the purposes of prioritising and targeting its enforcement activity.

Industry

This primarily comprises companies who require certification or authorisation of their operations under the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS), but excludes the Regulator and Government.

Risk

The risk of an event is calculated by multiplying its frequency with the severity of its consequences. The Safety Risk Model (SRM) calculates risk in units of FWI per year.

Societal concern

Societal concern refers to the concern and anxiety that the public feels about different types of risk. This concern might not reflect the true level of risk, is influenced by dread and other subjective or emotive feelings, and might change considerably following the occurrence of an accident. Societal concern about risk can result in pressure on the railway that is disproportionate to any objective evaluation of risk. It is not taken into account in the industry's determination of whether measures are reasonably practicable, although it can impact a company's profitability and performance, and therefore may be a factor in a commercial judgement.
This document has been superseded. Please go to -
1.1 Background

In the GB railway industry, almost every policy, investment or operational decision taken has an impact on safety; therefore, consideration of safety must be embedded effectively into such decisions. Taking safe decisions outlines the principles that duty holders in the railway industry apply in order to do this. These principles are applied so that decisions taken properly protect the safety of rail industry staff, passengers and others, satisfy the law, respect the interests of stakeholders, and are commercially sound.

The principles applied to decisions are:

- Railway companies want their staff to work, and passengers to travel, in a safe environment.

- Safety is good for business: it is in the commercial interests of companies to be, and to be seen to be, safe. Many decisions which impact upon and improve safety are actually taken voluntarily for commercial reasons. These decisions are often complex and involve issues like performance, profitability and the long-term reputation of the company. They are taken by companies through choice and may go beyond strict legal duty.

- Safety is a legal duty: decisions that affect safety must comply with the criminal law and not leave railway companies liable to civil actions. Railway companies assess how to meet their legal duty by applying professional judgement and analysis of risks and costs. Decisions taken to meet a legal duty are mandatory.

Followed consistently, the principles result in sensible decision taking, which helps duty holders to continually strive to reduce risk, whilst not allowing a culture of risk aversion to affect decisions. This approach allows duty holders to reduce risks and to protect staff, passengers and the public whilst acting as responsible custodians of the resources that are invested in the industry. These principles apply directly to the decisions of a single railway company and when two or more companies work together to manage a hazard that they share.

This document stresses that the principles applied by duty holders are distinct from those applied by the government when taking policy decisions. This reflects the differences in its authority and responsibilities from those of the industry. The government can mandate measures on the railway industry that reflect societal concern (based on public attitudes and opinion) in addition to the underlying level of accident risk. The government mandates these decisions (such as the removal of Mark 1 rolling stock from the network and the programme to install a form of train protection) on the industry as specific legal requirements, although the industry may not itself have identified them as being reasonably practicable by application of the principles outlined here.
1.2 Duty holder principles

There are two sets of considerations applied by duty holders to any decision which affects safety. If a measure is legally required, then it must be implemented. However, often in the railway industry, decisions are taken which impact upon safety but are not legally mandated. A duty holder might choose to implement measures that go beyond what is reasonably practicable for a variety of commercial reasons but is not legally obliged to do so. The duty holder may therefore choose not to implement such measures, or may decide to remove them at a later date (as long as it can be proven that they were beyond what is reasonably practicable).

1.2.1 Application of business principles

Most decisions in the railway industry are taken to meet sound business objectives, rather than any legislative requirement. These objectives are often complex and take account of a wide range of factors, including safety, performance, customer service and cost.

Safety can impact upon business considerations in many different ways. Societal concern about accidents might have real commercial impacts. The damage to a company’s reputation from being associated with an accident can be substantial. Loss of confidence in a company’s safety performance can significantly affect passenger numbers and hence revenues. In such a situation, there may be pressure to apply draconian risk control measures to regain passenger confidence, which may affect performance. Public and media perception that a company has a poor safety record, whether justified or not, can also affect the attitude of potential and current employees and result in low company morale. These perceptions can also affect shareholders and therefore impact directly on a company’s worth.

Often, major commercial decisions in the railway industry concern investment, renewal and the introduction of new technology, including, for example, new rolling stock or signalling systems. These are complex business decisions taken to improve performance, reliability and customer service. Whether or not to go ahead is rarely a question of legal necessity on safety grounds alone. However, safety is always a key concern; such investment provides a key mechanism by which safety is improved in the industry.

Fundamentally, safety makes good business sense. For a variety of commercial reasons, a railway company may wish to take an approach to control a specific risk to protect its staff or its passengers to a level greater than that which the law would require or that generally applies to those same individuals elsewhere in society.

1.2.2 Application of legal principles

Railway companies must be careful to ensure that they take all decisions that are necessary to meet their legal duties. To do this there are, broadly, three steps to follow.

First, any specific safety measures required by law are identified and implemented. An example of such legislation is the Railway Safety Regulations 1999, which mandated the fitment of a train protection system and the modification and removal of Mark 1 rolling stock.

Secondly, each railway company must identify the scope of its undertaking and the hazards that result from its activities. The Health and Safety at Work Act 1974 (HSWA) imposes a duty to ensure the safety of people affected by the undertaking so far as is reasonably practicable. The scale of risk arising from all hazards should therefore be evaluated.

Thirdly, in order to determine what is reasonably practicable, a reasoned judgement must be made that balances estimates of safety benefits against estimates of costs (time, money and inconvenience). There are various ways in which this can be determined whether or not the test has been met. If there is established good practice, and it is valid and appropriate in the circumstances, the practice is likely to be reasonably practicable. Established good practice takes several forms. For example, the industry maintains a suite of Railway Group Standards using a process of continuous review and update. Technical Specifications for Interoperability, mandatory for new or upgraded interoperable systems, may also suggest good practice in other circumstances, where they are found to be valid and appropriate.

Where no established good practice exists, judgement must be based on an estimation of costs and benefits. Balancing costs and safety benefits can be undertaken qualitatively or quantitatively.
many cases, simple inexpensive controls can be adopted on the basis of qualitative analysis, using professional judgement.

However, a more quantitative approach, using formal cost-benefit analysis, may be used to support a judgement when:

- The risks and/or controls are complex.
- The costs are high, either for a single location or when applied to similar situations across the whole network.
- There are a number of alternative options and it is not immediately clear which is the most effective and efficient.

In such circumstances, the cost per statistical fatality avoided (CPF) is compared with the value of preventing a fatality (VPF), which is issued by the Department for Transport in its publication Highways Economic Note 1. When safety improvements are being considered and the cost is less than the monetary value of the safety benefit determined by applying the VPF, the improvements are (generally) implemented. Where the cost is above the monetary value of the safety benefit, professional judgement is applied to determine whether the cost is grossly disproportionate to the safety benefit and it is reasonably practicable to implement the improvement. In making this judgement, particular attention is paid to:

- The degree of uncertainty in the assessment of costs and safety benefits.
- The range of potential safety consequences.

Where risks are difficult to quantify, a similar depth of analysis might be applied using qualitative techniques, such as structured workshop assessments supported by expert judgement.

Any determination of what is reasonably practicable should be subject to a final sense check, asking whether it is objectively reasonable to implement the safety measure in these particular circumstances. This check involves taking a step back to see if any decision indicated by the assessment seems sensible and appropriate. This judgement is a wholly objective one – it does not take into consideration societal concern or any other intangible or subjective factors.

It is acceptable to remove risk controls if we judge that they are no longer reasonably practicable. This situation might arise in the light of changed circumstances (such as the introduction of other control measures) or improved understanding of the level of risk. Similarly, as circumstances differ between locations, there is no requirement to apply control measures which have been found to be reasonably practicable in one particular location to other similar locations (unless the circumstances are found to be exactly the same).

In order to demonstrate that a decision is sound, it should be documented together with the reasoning that supports it.

### 1.2.3 Risk to individuals

When setting priorities for the development of further risk control measures, consideration is given to individual risk (the levels of risk to which individuals within particular segments of the population are exposed). However, this is a separate consideration to the legal duty, and does not relate directly to the duty to ensure safety so far as is reasonably practicable.

The Health & Safety Executive guidance publication, Reducing Risks Protecting People (2001) [Ref: 1], describes a tolerability of risk framework based on the risk to which individuals are exposed. Risks to individuals are categorised as 'unacceptable', 'tolerable' and 'broadly acceptable', with different priorities identified for each category.

The tolerability of risk framework is a conceptual model and its application is not mandated through legislation. The assessment of the level of individual risk depends largely on the selection of the segment of the population. There are no legislated quantified boundaries between the different ranges. However, in Reducing Risks Protecting People, the HSE has suggested guidelines of 1:1,000,000 fatality risk for the boundary between broadly acceptable and tolerable, and 1:10,000 (public) and 1:1000 (workforce) fatality risk for the boundary between tolerable and unacceptable.

In the railway industry, most population groups fall within the tolerable range and for such risks railway companies are committed to developing and evaluating options for further risk reduction and implementing those that are reasonably practicable.

In some cases, the risks are considered so low as to be broadly acceptable, ie they are generally
considered to be insignificant and adequately controlled. In these cases, there is no requirement for systematic evaluation and risk reduction, although there is still a requirement to implement any further measures which are reasonably practicable.

However, there may be some population groups where the risks to individuals is assessed as within or approaching the unacceptable range. In these cases, a high priority is allocated to the active development and evaluation of options for further risk reduction. Those that are reasonably practicable are implemented.

In summary, the legislative requirement to reduce risks, so far as is reasonably practicable, and the application of the VPF, applies equally in respect of all segments of the population regardless of the particular levels of risk to which they are exposed as individuals.

However, the priority and effort applied to analysing risks and evaluating potential measures for further risk mitigation increases in line with the level of individual risk. Further explanation of what this means in practice is provided in section 2.2.1.

Figure 1: The HSE’s tolerability of risk framework
Part 2 - The Decision taking framework

This document has been superseded. Please go to -
Introduction

In part one, we outlined the high-level principles for taking decisions in the GB railway industry. In part two, we suggest a framework for translating those principles into practical action.

Taking safe decisions is based on the fundamental principle that duty holders need actively to take decisions that impact upon safety and should not let inaction occur by default. Even if (ultimately) the correct decision is to do nothing, it is important that duty holders undertake an appropriate degree of analysis in support of a decision and are clear about the reasons why a particular way forward has been taken.

A framework for taking decisions that affect safety is set out. The framework does not describe a mechanistic process; rather, it suggests the stages that the decision taker might choose to follow and identifies the issues that need to be taken into account at each stage. Decisions that affect safety must always use judgement. This framework provides a structure to help a decision taker consider the options open to them, analyse these options at an appropriate level of detail and reach a clear judgement on the basis of the analysis.

The sequence of steps and the logic are the same whether the decision is taken by local or senior managers over a period of days or by the board of a company, possibly in consultation with the Regulator and Government, over months or even years.

2.1 Overview

Different types of decision are taken in the railway industry. For example:

- Duty holders may decide to take a decision because they judge that it is necessary in order for the company to meet its legal duty.
- Duty holders may decide to take a decision because they believe that it makes commercial sense for their business.
- Policy makers may choose to take policy decisions.

This document describes a process that duty holders can apply when taking decisions. It does not describe how government policy decisions are taken, other than to clarify that such decisions are distinct from those taken by duty holders. Detailed guidance on how such policy decisions are taken is described in the HSE document Reducing Risk, Protecting People [Ref 1].

Figure 2 shows how the legal duty relates to the decision taking process we subsequently describe in section 2.2.

Duty holders must comply with any mandatory requirements. There are various actions that duty holders must undertake to ensure that they are fulfilling their legal duty with regard to safety. The primary legislation regarding safety is HSWA.
For the railway industry, further duties are set out in the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS). ROGS substantially implements European legislation outlined in the Railway Safety Directive. Additional specific legislative requirements also exist in given circumstances.

HSWA states that it shall be the duty of every employer to ensure, so far as is reasonably practicable (SFAIRP), the health and safety and welfare at work of all his/her employees. Duty holders must identify all activities arising within the scope of their undertaking, assess the risk created by these activities and ensure SFAIRP the safety of those exposed to that risk. If a duty holder judges that a measure is legally required, it must undertake that measure.

A company might also choose to implement measures that go beyond the legal duty, for commercial, reputational or other reasons. This is a voluntary decision – the company is not legally obliged to do so. There are many such decisions in the railway industry.

It is critically important that duty holders record why a particular decision has been taken as well as the evidential basis for that decision. This document provides guidance to help duty holders generate the evidence to take their decision on the basis of clear criteria and then record the decision taken.

The feedback arrow on Figure 2 indicates how, in some circumstances, policy makers take decisions which might not pass the test of reasonable practicability that the industry applies to itself. If this is the case, then these decisions may be mandated upon the industry, for example by legislation.

Figure 2: Different types of decision and their relationship to legal duties
2.2 The Decision taking framework

The framework shown in Figure 3 consists of four sequential logical steps with feedback:

- **Scoping:** what is the nature of the decision, who should take it and what are the possible courses of action?
- **Analysis:** how do rules and good practice, quantitative and qualitative analysis, targeted engagement and strategic analysis help me to reach my decision?
- **Decision:** based on analysis and understanding of the problem, what decision should be taken and for what reason?
- **Review:** does the decision make sense? Over time, what does experience tell me about the decision taken?

This framework describes how to put the principles described in *Taking safe decisions* into practice. In particular, it spells out the differences between the criteria applied to decisions when:

- Judging whether or not a particular option is necessary to meet a company’s legal duty.
- Deciding whether or not an option should be taken voluntarily because it represents a sensible commercial/business decision.

Although the framework presented in Figure 3 is presented as a linear process, it is in fact iterative. At each stage of the process, the decision taker might uncover new information or gain improved understanding which would cause them to question previous assertions and assumptions.

Further detail is provided on how to apply each stage of the decision taking framework in the sections which follow. A running example of a decision problem, involving passenger security at stations, is used to illustrate the approach.
2.2.1 SCOPING

The need for a duty holder to take a decision that impacts on safety might arise in a number of different ways. For example:

- An incident might cause a duty holder to reconsidere or re-evaluate the levels of risk from certain hazards.
- A previously unknown hazard might be identified.
- New technology might become available which can be implemented to improve performance and reliability of the railway and hence impact upon safety.
- Equipment might be life expired, triggering decisions about how it should be renewed.
- New legislation might be passed mandating a certain approach.
- Local complaints might arise that draw the duty holder's attention to a specific safety issue.
- Through systematic periodic review of an activity or standard.
- The duty holder might become aware that a particular group is exposed to a comparatively high level of individual risk.²
- Operating conditions may change.

The above list is not exhaustive. Duty holders' safety management systems will describe the processes that they follow to ensure that they continually review, and effectively manage, safety. RSSB has produced various guidance documents which help to explain how safety decision taking links into duty holders' Safety Management Systems [Ref: 2, 3].

Where engineering change is being considered, such as the introduction of novel systems or equipment or introduction of major change or upgrades to the railway system, extensive additional guidance to that included here is provided in the ‘Yellow Book’ [Ref: 4].

² Individual risk is the probability of fatality per year to which a category of individual is exposed. Individual risk is a useful notion when duty holders are seeking to understand their risk profile and to prioritise and target safety effort. It estimates the net effect on safety of a range of different control measures, from the perspective of hypothetical individuals. If a category of individual is identified as having a relatively high level of individual risk, further investigation would be sensible. The duty holder might consider the effectiveness of the various existing measures that control risk to that individual. Alternatively the duty holder might consider if any additional control measures were warranted. However, the determination of whether each measure was necessary to reduce risk ALARP would ultimately be based on the change in collective risk, rather than any individual risk estimate.

For example, train shunters currently have the highest level of individual risk of any category of individual on the railway (the average fatality rate per shunter is 1 in 5200 years according to 2007 figures). Given this information, it would be sensible for duty holders to ensure that all reasonably practicable control measures are properly in place to protect them (eg training, shift planning, safe systems of work etc). Any judgement of whether further measures (for example fitting autocouplers to trains) should be implemented to reduce risk ALARP would be based on an assessment of the collective risk reduction that the measure would achieve, rather than the absolute level of individual risk to shunters.
2.2.1.1 Determining the nature of the problem

The first step in the scoping of the decision is to analyse and understand the nature, size and complexity of the problem. Figure 4, below, is presented as an aid to scoping and characterising a decision.

One end of the arrow at the bottom of the diagram points towards immediate decisions – decisions characterised as simple, well understood, mature, urgent, small scale or local. These decisions may be taken on the basis of judgement by front line operational staff and may involve application of rules or good practice. At the other extreme, some decisions are of a much greater scale and scope, and require industry to work together to agree the way forward. These decisions are characterised as complex, uncertain, novel, considered, large scale or national. Most decisions fall somewhere between these two extremes.

The diagram can be used to get a feel for the type of decision being dealt with by marking which responses are most applicable to each question and drawing a vertical ‘best fit’ line accordingly. This line can then be extended to the diagram of analysis methods (Figure 7) to assist with application of the next stage of the framework (analysis, see section 2.2.2).
At this point, it is sensible to ask what criteria might be applied to take the decision so that the analysis can be targeted to provide the evidence needed.

Are it likely that certain risks need to be addressed to ensure that the company is meeting its legal duties? Are there sensible business reasons for implementing a measure? These considerations will come to the fore when the decision is taken (see section 2.2).

2.2.1.2 Deciding who should take the decision

Decisions should be taken by the person closest to the subject who has sufficient authority and expertise. Many routine decisions are, and should be, taken by front-line operational staff. Routine decisions are usually well understood and there may be established good practice. At the other extreme, some decisions are of a scale and scope that affect the industry as a whole and are taken collectively (for example, the decision to adopt the European Railway Traffic Management System (ERTMS)). There is a wide range of decisions between these two extremes, as Figure 4 illustrates. All potential decision takers should know the scope of their authority and the company's principles for decisions that affect safety, so that they may be delegated to the appropriate level. Not all workers will consciously apply this particular framework, but the underlying principles should still be apparent in the approach that they take to their particular decision problem.

2.2.1.3 Deciding on the options for resolving the problem

The decision taker should consider the various options for resolving a problem. The aim is to consider or list all of the possible choices of action, including 'do nothing'. The decision to 'do nothing' should be recognised as a conscious choice, rather than the default outcome of inaction. Each of the options is then investigated in the analysis that follows.

2.2.1.4 Illustrative example

The application of the ‘scoping’ stage is illustrated in the following example, which concerns measures to address the issue of, and concerns about, passenger security at stations. It is a running example and is used to illustrate the application of each subsequent stage of the process.
Figure 6: Illustration of how the scoping diagram might be completed for the example

PASSENGER SECURITY EXAMPLE

SCOPING: The safety manager of a company notices that there are an increasing number of passenger complaints about security incidents on the routes that it operates. At the same time, staff security has become a key issue of concern for unions representing front-line train and station staff. The safety manager reviews the ‘nature of the decision’ by completion of the scoping diagram. The decision is moderately complex and he/she decides it will eventually need to go to the company board for consideration.

After contemplating a wide range of potential measures, the safety manager eventually decides to consider three possible options for how to proceed in these circumstances:

• Option 1: The introduction of passenger security teams at locations on the route.
• Option 2: The installation of a staff alarm system.
• Option 3: Do nothing.

The ‘nature of the decision’ might be somewhere in the middle of the ‘scoping’ diagram in this case, as is shown in Figure 6. First, the appropriate responses would be made to each of the queries on the left-hand side of the diagram; then, a ‘best fit’ line would be drawn:

Figure 6: Illustration of how the scoping diagram might be completed for the example
2.2.2 ANALYSIS

Analysis informs decisions and provides evidence to show that they have been soundly and consciously taken. In this framework, we describe five categories of analysis and evidence: rules and good practice, quantitative analysis, qualitative analysis, targeted engagement and strategic analysis.

Figure 7 provides a general indication of the significance of different analysis methods given the complexity of a decision. The horizontal axis is the same as that shown on the ‘scoping’ diagram (Figure 4). The ‘best fit’ line drawn on the ‘scoping’ diagram can be extended onto this ‘methods’ diagram to provide an indication of the type and extent of analysis that might be appropriate. The relative height of the bands indicates the relative importance of

Figure 7: ‘Methods’ diagram, indicating the weighting of various analysis methods depending on the complexity of a decision. The diagram is annotated to show the relative complexity of worked examples described in Part 3.
each method in the decision-taking process. The framework does not create a rigid set of barriers between different components of decision taking. Instead, it is used to indicate the broad emphasis we might apply to each of the components when taking a decision. The diagram is annotated with examples of where different decisions might sit on this axis.

Decisions to the extreme left of the diagram are determined by application of rules and standards. These decisions do not involve a deliberative process, and instead rely on the competence and knowledge of front-line staff.

2.2.2.1 Rules and good practice

Rules

In some circumstances in the railway industry, particular actions and responses to risk are mandated. In this document, the term ‘Rules’ refer to all of the prescriptive, formal, legal and contractual requirements with which the railway must comply. There may be specific legal requirements relevant to the management of railway risk. For example, Technical Specifications for Interoperability (TSIs) are mandatory for new or upgraded systems or assets on certain designated sections of the network. Specific legislation to address safety issues has been passed, such as the Railway Safety Regulations 1999, which prohibited the operation of unmodified Mark 1 rolling stock (except in certain circumstances) and the use of slam-door rolling stock; it also mandated use of a train protection system.

Railway Group Standards are technical and operational standards which set out the requirements where co-operation between duty holders is required in the management or operation of the GB mainline railway. These standards are applicable to infrastructure managers and railway undertakings operating on the network; they are also mandatory. Company standards and procedures are mandatory for employees of the company to which they apply.

European legislation also sets rules for the industry to apply. The Interoperability Directives set out a number of essential requirements to be met for interoperability, which include safety, reliability and availability, health, environmental protection and technical compatibility along with others specific to certain sub-systems. TSIs define the technical standards required to satisfy those essential requirements. Where the TSIs contain an error or an Open Point, or where a derogation has been granted, National Technical Rules (NTRs) have been supplied to the European Commission to describe the agreed GB railway approach to meeting the essential requirements.

Duty holders need to consider whether rules are appropriate to their particular circumstances. If they believe that rules are not appropriate then any deviation should be the result of a considered decision that follows the correct process. Further information on the role of standards in managing safety at interfaces is available from the RSSB website.3

Good practice

‘Good practice’ refers to measures, actions, procedures or specifications considered appropriate by professionals based on either experience of their application or a consensus view. Good safety practices is likely to ensure that risk is reduced ALARP. Applying good safety practice removes the need to assess safety risks from first principles, as well as providing quick and effective guidance as to how to proceed in particular set of circumstances.

Good safety practice might include:

- Guidance Notes.
- British and Euronorm standards.
- Codes of Practice.4
- Company Standards and Railway Group Standards.5

The less formalised good practice is, the greater the onus placed on the individual to determine its appropriateness (and whether it is a suitable proxy for what is reasonably practicable). Good practice should only be used if it is applicable to the given circumstances. If this is not the case, then the reasons why it is not applicable should be recorded. Good practice does not stand still – new good practices emerge over time (in response to incidents, in light of better information, or as new technology or techniques become available, for example). Where good practice has moved beyond being just an effective solution to becoming an established de facto way of working, it becomes close in status to a formal rule. Companies which did not wish to apply it would need to be confident that it does not, in fact, represent a reasonably practicable approach in its particular circumstance.

A measure is not necessarily good practice just because it has been implemented by a duty holder at a particular location or set of locations on the network. The circumstances in which the measure is applied are likely to differ from location to location. Alternatively, it may be the case that, in applying the measure, the duty holder decided to go beyond what was reasonably practicable. Ultimately, whether the measure should be applied depends on whether it is judged to be reasonably practicable, taking account of the specific circumstances of the given operation, its cost of application and the risk reduction it achieves (see section 2.2.3.1).

2.2.2.2 Quantitative and qualitative analysis

This section summarises the concepts behind risk and its estimation and analysis. Guidance can also be found in the ‘Yellow Book’ [Ref. 4] which describes an approach to managing risk arising from engineering change and maintenance.

Risk

Risk is expressed as the product of the frequency of an event, and the consequences of that event, where the frequency is quantified as the estimated number of events occurring per year, and the consequences are quantified as the fatalities or fatalities and weighted injuries (FWI) expected given the outcome of that event.

The frequency of a hazard or an accident, and the severity of its likely consequences, can be estimated using knowledge about the previous history and rate of occurrence of similar events. For example, if a duty holder has experienced approximately 100 slips, trips and falls’ in each of the last three years, resulting in approximately 100 reportable minor injuries. In each year, they might estimate their risk from slips, trips and falls to be approximately 0.5 FWI per year (based on a ratio of 1 fatality to 200 reportable minor injuries).

However, in making such estimations, the analyst must consider how representative the occurrence rates and severities of past events are to estimates of future risk. For example, the duty holder might revise the risk estimate for ‘slips, trips and falls’ described above to a lower per year figure on the basis that the circumstances had changed, for example if they had recently improved the flooring surface in the stations which they operate.

Risk assessment can provide a key input to a decision, but the analysis should only form one part of the decision-making process.

Risk can be calculated and aggregated in different ways. Collective risk is the aggregate risk estimate from one or more control measures or hazardous events. Generally a range of different people are exposed to this risk to varying degrees. In contrast individual risk is the risk to a category of individual circumstances.
Individual risk and collective risk are related however they are conceptually very different and are NOT interchangeable. Section 2.2.3.1 explains that decisions about whether or not a measure is reasonably practicable are based on the change in collective risk that the measure achieves.

Uncertainty

As accidents and their consequences are difficult to predict, the estimation of risk is an inherently uncertain process. Uncertainty is particularly likely when trying to estimate the risk associated with high-consequence, low-frequency events such as train collisions. There are two reasons for this. These incidents:

- Are rare so there is, by definition, little past data to use to develop estimates of risk.
- Can result in a wide range of consequences, the severity of which can vary greatly. For example, the Ladbroke Grove accident resulted in 31 fatalities. The accident at Southall was similar in many ways, but resulted in seven fatalities.

Conversely, the risk associated with high-frequency, low-severity incidents can be ascertained more easily, as there should be more historic data available to support risk estimation. The degree of uncertainty in risk estimates should be considered and factored into any judgement that the risk estimates are used to inform.

Quantitative risk assessment

The estimation of risk is sometimes undertaken numerically using a quantified risk assessment (QRA). This will comprise analysis supported by available data and the use of expert judgement.

QRA is particularly useful where some comparison of risk before and after an intervention is required, such as the implementation of a new system or control measure. Similar uncertainties and assumptions will be present in both assessments. Therefore, there will be a degree of error offset that will help to ensure that comparative results are meaningful. QRA is also undertaken to provide safety demonstrations, such as a determination that risk has been reduced to a level as low as reasonably practicable (ALARP) (see section 2.2.3.1). QRA is useful because it provides an objective basis for decision taking, and requires an analyst to study potential accident causal sequences in detail. This helps with the identification of measures to prevent these mechanisms occurring.

However, there are some pitfalls that any decision taker using the outputs of such an assessment to inform a decision needs to be aware of. In particular:

- Stating numerical risk estimates can sometimes lead to a false perception that the figures are precise.
- Risk can vary greatly depending on the particular situation or location. The assumptions underpinning a risk assessment need to reflect the particular circumstances in which the risk is considered. Anyone using such analyses to inform a judgement should be aware of the weaknesses, sensitivities, and assumptions of the model so that they can be factored into the judgement that the QRA influences.

RSSB maintains the Safety Risk Model (SRM), a model of the risk across the GB mainline rail network. This can be used to identify possible accidents, hazardous events and precursors in order to support a duty holder’s own risk analysis and modelling.

Qualitative risk analysis

In the railway industry, quantified risk assessment is often unnecessary. Risk can often be estimated quickly and effectively using judgement and experience, especially for front-line operational decisions, which are generally taken by staff on the basis of their competence and experience.

In other circumstances, risk is difficult to estimate using a quantitative approach. A safety system may be functionally complex or might comprise controls whose failure rates cannot be estimated
with confidence. In other cases the safety related activities might be conceptually removed from the accident sequence meaning that their impact on risk is unclear. 

Therefore, a qualitative assessment may be used as a better method of analysing and understanding risk. A process of structured professional judgement is applied to facilitate the analysis. Some common characteristics of professional judgement can be identified:

- The effort and rigour of analysis are proportionate to the complexity and importance of the decision.
- The necessary skills and competence are used to support each judgement in the process.
- A person or group is identified as responsible for taking the decision, taking account of all relevant judgement and analysis.
- The evidence on which the decision was based, and the reasoning used to interpret that evidence, are recorded. The records will again reflect the complexity and scale of the decision, (ranging for example from meeting minutes to a full safety case).
- A degree of independent review or challenge may be necessary.

There are several possible techniques and approaches. Examples include:

- Workshop-based assessments similar to hazard and operability studies (HAZOPs).
- Relative ranking of hazards or hazard causes using qualitative categories, for example ‘high’, ‘medium’ or ‘low’.
- Development of a reasoned written argument, expressing judgements about risk levels and appropriate responses based on professional experience.

6 The output of the SRM is published in the Risk Profile Bulletin. For details, see [Ref. 5].

7 One example is the preparation of data to configure a computer based signalling interlocking system. The quality of data preparation determines the integrity of the signalling system, which in turn affects safety.
Cost-benefit analysis

Cost-benefit analysis (CBA) weighs the expected costs of one or more options against the expected benefits in order to find the best option. The approach followed will depend on the type of decision and the criteria applied to it.

CBA assists in the determination of whether a particular measure is necessary to reduce risk so far as is reasonably practicable (see section 2.2.3.1). Current ORR guidance [Ref: 6] sets out the regulatory interpretation of how CBA should support such decisions. CBA can also be used to support a wider commercial decision (see section 2.2.3.2).

Safety benefits are incorporated into the CBA by multiplying the expected risk reduction associated with a measure by the value of preventing a fatality (VPF) figure.8 Risk, and therefore any reduction in risk, is quantified in units of fatalities and weighted injuries (FWIs).9 The risk estimate used is a collective risk estimate (not an estimate of the individual risk).

2.2.2.3 Engagement

There are two main reasons for involving stakeholders in the decision taking process.

First, an understanding of stakeholder needs is essential for effective decision making. In complicated situations, the decision taker can only assess the full scope of issues by specifically identifying the stakeholders affected and understanding their various perspectives.

Secondly, thorough consultation and discussion with stakeholders can ease the implementation of a measure. If stakeholders’ views are given due consideration, they will tend to be more willing to align themselves with the course of action subsequently taken, even if it is not their desired outcome.

Engagement might take different forms depending on the scope and scale of the issue and could include:

- Local engagement.
- Wider consultation with passengers who regularly use a line or service.

- Cross-industry consultation to agree an industry wide response to a particular risk.

Relevant interested parties to consider might include:

- Customers
- Technical experts from other organisations
- Employees
- Pressure groups
- Emergency services
- Suppliers
- Shareholders
- Unions
- Regulators

When taking decisions, engagement with stakeholders will usually involve understanding their concerns and how they could impact upon the efficiency or profits of the company (see section 2.2.3.2).

Where a measure is legally mandated, it may still be sensible to engage with those affected to explain the circumstances and ease implementation.

8 The VPF for the calendar year 2008 is £1,652,000 (http://www.rssb.co.uk/ssr_vpf.asp). This figure is calculated annually for the railway industry using the approach set out in Highways Economic Note 1: Valuation of the Benefits of Prevention of Road Accidents and Casualties 2005, published by the Department for Transport and available at http://www.dft.gov.uk/pgr/roadsafety/ea/pdfecnote105.

9 The railway industry agreed that the following ratios should be applied from April 2008: 1 Fatality: 10 Major injuries: 200 Reportable minor Injuries: 1000 Non-reportable minor injuries: 200 Class 1 shock/trauma cases: 1000 Class 2 shock/trauma cases.
RSSB has undertaken research that provides useful insights into how to plan and undertake engagement with stakeholders [Ref: 7]. The research report, which is available from the RSSB website, draws on experience from the railway and other industries and references techniques and approaches that may be useful.

2.2.2.4 Strategic analysis

General

For decisions of significant scope, complexity or novelty strategic analysis is required. Such decisions will, by definition, be those where there are genuine options about how to proceed. Therefore, such analysis aligns with decisions taken for business reasons (section 2.2.3.2). Strategic analysis is crucial in making sure that the decision outcome aligns with a company’s values, strategies and goals. This document is not intended to provide a comprehensive process for taking such decisions. These decisions will draw upon the experience, understanding and acumen of a company’s management team.

Strategic analysis is about looking at the decision in the round, taking into account the wider interests of the company or companies involved and of the railway in general. It requires mature consideration by those with the expertise and experience to appreciate the wider commercial and political implications of the decision being taken.

Where there are decisions which impact upon safety, but which are not legally required, then strategic analysis of the way forward might take into account consideration of societal concern – public reaction to certain types of risk. Public perception following accidents can have damaging effects on a company’s business performance.

Strategic analysis might also include consideration of project (rather than safety) risk, asking questions such as:

- Are there significant risks of overrun which would impact upon the railway service?
- Do we need to take a decision now, to ensure that we retain sufficient options later in the project lifecycle?

Organisational boundaries

Many risks arise from the interaction of parts of the network that are managed by different duty holders. Therefore duty holders need to work together to manage safety. Organisational boundaries have the potential to complicate safety management and duty holders need to be aware of the potential for this to raise problems. In such circumstances duty holders will need to reach agreement about how to proceed, and a forum may be needed to facilitate the necessary discussion and agreement.

Regulation 22 of ROGS places an obligation on railway duty holders to cooperate with each other to achieve safe operation of the railway system. The co-operation extends to co-operation for the purpose of enabling other transport operators to comply with the duty to carry out risk assessment and develop robust risk control measures. RSSB has produced guidance on how to satisfy these requirements [Ref: 2].

2.2.2.5 Illustrative example

The illustrative example shows that varying degrees of analysis were applied to the different options previously identified. Extension of the ‘nature of decision’ chart to the possible methods indicates that a range of different methods might be appropriate:
Option 1: The introduction of passenger security teams at locations on the route.

Following a quantified analysis of the risk reduction associated with the introduction of passenger security teams, the safety manager determines that the total cost for a four-year pilot exercise is estimated as £2 million (£500,000 per year). The approach gives an estimated safety benefit of £165,000 per annum.

No relevant standards or good practice are identified, although there is evidence that such teams have been effective for neighbouring TOCs.

Option 2: The installation of a staff alarm system

The safety manager is not able to confidently estimate any risk reduction associated with the implementation of the staff alarm system as he/she judges that the alarm may not be as effective at preventing the occurrence of incidents as the use of passenger security teams. The cost of a trial of the alarm system would be £1,000,000 over a four-year trial period. The system may provide some psychological reassurance to staff about their safety.

Option 3: Do nothing

The safety manager analyses the problem from a strategic perspective and perceives that doing nothing will impact upon the number of customers using the service. However he/she is unable to make a reliable prediction for the commercial impact that this would have.
2.2.3 DECISION

The third stage in the process is the actual taking of the decision. This should be executed on the basis of the evidence generated and information gathered by previous analyses. Figure 8 summarises the key concerns and criteria applied to industry decisions. Where a decision has a safety impact the decision taker must first decide whether or not it has a legal duty to act. The legal criteria are clear and specific and relate to evidence and information about the risks and costs associated with different options. If a measure is found to be legally required, either because there is prescriptive legislation or if taking the measure is judged by the duty holder to be reasonably practicable, it must be applied.

However, if a measure is not necessary in order to meet the legal duty, a company may still decide to apply it on the basis that it is sensible from an overall business perspective. The factors included in the business decision will be decided by the duty holder and encompass a wider range of factors than the ALARP consideration. The criteria applied to the commercial decision will depend on the company’s policies, values, priorities and resources. Where business decisions are considered to go beyond what is reasonably practicable they are optional. Any measures applied as a result of such decisions might be removed at a later date and are not considered to set any precedent for the duty holder or other duty holders.

Figure 8: Evidence and information that supports industry decisions and the legal and business criteria applied.
2.2.3.1 Industry determination of legal duty

Part one of Taking safe decisions outlined how railway companies must:

- Comply with any specific legislation.
- Estimate the risks from all activities arising within the scope of their undertaking.
- Ensure, so far as is reasonably practicable, the safety of those exposed to that risk.

These requirements set the criteria for deciding whether or not a particular measure must be implemented by a duty holder in order to meet its legal duty.

Mandatory requirements

Railway companies should be aware of any mandatory requirements relating to railway safety. These requirements would be described in specific UK legislation (which should be applied at the time that it comes into force). As these requirements are mandatory, they do not need to be considered in deliberative decision-taking processes.

Scope of undertaking

Each railway company must identify the scope of its undertaking and the hazards that result from its activities. The duty imposed by the Health and Safety at Work etc Act 1974 (HSWA) is to ensure the safety of the people affected by the undertaking so far as is reasonably practicable. The scale of risk arising from all hazards should therefore be evaluated.

Reasonable practicability

There is a general duty, under the HSWA [Ref: 8], to ensure, so far as is reasonably practicable, that people are not exposed to risks. This consideration is a key input to the decision taking process and, where safety controls are being considered, can determine what decision should be taken.

If an activity is deemed to be reasonably practicable, it must be undertaken by a company in order to discharge its legal duties. Conversely, if it is not reasonably practicable, there is no legal requirement to apply it.

In section 1.2.2, three factors which can inform a judgement about reasonable practicability to varying degrees in different circumstances were described:

- Good practice.
- Competence-based judgement.
- Cost-benefit analysis.

The relevance of good practice to the test of reasonable practicability was outlined in section 2.2.2.1. Essentially, where good practice relates to safety, and where it is relevant and applicable, it is likely to represent a reasonably practicable approach.

Judgements often need to be made fairly quickly and a detailed analysis of risks, costs and benefits are not considered to be practical or necessary given the likely risk or expense. In such cases a judgement might be made by a safety professional based on competence and experience.

Where risks are complex (and difficult to estimate), costs are potentially high and there is no relevant existing good practice, there may be a need to undertake both a risk analysis and a cost-benefit analysis, in order to support a decision. The cost-benefit analysis would form a key input into any judgement as to whether a particular measure reduced risk to a level that is ALARP.

Using cost-benefit analysis in ALARP demonstration

A cost-benefit analysis can be used to develop an explicit application of the test of reasonable practicability as outlined in the Edwards judgement [Ref: 9]. The case law describes how:

‘...a computation must be made...in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other'.
Hence the ‘sacrifice’ is taken to be the cost of a potential measure and the ‘quantum of risk’ the safety benefit associated with it. The quantum of risk is a collective risk estimate. The VPF is used to translate the safety benefit to a financial value.

The ORR has produced internal guidance for its inspectors describing how it believes that CBA should support SFAIRP10 decisions [Ref. 6]. This lists a range of factors that might be taken into consideration in these types of CBA, where they are appropriate and relate to the measure being implemented for safety.

Table 1 shows the costs and benefits that are routinely included in industry CBAs undertaken to support ALARP10 decisions.

There are potentially other costs and cost savings that might be included in a CBA in support of ALARP decisions. A duty holder would need to make a judgement as to whether costs or benefits relate to the measure under consideration.

Decisions often involve investments in measures where costs and benefits will accrue over a number of years. Therefore, all relevant future costs and benefits must be calculated in present-value terms. A discount rate is chosen to do this, and net present value calculated.

The ORR guidance document describes which discount rates should be used to account for future change in societal preference for safety. It also describes how:

- The costs of safety measures should include the costs of financing to reflect the cost of capital to the decision taker where appropriate.

- All costs and benefits should be in a common price base, meaning that scheme costs need to be uplifted by 20.9% to reflect indirect taxation, such as VAT.11

The comparison of costs and benefits is generally presented as a ratio. If the cost is clearly less than the safety benefit, this provides a strong indication that the measure is likely to be reasonably practicable, and there would have to be a clear and convincing argument why such an option would not be adopted. Conversely, where the cost is several orders of magnitude larger than the safety benefit, this would support a judgement that the measure is grossly disproportionate and therefore not reasonably practicable. However, the judgement is more complicated when the difference in size between the cost and safety benefit is somewhere between these two extremes. The decision taker will then need to consider, in particular, the level of confidence in risk and cost estimations made.

The decision taker might err on the side of caution where risk estimates are subject to uncertainty – as is often the case with low-frequency, high-severity accidents like train collisions (see section 2.2.2.2). Best estimates for risks, costs and benefits should be used, if necessary with higher and lower uncertainty bounds. Sensitivity analysis might be necessary in some cases – ie testing how sensitive risk estimates are to variation in the key assumptions.

In an ALARP analysis, the benefits of investment should be calculated over the life of the asset in question. Where a franchise is due to finish, prior to the point at which a potential investment would be justified on cost–benefit grounds, then the investor’s costs will need to be shared by the duty holder, the asset owner and future franchisees who share responsibility for the management of the risk. In such cases the ORR and DfT would need to facilitate and support funding arrangements to allow the measures to be put in place.

Case law establishes that financial strength or weakness is not relevant to determining the appropriate degree of care. Reasonable practicability is an objective test and the specific circumstances of the duty holder are not relevant.

10 Note – we prefer to use the term ALARP, which is more widely used in the GB railway industry. However, both terms refer to the same legal test.

11 Note that the current uplift percentage of 20.9% is based on VAT rates of 17.5%, applicable at the time of publication. Duty holders should consult with the ORR if seeking to confirm applicable rates at any given time.
Table 1: Applicability of costs and benefits to a CBA in support of ALARP decisions

<table>
<thead>
<tr>
<th>Cost/Benefit Description</th>
<th>In Scope of CBA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety Benefits</strong></td>
<td></td>
</tr>
<tr>
<td>Risk reduction (as per VPF)</td>
<td>Stated in the case law. [Ref: 9]</td>
</tr>
<tr>
<td><strong>Capital Costs</strong></td>
<td></td>
</tr>
<tr>
<td>Installation/upgrade costs</td>
<td>Stated in the case law.</td>
</tr>
<tr>
<td><strong>Operational Cost Savings</strong></td>
<td>Within scope. For example, if a level crossing is life expired and needs renewing, the cost of the minimum renewal would need to be netted off of the cost of putting in place an upgrade if that option was to be investigated.</td>
</tr>
<tr>
<td><strong>Ongoing Costs</strong></td>
<td>Ongoing costs that ‘relate to the measure being implemented’ should be included.</td>
</tr>
<tr>
<td>Maintenance costs</td>
<td></td>
</tr>
<tr>
<td>Training costs</td>
<td></td>
</tr>
<tr>
<td><strong>Ongoing Cost Savings</strong></td>
<td></td>
</tr>
<tr>
<td>Operational cost savings</td>
<td></td>
</tr>
<tr>
<td>Maintenance cost savings</td>
<td></td>
</tr>
<tr>
<td>Training cost savings</td>
<td></td>
</tr>
<tr>
<td>Avoided costs of accidents</td>
<td>The cost of accidents presents a real and recognisable cost which safety measures can mitigate.</td>
</tr>
<tr>
<td>Financing costs</td>
<td>To be included as outlined in ORR guidance [Ref: 6]</td>
</tr>
<tr>
<td>Allowance for taxation</td>
<td>To be included as outlined in ORR guidance [Ref: 6]</td>
</tr>
<tr>
<td>Performance costs/benefits and avoided direct costs</td>
<td>Potentially within the scope of a CBA to support an ALARP judgement. This is qualified by a judgement of whether or not the costs/benefits relate directly to the measure in the particular circumstances.</td>
</tr>
<tr>
<td>Performance costs</td>
<td></td>
</tr>
<tr>
<td>Lost revenue during installation/upgrade</td>
<td></td>
</tr>
<tr>
<td>Performance regime compensation payments</td>
<td></td>
</tr>
<tr>
<td>Ongoing lost revenue</td>
<td></td>
</tr>
<tr>
<td>Performance Benefits</td>
<td></td>
</tr>
<tr>
<td>Reduced performance regime compensation payments</td>
<td></td>
</tr>
<tr>
<td>Ongoing increased revenue</td>
<td></td>
</tr>
<tr>
<td>Outside scope of a CBA in support of an ALARP assessment</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Improved reputation</td>
<td></td>
</tr>
<tr>
<td>Reduced insurance premiums</td>
<td></td>
</tr>
<tr>
<td>Civil damages and legal costs</td>
<td></td>
</tr>
<tr>
<td>Passenger ‘time savings’</td>
<td></td>
</tr>
<tr>
<td>Environmental impact</td>
<td></td>
</tr>
</tbody>
</table>

14 Worked example 2 (fitment of sanders) provides an example of how performance benefits might be explicitly included in an analysis.
Removal of risk controls

It is permissible to remove/reduce risk controls that can no longer be shown to be reasonably practicable. This situation could arise if:

- The cost of the control increased (due to obsolescence, for example),
- The safety benefits reduced (due to the effect of other controls),
- It was found that the control had never been justified under the ALARP principle.

Decisions to remove risk controls should be justified by a thorough assessment of the risks and a carefully considered ALARP case.

As circumstances differ between locations, there is no requirement to apply control measures which have been found to be reasonably practicable in one location to other similar locations, unless the relevant circumstances are found to be the same.

2.2.3.2 Evidence and criteria for business judgement

Many decisions in the railway industry are taken for business reasons. This document does not provide detailed guidance in how to interpret information to take decisions for business reasons. Instead, it stresses that such decisions commonly arise, and clarifies that the criteria for taking them are distinct from those applied for legal reasons. These types of decisions are voluntary and typically depend on the judgement and acumen of a company's board or managers. In some circumstances, a company might choose to invest more in a measure that reduces risk than is necessary to ensure that risk is reduced ALARP.

CBA is only an input into the overall decision taking process and is used to inform a judgement. A CBA constructed to support a decision about whether a measure is ALARP might lead to a judgement that the measure is not reasonably practicable even if there is a positive cost-benefit argument. Where the gross cost of a measure (excluding any performance benefits) is substantially higher than the safety benefit then this would indicate that safety is not the key driver for the measure. For example, the industry decision to implement the European Rail Traffic Management System (ERTMS) in the UK has a positive business case and is predicted to improve safety. However, it is accepted that the implementation of ERTMS is a business decision and has not been taken on the basis that it was a reasonably practicable measure (business judgements are discussed in the next section). The expenditure is far in excess of the financial value of any safety benefit and therefore it is accepted that the safety benefit should not drive the decision making process in these circumstances.

Commercial decisions which impact upon safety might also be taken because of a perceived benefit to company reputation. Company reputation might be affected by societal concern about safety risk. The term societal concern refers to the concern and anxiety that the public feels about different types of risk. This concern might not reflect the true level of risk; it is influenced by dread and other subjective emotive feelings and might change considerably after an accident. Societal concern fluctuates because the public is exposed to information about risk in an uncontrolled and often retrospective way. As a result, the railway can experience pressure that is disproportionate to any objective evaluation of risk and can have significant practical effects on a company's profitability and performance. Train accidents are not the only cause of societal concern. Many people are worried about personal security, on stations and trains, and in station car parks. Furthermore, companies increasingly take a broader view of corporate social responsibility.

Using CBA to support business decisions

Cost-benefit analysis might also be undertaken in support of a business decision. In this case, the duty holder would need to decide what costs and benefits are relevant to the decision from a commercial perspective. When taking decisions for business reasons all of the information that informs the decision about whether or not a measure is legally required is still relevant. However, additional information may also be pertinent to the decision (See Table 1). In particular, the possible commercial consequences of an accident in which passengers or railway neighbours are killed or seriously injured.
can provide a greater financial incentive to avoid accidents than is suggested by the VPF. As with the ALARP judgement, the CBA would provide an input to the overall decision rather than a definitive result. However, in this case, even if the duty holder were to judge that a certain investment or measure was sensible based on the findings of the CBA there would be no compulsion to follow that investment or apply that measure, as the decision would be a voluntary one.

There are many other appraisal methods that a company might choose to help them in making a sensible business decision. This document highlights that CBA is one possible approach and stresses that if such CBAs are undertaken they are different to, and distinct from, CBAs constructed to support ALARP decisions (see section 2.2.3.1).

### 2.2.3.3 Principles of good decisions

Research has highlighted several principles that can improve the quality of decision taking [Ref: 10]:

- Problems can be over-analysed, resulting in information overload. It is not necessary to undertake detailed analysis in support of all decisions. Competent people can make good sensible decisions on the basis of available information very effectively. Very often, this is the sensible way to proceed. However, the decision taken and the rationale behind the decision still need to be recorded and documented.

- If the choice is highly emotive, then an individual's instincts may not serve them well. To take good decisions, they need to be wary not to latch onto the facts that support the option they already suspect is the best. A useful way to protect against this is to seek to identify information in support of alternative options.

- The more people invest in something the more commitment they feel towards it. This is known as the 'sunk cost fallacy'. For example, in the 1970s the British and French governments continued investing heavily in Concorde even after it became clear that the project was not economically viable. To avoid letting this phenomenon influence a decision, it is useful to acknowledge that it might, in some circumstances, be sensible to accept that a project is not likely to achieve its original objectives and that bringing it to a close is the sensible option.

- This document stresses the need for decisions to be supported by agreement and discussion between different experts and stakeholders. In a workshop environment, like-minded individuals sometimes talk themselves into extreme positions. In situations where everyone is in agreement, it can be worth playing a devil's advocate role to test the consensus of the group.

- Social pressure can influence decisions. In such circumstances, arguments in support of a position should be tested to ensure that the decision is sound.

### 2.2.3.4 Illustrative example

Returning to the passenger security example, the safety manager produces a report, based on the findings of their analysis that asserts that there is no legal duty to apply any measures but a decision might be taken for business reasons:
A company board report is produced outlining the recommendations of the safety manager, supported by the analysis undertaken. The board discusses the report and as a result of this the following decisions are made, and recorded in the board minutes.

**Option 1: The introduction of passenger security teams at locations on the route**

Based on the quantitative analysis undertaken, the ratio of the cost per preventing a fatality to the VPF is approximately 3:1. There is reasonable confidence in the estimates of safety benefit used to determine this ratio, as passenger security incidents are generally low-severity, high-frequency events, and significant representative data is available. The board therefore judges that, given the cost-benefit ratio of 3:1, it is not reasonably practicable to introduce the security teams as proposed.

However, there is also a benefit to the TOC’s reputation, as the measure represents a clear and visible commitment to passenger security. On the basis of this the board decides that, for business reasons, it is sensible to go beyond what is reasonably practicable and implement option 1.

**Option 2: The installation of a staff alarm system**

As they are not confident that the measure gives any safety benefit, it is judged to be not reasonably practicable. Given that option 1 is to be trialled there are few or no benefits associated with the measure. Therefore the board decides not to implement the staff alarm system.
2.2.4 REVIEW

2.2.4.1 Reviewing the decision

The final stage of the framework is to stand back and ask: ‘does the decision make sense?’ That is, does the decision meet the three fundamental goals of being:

- **Rational,** meaning the decision has been taken for sound reasons and is not arbitrary.
- **Equitable,** meaning that due regard has been given to everyone’s interest.
- **Defensible,** meaning that it can be explained if challenged.

A simple question for the decision taker to ask is: ‘how would the decision sound if it were challenged by a hostile journalist, at a shareholder’s meeting, or during cross-examination in Court?’ If any of the reasoning on which the decision is based is unsound, those challenges will find and expose the weaknesses. But if the reasoning is sound, there is a good starting point for explaining it, even if the arguments are subtle and complex.

2.2.4.2 Documenting the decision

A decision to do nothing should not be allowed to happen by default. Both the decision and the way it is reached should be documented so that they are transparent. Documenting the decision ensures that there is no doubt as to what was decided and provides an evidence trail if the decision is subsequently challenged. Management decisions are always codified in some form of written record, for example in a:

- Memo
- Business case
- Company policy
- Work instruction
- Meeting record

It is important that not just the outcome, but also the reasoning on which a decision is based, is recorded. The record should include:

- A clear statement of the issue.
- The options that were considered (including ‘do nothing’ if this was one of them).
- The results of all of the assessment and analysis undertaken including: any assumptions that were made; the data on which the assessments were based; the minutes of any review meetings and any other information that shows how the risks were assessed.
- The option that was selected, with the key reasons why it was preferred.
- How the decision was to be put into practice – for example as a company policy, rule or work instruction, or details of any briefing given to staff.
- The parties involved who took part in reaching the decision.

2.2.4.3 Ongoing review

When a decision is taken, it is based on certain assumptions about initial levels of risk, costs, and the effectiveness of a particular approach or measure. By monitoring how a decision is implemented and its effectiveness these assumptions can be revisited. This additional insight and understanding might lead to the decision being revisited or might influence other similar decisions in the future. HSWA regulations\textsuperscript{12} oblige duty holders to subject their risk assessments to ongoing review.

2.2.4.4 Illustrative example

Returning to the illustrative example we see that the company both reviews the initial decision and instigates a process of ongoing monitoring:

\textsuperscript{12} Regulation 3(3) of the Management of Health and Safety at Work Regulations 1999.
The company board reviews the decision and the underlying analysis supporting it and endorses the decision to introduce a trial of the passenger security team.

The board decides that the trial provides an opportunity to record high quality data to assist with the evaluation and possible roll-out of the approach following the trial period.

A thorough process of monitoring security incidents is therefore agreed and the pilot programme is planned to include staged reviews of emerging data so that the data can be reviewed at intervals in order to inform subsequent decisions.
3.1 Introduction

The ‘decision taking framework’ describes a process for applying the principles described in this document to railway industry decision problems. In this section, we use worked examples to illustrate how to apply the ‘decision taking framework’.

The following five worked examples are included:

- Removal of fire extinguishers.
- Fitment of sanders.
- Adoption of GSM-R and removal of signal post telephones.
- Track circuit or axle counters.
- The length of driver walkways.

3.2 Removal of fire extinguishers

To illustrate:

- Circumstances where removal of a safety control is consistent with the management of safety so far as is reasonably practicable.
- Where decisions about reasonable practicability are made on the basis of expert judgement and review of good practice.

3.2.1 Scoping

A clause in Railway Group Standard GM/RT2177 issue 1 mandated the provision of direct access to emergency equipment for use by passengers on trains. Following a spate of incidents of criminal damage to fire extinguishers and other emergency equipment, a decision was taken to review this requirement to determine whether or not its continuation was consistent with the management of safety SFAIRP.
fire and should not attempt to fight the fire themselves.

- The cost of replacing emergency equipment when it has been vandalised can be extensive.

- Fire extinguishers can be used as offensive weapons on traincrew members and passengers or to vandalise the railway vehicle.

A survey of good practice showed that other railways had addressed similar problems. A subsurface railway had previously had a requirement for fire extinguishers in each carriage. However, in the late 1990s, it was decided to have only one fire extinguisher per train. This decision had been made on the basis of similar arguments to those above. In particular, the analysis found that passengers were reluctant to use such emergency equipment even when it was available and in good working order.

3.2.3 Decision

The Standards Committee was presented with the impact assessment as a means of providing structure to their expert review of arguments for and against the removal of the clause mandating the provision of direct access for passengers to emergency equipment.

The Standards Committee members found that arguments for the removal of emergency equipment from each passenger rail vehicle were consistent with their own experiences. They also found the arguments to be convincing. On this basis, the committee judged that, given the potential for vandalism and misuse of emergency equipment, the requirement should be withdrawn. Given the current circumstances, the requirement was not considered to be necessary to manage safety so far as is reasonably practicable. Instead, it was decided that a requirement should be included for on-board emergency equipment that is directly accessible to staff only.

3.2.4 Review

In accordance with the procedure for standards review and update, a six-monthly review was planned to gauge how the industry had reacted to the standards change and evaluate any feedback and data arising at that time.

---

13 A Standards Committee is a committee made up of technical experts from across the railway industry with the competence and experience to approve Railway Group Standards, Railway Industry Standards, Codes of Practice and Guidance Notes. The Railway Standards Code gives the Standards Committee authority to take such decisions on behalf of the industry.
3.3 Fitment of sanders

To illustrate:

- Where a best practice safety measure is not implemented because it is not necessary in order to ensure safety SFAIRP, and there is no commercial argument for its implementation.
- Where duty holders work together to jointly agree control measures in fulfilment of their duty of cooperation.

3.3.1 Scoping

Following a number of station overruns, a train operator investigated the feasibility of fitting train sanders, a best practice low adhesion solution mandated by Railway Group Standards for new trains, but not for older trains which pre-date the Railway Group Standard. The train operator determined that further control measures might be required to mitigate the risk from low adhesion, and the fitment of train sanders was considered worth exploring, along with other possible measures.

Existing controls were a combination of:

- Vegetation control.
- The application of sandite (a mixture of sand and aluminium in a liquid suspension) to the track either with sandite trains or fixed sandboxes installed beside the track at high risk locations.
- Driver training in defensive driving techniques.

One way to further mitigate risk associated with poor adhesion is by the implementation of train sanders. Sanders are designed to deliver sand to the railhead to improve the level of adhesion available between the rail and the wheels of the train to which they are fitted. They have the advantage, compared to 'sandite' trains or static sanders, of being available all the time the train is in operation for use whenever slippage or sliding occurs. The train operator has a range of stock within its fleet. Some of these already have sanders, but a significant percentage do not.

After considering a wide range of potential measures, the train operator eventually decides to consider the following options that it can implement for further addressing adhesion risk:

- Option 1: Retro fit rolling stock with train-borne sanders.
- Option 2: Enhanced driver training and implementation of lineside signage at high risk locations to remind drivers to approach key junctions at much reduced speed if running under cautionary signals.

3.3.2 Analysis

The problem is considered to be required to agree a analysis, and some engagement and strategic analysis.

<table>
<thead>
<tr>
<th>WHERE WILL THE DECISION BE TAKEN?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers</td>
</tr>
<tr>
<td>Local Manager</td>
</tr>
<tr>
<td>Regional</td>
</tr>
<tr>
<td>National</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WHO SHOULD TAKE THE DECISION?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Done by one organisation</td>
</tr>
<tr>
<td>Done by many organisation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HOW MUCH CONSULTATION?</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
</tr>
<tr>
<td>Local</td>
</tr>
<tr>
<td>Regional</td>
</tr>
<tr>
<td>National</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPERATIONAL EXPERIENCE OF THE ISSUE?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensive</td>
</tr>
<tr>
<td>Considerable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TIME SCALARS?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minutes to hours</td>
</tr>
<tr>
<td>Days to weeks</td>
</tr>
<tr>
<td>Weeks to months</td>
</tr>
<tr>
<td>Months to years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXPERIENCE OF THE TECHNOLOGY?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology or way of working is mature</td>
</tr>
<tr>
<td>Technology or way of working is novel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>METHOD OF IMPLEMENTATION?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memo or instruction</td>
</tr>
<tr>
<td>Company policy</td>
</tr>
</tbody>
</table>

The problem is considered to be required to agree a analysis, and some engagement and strategic analysis.
3.3.2.1 Option 1: Retro-fit rolling stock with train-borne sanders

Railway Group Standards require the fitment of sanders to all driving vehicles in newly built trains to improve adhesion. However, there is no absolute requirement to retro-fit all trains with sanders. As some of the train operators’ stock was approved prior to the mandated fitment of sanders, fitment was not required for standards compliance. However, depending on particular circumstances, upgrade may still be required on the grounds of reasonable practicability. Some train operating companies have retro-fitted sanders to their entire fleet to mitigate against adhesion risk, though this did not necessarily mean that the operator should take the same decision, as an ALARP assessment inherently considers the local circumstances and operating factors relevant to the operator’s undertaking, which may be different.

The train operator undertook a detailed analysis of the safety performance improvement that would result from the fitment of the sanders with support of technical experts. This took the form of a quantified risk assessment. The potential safety benefit of fitting sanders was estimated, using the industry’s VPF in 2007 (£1.573m per fatality avoided), to be approximately £10,000pa.

The rental costs based upon the cost of purchasing and installing sanding equipment through a ROSCO over a 10-year life is approximately £450,000pa for the fleet of trains being considered. Maintenance of the train sanding equipment would cost £20,000pa. The avoided cost of an accident was estimated as £10,000pa.

In addition to the safety benefits, there were a range of business benefits that would result from the fitment of sanders:

- On-train sanders can operate under traction conditions as well as during braking, and thus can mitigate the effect of slipping which can severely impact on train service performance. This results in a potential operational performance benefit from reduced delay minutes during the autumn, estimated to be worth £30,000pa.

- From previous analysis, the cost of a SPAD is approximately £7,000 and the cost of a station overrun is approximately £1,000. Based on sanders avoiding one SPAD per annum and seven stations overruns per annum, there is a potential saving of £14,000pa.

- Wheel slides can also cause wheel flats, whilst the repair of wheel flats is borne by the maintenance company; there is a cost to the operator of service delays and cancellations associated with vehicles being out of service for rectification. Accounting for the likely number of service cancellations, the potential savings would be approximately £10,000pa.

In summary, the business benefits of fitting sanders were estimated at approximately £54,000pa; the safety benefits of the fitment of train borne sanders were estimated to be £10,000pa and the costs were estimated to be £460,000pa.

3.3.2.2 Option 2: Driver training and implementation of lineside signage at high-risk locations.

Risk analysis identified a number of key junctions where a SPAD could create collision potential at a facing junction and the train operator discussed this option with a safety manager from the Infrastructure Manager. They jointly determined that the fitment of signage to remind drivers to approach these junctions at reduced speed when running under cautionary signals would cost £3,000pa. The safety benefits were estimated at £3,000pa.

3.3.3 Decision

3.3.3.1 Option 1: Retro-fit rolling stock with train-borne sander

<table>
<thead>
<tr>
<th></th>
<th>Costs</th>
<th>Benefits</th>
<th>Cost-Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>per annum</td>
<td>£460,000</td>
<td>£64,000</td>
<td>7.1 (approx)</td>
</tr>
</tbody>
</table>

The overall benefits of sander fitment, taking account of safety benefits and attributable performance benefits, are £84,000pa. However, the costs are £470,000pa. This results in a cost-benefit ratio over 7.1. The train operator judged that even given possible uncertainty in the estimation of risks and costs the upgrade was not reasonably practicable and fitment was not justified on safety grounds alone.

There were also more intangible costs that might lead to such measures being implemented for...
commercial reasons. For example, the reputational
damage to the train operator might be significant
if there were to be a low adhesion related collision
or derailment, and a best practice control measure
such as on train sanders were not fitted. However,
the train operator takes the view that the risk of
such an incident was considered to be so small,
considering existing control measures, that it would
not be sensible to fit the sanders on this basis.

3.3.3.2 Option 2: Driver training and
implementation of lineside signage at high
risk locations

The train operator and infrastructure manager jointly
determined that installation of precautionary signage
and associated training of drivers could mitigate a
significant proportion of the identified risk associated
with low adhesion SPADs. The ratio between costs
and benefits is approximately 1:1. Therefore, the
train operator judges that fitment of the signage as
proposed is required in order to reduce risk so far as
is reasonably practicable.

3.3.4 Review

After a period of time, the decision was jointly
reviewed by the train operator and the infrastructure
manager. No low-adhesion incidents had been seen
at the locations targeted with signage and by driver
training and the control measures were continued on
this basis, and future reviews planned.
3.4 Adoption of GSM-R and removal of Signal Post Telephones

3.4.1 Scoping

The main purpose of voice radio systems between driver and signaller is to provide an effective means of communication to support the safe and efficient movement of trains and general operation of the railway. Under European Interoperability Directives 96/48/EC and 2001/16/EC, all railway routes in Europe being built, upgraded or renewed are to be subject to the requirements of the TSIs. The TSIs specify GSM-R voice and data radio. The strategic implications of the introduction of GSM-R across the UK railway network, are therefore being considered.

Where GSM-R is to be introduced, it is planned that it will be the primary means of communication. However, lineside telephones currently exist across the railway network. The railway will be significantly less reliant on these telephones where GSM-R is installed and fully operational. It may be that such telephones provide a useful back-up to GSM-R in the event of GSM-R failure. However, their upkeep and maintenance also incurs significant ongoing costs for the industry. RSSB commissioned consultants to advise on the issues surrounding the use of lineside telephones to support decisions about how to optimise communications following the introduction of GSM-R.

One of the key decisions being considered was whether to remove all lineside telephones once GSM-R was installed and operational.

A quantified risk assessment was conducted on the change from current risk levels associated with each option. The loss of the back-up phone system creates some additional risk associated with the potential for loss of communications in safety critical situations. However, this is offset by a reduction in the risk associated with train drivers alighting from the train to the trackside to use the phones. The analysis determined that the installation of GSM-R, whilst retaining all lineside telephones, would result in a reduction in risk of approximately 0.87 FWI/year (GSM-R availability was assumed to be 99%).
Using various assumptions and engineering judgement where necessary, the annual cost saving associated with the removal of signal post telephones (excluding those at level crossings and those outside of the GSM-R area) was estimated as £7.8m. Assuming there to be no alternative back-up phone system, the net risk reduction associated with the removal of the lineside telephones was estimated as 0.69 FWI/year.

The difference in collective risk estimates associated with the two scenarios was therefore determined to be 0.18 FWI per year. Given the VPF for 2007 of £1.573 million, the additional safety benefit associated with retaining lineside signal posts, when GSM-R is operational, is calculated to be approximately £280,000 per year.

3.4.3 Decision

The results of the analysis are summarised in the following table:

<table>
<thead>
<tr>
<th></th>
<th>£ per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>7.8m</td>
</tr>
<tr>
<td>Benefits</td>
<td>280,000</td>
</tr>
<tr>
<td>Cost-benefit ratio</td>
<td>28:1 (approx)</td>
</tr>
</tbody>
</table>

No decision was reached at this stage. However, the analysis indicates that, in theory, if the assumptions underpinning the cost and risk estimates are proved to be valid, then the analysis would support a judgement that removal of signal post telephones is consistent with the elimination of risk so far as is reasonably practicable. Therefore, it was decided that the option of removing these telephones was worth investigating further.

3.4.4 Review

Further analysis and review is required before this decision is taken. The assumptions that underpin the calculations need to be reviewed. The confidence limits associated with the risk and cost estimates should also be estimated to see the range of cost-benefit ratios that might be possible.
3.5 Track circuits or axle counters

To illustrate:

- The application of the guidance to a strategic decision early in the project lifecycle where there is insufficient quantitative data to perform QRA and the decision is taken by an expert panel, following a structured review process.
- The importance of identifying significant safety issues early in the project lifecycle and avoiding decisions being taken by default.
- Taking action to keep options open when the best option is not yet known.
- The importance of effectively deploying the necessary expertise to provide a sound basis for a decision.

3.5.1 Scoping

Government is sponsoring significant and time-critical development at a seaport. The port is currently served by a lengthy single-track railway, which had previously been double track. The route contains steep gradients and sharp curves. Train detection is provided using track circuits. The track is continuously welded with insulated block joints (IBJs) separating the track circuits. The fact that there are several level crossings on the route means that there are a large number of IBJs. The route carries both passenger and freight traffic and is nearing capacity.

To support the port development, a railway project has been initiated to restore the second track, using the existing alignment, and to upgrade the line to carry new heavy-haul, high axle-load freight trains, introducing a rail loading not previously experienced in the UK. It is recognised that these circumstances bring significant risk to the project. Although the options for controlling this risk are not clear at the outset, it is recognised that the last factor may mean that specialist advice and an appropriate decision making structure is needed in order to manage the risks and issues involved suitably and sufficiently.

Timescales for the project implementation are short. At the onset, exact freight flows are not determined (except within a broad range of tonnages) and the vehicles and their dynamic performance have not been specified.
Replacing the track circuits with axle counters, thereby doing away with the need for IBJs and permitting continuous welded rail throughout the heavy-haul route.

It is noted that the use of axle counters would also improve the reliability of train detection on those sections of the route that are subject to salt spray or heavy leaf fall.

It is also noted that there is an 18-month lead time for axle counters and that, if the project wishes to use them, it will need to take a decision to do so at the outset of the design phase. This is raised as a critical issue to the Project Board, which has representatives from the infrastructure controller, the TOC and FOC and the funding agencies.

Previous work on the safety analysis of axle counters is consulted. This shows that in addition to the issue described, relevant issues include:

- The ability of track circuits to detect some but not the majority of safety-critical rail breaks.
- The need for effective procedures for ‘reset/restore’, train protection and track possessions with axle counters.
- Maintenance.
- General human factors issues concerned with the introduction of new technology and methods (including the requirements for new skills, resources and equipment).

It is recognised that this is a complex, multi-disciplinary issue and a multi-disciplinary working group is convened with expertise in risk assessment, civil engineering (including track engineering), signal engineering, operations, maintenance and human factors. The group contains members from both the project team and the local unit of the infrastructure controller. However, there are some specialist areas, such as maintenance standards, resources and equipment for heavy axle-loads, where additional specialists are employed. (Note that the formation of this working group is an example of following the guidance in the framework on targeted engagement.)

The working group assesses both options and concludes that both are practical and, in particular, that the issues specific to axle counters can be effectively managed. Using axle counters in this case is estimated to increase project costs by about 5% compared with the base case of track circuits with an enhanced inspection regime for the IBJs.

A preliminary QRA is performed. In addition to the forecasting errors associated with the process in general, the results are found to be heavily sensitive to axle weights and annual tonnage carried. The vehicles and service patterns will not be finalised until 12 months before the planned commissioning date and hence, at the time of the QRA, there is significant uncertainty in both results. As a consequence it is only possible to conclude that the use of axle counters might or might not be required on grounds of reasonable practicability depending upon factors not yet known.

There was also some concern over the practicalities associated with the enhanced monitoring regime for the highest axle loads and annual tonnages due to local resource constraints.

The signalling scheme design does not have to be completed for six months. However, if the project were to proceed on the assumption that track circuits were to be used and then decide to use axle counters after all relevant information is available then the lead times for re-design and procurement of axle counters would cause a delay of 12 months, which would jeopardise the whole project.

3.5.3 Decision

With the working group’s support, the project engineer writes a paper containing recommendations to the Project Board on the course of action to be taken.

The project engineer and working group note that:

- Both solutions are capable of being implemented safely, although they highlight concerns over the practical issues of enhanced monitoring for the highest axle loads/tonnages.
- If a choice between them had to be taken on safety grounds immediately then the only defensible decision would be to adopt axle counters.

Given the uncertainty and expense, the issue is subject to strategic analysis. Looking at the issue in the round reveals that there is an opportunity to delay the final decision for a period of about six months.
The final paper contains recommendations to:

- Adopt the axle counter solution as the default, since it addresses all scenarios, including the case of high axle loads and high annual tonnages.

Order the axle counters now and proceed with a design which accommodates both axle counter and track circuit options and allows final selection of the train detection type at a point no later than six months before completion of the line upgrade.

- Carefully plan the training and other human factor action plans associated with the potential technology change to facilitate the later decision process.

- Revisit the cost-benefit analysis when decisions on vehicles and service patterns have been taken.

- Schedule a meeting in about six months, at a point no later than 12 months before commissioning, to take a final decision on the train-detection option and related human factors and resourcing issues.

The working group estimates that:

- In the event that the project decides to use track circuits, the costs of abortive work on deployment of axle counters would amount to about 0.8% of the project costs, with the unused axle counters being redeployed on a subsequent project.

- In the event that the project decides to use axle counters, the costs of abortive work to enable the deployment of track circuits would amount to 0.5% of the project costs.

The Project Board reviews the paper and finds the recommendations to be sensible. It concludes that the overall reduction in commercial risk to the project outweighs the additional costs of the recommendations and decides to accept them.

Note that, although the final decision between the options has been deferred, the Project Board has taken a decision to commit to action in order to keep both options open.

3.5.4 Review

The Project Board decides to meet in six months to:

- Review the cost-benefit analysis of deploying axle counters compared with deploying track circuits with an enhanced inspection and test regime for IBJs.

- Reconsider whether it is reasonably practicable to make the additional expenditure required by axle counters.

- Take a final decision as to which option to proceed with.

Ensure that the necessary actions to implement this decision fully are in hand.
3.6 The length of driver walkways

To illustrate:

The application of the guidance to a tactical decision involving relatively low risk but not covered by standards where the decision is taken by competent individuals using professional judgement and subject to peer review.

3.6.1 Scoping

A project has been initiated to carry out the necessary works to allow a double track route to be used for diverisory purposes for a service provided by trains that have never run on it before. The necessary works are in general specified and in hand. However, a project member has identified an issue which may be an exception.

The driver’s position in the diverted trains is different from existing stock. As a consequence, when stopping at some signals, he/she must stop further back in order to see the signals clearly. Moreover, the driver’s door is further from the front of the diverted train than for any of the trains currently running on the route.

Taken together, these factors mean that, when the diverted train is stopped at a signal, the driver’s door may be between 5m and 10m further from the signal than the driver’s door of any train currently running on the route. In many cases, this would leave the driver’s door metres short of the walkway to the signal post telephone, which departs from a requirement of Railway Group Standard GC/RT5203. The problem only exists for the diverted trains.

The requirement from Group Standard GC/RT5203 is applicable when access facilities are constructed or altered, when linespeeds are increased or when the extent of bi-directional running is increased. None of these criteria are met in this case, so the requirement is not mandatory but it is considered to be potentially good practice.

It is necessary to decide, for each affected signal, whether this situation may be allowed to persist or whether steps must be taken to reduce the risk further. Two general measures have been identified which would reduce the risk further:

- To extend the walkway.
- To move the signal while leaving the signal post telephone at its current location.

3.6.2 Analysis

It is recognised that the issue requires expertise in risk assessment, civil engineering, signal engineering, operations and driving to be analysed effectively. A working group is formed, comprising project experts in risk assessment, civil engineering and signal engineering, the infrastructure manager’s operations manager and the relevant TOC’s driving manager.
The working group carry out a hazard identification exercise and identifies two hazardous events related to the issue:

- Driver slips, trips or falls.
- Driver stops at a location where the signal is not clearly visible in order to align the train door with the walkway.

A brainstorming session identified the following exacerbating factors which could increase the risk of harm to the driver should they slip or trip:

- Line on viaduct or steep embankment.
- Signal post telephone placed between the sets of tracks.
- Line in tunnel.
- Restricted clearances.
- Poor walking conditions or obstructions in the cess.

The working group also notes that the risk is increased if the signal is controlled rather than automatic, as there is a greater likelihood that the train will stop at such a signal.

All but one of the signals concerned are automatic, in plain line and subject to none of the exacerbating factors identified. The consensus professional judgement of the group is that because:

- The route will be used infrequently as a diversionary route: only a few times per year;
- When it is used, the trains will stop infrequently at these signals: less than once per year; and
- On the occasions that diverted trains do stop, the risk to the driver is small,

the reduction in risk afforded by moving these signals or extending the walkway at these signals is very small.

One signal protects a junction and is controlled. At this location, the line is on a steep embankment and there is a possibility of severe injury to a driver should he/she fall down it.

3.6.3 Decision

On the basis of the analysis described in the previous section, the cost of taking action is considered to be grossly disproportionate to the reduction in risk for the signals in plain line. It is therefore concluded that neither moving these signals nor extending the associated walkway is reasonably practicable. No action is thus recommended for these signals.

The consensus professional judgement of the group is that mitigating action is reasonably practicable and required at the signal protecting a junction. Both extending the walkway and moving the signal are practical and would deal with the issue completely. However, the local situation is such that extending the walkway is the less expensive option. The working group recommends extending the walkway at this signal.

The working group’s recommendations and the rationale behind them are presented to the project’s hazard review group, which confirms that they are rational, equitable and defensible and which decides to adopt them. It is noted that the rationale rests on assumptions about the frequency with which diverted trains used this route and the frequency with which trains are stopped at the automatic signals.

3.6.4 Review

In addition to review by the project’s hazard review group, it is agreed with the infrastructure manager’s local management that:

- For the next 12 months, the frequency with which diverted trains use this route and the frequency with which trains are stopped at the automatic signals will be reviewed at the existing monthly meetings held by the local unit of the infrastructure manager and subject to review safety indicators.
- For the next 12 months, all slips, trips and falls by drivers on the trackside will receive particular attention at this meeting and it will be established for each occurrence whether the driver was walking on a walkway or not.
- There will be a further review of the decision in 12 months time.

The successful implementation of the extension to the walkway will be confirmed by the project’s normal hazard tracking processes.
### 4 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALARP</td>
<td>as low as is reasonably practicable</td>
</tr>
<tr>
<td>CBA</td>
<td>cost-benefit analysis</td>
</tr>
<tr>
<td>CPF</td>
<td>cost per statistical fatality avoided</td>
</tr>
<tr>
<td>DfT</td>
<td>Department for Transport</td>
</tr>
<tr>
<td>FWI</td>
<td>fatalities and weighted injuries</td>
</tr>
<tr>
<td>HSWA</td>
<td>Health and Safety at Work Act</td>
</tr>
<tr>
<td>IBJ</td>
<td>Insulated block joint</td>
</tr>
<tr>
<td>ORR</td>
<td>Office of Rail Regulation</td>
</tr>
<tr>
<td>ORA</td>
<td>Quantified risk assessment</td>
</tr>
<tr>
<td>RSSB</td>
<td>Rail Safety and Standards Board</td>
</tr>
<tr>
<td>SDP</td>
<td>Safety Decision Programme</td>
</tr>
<tr>
<td>SFAIRP</td>
<td>so far as is reasonably practicable</td>
</tr>
<tr>
<td>SRM</td>
<td>Safety Risk Model</td>
</tr>
<tr>
<td>TPWS</td>
<td>Train Protection and Warning System</td>
</tr>
<tr>
<td>TSI</td>
<td>Technical Specification for Interoperability</td>
</tr>
<tr>
<td>VPF</td>
<td>value of preventing a fatality</td>
</tr>
</tbody>
</table>
## References


5. Risk Profile Bulletin: Profile of safety risk on the GB mainline railway, issue 5.5, May 2008, RSSB.


