# MANAGING CHANGE – PRACTICAL APPLICATION OF THE COMMON SAFETY METHOD ON RISK EVALUATION AND ASSESSMENT AND ITS ROLE IN THE WIDER RISK MANAGEMENT PROCESS

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## SUMMARY

This paper introduces a risk management framework that is based around the related activities of safety monitoring, analysing and selecting options and making a change.

It relates this framework to recent European regulations, including European Commission (EC) Regulation 352/2009 for a Common Safety Method on Risk Evaluation and Assessment (CSM RA).

The paper summarises the way in which decisions that affect safety are taken in the GB rail industry and how the CSM RA is applied in practice. Some of the key points are illustrated by three worked examples.

## INTRODUCTION

The CSM RA is an EC Regulation that applies to technical, operational and organisational change on the mainline railway. It introduces a harmonised risk assessment process with the aim of ensuring both that change is delivered safely and that safety is not used as a 'virtuous barrier' to restrict access to the rail market. The regulation came into full effect in July 2012 and application of the process is mandatory for any change to the railway system that is considered to be 'significant', as defined in Article 4 of the regulation.

The CSM RA is one of six Common Safety Methods (CSMs) that apply across the European Union and describe what different entities need to do to manage risk. Two of the CSMs apply to transport operators (and can also apply to other rail companies): the CSM for Monitoring and the CSM RA. The other four apply primarily to Member States or their National Safety Authorities.

RSSB has been working with the GB railway industry to help it understand the implications of the regulatory changes brought about by the introduction of the CSMs and provide it with practical support. Among the activities RSSB has undertaken are:

- Carrying out research into the way that risk is managed within rail industry projects (R&D project T955 *Hazard Analysis for Rail Projects* [1]). This resulted in a set of six freely available Rail Industry Guidance Notes [2-7], which are closely aligned to the Regulation but written specifically for practitioners and include examples and templates.
- Independently assessing applications of the CSM RA process on a number of change projects.
- Working with a cross-industry steering group to update *Taking Safe Decisions* [8]. This guidance document sets out the consensus view of the GB rail industry on how decisions that affect safety should be taken. It outlines transport operators' legal obligations and the decision-taking principles they apply, including how these work together to ensure the safety and efficiency of the railway system as a whole.

This paper summarises some of the learning from this work. It begins by introducing the risk management framework from *Taking Safe Decisions*. It describes the different activities that take place within this framework, with a particular focus on 'making a change' and the role of the CSM RA. It demonstrates the practical application of some of the principles via three worked examples covering operational, organisational and technical change.

A RISK MANAGEMENT FRAMEWORK

Every organisation needs to understand and manage its risks, both on an ongoing basis and when it changes something. Risk management comprises three related activities, which ask questions about safety-related change:

i. Monitoring. Is my operation safe or might I need to make a change?

ii. Analysing and selecting options. What should I change and can it be done safely?

iii. Making a change. How do I make sure the change is safe?

Two of these activities, monitoring and making a change, are embedded in the CSMs. The associated activity of analysing and selecting options is about how to decide what to do when a problem or opportunity is identified. Figure 1 depicts the relationship between the three activities.

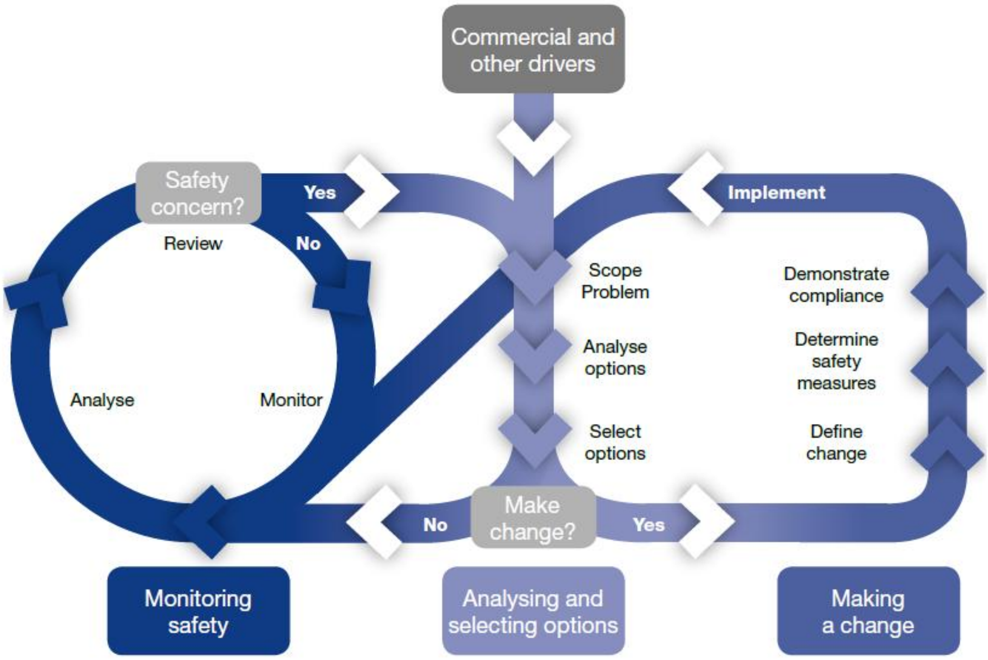


***Figure 1: A risk management framework***

The framework applies to all safety-related decisions but what is involved in each step will differ depending on the complexity and nature of the change being considered.

The origins of change: commercial objectives and safety monitoring

Most major changes are made to meet commercial objectives or requirements that are not primarily about safety. However, decisions often affect safety even when this is not the main intention. Investment to meet commercial objectives may also provide an opportunity to reduce risk: the introduction of new technology is an important mechanism by which safety can be improved.

The need to change can also arise from concerns about safety that are identified by monitoring. The CSM for Monitoring requires each transport operator to check the application and effectiveness of its own safety management system (SMS). Monitoring is a "repetitive and iterative" process that applies to ongoing operations and maintenance activities. A robust monitoring process will at times raise questions about whether the company's operation is safe or whether there might be a requirement to introduce additional safety measures. If the change originates from safety monitoring therefore, the options might relate directly to the implementation of new safety measures.

In either case, the decision as to which option to pursue will be based on consideration of both:

i. the business case associated with the change and

ii. the need to meet legal obligations with respect to safety.

Analysing and selecting options

When considering a change appropriate resource must be devoted to identifying and exploring options at an early stage. Even if it is not the main driver, safety needs to be considered from the start because this provides the opportunity to design in safety enhancements.

The process of managing the risk associated with a change is iterative. For any reasonably large project, there are likely to be design details that are not agreed until after the decision to proceed has been taken. However, the options need to be specified and analysed in sufficient depth to provide confidence that costly new requirements will not materialise later on. Additional requirements become increasingly expensive the later in the project life cycle they are identified. This is illustrated in Figure 2.

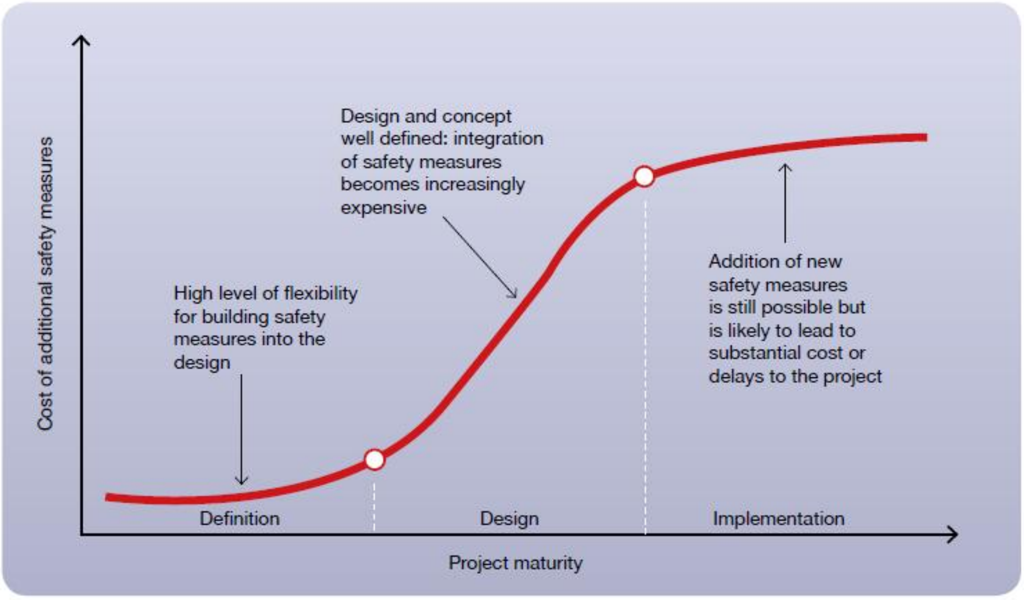


***Figure 2: Project maturity and the increasing cost of additional safety measures***

When a decision affects safety there is a legal obligation to manage the risk to an acceptable level. Identifying the necessary safety measures generally takes place in the ‘making a change’ stage of the process. However, when selecting the option to implement, there is a need to understand broadly what needs to be done because the cost of the safety measures might impact on the business case.

High-level risk analysis carried out at this stage will include some consideration of the extent to which the hazards will be covered by standards and, where there is existing operational experience, the way in which risk is managed in similar circumstances. Once an option has been selected, this early analysis leads into the risk management process for making a change – and potentially the full application of the CSM RA – that is described in the next section.

If a safety measure is found to be legally required, either because there is prescriptive legislation or it is judged necessary to reduce the risk to an acceptable level, then it must be applied.

If a measure is not legally required then a company may still decide to apply it on the basis that it is sensible commercially. One reason why a company might decide to go beyond its legal obligations is because of a perceived benefit to its reputation.

It is useful to involve stakeholders in the decision-taking process because:

- It is often only possible to understand the full scope and implications of a change by identifying the affected parties and understanding their various perspectives.
- If stakeholders are consulted and their views discussed, regardless of what the ultimate decision is, they will tend to be more willing to accept the decision thereby easing its implementation.

Sometimes a change can only be introduced with support from interfacing organisations because it might fall on them to implement some of the required safety measures. If the risk is to be assessed using a similar reference system (discussed further in the next section) then establishing a good working relationship with the owner of the reference system is useful for understanding the system and its safety measures.

Before proceeding with a change, the decision should be subject to a sense-check. A simple question for the decision taker to ask is: 'How would the decision look if it were challenged by a hostile journalist, at a shareholders' meeting or during cross-examination in Court?' If any of the reasoning on which the decision is based is unsound, these challenges will find and expose the weaknesses.

Making a change

The risk acceptance principles from the CSM RA provide a useful framework when evaluating options to provide confidence that a change can be implemented safely. If the change is significant then full application of the CSM RA would flow naturally from this initial assessment.

The CSM RA defines a process, which essentially consists of the following steps:

a) The proposer of a change produces a preliminary definition of that change and the system to which it relates. It then examines it against the significance criteria in the regulation. If a change is deemed to be significant then the proposer applies the risk management process from Annex I of the regulation and appoints an independent assessment body to assess application of the process.

b) The risk management process starts with the system definition. This provides important details of the system that is being changed – its purpose, functions, interfaces and the existing safety measures that apply to it. Some of this information will be known from the earlier analysis carried out to support option selection. A good definition helps to confirm understanding of the change and identify who else will need to be involved in delivering it. Further details are agreed as the risk assessment progresses. These are reflected back into the definition, which is a live document that serves as a repository for safety measures and assumptions.

c) All reasonably foreseeable hazards are identified and their risk is classified and / or analysed. An initial consideration of hazards will have informed option selection. Once the change has been defined, more rigour may be needed to ensure that all reasonably foreseeable hazards have been identified so they can be analysed to an appropriate degree. The regulation does not prescribe a particular approach but states that the hazard identification should be carried out "systematically" and "using wide-ranging expertise from a competent team." There are various approaches to identifying hazards and the best one to use depends on the novelty and complexity of the proposed change.

d) Safety requirements are identified by application of one or more of the three risk acceptance principles to each hazard. The risk acceptance principles are discussed in more detail below.

e) A hazard record for the system that is to be changed is produced and maintained. Its purpose is to track progress of the project's risk management process. For each hazard, it is likely to contain links to information about: (i) the associated risk, (ii) the safety measures that will be implemented to manage that risk, (iii) a justification for why these reduce the risk to an acceptable level, (iv) the means by which compliance will be demonstrated and (once achieved) evidence that it has been done.

f) Before acceptance, the change proposer demonstrates that the risk assessment principles have been correctly applied and that the system complies with all specified safety requirements. Compliance can be demonstrated by testing, inspection, analysis or a combination of those things.

g) The assessment body provides its report to the proposer. The proposer remains responsible for safety and takes the decision to implement the proposed change.

The process is dynamic: several iterations are likely to be required for all but the simplest of changes.

RSSB has produced a set of six practitioner-level guidance documents that address different elements of the process. These have been published as Rail Industry Guidance Notes in the GE/GN864x series [2-7] and are freely available from www.rgsonline.co.uk. Figure 3 (overleaf) shows the risk management process defined in the CSM RA and how the guidance maps to it.

The process set out in the CSM RA is scalable. That is, it can be applied to a depth appropriate to the complexity of the change. The basic elements in the CSM RA risk management process – defining the system, identifying its hazards, and putting in place the controls needed to reduce the risk from them to an acceptable level – were already well-established in the GB rail industry as a means of satisfying the requirements for risk assessment set out in existing domestic legislation (the Management of Health and Safety at Work Regulations 1999). It will therefore make sense for GB transport operators to apply the risk management process defined by the CSM RA to all changes, including those that are not “significant” (although in this case they may decide not to commission an independent assessment). This will avoid the need for them to have duplicate risk assessment processes.

The CSM RA defines three risk acceptance principles, which can be used, either individually or in combination, to identify safety measures required to control the risk from each hazard to an acceptable level. The depth of analysis needed to support a change is usually commensurate with its novelty and complexity.

i. *The application of codes of practice*

The regulation defines a code of practice as a “written set of rules that, when correctly applied, can be used to control one or more specific hazards”. For example, the set or rules may be made up of clauses from one or more EC-published Technical Specifications for Interoperability or GB Railway Group Standards. The application of codes of practice can be a relatively simple way of closing out hazards. However, codes of practice are rarely written just to control hazards and there is often no explicit map between requirements and the hazards they control. There’s a need to assess whether safety measures derived from codes of practice are sufficient for controlling the risk, which is not the same as it being necessary to apply them.

ii. *Comparison with similar reference systems*

Comparison with a reference system can also be an efficient means of identifying safety measures and reaching conclusions about the acceptability of risk. The reference system needs to be similar to what is being proposed in terms of its functions and operating environment. It also needs to have been “proven in use” to have an acceptable level of safety and be compatible with current good practice. Good practice does not stand still but evolves over time in response to incidents, better information, and new technology or techniques. A technology or method of working that was deemed safe in the past may, in some circumstances, no longer manage the risk to an acceptable level.

iii. *Explicit risk estimation*

Explicit risk estimation tends to be the most time consuming and potentially resource intensive of the risk acceptance principles to apply. It requires a more bespoke approach, based on qualitative or quantitative analysis. Explicit risk estimation is therefore most often used when applying the other principles is impractical or is not sufficient for identifying the safety measures required to reduce the risk from all hazards to an acceptable level. In the latter case, a hybrid approach that combines explicit risk estimation with one or both of the other principles can be followed.

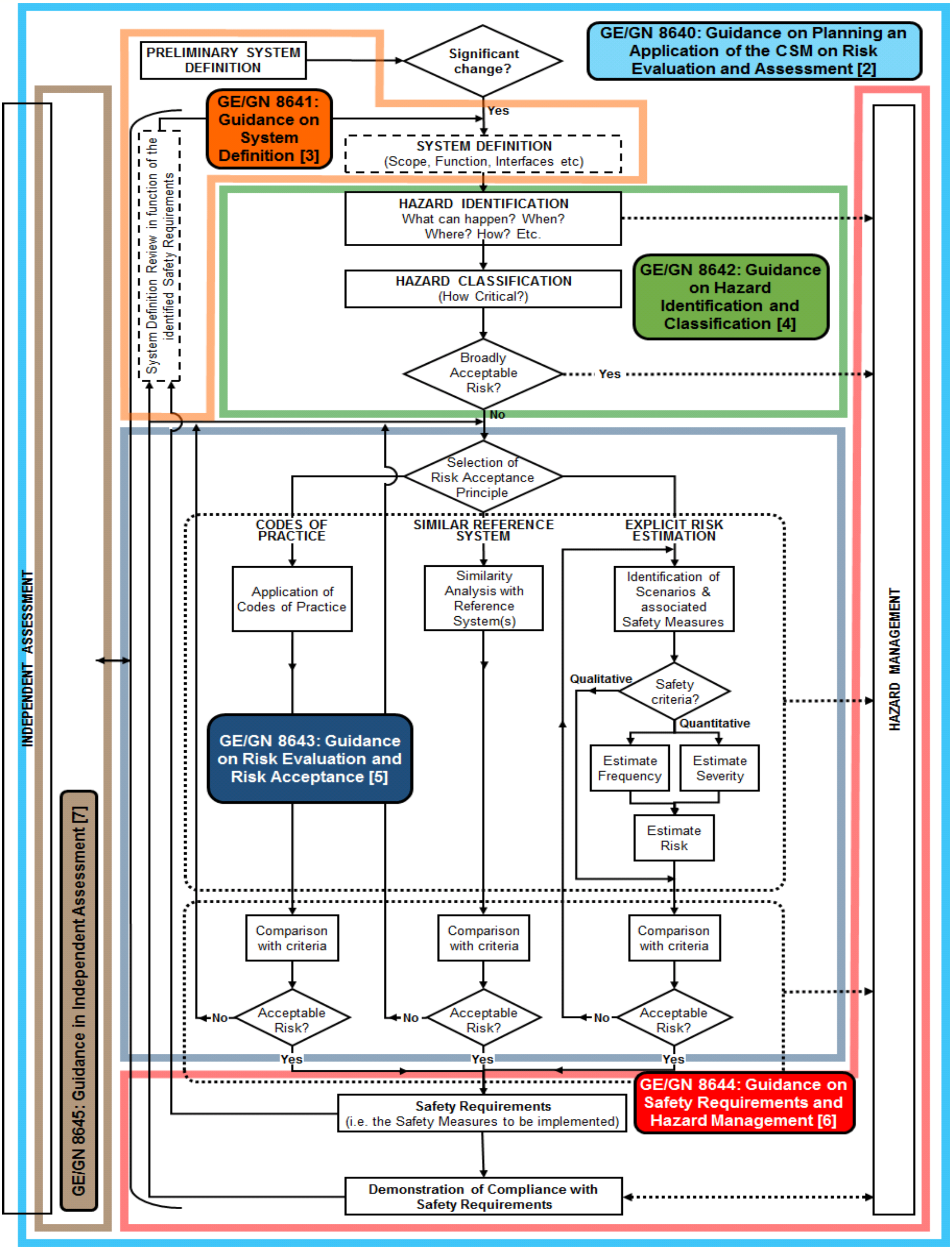


***Figure 3: The CSM RA process and the elements to which the Guidance Notes relate***

When explicit risk estimation is applied and 'mutual recognition' across Member States is not required the risk acceptance criterion that is generally used in GB is to ensure safety 'so far as is reasonably practicable' (SFAIRP). This requirement is familiar to the GB industry because it is set out in domestic legislation: the Health and Safety at Work etc. Act 1974 imposes an obligation on employers to ensure the health and safety of people affected by their undertaking SFAIRP. For transport operators, this covers their employees, passengers and members of the public.

To determine whether a safety measure is reasonably practicable, its safety benefits are compared with its costs. Case law has established that a safety measure is reasonably practicable unless the cost is 'grossly disproportionate' to the benefit. Professional judgement is applied to determine whether or not this is the case. In the GB rail industry, the concept of gross disproportion is taken as an acknowledgement that, because accidents and their consequences are difficult to predict, the estimation of risk is an inherently uncertain process: in some circumstances wide confidence limits need to be applied.

Decisions can often be based on expert judgement without any need for quantification. There are established techniques for eliciting risk estimates and hazards, often involving the use of experts in structured workshops, but for simpler decisions that may not be necessary.

A quantitative approach using formal cost-benefit analysis (CBA) can be useful when a decision cannot be based on good practice or qualitative reasoning. This is often the case for decisions where there is technical or operational complexity, uncertainty in risks, and trade-offs of risk and cost associated with the various options being considered.

In a quantified CBA, the different elements – which might include financial costs, performance and safety – need to be expressed in the same units and it is usually most convenient to use a financial measure. The GB rail industry converts safety consequences to an equivalent monetary value using the Value of Preventing a Fatality (Vpf), which is published by the UK Department for Transport and uprated annually by RSSB.

When applying the CSM RA, the onus is on identifying the safety measures required to control the risk arising from each hazard to an acceptable level. Frequently, a risk control affects more than one hazard, just as each hazard is managed by more than one risk control. Therefore, when applying explicit risk estimation to determine whether or not a risk control is needed to reduce risk to a level that is reasonably practicable, the assessment is based on its overall effect across all relevant hazards.

Reviewing the change

When the change has been implemented, any company whose operation has been affected by it will need to update its SMS to incorporate information from the change project's hazard record.

The company will also therefore need to review its strategy, priorities and plans for monitoring so that it continues to focus on the most critical and vulnerable systems and ensures that it can identify issues so that those who need to act can do so in a timely manner. Initially, there may also be specific aspects of the change that need monitoring to address concerns that were identified or validate assumptions that were made in the risk assessment.

WORKED EXAMPLES

The following worked examples are based on real decisions that have been taken in the GB industry but they have been combined, simplified and idealised to highlight learning points. The third example is described in most detail. Further detail on the first two can be found in worked examples developed to support Taking Safe Decisions, which are available from the RSSB website (www.rssb.co.uk) [9, 10].

Operational change: introducing driver only operated passenger services (DOO(p))

A railway undertaking (RU) plans to remove guards from its trains and run them 'driver only' to reduce operating costs. The RU determines that the financial case is favourable: they are at the beginning of their franchise and expect the likely implementation costs to be outweighed by savings over a five-year period.

The case for change is developed over a period of months alongside extensive consultation because of the potential impact on industrial relations. Other RUs are already operating DOO(p) services in similar circumstances, which provides confidence that the operation can be made safe. However, because the change is novel for this particular RU and because hazards associated with train dispatch have potentially fatal consequences, the change is deemed to be significant and an independent assessment body is appointed.

Once the decision to implement the change has been made in principle, detailed risk assessment work begins. The RU undertakes site visits and reviews existing documentation, incident reports and safety data to build the system definition and generate an initial set of hazards, which is reviewed and analysed in a series of workshops. Recognising the sensitivity of the change, Trade Union health and safety representatives are included on the project steering group from the beginning so that concerns can be raised and addressed as they arise.

Another RU with three years' experience of DOO(p) on comparable lines using similar rolling stock is also involved from an early stage and takes part in the workshops. Many hazards can be 'closed out' using the similar reference systems risk acceptance principle and, because the RU making the change has built up a good and open relationship with this other operator, this proves a relatively straightforward and efficient way of identifying safety measures and demonstrating that they will control the risk to an acceptable level. The risk assessment considers local characteristics and different solutions (for example, driver look-back, mirrors and CCTV monitors) are identified for different platforms. It identifies that additional lighting is required at some platforms and also the need to put in place a process to identify events that will lead to high levels of usage at stations close to sporting and concert venues and to put additional staff on crowd control duties when such situations are likely to arise.

The RU runs test trains during a six-month trial period, with a project manager and Trade Union representative on board, to verify that the required safety measures are in place and working and to identify any additional issues. Each platform is assessed and any issues resolved before it can be 'signed off' by the project team and the Trade Union representatives. This leaves a clear audit trail and reassures the Trades Unions that safety matters have been properly addressed.

The early stages of implementation are subject to further monitoring of both operational and safety performance indicators. The main issue relates to the visibility of monitors in some sunlight conditions. Additional safety measures are identified and implemented, such as replacing black-and-white monitors with colour screens and adding hoods to prevent glare.

The RU observes an 80% reduction in incident reports between the first and second post-implementation reviews (undertaken six and twelve months after the change respectively), which indicates that the new mitigation measures have successfully addressed most of the issues.

<u>Organisational change: forming a railway undertaking / train operator alliance</u>

An infrastructure manager (IM) and RU start discussions around forming an alliance to manage rail operations in one of the GB regions. The motivation behind this is that a combined organisational structure will encourage teamwork and co-operation and so improve efficiency and performance. For example, alterations to the timetable can be based on consideration of maintenance requirements, the impact on train services and the overall effect on safety. The IM and RU are legally obliged to continue as separate organisations with separate Safety Certificates / Authorisations and separate SMSs. Alongside legal requirements, project, commercial and safety risks inform the development of the proposed new organisational structures. The Safety Directors of the two organisations take a prominent role in formulating options to provide confidence that operations under the new structure will be safe.

Such a 'deep' alliance would be novel in GB and the change is relatively complex. Local and national consultation is carried out from the inception of the project and the regulator is involved from the start. The IM acts as the proposer and applies the process defined by the CSM RA to what it judges to be a significant organisational change.

Codes of practice and similar reference systems are not available and so the explicit risk estimation risk acceptance principle is applied. The IM already has a structured safety validation process for organisational change within its SMS and this meets the requirements of the CSM RA. Assessing the risk associated with organisational change is not an exact science. The risk associated with the proposed changes to the way people are managed and organised is therefore evaluated qualitatively in a series of structured workshops.

Hazards are identified in workshops involving both managers and front-line staff from the IM and RU and further input is provided by other stakeholders, such as Trades Unions and interfacing RUs. The workshops provide the people affected by the change with a chance to voice their opinions and so help to achieve understanding and acceptance.

The hazards are then classified by the project team using vulnerability rankings. This is challenging; they often have to be based on collective 'gut feeling' because organisational issues, such as the impact of different personalities within the companies, are complex and difficult to quantify.

Further workshops are held to identify the risk controls that are needed to reduce the risk from the hazards to an acceptable level. These are integrated into the hazard record for the project and developed into a risk-based implementation plan in three stages:

1. Before implementation ('development'). For example, "confirm that new post holders have been briefed on their job description, cover arrangements or other duties, including relevant standards."
2. During transition ('start-up'). For example, "confirm that all direct reports have been briefed on the new organisation structure and they have arrangements in place to brief their teams within four weeks of 'go live'."
3. Post 'go live'. For example, "undertake the post implementation review."

The independent assessment body is engaged early in the process and attends the workshops and review meetings (taking care to maintain its independence). It is provided with ample opportunity to comment on the application of the CSM RA process and the project team engages it throughout, taking account of comments and suggestions. The early and continued involvement of the assessor and the engagement and responsiveness of the project team are seen as critical to the project's success.

During the transition to the new structure, the combined team that has been set up by the companies undertakes regular reviews, including assessing the effectiveness of the control measures put in place. The arrangements are reviewed after the new organisation goes live. There are regular meetings, in which the change is discussed and concerns identified, and meetings with other stakeholders provide an external sense-check. A post-implementation review committee is set up to report progress to the governance board at six-monthly intervals.

Technical change: building a station footbridge

The Persons with Reduced Mobility Technical Specification for Interoperability (PRM TSI) requires measures to be implemented that will 'enhance the accessibility of rail transport to the persons with reduced mobility'. This can necessitate the provision of a safe means of crossing the track at a station, which might involve the installation or upgrade of a subway or footbridge.

The UK Department for Transport determines that an upgrade to a particular station should be carried out to ensure its compliance with the PRM TSI. The need to make a change is therefore mandated on the IM, but the IM must determine how it will meet the requirements in a way that is commercially sound and safe. The IM quickly determines that installing a subway would be prohibitively expensive and so provision of a new footbridge is the preferred means of providing safe access across the track.

The options available to the IM, which is acting as the proposer of the change, are constrained by the station lay-out and the width of existing platforms. There is a need to: (i) ensure that passengers have sufficient space for waiting on the platform and moving along it; (ii) achieve the required clearance to the track, and to (iii) provide suitable access to and egress from the platform.

Reduction of the available platform space adjacent to the bridge support and access ramp locations will impact not only the passenger flows and the access arrangements for the station but importantly also the access arrangements for future inspection and maintenance. All of these factors, with the possible exception of maintenance, also require consideration during the temporary phase when the bridge is constructed.

The IM consults and holds workshops during the option evaluation to achieve consensus on the safety and commercial benefits that the project will deliver. It includes the company that manages the station, those that provide train services through it, and representatives of other affected parties such as passenger groups.

The IM has experience of building bridges at other stations and so identifies an initial set of hazards using the hazard records from these projects. It holds a workshop to validate these hazards, understand aspects of the risk that are particular to the current proposal, and perform an initial classification of the hazards to identify where to focus subsequent risk assessment work. Hazard identification covers both the installation phase of the project (the construction work and its effect on operations) and the use of the bridge once it has been built.

Once the preferred location of the bridge has been identified (at the end of the platforms) the IM's attention moves to bridge design, focussing on the hazard of the bridge being struck by a derailed train.

Railway structures are designed using the Structural Eurocodes (EN1991 part 1-7) in accordance with domestic GB law (the Utilities Contracts Regulations 2006). Where the distance from the centre line of the track to the face of an adjacent structure is 5m or less, the Eurocodes (and the National Annex to them) provide design requirements for the resistance of the structure to forces that represent impact from a train. These forces are large and the cost of compliance can be very high. Risk assessment is a permitted means of establishing the design requirements as an alternative to designing for the values provided. Guidance on the 'planning and execution of risk assessment' is included within Annex B to EN1991 part 1-7.

If the footbridge supports were designed to resist the specified forces then the Codes of Practice risk acceptance principle could be applied and the hazard 'closed out'. However, the IM believes that the expense required for such compliance may not be justified at this station.

The IM has recently constructed basic (non-compliant) bridges at other locations. However, the speed of trains passing adjacent to the platform and the curvature of the track mean that the risk from a train derailing and striking the bridge support is potentially greater at the station in question and the IM concludes that none of the potential reference systems are sufficiently similar. Had it been possible to apply this risk acceptance criterion, it is unlikely that evidence of in-service history alone would be sufficient to conclude that the risk were acceptable because of the low failure rates for footbridges. Therefore evidence that safety engineering principles had been properly applied in the development of the reference system would have been required, taking account of the specific risk factors arising from the station and operating environment.

The IM instead undertakes an explicit risk estimation to identify a suitable design that reduces the relevant risk to an acceptable level. The basic (non-compliant) bridge used at other locations is taken as the base case and three alternative design options are identified, listed here in order of increasing cost and reducing risk:

i. Modification of the footbridge supports (but not so that it can resist the forces specified in EN1991 part 1-7)

ii. Building an impact wall (that provides a compliant level of resistance)

iii. Providing a long-span footbridge that avoids the need to have supports located close to the track.

The risk assessment considers the possible event sequences associated with a derailment close to a footbridge and the risk escalation factors. These are summarised in Table 1, below.

| Scenario | Influences on event likelihood |
|---|---|
| Derailment | Switches and crossings located on the approach to a structure<br>Permissible train speed<br>Train frequency<br>Track curvature |
| Derailed train impacts bridge supports | Distance from track to support<br>Deceleration rate of derailed train<br>Track curvature<br>Ground topography |
| Bridge collapses | Permissible train speed<br>Robustness of structure |
| Secondary collision | Number of tracks<br>Train frequency |

***Table 1: Hazard scenarios for impact with bridge supports***

UIC leaflet UIC-777-2R ‘Structures built over railway lines – Construction requirements in the track zone’ [11] sets out a method for quantifying the risk from this hazard as well as suggested values for some of the parameters in Table 1. The UIC model does not account for some of the risk-influencing factors, including track curvature. This can be taken into account by changing the derailment parameters in the model that would be influenced by track curvature on the basis of expert judgement. The IM also changes some default values in the model to reflect GB-specific risk as estimated by the industry’s Safety Risk Model. The UIC model includes an ‘aversion factor’ but this parameter is set to 1 (effectively removing it from the equation) because societal concern is not deemed relevant to the legal requirements of a company in the GB rail industry.

The risk is expressed in monetary form using the value for preventing a fatality. The reduction in risk from strengthening the support (option i) can then be compared with the associated cost. The analysis yields a benefit-cost ratio of 0.5, suggesting that the costs outweigh the benefits. However, taking into account the uncertainty in the model and its parameters, and after carrying out some sensitivity analysis, the IM judges that the cost is not ‘grossly disproportionate’ to the reduction in risk and so determines that it has a legal duty to implement the measure on the grounds that is necessary to ensure safety ‘so far as is reasonably practicable’.

The additional cost and risk reduction associated with the impact wall (option ii) are then evaluated, and yield a benefit-cost ratio[1] of 0.1. Even when the uncertainty in the model is taken into account the IM is confident that the cost exceeds the benefit. It judges that this improvement is not required and does not implement it.

Note that both option ii and option iii can be assumed to reduce the risk to an acceptable level: option ii complies with a code of practice that is deemed sufficient to manage the risk from this hazard, and option iii effectively designs out this risk. The IM may still decide to implement the more expensive option iii to reduce the risk to a level below what is legally required for business reasons, for example to reduce reputational risk. In this case, the IM does not deem this a sound commercial decision and so decides to implement option i.

The IM continues with the risk assessment process, identifying additional safety measures relating to the bridge design (such as the addition of a high parapet fence to prevent contact with the overhead line or the placing of large objects on the line) and the operation of the station when the bridge has been built. The operational safety measures need to be implemented by the RU that manages the station. Because the IM has engaged with interfacing organisations from the start of the project there is close co-operation between the two companies. It

[1] The comparison between costs and benefits in a CBA is often presented as a benefit-cost ratio (BCR) – that is, the estimated benefits divided by the estimated costs. Reference [12] provides guidance on safety-related CBA in the GB rail industry, including the interpretation of the BCR.

remains the responsibility of the IM, as proposer of the change, to demonstrate that all safety requirements (include those being implemented by others) are being complied with and that the operation is safe.

CONCLUSIONS

Risk management can be thought of as comprising the three related activities of safety monitoring, analysing and selecting options and making a change. Most major changes are made to meet commercial objectives but legal obligations with respect to safety must be met.

The CSM RA sets out a robust risk assessment process that applies once you have decided to make a change. However, it is important to consider safety early on because additional requirements become increasingly expensive the later in a project they are identified.

The three risk acceptance principles defined by the CSM RA provide useful means of identifying safety measures and ‘closing out’ hazards in different circumstances, as illustrated in the worked examples on operational, organisational and technical change.

It is important to establish a good working relationship with interfacing organisations, other stakeholders affected by the change and – when the change is significant – the independent assessment body.

To date, the practical application of the CSM RA in GB – supported by guidance referenced in this paper – has proved successful and given a high degree confidence that changes are being made in a manner that results in an acceptable level of risk.

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