



Strategy for regulation of health and safety risks - Chapter 12: Health and Safety by Design

Introduction

ORR's strategy for Health and Safety by Design:

Health and safety by design is the elimination or control of health and safety risks in infrastructure, products or processes by early consideration and addressing those potential risks at the design stage.

Too often the planning of new and modified works fails to take simple steps to avoid future hazards to the health and safety of passengers and workers. Better planning, more consistent application of standards, good practice and incorporating advice from operators and users at an early stage would help to reduce late changes in projects to deal with emerging issues and also drive down levels of ill health, incidents and accidents in the longer term.

ORR inspectors already work with existing duty holders to look at the issues involved in health and safety by Design under a number of the Railway Management Maturity Model assessment criteria. We will continue this approach and encourage duty holders to develop good health and safety by design practices.

We have revised and republished an updated version of the previous Railway Safety Principles and Guidance Part 1 document (RSPG) to ensure that the minimum design and operational principles we expect of railway undertakings are clearly set out.

Vision

- Everyone who is planning new work, or making changes to existing infrastructure and systems should be considering through good design how they can make their systems inherently safer for public, passengers and employees and with less risk to health.

In particular:

- Industry ownership of health and safety by design as part of routine business management processes;
- The routine and early application of health and safety by design principles to all renewal, enhancement and new build projects;
- A strong approach to health and safety by design by duty holders through:
 - monitoring safety trends and periodically reviewing previous risk assessments, including the risk controls and technologies used to control them to inform design decisions, updating guidance and standards where necessary;
 - having a holistic view of the railway system, taking account of how disparate activities and projects interact to increase or decrease risk;
 - risk assessment using the Common Safety Method or other credible methodology;
 - due consideration of the reasonable practicability of health and safety enhancements, including of the residual risks their introduction is likely to pose;
 - appropriate research into the full range of potential risk control options, including a review of how similar risks are controlled by other railway systems and sectors around the world;
 - a record of the optioneering assessment process, including the realistic costs and benefits of each option and the decision taken and showing how the principles of risk control have been considered;
 - mechanisms to ensure that design health and safety decisions are delivered by the project;
 - effective integration of enhanced controls into existing equipment, systems and operations; and a post-implementation review process; and
 - a planned, iterative process for considering human factors issues throughout the whole of the design and development work, with the active participation of end users throughout.
- By doing all of these things the industry can achieve reduced harm and costs from health and safety issues that could have been avoided through better design of infrastructure and systems.

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Introduction

1. Health and safety by design is the elimination, or reduction and control, of health and safety risks in infrastructure, equipment, products or processes by early consideration and dealing with those potential risks at the design stage.
2. It requires those making the changes to consider early in the planning and design stages what the impact of the change will be on the whole railway system throughout the lifecycle, including construction, installation and commissioning, operation, maintenance, de-commissioning and dismantling or demolition. Having considered and identified the risks and impacts, to then design out those issues, or where elimination is not reasonably practicable to ensure the residual risks are capable of effective control and that this is communicated to those who will control the risks in the future.
3. It should begin at the earliest stages of a project and continue as design choices are made; designers should regularly be evaluating the impact of their decisions on all aspects of the lifecycle of the works.
4. The term ‘Safety by Design’ should always be considered to cover not just safety but also health. Consideration of the health of those constructing, maintaining and using the railway is as essential as considering their safety. It is preferable to use “health and safety by design” to emphasise this wider application.
5. Different industries and companies may often use differing terms to address the Health and Safety by Design concept; what a company calls the approach is not important as long as they undertake their planning and design work in a way that seeks to eliminate and reduce risks as part of that process.
6. Health and Safety by Design is a requirement of the law as covered later in this chapter, but aside from this good design can help to prevent injury and disease for those constructing, operating, maintaining and using infrastructure and equipment. It can also often improve the functionality of equipment and facilities in turn improving productivity and cost-effectiveness. Addressing risks early in a project can help to reduce the need for costly changes later on.
7. This is not a new approach, Britain’s railway safety systems of today are built on learning from almost 200 years of operational incidents that has developed and been built into standards and guidance. ORR wants industry to move on from just learning from experience to proactive Health and Safety by Design considerations that should ensure that potential issues are identified and designed out before incidents occur in the future.

Cost and Efficiency – The risks and benefits

8. The RSSB document 'Taking Safe Decisions' gives a good summary of the benefits that can arise from applying Health and Safety by Design thinking, an extract is given below:

Major change is often taken to meet commercial objectives. However, even if it is not the main driver, safety needs to be considered early on because it provides the opportunity to design in safety enhancements which will ultimately reduce risk to an acceptable level: additional requirements become increasingly expensive the later in the project life cycle they are identified. This is illustrated in Figure 7. The options need to be specified and analysed in sufficient depth to provide confidence that costly new requirements will not materialise later in the project. It is not acceptable to argue that a measure is not necessary to ensure safety SFAIRP on the basis of excessive cost if that measure could and should have been identified at an earlier point in the project when its implementation would have been required.

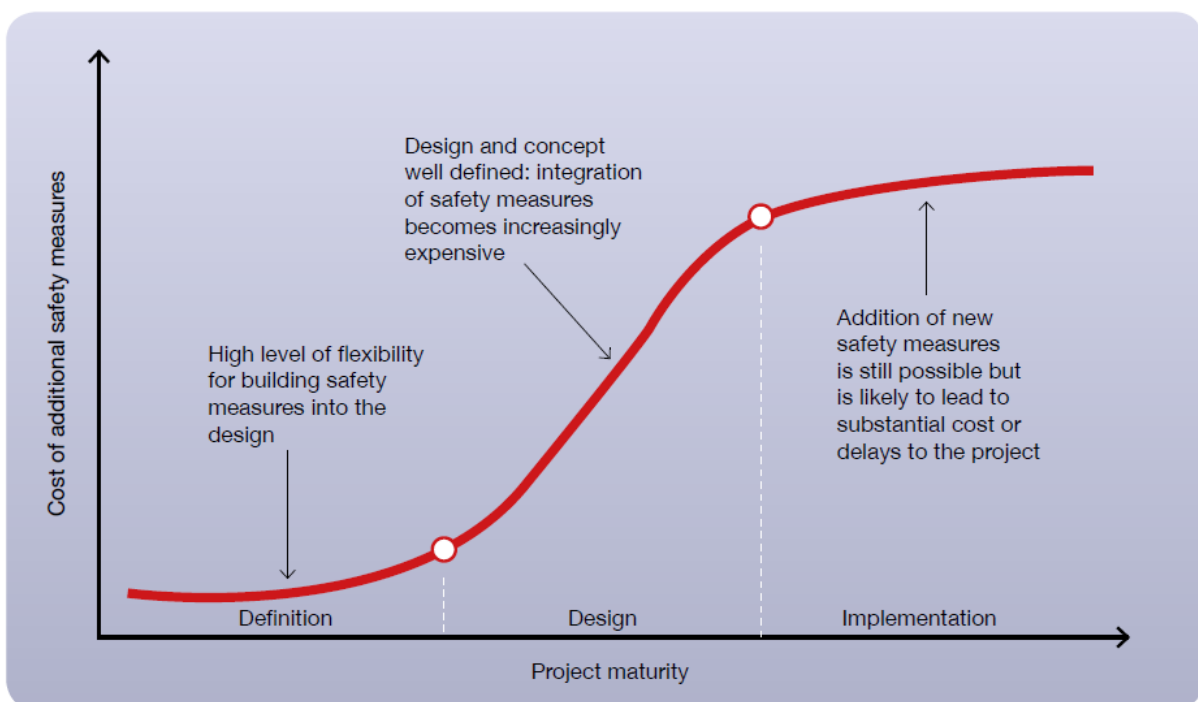


Figure 7: Project maturity and the increasing cost of additional safety measures

Source: RSSB 'Taking Safe Decisions'

<http://www.rssb.co.uk/risk-analysis-and-safety-reporting/risk-analysis/taking-safe-decisions>

9. Through a stronger focus during the concept and design stages and bringing in operational expertise to inform design, designs can be produced that improve the operation of the railway. Rolling stock, systems and infrastructure that are simpler to use and maintain are less costly to operate as a result of reduced maintenance requirements and lower levels of necessary maintenance staffing. Systems can also incorporate learning that will support more efficient operating methods.

10. Designing out a hazard at an early stage will then remove the on-going cost of managing that hazard over the rest of the operational life of the infrastructure or equipment or rolling stock.

11. By bringing construction and manufacturing expertise into the planning and design process from early stages thought can be given to what is being built and how it can be built. Taking

advantage of developments can allow newer technologies to simplify construction methods (reducing build times) improving the logistics of construction operations as well as eliminating or reducing risks to health and safety from construction activities.

12. Every injury represents lost time, delays and as a result additional costs to projects and operations. There is also the potential for dealing with the costs of civil claims or criminal investigations for breaches of health and safety law. Better planning of construction and manufacturing work and consideration of the methods to be used can reduce exposure to health and safety risks and as a result directly reduce the impacts of incidents.

13. HSE estimate that “injuries and new cases of ill health in workers in Great Britain resulting largely from current working conditions cost society an estimated £14.3 billion in 2013/14”. With figures this large it can be appreciated that even small improvements in performance can return significant financial benefits that will outweigh the costs of making the improvements early in lifecycle of the design.

HSE: <http://www.hse.gov.uk/statistics/index.htm>

RSSB: <https://www.rssb.co.uk/risk-analysis-and-safety-reporting/safety-performance-reports>

ORR: <http://orr.gov.uk/rail/health-and-safety/annual-health-and-safety-report>

The law

14. The concept of health and safety by design is covered in a number of different items of health and safety legislation.

- Health and Safety at Work etc. Act 1974 (HSWA), particularly section 6
- Management of Health and Safety at Work Regulations 1999 (MHSW)
- Construction (Design and Management) Regulations 2015 (CDM)
- Railways and Other Guided Transport Systems Regulations 2006 (ROGS)

The application of each of these is explored further in Appendix B.

15. ORR has entered into an agency agreement with the Health and Safety Executive (HSE) on the enforcement of health and safety by design in respect of railways and other guided transport systems. The agreement has the effect of giving ORR an enforcement role at an earlier stage in a project and, therefore, an improved opportunity to influence health and safety by design.

16. A copy of the agreement can be seen on ORR’s website: <http://orr.gov.uk/about-orr/who-we-work-with/agency-agreements-and-mous>.

The Challenges

17. There are a number of issues that can restrict a good approach to designing out health and safety risks. These include:

- Clients setting too restrictive a brief and leaving designers little flexibility in their approach. Note that this might in turn mean that Clients are effectively taking on some of the roles of Designer under the Construction (Design and Management) Regulations 2015 (CDM).
- Designers being restricted in the time and budget available to them, limiting their ability to spend time thinking through or considering a suitably wide variety of options.

- Designers being insufficiently briefed on the potential uses and users that the infrastructure, rolling stock, equipment or systems that they are planning will have. This can lead to incorrect assumptions and to risks being created. Clients therefore need to make sure they provide designers with the right information about the planned use.
- Clients and Designers being highly risk averse and avoid using new products, technologies or ways of working. This leads to a tendency to purchase and to design 'more of the same' to reduce uncertainty, but this approach may fail to design out known problems or take advantage of technological developments or newer products with better health and safety characteristics.
- Optioneering being done merely to justify a decision that has already been made. There needs to be a more honest and open approach if innovative solutions are to emerge.

ORR's priorities

18. Much of the duty to undertake health and safety by design activities lies with the designers of infrastructure, rolling stock, equipment and systems. Clients also have a big part to play, particularly where they may set constraints on designs or specify particular standards, materials, products or operating practices; it will then also be important for the client to be able to show that they have considered the impact of those decisions. Designers need to be able to inform clients where the requirements that have been set may result in risks and be able to suggest effective ways to eliminate or control them.

The term 'Designer' is used here to include anyone who undertakes design work of any kind, this includes, architects, landscape architects, engineers, industrial designers and can also include those who give advice that affects design such as ergonomists, occupational health advisors etc.

19. Manufacturers and construction contractors can also play an important role around helping designers and clients understand the risks that arise in the construction phase and how these might be avoided through design and planning of works. Similarly suppliers and manufacturers should be clear about the performance characteristics of their products to help clients and designers understand the limitations and opportunities that may exist from different products.

20. Those already maintaining similar infrastructure and equipment can bring useful lessons learned to avoid the repeat of previous poor practice, or help to avoid high maintenance solutions being proposed. Clients and Designers should be proactive in seeking out the experience of others and where possible seeking best practice to drive forward on standards of performance. Best practice comes not only from within the railway industry but can be drawn from a wide range of other business sectors where appropriate.

21. Where appropriate clients and designers should take early advice from specialists such as the emergency services and bodies such as the Centre for the Protection of National Infrastructure (<http://www.cpmi.gov.uk/>).

22. For some infrastructure, rolling stock, equipment and systems the input of user representatives can help to shape design considerations. In particular groups representing those with various forms of disability can offer realistic advice on practical needs of potential users from the earliest stages of planning onward.

23. These duties to use design to prevent and mitigate health and safety risks apply across the whole of the railway and guided transport industry, from high speed rail developments, through the conventional mainline railway and on into the metro, light rail and innovative transport sectors, and

even heritage railways and tramways. Everyone who is planning new work, or making changes to existing infrastructure and systems should be considering through good design how they can make their systems inherently safer for passengers and employees with reduced risk to health.

ORR Activity

24. Under our Risk Management Maturity Model (RM3) system¹, which seeks excellence in management, ORR inspectors dealing with existing duty holders look at the issues involved in health and safety by design under a number of the RM3 assessment criteria including 'OC5: System safety and interface arrangements', 'PI1: Risk assessment and management' and 'RCS3: Change management (process, organisational and engineering)'. Inspectors will continue to challenge duty holders to show that they are working on 'change' in a proactive and planned way using good practice and relevant standards.

25. We have revised and republished² an updated version of the previous Railway Safety Principles and Guidance Part 1 document (RSPG) to ensure that the minimum design and operational principles we expect of railway undertakings are clearly set out.

26. ORR has also allocated some specific resource to monitor and influence the development of some major schemes where there is currently no existing railway duty holder such as High Speed 2 (HS2).

27. We will continue to support the Prevention through Engineering and Design initiatives of Network Rail (Network Rail Safety Central <https://safety.networkrail.co.uk/safety/prevention-through-engineering-and-design/>) and look to see that Network Rail projects are applying their own internal standards and guidance on Health and Safety by Design. In the course of inspection work we will check that processes for project assurance and control incorporate appropriate checks to ensure optimum health and safety outcomes for projects.

28. Where duty holders have established specific procedures or standards that address the Health and Safety by Design principle then we will expect to see that these are being applied in practice. We will also want to be assured that dutyholders have design assurance procedures that check that industry and company standards are complied with in design work and that deviations are authorised through robust challenge processes. Checks should also be made that the approved designs are actually what is delivered by contractors.

29. ORR already engages in formal 'permissioning' functions such as delivering Authorisations under the Interoperability Regulations, Level Crossing Orders under the Level Crossings Act and certain other specific approval or authorisation duties under varied items of private legislation linked to specific transport systems. Where we have such duties we will where appropriate seek evidence that health and safety by design has been addressed

What will ORR expect to see as indicating good practice?

30. We will expect to see that through their monitoring of safety incidents and trends dutyholders consider what risk controls should be used in the future to manage these issues and ensure that guidance and standards are updated to reflect this learning.

¹ <http://orr.gov.uk/rail/publications/guidance/health-and-safety/risk-management-maturity-model-rm3>

² <http://orr.gov.uk/rail/health-and-safety/health-and-safety-strategy/goal-setting-principles-for-railway-health-and-safety>

31. Where proposed projects are of a type new to the dutyholder we will expect that evidence will have been gathered on good practice and previous experience of other dutyholders to ensure that optimal design decisions are reached.
32. We will expect that where dutyholders are planning change and undertaking (or commissioning) design that this takes a holistic view of the railway as a system and considers the interaction between the planned work and other parts of the railway, and where appropriate other systems beyond the railway. This should include realistic assessments of the interaction between the new works and existing risk issues.
33. We will expect to see that dutyholders have consistent ways of undertaking risk assessment that are proportionate to the scale of change. Where relevant we will expect evidence of the use of the Common Safety Method for Risk Assessment.
34. We will expect that where change is being made that reasonably practicable opportunities are taken to improve on conditions, for example not just resurfacing a platform, but considering laying tactile paving or resolving issues with platform to train stepping distances.
35. Design processes should wherever reasonably practicable include the use of recognised methods from the field of human factors to address risks associated with the design and use of equipment, tasks, systems and the working environment, taking into account human capabilities as well as limitations, and influences on human performance
36. We will expect to see that dutyholders can show that they have considered the needs of people with impairments when designing systems, equipment and infrastructure for public use. Where systems, equipment and infrastructure are for the use of employees only then we will expect that reasonably practicable steps have been considered to ensure that they are suitable for all employees and that people with protected characteristics³ are not excluded from employment by the nature of the workplace or work equipment when it would have been reasonably practicable to produce an inclusive design.
37. We will expect designers and clients to select equipment that has intrinsic safety features where possible to ensure that the equipment fails to safe conditions, and that staff are not exposed to hazards during inspection and maintenance activities.
38. We will expect that where it has not been possible to completely design out a risk that the residual risks have been documented, properly communicated back to the client, passed to the eventual operator or manager and that suitable operational controls are then in place.
39. We will expect organisations with large programmes of design and development work to use proactive performance indicators to measure how well their design processes are functioning.
40. Designers should be considering not just the intended operational use specified by the client, but also consider reasonably foreseeable misuse.
41. We will expect that dutyholders will be able to demonstrate that they have explored a range of solutions and options to find the most reasonably practicable option with the lowest level of overall risk.

³ <http://www.equalityhumanrights.com/private-and-public-sector-guidance/guidance-all/protected-characteristics>

42. We will expect dutyholders to be able to show that they have considered the whole life cycle of infrastructure, equipment or systems when selecting design options and that they have regard to the optimally 'safest' solution over the whole life of a design and not just in one phase such as construction or operation.

43. We will expect duty holders to build on approaches such as BIM to ensure that Health and Safety by Design issues are documented and managed through the life of assets, and that this information is leveraged to achieve good risk management.

44. We will expect that where project control is through methods with stage gates that health and safety criteria form part of the gate assessment where appropriate.

Design for cyber security

45. We will expect duty holders to have addressed cyber security issues in the specification, design and purchasing of equipment and systems. The Department for Transport produces specific guidance for the rail industry on this overall topic: <https://www.rspb.co.uk/improving-industry-performance/cyber-security/government-guidance>. Additionally the guidance on design of industrial control systems available from the National Cyber Security Centre should be considered: https://www.ncsc.gov.uk/content/files/protected_files/guidance_files/SICS%20-%20Manage%20ICS%20Lifecycle%20Final%20v1.0.pdf.

Appendix A - Useful Sources of Information

Network Rail Safety Central: <https://safety.networkrail.co.uk/safety/prevention-through-engineering-and-design/>

HSE CDM 2015 website: <http://www.hse.gov.uk/construction/cdm/2015/index.htm>

CITB CDM 2015 website: <http://www.citb.co.uk/health-safety-and-other-topics/health-safety/construction-design-and-management-regulations/cdm-guidance-documents/>

HSE managing Construction Health Risks:
<http://www.hse.gov.uk/construction/healthrisks/index.htm>

HSE Policy and guidance on reducing risks as low as reasonably practicable in Design:
<http://www.hse.gov.uk/risk/theory/alarp3.htm>

Crossrail “Healthy by Design”: http://74f85f59f39b887b696fab656259048fb93837ecc0ecbcf0c557.r23.cf3.rackcdn.com/assets/library/document/h/original/healthy_by_design_version_3.pdf

Crossrail Learning Legacy website: <http://learninglegacy.crossrail.co.uk>

HSE: “Costs to Britain of workplace Injuries and new cases of work-related Ill Health”
<http://www.hse.gov.uk/statistics/cost.htm>

RSSB: “Costs of impaired health across the network” <http://www.rssb.co.uk/library/improving-industry-performance/2014-02-report-whwp-costs-of-impaired-health-across-network.pdf>

ORR’s guidance on Safety Verification: <http://orr.gov.uk/what-and-how-we-regulate/health-and-safety/regulation-and-certification/rogs/safety-verification>

Centre for the Protection of National Infrastructure: www.cpni.gov.uk

ANSI/ASSE Z590.3-2011 “Prevention through Design Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes”

Australian Government: “Guidance on the principles of safe design for work”
<https://www.safeworkaustralia.gov.au/doc/guidance-principles-safe-design-work>

RSSB: “Taking Safe Decisions” <http://www.rssb.co.uk/risk-analysis-and-safety-reporting/risk-analysis/taking-safe-decisions>

RSSB: “Understanding human factors” <http://www.rssb.co.uk/Library/improving-industry-performance/2008-guide-understanding-human-factors-a-guide-for-the-railway-industry.pdf>

London 2012 Olympics learning legacy: <http://learninglegacy.independent.gov.uk/themes/>

Appendix B – The law

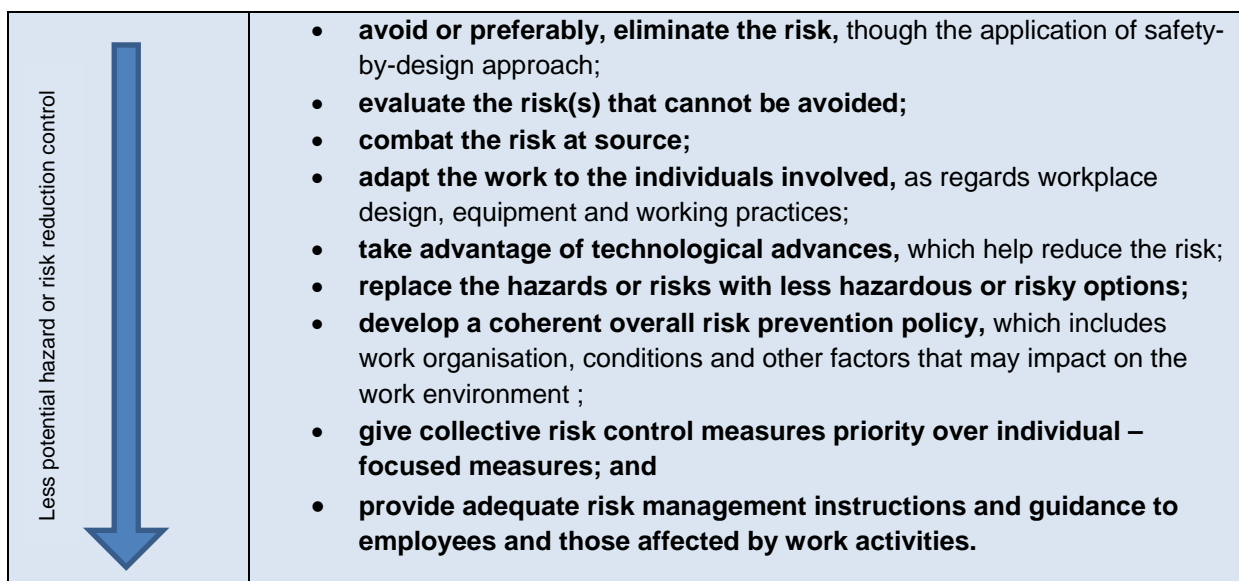
Health and Safety at Work etc. Act 1974 (HSWA)

1. The general duties that arise under sections 2, 3 and 4 of the Act to do what is reasonably practicable to secure the health, safety and wellbeing of employees and others can be interpreted as requiring reasonable consideration of health and safety by design matters and acting on the findings.
2. Section 6 of the Act has a specific requirement to ensure through design and manufacture that ‘articles used at work’ do not present safety or health risks during set up, operation or maintenance. This is a relatively narrow duty compared to the generality of ‘safety by Design’ however as ‘article’ is itself a specific term under the Act and does not encompass the entirety of railway systems, merely some of the items of machinery or equipment that exist within the railway system. For those items in scope however it is very relevant to Health and Safety by Design considerations.
3. The Act sets out the general duties but perhaps more importantly it creates the power to set up a framework of subsidiary regulations. The following three statutory instruments made under the Act expand on the general principles and deal more particularly with topics relevant to Health and Safety by Design.

Management of Health and Safety at Work Regulations, 1999 (MHSW)

4. MHSW Regulations create a very explicit duty to carry out a suitable and sufficient risk assessment and then undertake prevention of the risks identified. The two key regulations are:
 - Regulation 3, which set out the requirements on duty holders to conduct a suitable and sufficient risk assessment; and
 - Regulation 4, which asserts the general principles of prevention, which are then set out in detail in schedule 1 of Regulations – see below. This is commonly referred to as the hierarchy of risk control.

Hierarchy of risk control – based on MHSW Schedule 1:



Construction (Design Management) Regulations 2015 (CDM)

5. The Construction (Design and Management) Regulations 2015 apply to all railway building and construction projects, regardless of their size, duration and nature.
6. These regulations place responsibility for the previous 'CDM coordinator' functions in the 2007 regulations on the new 'principal designer' role, including crucially the pre-construction phase responsibilities. This entails taking account of the general principles of risk prevention to eliminate, so far as are reasonably practicable, risks to people using or maintaining a structure, which includes a railway. Where it is not possible to eliminate these risks the designer must, so far as is reasonably practicable, take steps to reduce or control the risks through the subsequent design process. The designer's duties start as soon as designs are prepared which may be used in construction work. This includes the concept design stage and work carried out for feasibility studies. The emphasis is on addressing health and safety issues from the earliest point in a project to eliminate foreseeable risks and avoid costly changes or adaptations later on.

Railways and Other Guided Transport Systems Regulations 2006 (ROGS) as amended

Risk Assessment

7. For all duty holders, mainline and non-mainline, responsibilities around risk assessment are set in regulation 19 of ROGS.
8. ROGS Regulation 5(1)(b) requires that a mainline duty holder's Safety Management System applies the relevant parts of Common Safety Method on risk assessment and evaluation (CSM-RA). The CSM-RA requires that mainline railway duty holders proposing any significant safety-related technical, operational and organisational change use a common approach to assess and evaluate the risk posed by the change.
9. Before any significant proposed change, which is likely to be associated with an opportunity to re-design a product, equipment or process, they must demonstrate that the 'risk assessment' principles have been correctly applied, including coordinating and managing the demonstration that the safety requirements are met; of course, this may include assessments made by other organisations as part of larger projects.
10. The CSM-RA approach covers hazard identification, then risk analysis and evaluation via three main routes; the use of codes of practice or standards, using comparable reference systems, or undertaking explicit risk estimation. This approach also requires the use of an independent Assessment Body (AsBo) to input to and monitor the process.

Cooperation

11. ROGS Regulation 22 requires all transport operators to cooperate with one another. This can at times be central to the health and safety by design approach when dealing with shared risks or across interfaces between adjacent duty holders. It covers both basic design compatibility, such as between train and platforms, as well as operational issues, for example ensuring stations are designed with ventilation to ensure operators staff are not exposed to DEEE.

Application of ROGS before operations begin

12. Regulations 3 and 4 of ROGS only require mainline railway dutyholders to have a SMS once train services are operating. For new build mainline railways not associated with an existing

infrastructure manager there is therefore no need to have a ROGS compliant SMS in place and the requirement under ROGS to follow CSM-RA is not in place either. In practice this should have minor effect since in order for a scheme to be Authorised under Interoperability it will have had to follow the CSM-RA process anyway.

13. For non-mainline railways and other types of transport system, such as metros and tramways, there is a requirement under regulation 6(6) of ROGS that if there is no 'transport operator' in place while a system or project is being developed then a responsible person takes on some of their duties. Those duties are the ones in paragraph 6(4) of ROGS to undertake Safety Verification (SV).

14. SV is a requirement under ROGS that when non-mainline transport operators (transport undertakings or infrastructure managers) introduce new or altered rolling stock or infrastructure, they need to ensure that health and safety considerations are incorporated into their design processes. SV is therefore entirely compatible with and a part of good Health and Safety by Design practice. The Competent Person required under SV is there to advise and comment on the application of standards and good practice and to help decide on the assessment and acceptance criteria for projects.

15. SV does not apply to all non-mainline projects, there is a risk and difference test built into the system, but nevertheless whether formal SV is used with a Competent Person, or whether there is advice taken from an Independent Safety Advisor, the function of having some external advice can be a valuable role to help guide a project toward good practice and ensure that this is implemented properly.

16. There is further guidance on SV and the role of Competent Persons on ORR's website and the broader issues around 'change management are addressed in ORR's separate Strategic Risk chapter on this topic.

Appendix C – Abbreviations and Acronyms

Glossary of terms	
Acronym	Definition
ALARP	As Low As Is Reasonably Practicable
ANSI	American National Standards Institute
AsBo	Assessment Body
ASSE	American Society of Safety Engineers
BIM	Building Information Modelling
CDM	Construction (Design Management) Regulations 2015
CITB	Construction Industry Training Board
CPNI	Centre for the Protection of National Infrastructure
CSM-RA	Common Safety Method on risk assessment and evaluation
DEEE	Diesel Engine Exhaust Emissions
HS2	High Speed 2 Railway Project
HSE	Health and Safety Executive
HSWA	Health and Safety at Work etc. Act 1974
MHSW	Management of Health and Safety at Work Regulations 1999
ORR	Office of Rail and Road
RM3	Railway Management Maturity Model
ROGS	Railways and Other Guided Transport Systems Regulations 2006
RSPG	Railway Safety Principles and Guidance documents
RSSB	Railway Safety and Standards Board
SFAIRP	So Far As Is Reasonably Practicable
SMS	Safety Management System
SV	Safety Verification



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