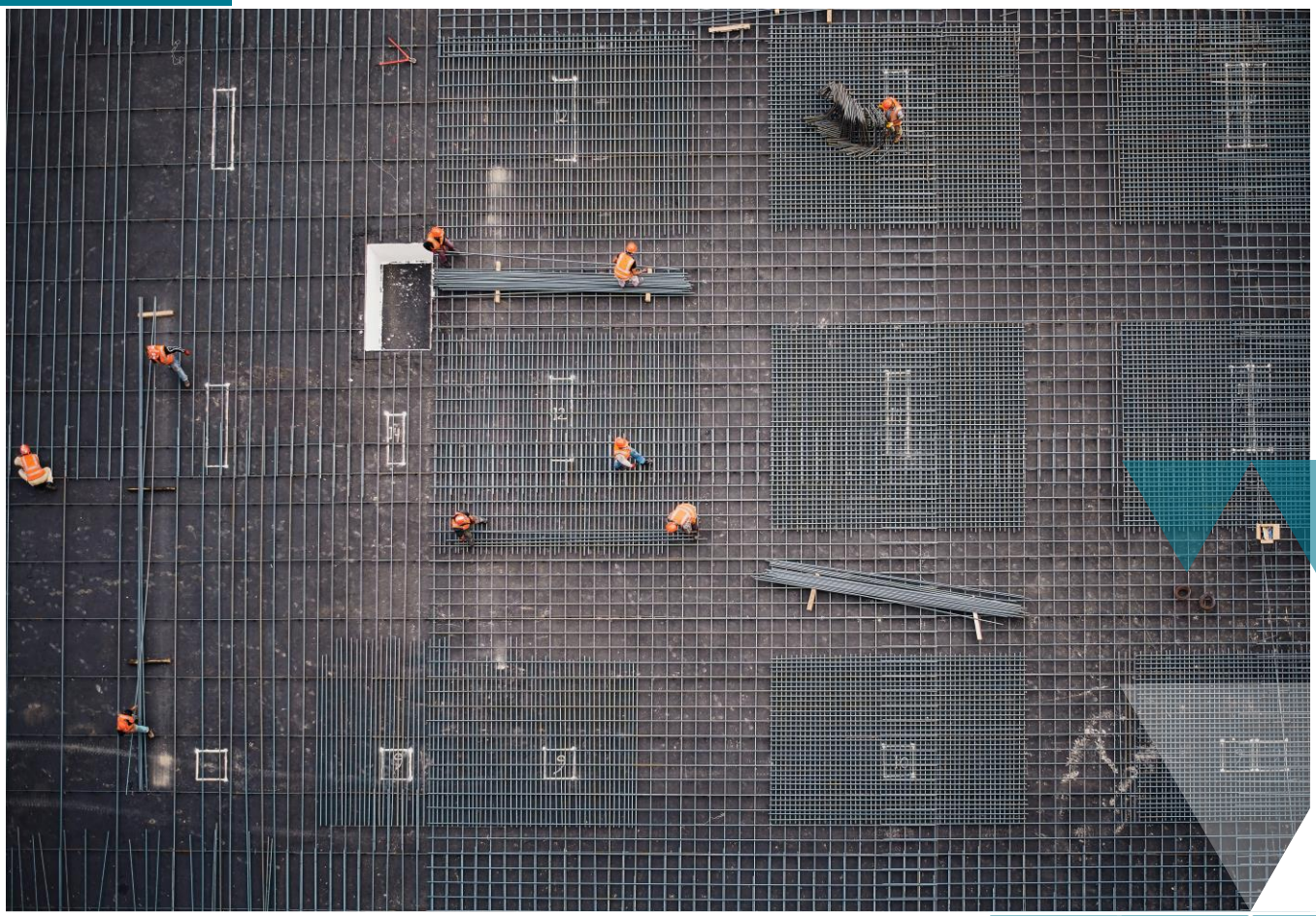

Guidance for design risk management

Improving design risk management (DRM) in the construction industry.

Version 2 – April 2020

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Guidance for design risk management

Design risk management (DRM) is a means by which designers can demonstrate that their designs can be built, used, maintained and eventually demolished without negatively affecting the safety, health and wellbeing of those involved in the construction process or those who may be impacted by the structure. The purpose of this document is to provide the reader with an understanding of how to discharge certain duties relating to the management of risk where projects fall within the remit of The Construction (Design and Management) Regulations 2015 (CDM 2015).

Contents

This document is a revised version of the original DRM guidance and replaces all previous versions.

Executive Summary

ICE has developed this guide with the aim of improving design risk management (DRM) within the construction industry. This 'risk-based' management process creates new opportunities in project delivery that can be reflected within an organisation's business processes. Through taking a pragmatic approach, DRM not only builds upon good engineering practice, it helps to provide a more holistic solution for all stakeholders.

A benefit of this approach is that other important issues such as competency, clarity of responsibility, supervision and review can be addressed by the right people at the right time. Hence, it is relevant to all those in the industry who either carry out or instruct 'design work'. The Guide is written as a complementary advice piece to enable the reader to use as a "go to" document for quick and easy support and a means to "signpost" readers to existing published CDM documents.

It may be perceived that DRM and the definition of how to approach it has not been covered particularly well in the past; however, this guide, with its pragmatic approach, describes the process, with the aid of flow charts and descriptions, by which individuals and organisations can better approach the issue of 'so far as is reasonably practicable'.

Central to the understanding of how to carry out these duties (notwithstanding the existing and well known 'Principles of Prevention') is the adherence to three fundamentals of DRM, which takes the reader through the steps of:

- Safe and Healthy Design – that is designs that conform to the accepted norm of prevention of harm through good design;
- Use of Contemporary Guidance – referring to the use of peer-recognised good or best practice design approaches to provide safe and healthy outcomes; and,
- Communication – highlighting the importance of ensuring that the right people get the right level of information in time to make the right decision(s).

While adhering to the three fundamentals it is important to note that the information to be shared should ideally relate only to non-routine activities where a significant risk has been identified (i.e. risks, including health risks, that are not likely to be obvious, are unusual or likely to be difficult to manage effectively). This approach helps in the reduction of unnecessary paperwork. Key to the successful application of DRM is how the findings are communicated to the various members of the wider team and there is an example of how this can be done in Appendix C.

The production of this ICE guide is seen as a vital and welcome addition to those seeking to put DRM into meaningful practice and to enable users to proceed with confidence.

Introduction

This guide is designed to provide the reader with some complementary advice on how to discharge the duties relating to design risk management (DRM) under the CDM Regulations 2015 (HSE 2015). It assumes that the reader is already familiar with the requirements of CDM 2015, including an understanding of the statutory responsibility of the duty holders.

The following advice is a clarification of the ICE's understanding of what is required in order to sufficiently discharge the designer's duties in relation to DRM. The purpose is to provide its members, and the wider construction industry, with a straightforward 'risk management' based guide that can be read alongside other available guidance, for example Construction Industry Research and Information Association (CIRIA) guidance (Iddon and Carpenter 2009, CIRIA 2015, and Gilbertson 2015). Additional information regarding the CDM 2015 regulations is provided in the following resources:

- HSE - L153 Managing health and safety in construction;
- CITB – CDM 2015 industry guidance for designers; and
- ICE: New Construction (Design and Management) Regulations 2015

This guide is intended for those who carry out design and for those who manage design and the design process. The regulations place obligations upon all those involved in the design process including line managers, senior managers and the Board (all of whom may represent the corporate design organisation to varying degrees). In smaller organisations these roles may merge, but the obligations placed upon them remain. Managers and board members can gain an appreciation of the importance of DRM through this guide as well as find more detailed information in the 'Who should do what?' section.

It is also useful for Contractors (who construct), Clients (who generally represent those who commission, use, operate, repair, maintain or decommission structures) and Principal Designers who need to know what designers should be doing and how best to support them in carrying out their duties.

This guide is designed to be accessible to professional designers, and while arising out of CDM 2015 it is transferable to other regulatory regimes. The detail of the legislation, where quoted, may vary in jurisdictions outside of GB, the principles outlined in this guide will generally hold good internationally.

Readers are reminded to check the regulatory requirements of the national statutory body of the jurisdiction in which they are working.

Design risk management and a team approach

The purpose of DRM is to control or limit design-related uncertainty in order to prevent harm coming to those involved in the construction and use of structures, as well as those who may be directly or indirectly impacted by them. In construction we have a great deal of uncertainty that has to be managed effectively; for example, in addition to safety, health and wellbeing there are cost, quality, time, fitness for purpose, aesthetics and environmental impact; constraints that may affect the design choices. Therefore, the contribution of other team members engaged on the project may be invaluable to the designer.

Remember that while a team approach may provide a wider insight that could prove to be useful in the delivery of a safe and healthy construction project, providing advice or being part of a conversation relating to a design doesn't automatically mean you are considered to be a designer. Not all team members may have the competence and/ or capability to act as a designer, but they may have useful input that could inform good design choices.

CDM 2015 is quite clear on who may be deemed a designer and that is an individual or an organisation who prepares or modifies a design for a construction project (including the design of temporary works) or indeed an individual or organisation who arranges for or instructs someone else to do so. However, only the designer (an individual or an organisation) assumes the responsibility for completing the actual design task for that design element, taking due cognisance of any advice or assistance received, and in so doing so they are responsible for ensuring compliance with Regulation 9. **Note:** Designers cannot abdicate or avoid their statutory responsibilities by indicating that the design decisions were made by a collective.

Where two or more designers are working on a project, collaborative working (and sometimes collective decision making) is required. In these circumstances the Principal Designer plays a role (an individual or an organisation can assume this role also). Among other duties it is for the Principal Designer to coordinate the work of others in the project team and ensure cooperation among and within the team to ensure that significant and foreseeable risks are managed throughout the design process and that a safe and healthy project outcome is deliverable.

ICE recognises the need to collaborate and communicate within the wider project team and that teamwork is vital to the success of a project. Indeed, the team approach to managing risk can often bring advantages such as a broader set of experiences and knowledge from the wider team. Designers (or Design Organisations) must, however, ensure that they are content with the resultant design and that they have considered the general principles of prevention to adequately manage any risks as required by Regulation 9 of CDM 2015.

The objective is to give careful consideration to all of the hazards identified during the design process in order to maximise the opportunity to eliminate or, if not feasible, reduce the risk of harm during the whole life cycle of a structure (i.e. the construction, commissioning, use, maintenance, repair, decommissioning and demolition). It is easier and more cost effective to tackle these issues during the design phase when there is time to develop a suitable solution rather than addressing them in an unplanned and informal fashion during construction or commissioning or to make modifications once the structure is in use.

Design risk and other project risks

There are a range of challenges and uncertainties faced by those working on projects. A Risk Management strategy is key to anticipating and dealing with the wide array of project risks and DRM, in this context, is no different. DRM should not, therefore, be done in isolation but as an integral part of the overall project risk management process and an iterative part of the design process and not a 'bolt-on' exercise. Of course, design itself can also present a risk to the project; mistakes in safety-critical calculations, for example, need to be mitigated, for example by using checking regimes and through provision of appropriate level of supervision to less experienced staff.

Who is at risk?

The designer needs to consider all those whose safety, health and wellbeing may be affected by the design not just during construction but also in the commissioning, operation or use, repair and maintenance, decommissioning and finally demolition of the structure (the whole life cycle).

This can include the occupants of a dwelling or the staff, operators and maintenance personnel for a structure. Consideration should be given to a variety of different circumstances, including emergency situations and the design adjusted accordingly to ensure the safety, health and wellbeing of those who may be affected.

Examples of the type of situations that the designer may consider include:

- Has the designer considered the need for access in extreme weather conditions?
- Has the designer considered alternative traffic flows during repairs or road traffic incidents by providing removable barriers?
- Has the designer considered emergency access for repairs in the event of a component failure?

Civil Engineers should also bear in mind the ICE Code of Professional Conduct Rule 3 which requires its members to take all reasonable steps to protect the health and safety of members of the public and of those engaged in the project. This covers the whole life of a project during construction, operation, maintenance and decommissioning.

Who should do what?

Design risk should be managed at different levels throughout the design organisation.

Board of Directors (or equivalent):

The failure of an organisation to manage design risk may significantly impact on them through reputational damage, operational failures or financial penalties and could result in prosecution and even the possibility of jail sentences for individuals within that organisation (ICE, 2004 and ICE, 2006). It is well-established that good health and safety management is good business (HSE, 2020) as the approach to managing risks i.e. identifying and managing by analysis of the designers' work ahead of their impact, leads in turn to a correspondingly wider benefit.

A booklet produced by CIRIA (Horner and Duff, 2001) illustrates how improved planning by contractors could lead to significant productivity gains. There are many aspects to that text which could apply to designers, and the central thread to this is integrated risk management, adopting contemporary practice, and good communication. CDM 2015 is very much about good communication, co-ordination and co-operation. Consequently, the strategy set by the Board should establish a matrix of risk management responsibilities, ensure staff are trained on the procedures and establish how the DRM process will be managed and monitored. The Board should make it clear that line managers need to take an interest and give confidence to employees in raising issues of concern.

Managers:

Managers take a key role in ensuring that the strategy set out by the Board (above) is carried out. The Managers will put into place and monitor compliance with processes and procedures that have been developed to ensure risk management is undertaken as required by the Board. The adequacy of an organisation's procedures is central to ensuring that project risks are addressed sufficiently, this includes the risks arising from the design itself, for example an error in the concept or the calculations.

The organisational or management tasks would include, but not be limited to:

- Ensuring that internal procedures and standards are communicated, and that relevant staff receive the appropriate training;
- Allowing adequate time for the design process;
- Team capability assurance. (Skills, Knowledge & Experience);
- Arranging for Design Reviews as part of the design process;
- Maintaining a checking and approval processes;
- Validation of software;
- Determining risk management formats; and
- Procurement.

Project Team:

The project team have a strong influence over the safety, health and wellbeing outcomes of a project. Project Team tasks would include, but not be limited to:

- The implementation of organisational procedures as relevant to the specific project;
- Identifying, eliminating, reducing design related risk;
- Ensuring clarity of responsibility;
- Understanding the risk tolerance of the project sponsors;
- Participating in and recording the outcome of any DRM discussions;
- Keeping records; and
- Collaboration, Co-operation and Communication with Stakeholders (internal and/or external).

Appendix A presents a list of items to be considered by the project team (SCOSS, 2006).

Individual Designer:

The individual's key tasks would include, but not be limited to:

- Not undertaking a task for which they have insufficient skills, knowledge or experience, unless supported by those who do;
- Adapting to technical progress;
- Considering the hazard(s) associated with their design and taking appropriate steps to avoiding or mitigating accordingly;
- Reviewing remaining significant risks as the design progresses to see if they can now be eliminated/ reduced
- Ensuring the DRM process delivers a net benefit by not inadvertently introducing new, more significant risks
- Communicating the relevant information on significant risks in an appropriate format to those that need the information.

How DRM works

CDM 2015 places the onus for complying with Regulation 9 upon the designer and not the Principal Designer. However, the Principal Designer, where one is appointed, also has statutory obligations under the CDM 2015 regulations. The Principal Designer is pivotal in supporting the various parties involved in the design phase, ensuring they are working together to identify hazards and the potential ways that they can be controlled. In this way each Designer (or Design Organisation) understands how their own design decisions impact on the overall project during its life cycle. However, the Principal Designer is not responsible for the design output of others, rather their role is about promoting co-operation and communication between design teams and ensuring that health and safety risk is considered throughout the design process.

Most tasks carried out during the lifecycle of the structure will be routine activities where the risks can be managed by simply providing the relevant information to those persons with the relevant skills, knowledge and experience who plan to undertake those tasks on a regular basis. This is not to say they carry no risk, but rather the industry has well established ways of managing those risks (e.g. Industry Good Practice, Safe Systems of Working and Standard Design Details). Therefore, for these 'routine activities' where there are established industry solutions both in design and construction and where these are followed, the designer will normally have achieved what is reasonably practicable.

Over time however, methods of control may change. For example, new methods are developed, or new materials arrive on the market. The designer should keep abreast of such developments. The designer is obliged to think beyond the construction phase to other phases in the life cycle of the structure. For example, can the structure be safely inspected or cleaned? Or is there a sequence to be followed when demolishing the structure? Although the designer usually has no presence or control over the work undertaken once the design is complete their design decisions do impact upon the safety, health and wellbeing of those interacting with the structure throughout its life cycle.

Accordingly, designers need to be included when late changes are made to their design, for instance when difficulties arise on site. The designer must then review the consequential effects of that change before allowing the contractor to implement it. There may have been a good reason that the original design decision was taken, which should be made clear in pre-construction information. It is important also to regularly review the design to confirm that the elimination of one hazard or reduction of its impact does not introduce a different hazard.

Exposure to hazards arise for a variety of reasons including the complexity of the design, structural interfaces, the location of the project, the environment in which the work is to be performed or the construction activity itself. Designers should look beyond individual hazards and consider the overall impact of a group of hazards or the circumstances in which the hazard(s) may be experienced. They should also consider changes or alterations to an existing structure.

Aside from the physical interfaces, DRM procedures should also include:

- Responsibilities;
- Communication methods between designers;

- Handovers from one party to another; (e.g. from one design team to another or from construction to commissioning/ operation); and
- Demarcation (i.e. communication between adjacent, but separate undertakings).
- Design change management, particularly those that occur late in the day, say during construction or commissioning

Appendix C sets out an example format of a pro-forma that may be used to record the consideration of risks and the design decisions arising from that thought process.

Involving others:

As part of the DRM process the designer should consider early contractor engagement to assist with considering the construction phase risks. Similarly, the designer should also involve the operator, where possible to assist with considering the hazards associated with the operation and maintenance of the structure. In this way, the risks associated with the design, including the assumed method of work, may be tailored to suit the party implementing it, and therefore only include risks which may be safely accommodated. It is acknowledged that this direct contact is not always possible either because a contractual link is missing or because the timing of appointments does not align (Iddon and Carpenter, 2009).

The designer should do all that is reasonable to communicate directly with other parties as noted above. Where this is not possible:

For construction tasks: the technique assumed by the designer should be provided in writing:

- if not likely to be obvious to a competent and capable contractor,
- if it is an 'non-routine or unusual activity' or
- if it involves significant risk.

For operation and maintenance tasks, the designer should:

- Determine preferences and agree operational/ maintenance proposals.
- Produce 'design philosophy statements' setting out the anticipated method of work for anything that is not a routine activity.

Team discussions are to be encouraged as part of the wider requirement to co-operate and co-ordinate. However, remember that the responsibility for elimination of a hazard or reduction of its impact lies with the designer whose design or element of design may have given rise to the risk of harm in the first place and not through any collective. This is an important distinction.

On projects where there are several designers or design organisations working on different aspects of the design it is expected that each design organisation will carry out its own internal review of their design output. In addition, the Principal Designer will, where appropriate, bring the various design streams together as early as possible, and then on a regular basis, to look at the design interfaces and to ensure that foreseeable risks are identified and addressed.

For those intimately involved in projects, it is easy to get so close to the detail that the wider issues or the overall perspective is missed. A useful approach is to use an impartial facilitator, who understands the specific issues associated with that discipline, to lead risk reviews; someone with appropriate experience, knowledge and leadership skills. This is most likely to be the Principal Designer (where one is appointed) and they should be consulted whenever appropriate as they will have access to information regarding pre-existing health and safety risks such as the pre-construction information and any existing H&S file, relevant elements of which should be provided to the designer by the PD or Client. Alternatively, someone from within the design organisation with the right skills knowledge and experience, but not otherwise involved in the project could also be a good candidate for this action.

Routine and non-routine activities

Use of contemporary design guidance will generally lead to situations which may be routinely dealt with by competent and capable contractors or operators, familiar with the situation presented. Accordingly, designers must endeavour to keep abreast of such guidance through maintaining their Continuing Professional Development, a formal requirement on all Institution of Civil Engineers members at all grades.

It would be reasonable for the designer to assume that the tasks carried out during the lifecycle of a structure will be implemented by competent persons; that is those with appropriate skills, knowledge and experience who work in organisations with appropriate organisational capability. These persons, therefore, can handle routine activities (see Table 1) without causing harm to those involved or otherwise affected, provided the relevant information has been provided by the designer at the right time to enable them to do so. No further design modification is required by the designer for routine activities in a standard setting and ordinarily these account for most design outputs (See Figure 1).

However it is necessary for the designer to be mindful of what constitutes 'contemporary practice' in the construction, commissioning, use, maintenance, planned repair, operation or de-commissioning of a structure as well as any other contributing factors such as environment (e.g. marine) or location (e.g. at height) which may result in an non-routine activity with potential risk.

Where there is no industry accepted solution, or the approach is novel then a detailed assessment of risk reduction is required and that may include discussion with construction professionals or safety specialists as well as those who may use the structure. Those consulted do not need to be those who will be carrying out the actual works, but they do need to have the appropriate level of expertise and understanding of the associated proposed work, the hazards and potential risks.

Sources of contemporary guidance

Some design-related risks have already been considered by industry organisations e.g. Health and Safety Executive (HSE), CIRIA as well as learned institutions such as, Steel Construction Institute, British Constructional Steelwork Association, British Standards Institution (BSI), European Committee for Standardization (CEN), International Organisation for Standardization (ISO) who have each published what would be considered to be contemporary and authoritative industry guidance. BSI, for instance, cover a number of design related risks, most specifically structural design codes against the risk of collapse; Eurocodes, while HSE have a range of Approved Codes of Practice and guidance. (See Appendix B for details).

For the non-routine activities, the designer may continue to be presented with a dilemma e.g. how far to go to eliminate or reduce risk? It is likely that this will only apply to a minority of situations. If the designer has any doubt as to whether items of work are 'routine activities' it should be assumed they are 'non-routine activities' and treated accordingly.

When considering risk sizeable elements of the design may be classified in one go rather than individual work tasks, e.g. an entire in-situ concrete frame, or a drainage system and in so doing the designer should check whether 'non-routine activities' are occurring in amongst such routine activities. If in the judgement of the designer they are indeed 'routine' then no modification to, or further consideration of, the design is required by the designer. The provision of information or additional contemporary advice, if available or relevant should still be undertaken along with recording the decision. This process may be beneficially assisted by input from the Principal Designer, where applicable.

Even for 'routine activities', including those that are grouped as an element of the project, it is important to record that they have been considered, rather than ignored. The pro-forma in Appendix C can be used to record such decisions.

Task Classifications *(If in doubt classify task as non-routine)*	Commentary
Routine activity	Those activities that through established contemporary practice can be performed with accepted present-day levels of safety, health and wellbeing. These activities may be holistic in nature i.e. erection of steel frame, laying of drainage pipes, construction of road pavement, rather than broken down into individual tasks, providing none of these have any aspect to them which categorises them as 'non-routine activities' (see Table 2 for examples). The designer should be aware that contemporary practice will, by definition, change over time.
Non-routine activity	A non-routine activity is one where contemporary practice doesn't exist, is unlikely to apply or would be difficult to use or adapt. This could include when a routine activity is subject to complicating factors preventing present-day levels of safety, health and wellbeing from being effective. Judgement is required here, and advice from contractors or others may be necessary, e.g. occupational hygienists. Where feasible, discussions should include contractors (for construction tasks) and/ or operators (for repair, maintenance or decommissioning tasks).

Table 1: Task classifications

When routine activities become non-routine

(Routine activities involve a range of safety and health related hazards all of which are well known and for which safe and healthy methods of work are well established. Accordingly, a competent and capable contractor can anticipate and deal with the resulting risks.)

	Routine activity	Issues that could make it an 'non-routine activity'
1	**In-situ concrete frame**	▪ Lack of access to construct using normal methods. ▪ Interim instability issues. ▪ Slab unable to take predictable temporary loads during construction.
2	**Drainage to car-parking area around office building (standard depths, no unusual ground conditions)**	▪ Poor ground conditions with lack of Site Information data. ▪ Proposed drainage runs adjacent to existing buildings. ▪ Connections into existing system creating high-risk situations (confined spaces or associated highway traffic, for example). ▪ Use of car park during construction works.
3	**Re-siting of lamp street standard:**	▪ Localised contaminated ground. ▪ Adjacent operational footway. ▪ Lack of access for lifting equipment. ▪ Proximity to traffic and traffic flows.
4	**Like for like replacement of existing windows**	▪ Difficult access. ▪ Windows accessible only via fragile roof. ▪ Windows excessively heavy due to size.

Table 2: Examples of 'routine' and 'non-routine activities

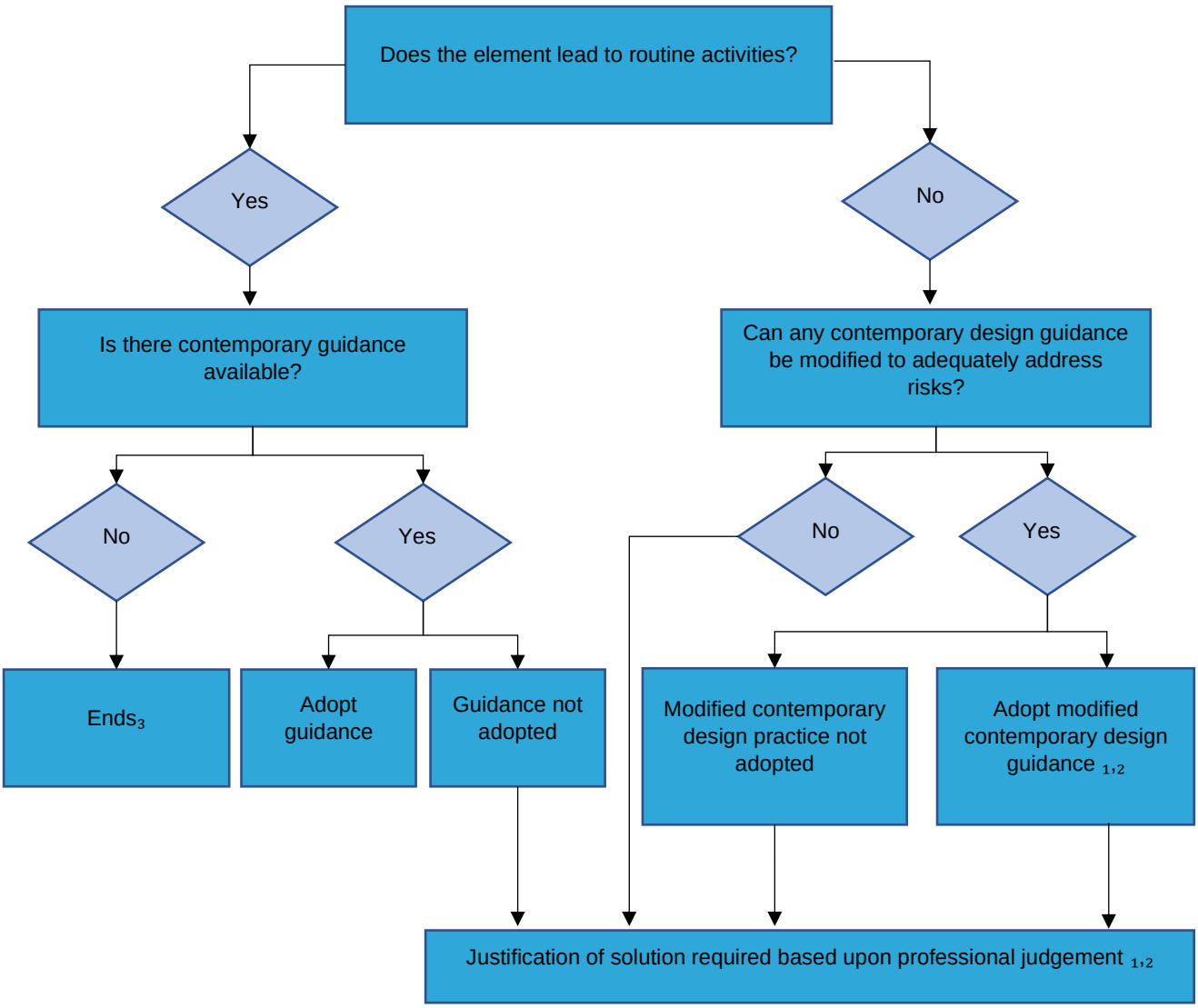

Figure 1: flow chart of actions

Designing for safety, health and wellbeing

Having used the flow chart in Figure 1 above to decide which elements of design will result in routine or non-routine activities, the designer can then move onto the next phase in the DRM process for those non-routine activities.

The designer could use the acronym ERIC; eliminate, reduce, inform and control, to assist in structuring the process of DRM for the non-routine activities, particularly when involved in group discussions. This approach (Table 3), which promotes the elimination of risk above the reduction of risk, is a means of following through on the requirements in the CDM 2015 set out in the guidance on the regulations (HSE (2015). Alternative approaches would include the 'avoid, mitigate, control' approach advocated in CIRIA C755 (CIRIA 2015).

	Element	Commentary	Guidance
E	Eliminate	Can the identified risk be eliminated so far as is reasonably practicable (SFARP)?	See the 3 fundamentals below for the suggested means of doing this.
R	Reduce	And if it cannot be eliminated can the identified risk be reduced SFARP?	
I	Inform	Pass on details of significant risks to those who need to know (client, other designers, contractors)	Very important to note that designers are to provide information about elements of the design, which present significant risks that cannot be eliminated. This should include information about unusual or complex risks that are more likely to be missed or misunderstood by contractors or others on the project rather than risks that are well known and understood.
C	Control	What actions does the designer consider are necessary to be taken to control the foreseeable risks that could not be eliminated or have had their impact reduced through the design?	For most hazards, control will be done by those undertaking the work e.g. the contractor (it would be unusual for the designer to specify these, although the design information is to identify designers' thinking regarding control). Exceptions would include items such as specified construction sequences or temporary works. However, when it comes to design risks, such as a mistake in safety-critical calculations, the control is to be implemented by designers e.g. checking regimes,

Table 3. ERIC in action

When preparing a design the designer must take into account the general principles of prevention as described in the HSE publication L153 - Managing Health and Safety in Construction (HSE 2015), which provide advice and guidance for designers when considering foreseeable risks that may affect those involved in the lifecycle of the structure.

The principles of prevention a requirement of the Management of Health and Safety at Work Regulations 1999 apply to all industries, construction included. They provide a framework to identify and implement measures to control risks on a construction project. Professional judgement is required in their interpretation and use.

For 'routine activities' there will not be any need to directly refer to these principles as they are already implicit in the method of work.

The general principles of prevention are to:

a) avoid risks;

b) evaluate the risks that cannot be avoided;

c) combat the risks at source;

d) adapt the work to the individual, especially regarding the design of workplaces, the choice of work equipment and the choice of working and production methods, with a view, in particular, to alleviating monotonous work, work at a predetermined work rate and to reducing their effect on health;

e) adapt to technical progress;

f) replace the dangerous by the non-dangerous or the less dangerous;

g) develop a coherent overall prevention policy which covers technology, organisation of work, working conditions, social relationships and the influence of factors relating to the working environment;

h) give collective protective measures priority over individual protective measures; and

i) give appropriate instructions to employees (HSE, 2015)

Designs prepared for workplaces should also take cognisance of The Workplace (Health, Safety and Welfare) Regulations 1992 and the CIRIA guidance on workplace 'in-use' (Gilbertson, 2015), ensuring that safety, health and wellbeing issues in use and in maintenance are appropriately addressed.

Many organisations will have their own processes for managing risks (some of which will be industry specific) and may have proforma for their staff to use when recording the outcomes of design considerations as well as key words or scenarios to consider, for example security, commissioning or access. The process described in this guide is the next step in the evolution of DRM within the industry which organisations can use to build upon their existing good engineering practices and to modify and enhance their current processes and procedures to ensure full compliance with CDM 2015.

Regardless of how DRM is addressed in an organisation the three fundamentals of DRM (below) should be followed.

The three fundamentals of DRM

The three fundamentals, developed to guide the designer through the DRM process, are intended to be a practical interpretation of CDM 2015 Regulation 9. Designers' adherence to these fundamentals should be enough to satisfy Regulation 9.

> ***Fundamental 1: Safe & Healthy Design***
>
> *Designs shall be capable of being built, used, maintained and eventually demolished without negatively affecting the safety, health and wellbeing of those involved in the construction process or those who may be impacted by the structure. It is reasonable for the designer to assume that these activities will be undertaken by competent and capable people who will be able to manage the "normal" day to day construction/ operational/ repair tasks and associated risks, arising from the design.*

Design involves the weighing up of risk against the resources needed to eliminate or reduce the risk. Risk may include, for example, cost, planning, market conditions, technical, performance criteria, environmental impact and always, the safety,

health and wellbeing of others. Where no specific mandatory requirement exists, a judgement is to be made in the light of all the facts.

'Safe and healthy' is not absolute; there will always be some hazards. It means, in this context, that the designs conform to expected norms of work and competence, and that there are no significant unexpected aspects, or similar surprises e.g. lack of access, interim instability, or low-risk activities becoming high-risk non-routine activities, without there having been a weighing up of the risk, consideration of avoidance/ mitigation/ control and the provision of adequate accompanying information (see Fundamentals 2 and 3). For example:

- Where working at height is unavoidable, suitable fall protection systems (either fall arrest or fall restraint) must be considered as part of the design (Iddon J, and Carpenter, 2009).
- A steel frame of conventional construction is 'safe' to construct. However, if its stability relies upon a particular sequence of construction relating to, say an adjacent building, and this was not considered by the designer, nor brought to the contractor's attention, it would be classified as unsafe in the absence of further ameliorative action, or pre-construction information;
- Checking of safety-critical calculations and concept is accepted as part of reasonable measures to provide a 'safe and healthy' structure. However, if no account was taken of the competence of the checker, or complexity of the project, it would be classified unsafe; and
- While a 'structure' of conventional design may be 'safe', however, if there is insufficient access to, and/or around the works, to use conventional means of construction then it would be classified as unsafe.
- Proactively replacing hazardous materials during construction to benefit the workers in this phase, thus creating a healthier environment, leading to healthier conditions during operation and ultimate demolition/removal. Further information is available through ICE's Designing for Health Guidance documents.

Therefore, safe and healthy design, using accepted norms as the benchmark, is qualitative, recognising that accepted norms change over time. Consequently, designs must be produced by competent and capable designers, who are keeping abreast of contemporary design practice (Appendix B). To be satisfied that safety, health and wellbeing has been adequately addressed in the design oversight is advised; using design reviews, conducted by other equally competent and capable designers. If required others suitable advisors, for example appropriately experienced contractors can be used in the design review.

> ***Fundamental 2: Use of Contemporary Guidance.***
>
> *Designs shall comply with good industry practice as regards the safety, health and wellbeing of persons, unless there is good reason for not complying. Where there is good reason for not conforming to contemporary design practice the designer will make that known (also see Fundamental 3).*

It is important to remember that the effort required to make things safe and healthy changes with time, as new products come onto the market, new technology develops, better engineering controls emerge, environmental protection constraints and H&S legislation change and societal expectations rise. There may also be external events or circumstances that will make contemporary practice no longer relevant. Thus, what is deemed safe and healthy under Fundamental 1 will change with time.

The contemporary view, on many key issues, is contained within current industry or HSE sponsored guidance. It is expected, as a matter of duty of care (notwithstanding any statutory obligation) that designers follow this guidance, which is usually created by their peers. Where there is good reason not to do so, for example, when the circumstances don't fit the guidance the designer should at least aim to match the intent of the guidance and keep a record of the reasons for departing from

contemporary advice. The Principal Designer (PD), where appointed will expect to see such records. The guiding premise being that, regardless of the existence and/ or relevance of any contemporary guidance, designs must be such that they can be built, used, maintained and demolished taking account of the safety, health and wellbeing of all those impacted by the structure.

There is an expectation that designers will follow available contemporary advice, unless there is a good, and documented, reason not to. Recognised contemporary advice will evolve, but there are examples in Appendix B of some currently available, which should allow the designer to proceed with confidence.

> ***Fundamental 3: Communication***
>
> *Information on significant risks shall be communicated to all those who need to know in an easily understood format, in enough time to allow them to make the right decision(s).*

It is essential that the designer provides the right information to the right people at the right time in an appropriate format to enable them to make the right decisions that will underpin the safety, health and wellbeing of those affected by the structure. The information provided should be focussed on the significant risks.

The questions for any designer to ask include:

- If I were the contractor's designer/ temporary works co-ordinator (TWC)/ supervisor/ chargehand / team-leader, for example, would I be content with the design information presented?
- If I were responsible for maintenance or repair, would I be content with the information presented?
- If I was compiling the 'construction phase plan' would I consider the information from the designer adequate for my needs?
- If I was using the Health and Safety file would I have enough information (e.g. demolition sequence/ safe means of access)?

Recording and communicating the significant risk

The recording of DRM decisions and actions is good business practice. However, this should be done in an effective manner that does not produce unnecessary paperwork. Appendix C gives an example format (following Figure 1 above) that may be used to record the DRM process. The rationale behind this form is that for routine activities no additional consideration of the design is required, and hence no paperwork other than a confirmation that the tasks arising from the design in a particular area, or other aspect of the design, have been considered, rather than ignored, and judged to be routine. This minimises the paperwork and allows concentration on the non-routine activities.

The non-routine activities do require more detail on the decisions and actions arising from DRM. Use of the Appendix C pro-forma will enable this to be recorded. The Appendix C proforma or any digital format used for recording the review and solution should be shared with appropriate team members and all relevant parties.

The information about any remaining significant risk(s), that is risks that a competent contractor or another designer would consider less obvious, unusual, unexpected or difficult to manage, should be communicated in a format that is suitable for use by those that need to know. They shouldn't be hidden deep inside documents where they could be missed or overlooked.

The designer should consider the use of pre-construction information, (which provides information for all pre-construction activities such as design and planning) or Works Information to convey risk information to other parties.

For construction workers carrying out the tasks who are unlikely to have access to contract documents or large spreadsheets it is far better to convey the information succinctly to those who are more likely to be at risk using safety, health and wellbeing notes or symbols on drawings. Where building information modelling (BIM) is in use relevant safety, health and wellbeing information can also be made available on the appropriate modelling/ visualisation software. Other methods of communication for which the designer may be able to provide information could include design co-ordination workshops, safe systems of work and task briefings.

Providing this information to the workforce enables them to make good decisions for the benefit of the project and for the safety, health and wellbeing of all concerned.

For tasks likely to be carried out post-construction such as planned repair or decommissioning it is more likely that the information will be provided in writing or on as built drawings provided in the H&S file. Increasingly BIM is used to convey relevant health and safety information. Again, the designer should seek to highlight the information so that it is easy to find and understand.

Conclusion

With this DRM guidance ICE has endeavoured to give a flavour of what constitutes best practice in the world of construction design, with the focus clearly on safety, health and wellbeing. DRM, safety in design and/ or prevention through design are all variations on a theme and regardless of the language used the message is clear; designs should be such that they can be built, used, maintained and eventually demolished without harm to construction workers or anyone impacted by the structure. That doesn't mean creativity is to be sacrificed, rather creativity is a critical aspect of the design process and this guidance has been published to add to the designers' library of well-conceived assistance.

There are uncertainties and major challenges in construction projects, and it is incumbent upon designers, having carefully considered all the hazards identified during the design process to maximise the opportunity to eliminate or, if not feasible, reduce the risk of harm during the whole life cycle of a structure. It is easier and more cost effective to tackle these issues during the design phase when there is time to develop a suitable solution rather than addressing them in an unplanned and informal fashion during construction or commissioning or to make modifications once the structure is in use.

Writing in the 2nd edition of the ICE Manual of Health and Safety in Construction (McAleenan and Oloke, 2015) Professor Balmforth (past president) quoted one of the contributing authors:

> *"There is a way of thinking that considers construction site hazards as not occurring naturally but arising as part of the design process. If this is so, then designers have the power and opportunity to eliminate many of the hazards before they even occur on the job site. This gives rise to the idea and indeed the ideal of prevention through design." This is more than just an aspiration; ICE's code of conduct requires that civil engineers have full regard for the public interest, particularly in relation to matters of health and safety [and wellbeing], and in relation to the well-being of future generations.'*

Contributors

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Glossary

ACOP: Approved Codes of Practice published by HSE as guidance.

BCSA: British Constructional Steelwork Association

BIM: Building Information Modelling (BIM) is a collaborative tool showing detailed information, often including a 2D/ 3D digital representation of a structure which can provide a reliable basis for decision making during its life-cycle.

Board: In this context the board means the controlling officer(s) of the design organisation whether this is the Board of Directors, a group of Trustees, Partners of an organisation, or the main decision makers of some other organisational structure.

BSI: British Standard Institute

Capability: Capability refers to having the capacity to act in a competent manner. That includes having enough resources and the authority to make decisions.

CDM (and CDM 2015): The Construction (Design & Management) Regulations 2015 or in Northern Ireland, the Construction (Design & Management) Regulations (Northern Ireland) 2016

CEN: European Committee for Standardization

CIRIA: Construction Industry Research and Information Association

CITB: Construction Industry Training Board

Competence: Competence refers to having the necessary skills, knowledge and experience or to being under the supervision of a competent professional. In the case of an organisation it includes having appropriate organisational arrangements.

Contemporary design practice: Contemporary design practice in this guide relates to currently acceptable good or best practice for designers.

Continuing Professional Development (CPD): This is the term used to describe the learning activities undertaken by professionals to develop their skills, it ensures that an individual's skills, knowledge and experience does not become out-dated or obsolete.

Designer: The Designer is a reference to the individual and/ or design organisation defined in CDM 2015.

DRM: Design Risk Management

ISO: International Organization for Standardization

Non-routine activity: All work other than routine activities (examples are given in Tables 1 and 2)

Routine activity: Those activities that through established contemporary practice are able to be performed with accepted present-day levels of safety, health and wellbeing (examples are given in Tables 1 and 2).

SCI: Steel Construction Institute

Significant risks: The significant risks are not necessarily those that involve the greatest risks but those which are not likely to be obvious, are unusual, unexpected or difficult to manage on this occasion (HSE, 2015).

Structure: Structures are as defined in CDM 2015.

Wellbeing: Workplace wellbeing relates to all aspects of working life, from the quality and safety of the physical environment, to how workers feel about their work, their working environment, the climate at work and work organisation. The aim of measures for workplace wellbeing is to complement safety and health measures to make sure workers are safe, healthy, satisfied and engaged at work.

Appendix A: Items project team should consider to avoid/ mitigate risk

This is adapted from a Standing Committee on Structural Safety Topic Paper, SC/06/28 (SCOSS 2006), which shows 5 stages and items to be considered over a typical project.

1 Analysis and Design

- Ensuring that those involved are capable of carrying out the task in this field.
- Identification of hazards and resultant risks affecting robustness in Stages 2-5.
- Quantification of significant risks.
- Choosing appropriate design details.
- Advising constructors and future owners of assumptions associated with the design detail adopted (via the drawings and health and safety file). For example: the necessary construction sequence; the method assumed for implementing specific maintenance tasks.
- The need for an independent review of design (supplementary to numerical checks). The scope may include design, operability, maintainability, constructability, commissioning and the like, according to need.
- Having an overall point of responsibility.

2 Procurement

- Competency of those organisations procured.
- 'best value' tendering
- Clear lines of responsibility and authority.
- Clear reporting protocols.
- Adequate information for planning and pricing construction phase.
- Adequate specification.
- Inclusion of adequate monitoring procedures (avoidance of self-certification approaches).

3 Construction

- Ensuring that those involved are capable of fulfilling the role in this field.
- Understanding the stated objectives and purpose of the design.
- Identification of hazards and resultant risks having regard to temporary conditions and commissioning.
- Implementing the strategy outlined in the construction phase plan or elsewhere.
- Ensuring contractor-design is co-ordinated.
- Ensuring adequate monitoring, reporting and action where required.
- Collation and assessment (gap analysis) of Pre-construction Information supplied by the Client and the gaining and use of requested Pre-construction Information.
- Issue of the Health and Safety File using appropriate information from Designers.

Operation

- Ensuring that those involved are competent in this field.

- Implementing the strategy and requirements outlined in the health and safety file.
- Ascertaining and managing the effects of changes/refurbishment.
- Ensuring adequate maintenance of critical items.
- Ensuring that those involved are competent in this field.

De-commissioning

- Identification of hazards and resultant risks, specifically those outlined in the health and safety file.
- Having regard to temporary conditions.

Appendix B: Existing contemporary advice

This appendix provides the existing contemporary advice for designers. A regularly updated version of this information is included on the document's main webpage.

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Appendix C: Example of a form for recording DRM decisions

Project:	Project Ref:
Originator:	Reviewer: *see note 1
Date:	Date:
Describe element of project under consideration: * see note 2	
Q1. Is Element made up of routine activities in a standard situation? * see note 3	
Y/N IF "YES" go to Q2 IF "NO" go to Q4	
Q2. Does it comply with available contemporary design guidance, advice and industry good practice?	
Y/N IF "YES", list advice or industry best practice adopted during design here and provide any relevant information or show where it can be found. ENDS. IF "NO" go to Q3 * see notes 4 & 5	
Q3. State why contemporary design guidance and advice is not appropriate or why industry good practice may not be enough to address risks	
Q4. What are the non-routine features of this design/activity?	
Q5. Are any of these items covered by any specific contemporary or best industry practice?	
Y/N	

IF "YES" list advice or industry best practice adopted during design here and indicate how it applies.

For other items of IF "NO" go to Q6 * see notes 4 & 5

Q6. Has the issue been discussed with contractors/operators /safety professionals as appropriate? * see note 6

Y/N

IF "YES" record salient points here IF "NO" record reasons for lack of discussion *see note 6

IF "YES" does the design and information provided align with advice received? *see note 7

Y/N

IF "YES" record design modifications and references to key information here If "NO" provide explanation* see note 8

Q7. Are there significant risks remaining?

Y/N

IF "YES" record where risk information can be found here. IF "NO" ends.

Notes

1. Review is essential; a lack of review by someone else can also be a risk. The reviewer should be a person with the appropriate skills, knowledge and experience. This may be the Principal Designer, if one has been appointed.

2. This may be an area, floor, single design element or for a small project it may be the entire design e.g. a plant room, a concrete slab or a retaining wall.
3. Refer to "How DRM works" section of guide as well as Tables 1 and 2.

4. This is where the designer can be satisfied that the guidance, advice and industry good practice adopted will be enough to address the risks.
5. Ensure relevant information has been made available to others and indicate where this is shown.

6. Reference can be made to meeting minutes here.

7. Essential that the designer has confidence that the detail can be safely dealt with by those who will undertake the task.

8. Having sought advice it should be followed. If not, the reviewer needs to be satisfied with the reasons for not doing so.