

Issued July 2014

Revised May 2021

**Highways Safety Hub**

**Raising the Bar 26**

Safety by Design

**Contents**

|  |  |
| --- | --- |
| **Objective** | **1** |
| **Scope** | **1** |
| **Background** | **2** |
| **Governance Requirements** | **2** |
| **Minimum Requirements** | **3** |
| **Guidance** | **3** |
| **Overview** | **3** |
| **1. A Safety by Design from the outset** | **3** |
| **2. Digitally Capturing and Sharing Information** | **4** |
| **3. Design for Manufacture and Assembly (DfMA)** | **5** |
| **4. Design Risk Management****5. Designing Collaboratively** | **6****10** |
| **People Requirements** | **13** |
| **Continuous Improvement** | **14** |
| **References** | **14** |
| **Appendix 1 – Safety By Design Plan Guidance** | **16** |
| **Appendix 2 – Principal Designer / Designer Competency check process examples** | **17** |
| Status boxes have been included at various points to highlight where there are outstanding issues to be resolved, additional input is requested or as a marker where action needs to be taken. |  |

Table to be updated,

Verb usage to be checked throughout document– must, shall, should, etc

Check for repetition and edit for removal of surplus / unnecessary text which h adds no value.

Cross check required with other RtBs for duplications, inconsistencies and inclusion of relevant cross references

**Objective**

**Safety by Design must become business as usual within all of our design teams.**

This Raising the Bar Guidance Document provides practical guidance on how to the comply with the Supply Chain Safety Leadership Council [Common Intent Document on Safety by Design](https://www.highwayssafetyhub.com/uploads/5/1/2/9/51294565/common_intent_-_safety_by_design.pdf)  as well as providing guidance to the Designer and Contractor as to the standardised method of compliance preferred by Highways England in securing safety by design. The Common Intent document contains 5 key themes which are replicated in this document:

Need to check in final review that practical guidance has been provided.

* **We will expect a Safety by Design mindset from the outset**
* **We will capture and share information throughout the project life-cycle as per PAS1192:6**,
* **Offsite manufacture and assembly will be promoted as the default construction assumption.**
* **Where we can’t eliminate risks, we will aim to reduce them or ultimately isolate them.**
* **We will foster virtual rehearsal as ‘business as usual’, with the ensuing insights informing our design development.**

The purpose of this document is to drive improvement to ensure effective whole life design for safety makes a significant contribution to eliminating or reducing harm as a consequence of the project. It does this by:-

* Capturing best practice for identifying, assessing and mitigating risks that can result in injury during the life of a project, from across the design supply chain and the wider construction industry.
* Presenting this best practice as the standard to aspire to when working on schemes on the strategic road network or other areas of the Highways England estate.
* Recognising the importance of human centric design, the key to a successful outcome

Review statement and bullets once document completed to ensure it is still accurate.

**Scope**

This safety by design guidance is applicable on all Highways England projects. The guidance is relevant to all design activities over the whole life cycle of the works and should therefore be considered from the concept stage onwards.

The document applies to all designers, both in the supply chain and within Highways England, working on the development of works for the strategic road network or other areas of the Highways England estate.

Design for safety considers the impact of the proposed work on all populations who might be affected by it throughout the lifecycle of the asset. (see [GG 104](http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol0/section2/GG%20104%20Requirements%20for%20safety%20risk%20assessment-web.pdf) for definition of populations to be considered)

When considering the scope of design and designers, the following definitions of design and designers within the Construction (Design and Management) Regulations 2015 Regulation 2 should be referred to.

“design” includes drawings, design details, specifications and bills of quantities (including specification of articles or substances) relating to a structure, and calculations prepared for the purpose of a design;

“designer” means any person (including a client, contractor or other person referred to in these Regulations) who in the course or furtherance of a business—

1. prepares or modifies a design; or
2. arranges for, or instructs, any person under their control to do so, relating to a structure, or to a product or mechanical or electrical system intended for a particular structure, and a person is deemed to prepare a design where a design is prepared by a person under their control;

In the context of the above definitions “structure” means—

1. any building, timber, masonry, metal or reinforced concrete structure, railway line or siding, tramway line, dock, harbour, inland navigation, tunnel, shaft, bridge, viaduct, waterworks, reservoir, pipe or pipeline, cable, aqueduct, sewer, sewage works, gasholder, road, airfield, sea defence works, river works, drainage works, earthworks, lagoon, dam, wall, caisson, mast, tower, pylon, underground tank, earth retaining structure or structure designed to preserve or alter any natural feature, and fixed plant;
2. any structure similar to anything specified in paragraph (a);
3. any formwork, falsework, scaffold or other structure designed or used to provide support or means of access during construction work, and any reference to a structure includes part of a structure;

This document should be read in conjunction with [GD 304 - Designing Health and Safety into Maintenance](http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol0/section2/GD%20304%20Designing%20health%20and%20safety%20into%20maintenance-web.pdf)

*For the purposes of this document, “works” is used to cover new, maintenance and operational construction activities on the network.*

These boxes are used to highlight specific examples and links to good practice.

**Background**

Designers have a legal duty set out in the [Construction (Design and Management) Regulations 2015](https://www.legislation.gov.uk/uksi/2015/51/contents/made) to eliminate or mitigate **foreseeable** risks to the health or safety of any person affected by their design. Designers have a responsibility to apply the principles of prevention to eliminate hazards and reduce the risks identified in each and every part of the works’ life cycle.

Beyond this legal duty, designers are morally, professionally and financially obliged to produce safe designs. In order to support Home Safe and Well, safety by design must be a consideration from the inception or outset of the works, as decisions made early on can have a significant impact on the level of safety risk involved in later stages.

However, hazards introduced at any stage, can impact all stages of an asset’s life cycle including construction, operation, use, maintenance and decommissioning activities. It is essential to consider how we firstly identify and then eliminate or mitigate hazards during the design phase of any works.

Hazards are more efficiently removed early in the development of infrastructure. Making changes during detailed design or even on site to address hazards consumes substantially more resources than addressing the issue during concept or preliminary design. The most effective way of managing health and safety risks is to design hazards out at source before relying on other control mechanisms on site.

It is important to recognise there are often multiple designers involved in projects from concept and option studies through to preliminary and final design stages. Ensuring focus on hazard elimination at all of these phases is critical, together with effective handover between designers and provision of hazard and risk information to all stakeholders.

Is there any governance required for contractor to accept hazards not eliminated or sufficiently mitigated by designers. Or do we go for internal designer sign off and a feedback process from contractor to drive continuous improvement?

Mandatory Elements

* Designers must be able to demonstrably show consideration of safety as an influence on the design from the outset of a scheme.
* The Project Lead must prepare a Safety by Design plan containing details of how design risk management activities will be undertaken and managed during the design of the works.
* Records must be kept of the design risk management process and decisions taken which impact upon the safety of any of the populations identified in GG104 during the whole life of the asset.
* A formal handover must be undertaken where the principal designer duty transfers from one party to another.
* **Add further where appropriate**

**Governance Requirements**

There is a clear expectation within the Supply Chain Safety Leadership Group Common Intent Document on Safety by Design that arrangements for designing out hazards should be put in place from the outset of the works. These processes will be overseen by the principal designer, whether this role is fulfilled by the client during the early stages of design, a designer appointed by the client or handed over to a contractor during the latter stages of a project.

A formal handover must be undertaken where the principal designer duty transfers from one party to another. The incumbent principal designer shall provide sufficient evidence to the incoming principal designer to ensure they are satisfied the legal duties and the requirements of appropriate additional guidance, including this Raising the Bar document, have been met. The incoming principal designer shall confirm to the client, within a month of appointment, that they have received sufficient information to be able to take on the duties, or highlight areas of shortfall and submit a plan for how to address these.

**Minimum Requirements**

The following elements are mandatory requirements and suppliers shall ensure these elements are applied fully on Highways England sites. Further details on these elements are provided within this Raising the Bar document. ›

**Guidance**

**Overview**

**The following guidance is written with the expectation that it represents best practice and as such should normally be followed unless a better local solution has been devised to meet the overall objective.**

**1.** **Safety by Design from the outset**

Text highlighted yellow is taken from each level of the common intent. It is not intended for this text to stay but is here to ensure we address the points where possible in the RTB. To be deleted from final version

**Common Intent Expectation 1**

We will expect a Safety by Design mindset from the outset, demonstrated through pro-active safety leadership and teamwork within an inclusive working environment. Approaches may vary but should include appropriate training/onboarding, with specific commitment to behaviours that effect safer designs outcomes, including evidencing consideration of operations and maintenance activities, and ongoing monitoring using leading performance indicators.

A Safety by Design plan must be produced at the outset of the project and owned by the Project Leader. This plan should set out how hazards will be identified and managed during the pre-construction phase of the works. When work is transferred between designers at various gateways, the plan for managing hazards will be included in handover documentation passed to the incoming designer.

The Principal Designers Working Group have developed useful information on Eliminating Risk from the Outset and can be found on the Highways Safety Hub - <http://www.highwayssafetyhub.com/eliminating-risk-from-the-outset.html>

There are currently only 3 PowerPoints on this web page at the moment, is it the intention there will be more information or shall we remove this sign post sentence? – M Bridges

A key role in this plan should be that of a Safety by Design lead. This should be an individual with a good knowledge of the requirements of the Construction (Design and Mangement) Regulations and other relevant safety legislation and engineering knowledge related to the works to be constructed. They should have sufficient seniority within the team to be able to influence design decisions.

The minimum requirements for this plan are provided in Appendix 1 and further examples from the supply chain are accessible on the Highways safety hub website (add in hyperlink when page is set up)

Skanska employ “developing safety culture sessions” to raise awareness amongst their designers of the importance of design risk management decisions enabling challenge around acceptable residual risks resulting in a safety first approach to design. - Draft text by Paul Brown to be reviewed by Liz Brathwaite

To develop the team mindset necessary to eliminate risks from the outset, the Safety by Design plan shall be briefed directly to all team members. At the start of the design phase for any works, a workshop should be held to set out the requirements of the Safety by Design plan.

Where possible the Safety by Design workshops should involve representatives from the construction, operational and maintaining organisations.

Further reviews and updates to the plan shall be undertaken at appropriate intervals during the design of the works.

**2. Digitally Capturing and Sharing Information**

Common Intent Expectation 2

We will capture and share information throughout the project life-cycle as per PAS1192:6, using structured common data environments and data sets. We will increase the use of web-based ‘project portals’ as the primary means of access to project development work, including clear and intuitive frameworks for managing HS&W. Project portals will provide remote access to single-source information for all authorised parties including client, designers, contractors and temporary works designers. We will work with Highways Safety Hub to provide an accessible repository of case studies and best practice construction, operations and maintenance examples, including videos and virtual rehearsals, to educate design teams. We will engage the supply chain to facilitate active, industry wide take-up of this ‘digital by default’ approach and drive full life-cycle compliance. We will monitor handovers to ensure effective transfer of relevant design data without loss or duplication.

**Building Information Modelling (BIM)**

BIM has the potential to be a valuable tool in identifying, co-ordinating, managing and communicating risks and facilitating clash detection throughout the project lifecycle. The application of BIM supported by 3D modelling will not be appropriate for all works. When BIM is adopted for the works, it should be used to capture and share health and safety information applying PAS1192 / 6 or ISO 19650-5 where appropriate, and using structured common data environments and data sets.

If BIM is not adopted, then it is recommended that hazards , particularly those residual hazards associated with the life of the asset, are captured within the Highways England Geographical Information system for transmission to those who will need to information in the future.

**3D Design and Modelling**

Designers should maximise the benefits of 3D digital technology (Building Information Modelling (BIM) and Geographical Information Systems (GIS)).

The development of Project Information Models (PIM) which capture all existing hazards and form a fundamental part of the pre-construction information. The PIM model should be a live entity which grows with the design, is handed over to the site delivery team, kept up to date at all times and captures asset data and residual hazard information on handover.

The BIM Execution Plan (BEP) integrates workflows to enable the design management process, this may include integrated design reviews, interdisciplinary design checks and the review of interdependencies of hazard information relating to the design. The BEP should be maintained, reviewed and updated during the life of the scheme and the roles and responsibilities clearly set out to ensure that the PIM (where applicable) contains the relevant health and safety information and is accessible to all members of the project delivery team and key stakeholders at all times. The aspiration is that the PIM Asset Management Handover model generated on completion of a scheme will be handed over to the Client and maintainer and form the portal by which all future maintenance asset data is captured to improve safety.

Contractors can input critical information into the model before beginning construction to identify opportunities to pre-fabricate or pre-assemble some systems off-site and can consult maintainers and operators on the impact of the solutions.

Future BIM integrated projects should utilise BIM to develop integrated programmes for construction operation and maintenance which will further highlight areas where risks accumulate.

**Capturing and Cascading Lessons Learnt and Good Practice**

Sharing previous experience is a continuous process. All Works should commence with a knowledge and experience review. Whenever possible these sessions should involve the workforce who have experience in this area.

Communication such as digital surveys and reviews of digital rehearsals can capture valuable insight re what approaches have worked well in the past and why. These can also help identify what hasn’t work well and the reasons for that failure can be captured and addressed at an early design phase.

**3. Design for Manufacture and Assembly (DfMA)**

Common Intent Expectation 3

Offsite manufacture and assembly will be promoted as the default construction assumption. We recognise that the supply chain is evolving in this area in terms of standardisation. industry readiness, product availability and other aspects. Where practicable, we will design for offsite manufacture and assembly to eliminate several risks common to construction sites, whilst ensuring associated on-site assembly risks are managed effectively. Offsite preparatory solutions should also achieve better quality of product and reduce the duration of site activities on the network. Approaches not using either Design for Manufacture and Assembly (DfMA) or standardised solutions will be the exception and require appropriate senior designer sign-off.

DfMA does not have to be complicated to be effective. Within the Smart Motorway Alliance, the first stage of the programme of retrofitting stopped vehicle detection units to the network, included identifying opportunities for standardisation and off site production. A single solution for a pre-cast concrete base, manufactured off site, was developed through collaboration between the technology designers, post designers, socket manufacturer, the supply chain and the onsite assembly partner. This eliminated a number of hazards, reduced time on site and number of visits required to complete installation.

Design for Manufacture and Assembly (DfMA) is a design approach that focuses on ease of manufacture and efficiency of assembly by simplifying the design of a product. In a similar approach to lean construction, applying DfMA enables the identification, quantification and elimination of waste or inefficiency in product manufacture and assembly.

The Type 2 Technology Chambers developed by Balfours I think – Harry Parnell – Example supplied by D Potter – can anyone expand on this ?

The government are pushing for a digitally designed set of components to be used 'wherever possible' across a range of government construction programmes and projects. These components would be manufactured in factories and assembled on site.

Can we refer to a component library specific to highways / HE?

Is there anything happening at the moment in this area?

The main benefits of DfMA are:

* **Worker Safety -** less man hours at the side of the road, often less working at height, less crane lifts, repeatable right first time process leading to fewer change management issues. In addition, by removing construction activities from the side of the road and placing them in a controlled factory environment there is the likelihood of a significant positive impact on safety and quality.
* **Speed -** One of the primary advantages of DfMA in construction is the significantly reduced programme on-site using prefabricated elements. This not only benefits the road user from short road works durations, the dangers of incomplete or temporary works but also the road worker whose exposure to working next to live traffic is greatly reduced due to shorter assembly time. By utilising standard assembly practices such as vertical assembly and self-aligning parts. DFMA also ensures that the transition from the design phase to the production phase is as smooth and rapid as possible.
* **Higher quality, lower cost and sustainable** - A highly automated approach can enhance quality and efficiency at each stage. There may be less waste generation in the construction phase, greater efficiency in site logistics, and a reduction in vehicle movements transporting materials to site. By using fewer parts, decreasing the amount of labour required, and reducing the number of unique parts, DfMA can also significantly lower the cost of assembly. Minimise the number of components: Thereby reducing assembly and ordering costs, reducing work-in-process, and simplifying automation. From a quality aspect DfMA increases reliability by lowering the number of parts, thereby decreasing the chance of failure.

The highways sector has begun to adopt DfMA for the off-site prefabrication of construction components such as concrete bridge beams, structural columns and signal gantries. Designers should record an assessment of opportunities for Design for Manufacture and Assembly as part of the design process. This could include challenging conventional issues, such as standards, materials, sources, leading to creating more opportunities for offsite production and on-site assembly. Assessment workshops should include appropriate representatives from the supply chain to ensure the reviewing team have the necessary skills, knowledge and experience to undertake an informed assessment.

A case study of DfMA being applied on a Highways England Project. [https://www.ice.org.uk/knowledge-and-resources/case-studies/dfma-a453-road-widening-new-approach-bridge](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.ice.org.uk%2Fknowledge-and-resources%2Fcase-studies%2Fdfma-a453-road-widening-new-approach-bridge&data=04%7C01%7CMark.Bridges%40Gallifordtry.co.uk%7C1168a114a4284c5bd94a08d8897171e8%7C15813f7f44bc4e8fbab129b341c4f66f%7C1%7C0%7C637410467626230015%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=LURPgI3nI5woUDAbRDfqy8lUFFJ4WcVFD70AFQq1AqU%3D&reserved=0). This case study describes how the use of modular and offsite manufacturing solutions helped save 6 months construction time and reduce site labour by 30% on the A453 Road Widening project

Examples of DfMA need adding to PDWG and made more obvious. Specific link to be provided here

The Principal Designers Working Group have identified several good practice examples on DfMA available to all in the industry on the Highways Safety Hub website. <http://www.highwayssafetyhub.com/>

When reviewing opportunities for Design for Manufacture and Assembly, it is recommended that the key components which make up the infrastructure being installed as part of the works are identified and recorded. Each element should then be challenged to determine if elements of in-situ construction can be undertaken off-site and ready made products delivered ready for assembly on site.

Whilst offsite manufacture and assembly will minimise some risks the additional risk of transportation also needs to be considered. Designers should ensure they plan for transportation requirements as part of the DfMA process and accordance with Raising the Bar 36 – Lost Loads. With DfMA, as with any other lean approaches, ensure the simplification of the process has been clearly communicated to all involved. Ensure any use of technology has been thoroughly explored such as reliability and resilience.

**4. Design Risk Management**

**Common Intent Expectation level 4**

Where we can’t eliminate risks, we will aim to reduce them or ultimately isolate them. We will focus on the elimination of risk in the design phase wherever possible. We will actively engage with constructors, operators and maintainers, including clients, to understand contemporary capability and techniques to manage residual risk, which will positively influence our decisions to eliminate, reduce or isolate. Design models will predominantly be 3D+/4D-enabled and GIS based, updated continuously with all known hazards, and documented using a controlled Design Risk Management system for effective handover.

Design risk management should not be undertaken within discipline focused silos. Design risk management workshops should be organised at a frequency appropriate to the complexity or scale of the project.

Design risk management is not defined in terms of a single process or a one off activity. To be effective however, there are key aspects which must be considered in developing the appropriate safety by design approach for the design of any particular works package.

* Complexity of works
* Any unusual aspects
* Constraints which may affect construction
* ADD ADDITIONAL FACTORS

This can be achieved using some of the following key tools either as combined activities or standalone events.

**From the Outset**

Design risk management must be undertaken through the whole life of the design. The elimination of hazards is more effectively done at the outset as it avoids having to revisit decisions later in the design or having to develop mitigations whilst already constrained by earlier decisions. In this respect the client brief can have a significant impact and those writing these should have an awareness of the potential to introduce constraints which may have an unintentional adverse safety impact.

The specifications and standards form the foundations of designs and therefore can have a significant role to play in the management of hazards. Authors of specifications and design standards should be able to demonstrate that during the development of the documents, they have discharged their designer duties to identify foreseeable risks to the health and safety of any person.

Whilst document authors may not be in a position to eliminate or mitigate potential hazards which will be applicable in specific circumstances, they should consider and provide information in relation to, potential hazards arising from the application of the particular specification or standard. This can take the form of a hazard log included as an appendix to the specification or standard which conveys useful and relevant hazard information to those applying the standard.

Authors of specifications and standards should particularly consider how a number of these documents may be applied together to create a final product.

GD301 – Smart Motorways and GD 300 - Requirements for new and upgraded all-purpose trunk roads (expressways) – development of both these standards included development of a schedule identifying potential hazards when applying the standard in site specific circumstances.

**Hazard Identification**

Designers must accurately identify hazards and avoid the use of generic lists of hazards. It is possible that a hazard in one location may require a different mitigation to the same hazard in a different location in the works.

Designers should consider all foreseeable risks, including those which might be considered normal or generic e.g. working from height and seek to reduce these but, for the purposes of transferring hazard information over to the principal contractor, should focus on the unusual or difficult to manage i.e. those that are site specific.

Designers should avoid combining multiple hazards as a way of simplifying the design risk management schedule. By doing so there is an additional risk that the mitigation developed is a compromise to fill a box and does not reduce risk so far as is reasonably practicable.

A designer inadvertently combined multiple hazards relating to work on a parapet over a live railway line. The designer recorded a single hazard of working at height. This does not differentiate between the risk of workers falling from height and the risk of workers dropping tools on passing trains. The mitigation for these two risks is likely to be very different but recording and monitoring them is difficult if they are combined as a single entry.

When identifying hazard mitigations, it is important that designers not only identify the hazard but the root cause of that hazard. The first requirement of the principles of prevention is to avoid risks and to do this, designers need to consider the root cause not just the potential consequence. For example, why do people need to implement a “work around” deviation from process, or has sufficient training been delivered or monitoring to ensure compliance. Failure to identify the root cause will likely result in a less effective or appropriate mitigation.

The root cause of hazards is the most important aspect to consider. There are reasons why humans make errors. This may be due to lack of training, distraction, ill health, complacency or can be due to a deviation from policy, either intentionally as an unauthorised improved way of working, or due to lack of compliance monitoring and accountability. Designers should engage with the work force as they may hold the answers and the solutions.

The design hazard workshops should include representation from constructors, Maintainers, Traffic Officer Service and other relevant stakeholders.

Design teams should consider hazards as multidisciplinary issues. Hazards need to be recorded and be accessible to and understood by the whole team using a design risk management schedule.

Allocating numeric values to hazards is not essential. Assessing likelihood and severity factors does provide an opportunity to prioritise design mitigation resources. Also, before and after mitigation scoring supports reporting and graphical representation of the effectiveness of the design risk management applied to the project.



These appear in a range of formats within the supply chains internal systems. To be effective the schedule must precisely identify:

* + what the risk is,
	+ where it is,
	+ who is at risk,
	+ when they are at risk
	+ what is happening when the risk might occur.

Furthermore, it will be able to demonstrate how the mitigation is linked to the risk and how the risk is eliminated or reduced by the mitigation. The use of separate entries under eliminate, reduce and inform headings is one way of demonstrating the application of the basic hierarchy of the principles of prevention.

The schedule may also capture any factual information about the hazard which may be useful to others who have to manage the risk later in the works. It could include details of documents and their locations which contain the information and instructions to secure the health and safety of the worker for the lifecycle. This information may alternatively be provided within the pre-construction information.

**Safety by Design Workshops**

There is no one size fits all solution to Design Risk Management / Buildability / Operability workshops. The requirements for individual projects should be developed as part of the Safety by Design plan. Workshop planning should consider the following:

* Stage of project
* Appointment of key stakeholders (e.g. is contractor known)
* Complexity
* Duration

Add to list as appropriate.

The workshops will include representation appropriate to the stage in the design development and scale of the works, but consideration should be given to inclusion of organisational representatives from,

Early engagement with stakeholders via Safety by Design workshops should be the default position. Designers should provide sufficient early information to stakeholders to allow them to determine if they wish to be involved at a particular stage.

On schemes which may impact on the communications network, early involvement is vital with NRTS. Being the backbone to the functionality of the network, late involvement may delay works or incur extra risks, costs and the potential need to re-plan. These additional pressures introduce an avoidable increase in safety concerns.

* maintainers,
* operators and
* other relevant stakeholders

*Note: Maintainers and operators need to consider all those undertaking specialised work on the network alongside the major contractors. E.g. NRTS and associated technology contractors.*

As well as specialists in key areas including:

* Health and Safety

Do we need safety by design reviews, buildability reviews, constructability reviews and design reviews?

Are there any instances where a buildability review is undertaken outside the umbrella of a Safety by Design workshop?

Possibly remove but cover within scope of Safety by Design reviews in section above.

* Occupational hygienists
* Human factors
* Temporary Traffic management

The workshops can look at whole scheme issues or be focused on specific geographic, technical or operational aspects of the works.

The M62 J20-25 Smart Motorway team held a design risk management workshop focused on the major causes of worker injuries on the highway network. Designers were challenged to identify means of eliminating some of the major causes of slips, trips and falls during construction, operation and maintenance.

As a minimum the following topics and challenges should be considered, from both a health and a safety perspective, at these workshops:-

* Buildability
* Maintainability
* Deconstruction / Decommissioning
* Impacts on different populations (GG104)
* Whole life costing
* Challenge the norm
* Human factors
* Clash detection
* Design standards
* Materials

**Design Reviews**

Need to consider if we advocate specific Safety by Design reviews or that Safety by Design is a key element of any design reviews. May be better to embed within day to day design reviews promoting safety by design as business as usual rather than something which comes up for review every now and then? Then Safety by Design workshops can become more of a focus.

External design reviews, with a specific focus on safety risk management can be adopted with the frequency based on the levels of risks involved.

Any critical designs need to be subject to a periodic review, unless it is agreed with the principal designer that the amount of design activity does not warrant this frequency i.e. during a ‘design freeze’.

All design reviews should include consideration of hazards and the evaluation of safety risks as an agenda item. Assumptions an decision logs should also be reviewed to identify potential safety implications.

Project leaders shall ensure that such reviews shall be chaired by a person with sufficient training, skills and experience, and for the purposes of consistency, generally by the same person throughout the life of design.

Within the Designer’s project documentation, the competency requirements of the chairperson shall be defined and evidence that these requirements have been met shall be recorded and maintained.

A record shall be maintained of the external design review and the record shall include:

* All attendees
* Titles, organisation and role of the attendees
* Date, time and location of the review
* Details of the documents, drawings, specifications, calculations or other aspect of design being reviewed
* The design risk register by revision including the addition of new risks, mitigations and further design actions required
* Actions arising from the review meeting
* The signature of the lead design coordinator, that the record is a true reflection of the meeting.

**Buildability Reviews**

Buildability, based upon the site and its constraints, should be reviewed at several stages of a project, particularly at feasibility / option selection, approval in principle and detailed design. On complex projects Buildability Reviews should be held as design develops and understanding of the design and construction issues increases. Buildability Reviews should encompass assessments of Temporary Works at an early stage.

**Mitigations and alternative designs**

When determining a preferred mitigation between a range of potential approaches each one shall be assessed using whole life costs and benefits into account. Alternative scenarios shall be compared in accordance with GG104 –Requirements for Safety Risk Assessment.

Alternative design solutions shall also be compared using GG1004 so as to allowed safety to be appropriately considered alongside other factors which may determine the preferred option.

**Records**

Records must be kept of the design risk management process and decisions taken which impact upon the safety of any of the populations identified in GG104 during the whole life of the asset. The potential mechanisms for meeting this requirement include:

* Safety by Design Plan
* Design strategy record as set out in GD301.
* Design Issues record
* Design change record
* Design Risk Management Schedule
* Design decision log. This approach could be used to record design decisions, decision owners and any potential impacts on safety taken into consideration in making the decision.
* Assumptions Log

Any further thoughts on records which should be kept or how they should be kept?

**5. Designing Collaboratively**

**Common Intent Expectation level 5**

We will foster virtual rehearsal as ‘business as usual’, with the ensuing insights informing our design development. We will work collaboratively across designers, constructors, maintainers, operators and customers in order to better inform our design models for both permanent and temporary works solutions. We will plan to succeed safely and right-first-time on site through the use of digital models, for example to derive the benefits of virtual trial erection, full-scale mock-ups, etc., and to refine activity interfaces and eliminate potential clashes.

Designers should work collaboratively with constructors, maintainers, operators and customers in order to better inform design models for both permanent and temporary works solutions. Reviews of hazards and mitigations should be undertaken at a frequency proportionate to scale of the works and levels of risk.

The provision of information and instruction is considered to be the most effective way to influence health and safety outcomes.

How should residual hazards most effectively be conveyed to site teams? Drawings, Works information. Model?

Designers should be engaged in regular workplace inspections of site during construction.

Designers should be an integrated part of the construction team; on hand to collaboratively resolve any design issues / changes that arise and record design change in a collaborative way. Where changes impact on the design risk management schedule, the schedule must be updated and the safety implications of the change recorded via the appropriate technical query or request for information process. Hazards associated with design changes during construction, should be captured at regular ongoing joint meetings and where necessary added to the Design Risk Management Schedule which should be maintained and updated during construction in prep for handover.

Designers should refer to industry best practice to identify developments in which represent opportunities for improving the safety of designs. When identified these should be used to review and update Table E of [GD 304 - Designing Health and Safety into Maintenance](http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol0/section2/GD%20304%20Designing%20health%20and%20safety%20into%20maintenance-web.pdf) where appropriate.

A suggested check-list for every designer to consider is included in Appendix A. -

Removed this appendix as GD304 already effectively contains RAG lists. Could replace with list summarising tried and tested approaches. Should it be retained? Does it need updating if retained?

**Virtual Rehearsals**

Using 3D+/4D-enabled design models will enable the construction team to undertake a virtual rehearsal of how a product is to be constructed in order to ensure the proposed methodology will work. For example the constructor will be able to virtually check that the size of plant needed to construct the product will fit and be able to operate safely within the area before any commitment needs to be made.



The use of 3D visualisation allows all stakeholders to understand how the design will impact them. 3D modelling of both temporary and permanent works enables simulated construction, operation or maintenance in order to reduce uncertainty, improve safety, resolve issues, and simulate and analyse potential impacts.

Do we have any recordings of virtual rehearsals that can be uploaded to Hub website and link created here?

* M4 demolition works
* M42 J6 – Liz Brathwaite

**Temporary Works**

Many of the problems caused by Constructability of Temporary Works are due to lack of focus and planning at an early enough stage in the project therefore it is good practice not to leave temporary works design until construction stage, the key point being that the later Temporary Works are considered, the more difficult and costlier it is to make any necessary adjustments to the design, leading to a likelihood of imported risk. Where DfMa is a feature, designing standardised temporary works for each manufactured element can provide an easy and safe front end solution. An early understanding of Temporary Works requirements and staging is essential to understand the true scope of works and the associated risks.

To achieve this the early involvement of Designers with confirmed Temporary Works and Constructability competencies should be sought. Where a contractor is not yet appointed in the early design phase of a scheme the use of Early Contractor Involvement (ECI) should be adopted to test Constructability as it may also reduce or eliminate the need for Temporary Works in the first place.

It is recommended that Designers provide a Pre-Construction Temporary Works Schedule at the earliest possible stage and share this with the contractor. All parties can then review and comment to gather the broadest possible views on Temporary Works and Constructability. This should not be confused with the Temporary Works Register which is intended to feed from the Pre-Construction Temporary Works Schedule in readiness for the Construction Phase.

It is considered good practice for the HE Project Manager to work with the principal designer, principal contractor temporary works co-ordinator and Designers to enable the Temporary Works Register to be combined with the projects Permanent Works Register. This will help enable a consideration of integration between Permanent Works Designs and Temporary Works Designs as the designs are developed Great care and engineering attention to planning is needed during design, with close on-site supervision & planning in the execution of temporary works schemes, to ensure safety.

**Safer Systems / Human Factors**

Good design must consider where, how and why people may make mistakes, in order to design to prevent these opportunities for error and manage them when they occur. Whilst a design might comply with standards, it may still not be intuitive to users; there are locations with high collision rates that are DMRB compliant but still clearly present difficulties for users. Designs which rely upon safe systems of work being followed by individuals as the primary mitigation of a hazard should be the exception not the norm.

Operational safety specialists, with extensive experience of human factors, can help to identify the potential for human error allowing it to be eliminated or managed. Assets which are easily understood by users are safer and result in a more positive experience for the user (customer satisfaction).

Designers should recognize the relationship between their designs and human factors. BIM visualization tools are likely to be of assistance in identifying possible problems prior to construction.



**Monitor**

Have mitigations been completed?

Reporting on indicators – How much have processes affected H&S issues?

The project safety by design lead should review design risk management records to confirm they demonstrably show:-

* Designers are proactively identifying hazards and updating records at an appropriate frequency relative to the nature, scale and, complexity of the works;
* Mitigations have achieved a reduction of risk to as low as is reasonably practicable;
* Mitigations are practical and that the measures identified are within the remit of the designers to deliver;
* Mitigations have been completed;
* Measures contained within Table E of the Nationally Applicable Annex to GD 304 have been adopted where relevant;
* Information on residual risks is useful, relevant, proportionate and has been effectively communicated.

Risk has not disproportionately been transferred from one population to another. (HSE approved concept of trade off may be applied Ref: HSE Doc. R2P2 Reducing Risk and protecting people)

Human Factor considerations:

* Identify and address **root cause** of hazards – there are reasons why people do what they do – if you wish to change that behaviour you need to understand the WHY.
* **Training** – to minimise error ensure everyone has received the training they require to undertake their role
* **Guidance** – any guidance or policies in place ensure they are clear, concise and have been successfully communicated to all workforce. Also ensure the location of these documents are known and the protocol to suggest and inform changes is clear.
* **Compliance** – ensure monitoring is undertaken to ensure compliance with guidance and policies. For high levels of compliance there must be visibility of accountability and consequences if compliance is not achieved.
* **Environment –** Consider the environmental factor influences on your work force, this could be extreme weather conditions with the need for appropriate work wear or noise levels, temperatures. The changes in the environment can have significant effect on the human’s ability to function. For example, heat can cause tiredness whilst noise or extreme weather can cause distraction or lead to safety measures not be undertaken.
* **Governance and communication**– Ensure workforce know who to contact for assistance, how to make contact and where to seek additional support. Any changes must be clearly communicated to all.
* **Empowerment** – the workforce is one large team from the design concept stage to construction and delivery. Ensure everyone involved feels empowered to deliver the design safely. The workforce needs to feel recognised and listened too, they need to feel part of the process to ensure they feel comfortable and competent in their role which will result in a high level of commitment, responsibility and pride in the work they deliver. The workforce needs to have the confidence to raise issues of concern and feel supported by the governance structure.

**People Requirements**

**Training, Onboarding and Competency Requirements**

Suggestion for the provision of two examples of individual competency process – one for a high performing organisation and one for minimum performance. – thoughts?

Consideration needed on how we confirm competence of designers and what training is appropriate.

Procurement process by HE ensures overall company competence, but should we be challenging individual competence? Is it right to do so in here or is that something for individual companies to do?

Any good examples of competency checking etc?

Do we add in BAM PD competency check process into Appendix 2 ?

 Presumably there are lots of others we could include?

Working group to pick out good points from all available processes? Add examples from supply chain to section on PDWG pages of Hub website and cross reference from here?

PD team from both design and contractor have to complete CDM training course and then each individual on PD Team has to undertake a Competency Assessment, which is reviewed and approved by Head of Design and each team member is formally appointed - BAMNuttall

[Text to go in here]

**Responsibilities of Personnel**

We will expect a Safety by Design mindset from the outset, demonstrated through pro-active safety leadership and teamwork within an inclusive working environment. Approaches may vary but should include appropriate training/onboarding, with specific commitment to behaviours that effect safer designs outcomes, including evidencing consideration of operations and maintenance activities, and ongoing monitoring using leading performance indicators.

* The Client - Pro-active safety leadership? - Accountable for the management arrangements and provision of information
* Designer Senior Management – Pro-active safety leadership - Accountable for ensuring project controls are complied with
* The Project Design Lead / Lead Engineer – accountable for design change decisions.
* The principal designer lead -accountable for identify what is and is not to be treated as a significant risk
* The designer lead – accountable for application of the principles of prevention for their scope of work.
* All – responsible for the application of principles and prevention

Text to be added to identify accountability and responsibility. Possible RACI type matrix.

**Continuous Improvement**

**Incident Investigation**

To drive continuous improvement and development of early project hazard elimination, designers and principal designer lead representatives should be involved in on site incident investigations to determine if the design could have been prevented. Engagement with the contractor during the construction preparation stage should be used to facilitate communications regarding incidents on site to enable designers to attend investigations.

Learning from incidents and accidents should be used to update standards and guidance. The Principal Designers Working Group have identified several Lessons Learnt Case Studies from Incident Investigations available to all in the industry on the Highways Safety Hub website.

<http://www.highwayssafetyhub.com/learning-from-incidents.html>

**Lessons Learnt**

Lessons learnt reviews should not be restricted to the start and end of the design phase. Designers should maintain a live lessons learnt log, the contents of which should be briefed out to team members during progress meetings and shared with the wider community at regular intervals. The sooner lessons learnt are shared, the sooner the benefits start to be realised. The outcome of these lesson learnt exercises should be shared with the supply chain through the appropriate forums.

Lessons learnt relating to opportunities for improved design interventions should be shared with the design community for consideration in future schemes.

Is there an example (s) of how lessons learnt have been effectively shared across the supply chain? How do we do this?

Are there any examples of how models have been handed over either between stages or at the end of a project and successfully used at a later date? What processes have proved effective in ensuring information is transferred efficiently and without risk?

Lesson learnt should be shared on the Highways Safety Hub website ([Highwayssafetyhub.com](https://www.highwayssafetyhub.com/)) and with the principal designers working group (<https://www.highwayssafetyhub.com/principal-designers-working-group.html>)

Contractors should provide feedback to designers on hazard mitigations in order to support improvement in the elimination and mitigation of hazards during the pre-construction phase. Where formal reviews do not take place, the principal contractor should provide feedback to the principal designer, on hazards which have been identified on site and should be considered when designing future works.

**References / Useful Contacts**

The following documents have been developed to support designers when considering safety in design or provide guidance from other industries which may be applicable to highways work.

[GD 304 - Designing Health and Safety into Maintenance](http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol0/section2/GD%20304%20Designing%20health%20and%20safety%20into%20maintenance-web.pdf)

Supply Chain Safety Leadership Group

Common Intent Documents –

Safety By Design

Utility Strike Avoidance

Lost Loads

Raising the Bar Documents

RtB 9 – Utility Avoidance

RtB 36 – Lost Loads

Office of Rail and Road - [Positive and negative indicators of H&S by design](http://orr.gov.uk/__data/assets/pdf_file/0019/22159/positive-and-negative-indicators-for-health-and-safety-by-design.pdf)

Healthy by design – [A guide for Crossrail design teams](http://74f85f59f39b887b696f-ab656259048fb93837ecc0ecbcf0c557.r23.cf3.rackcdn.com/assets/library/document/h/original/helathy_by_design_version_3.pdf)

<https://www.twforum.org.uk/home>

L153 Management of HSE in Construction (CDM 2015)

• Specification for collaborative sharing and use of structured H&S information using BIM: PAS-1192-6

[The Construction Playbook](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/941536/The_Construction_Playbook.pdf)

**Appendix 1 –Safety by Design plan guidance / requirements**

The plan should consider as a minimum:-

* Roles and responsibilities for design risk management,
* Capability required within the Team including plans for on-going training and development
* Approach to embed a safety culture within the design team
* General whole life management approach to:-
* identifying hazards,
* eliminating hazards,
* mitigating hazards
* communicating hazards.
* Use of technology to track, log and monitor progress with elimination or mitigation of hazards
* Ownership of cross discipline hazards – e.g. Services
* External stakeholders / consultees
* Frequency and format of safety by design reviews,
* Arrangements for Buildability, Operability and De-constructability reviews
* Recording actions taken in accordance with the principles of prevention.
* Process for capturing temporary works requirements
* Arrangements for communicating changes to the design team
* Arrangements for communicating latest safety alerts and similar with the design team

**Alternative Listing**

* Health and safety in design aims
* Design Team Organisation
* Duty Holder contacts on F10
* Other Organisations / contact list
* Design scope
* Key dates
* Design Management process
* - Design Risk Management process
* - Meetings with Others
* - Open Issues
* - Design Change
* Design management controls
* RAG List
* Building information Modelling
* Provision of Information to others
* Individual SKE
* Managing lessons to be learned

To be developed further. Any suggestions on items for inclusion?

**Appendix 2 – Principal Designer / Designer Competency check process examples**

Should we include individual company processes or develop composite guidance on key features expected within a competency check for designers?