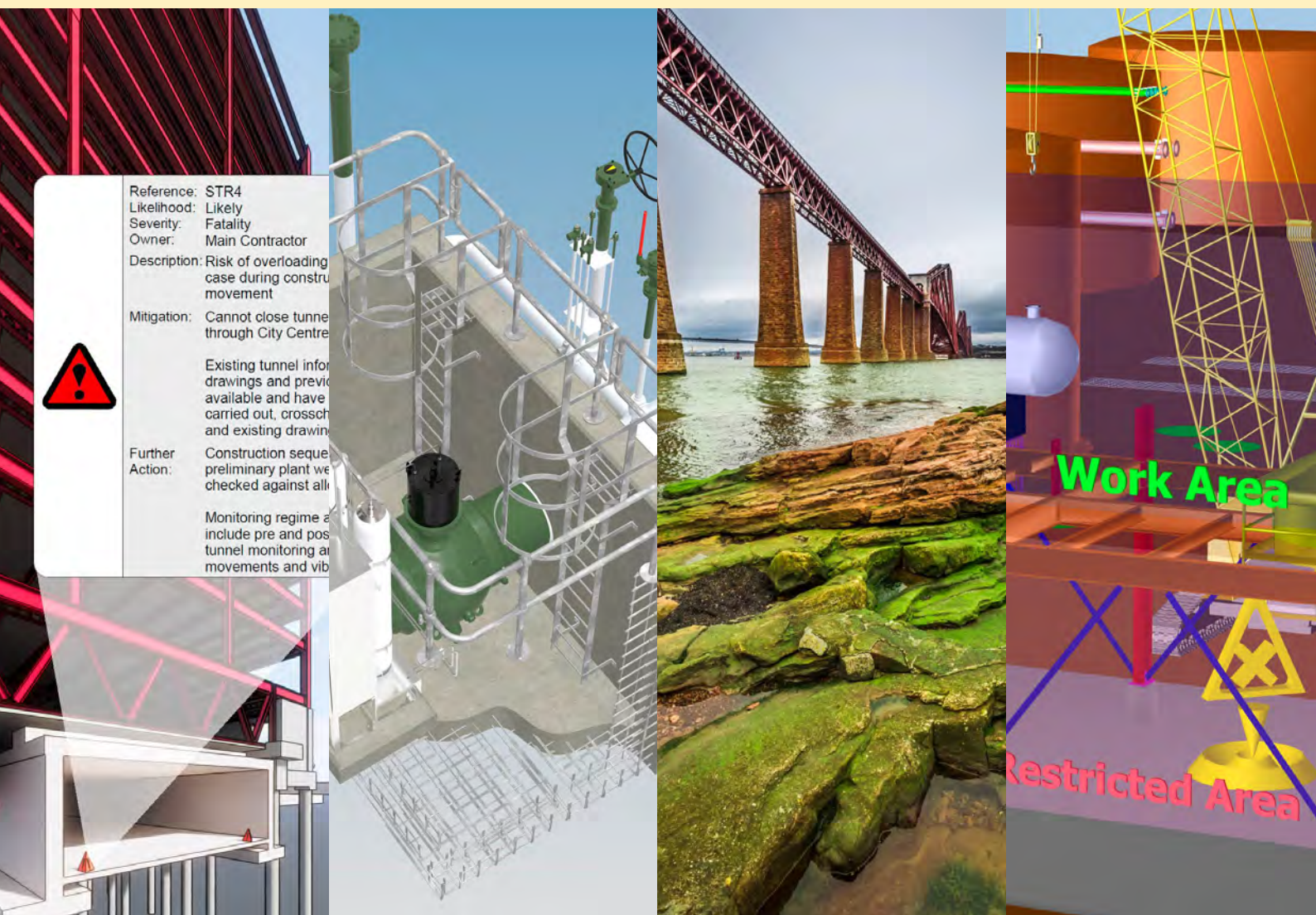


PAS 1192-6:2018

Specification for collaborative sharing and use of structured Health and Safety information using BIM



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Foreword

This PAS is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 19 February 2018.

This PAS was sponsored by Costain PLC and Health & Safety Executive (HSE). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 19.02.2018.

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This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a specification to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Use of this document

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Requirements in this standard are drafted in accordance with *Rules for the structure and drafting of UK standards*, subclause J.1.1, which states, “Requirements should be expressed using wording such as: ‘When tested as described in Annex A, the product shall ...’”. This means that only those products that are capable of passing the specified test will be deemed to conform to this standard.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Particular attention is drawn to the following specific regulations and their regional equivalents:

- The Health and Safety at Work etc. Act 1974 [1];
- The Construction (Design and Management) Regulations (CDM) 2015 – SI. 2015 No.52; [2];
- The Management of Health and Safety at Work Regulations (MHSWR) 1990 – SI. 1999 No.3242 [3]
- Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) [4]
- The Regulatory Reform (Fire Safety) Order, 2005 [5]
- Work at Height Regulations 2005 [6]
- Control of Substances Hazardous to Health Regulations 2002 [7]
- Control of Asbestos Regulation 2012 [8]
- The Ionising Radiations Regulations 1999 [9]
- The Dangerous Substances and Explosive Atmospheres Regulations 2002 [10]
- The Lifting Operations Lifting Equipment Regulations 1998 [11]
- The Electricity at Work Regulations 1989 [12]

Introduction

The UK Construction sector is obliged to manage and protect the occupational health and safety (H&S) of its workers and the public affected by its activities. In planning, designing and constructing buildings or infrastructure clients, designers and contractors are obliged to apply the principles of prevention and mitigate the inherent H&S risks within the constructed design solution and those hazards associated with the intended activities of the end user(s) or occupier(s).

These obligations are a requirement of the UK Health and Safety at Work etc. Act 1974 [1], the Construction (Design and Management) Regulations 2015 (CDM) [2] and other statutory instruments; and are enforced by the UK Health and Safety Executive or designated Local Authority.

H & S has always advocated the anticipation of risk, for example, the duty in CDM that designers must identify “foreseeable risk”. The increased use of digital information and modelling software applications in design development and delivery enhances the designer’s ability to anticipate, spot and foresee hazards and risks in the design. Designers can use a variety of applications which enable locations to be accurately visualized, sequences of activity to be realistically demonstrated and construction programmes simulated.

Software applications enable multi-discipline 3D models and construction programmes to be brought together to create ‘4D’ time-line models. A 4D animation can be used to review, assess and communicate construction options, hazards and risks. A 4D animation of difficult construction sequences is more easily understood by those who have to take responsibility and accountability for risk mitigation, control and management. The use of 3 D and 4D models in design supports the principles relating to an ‘inherently safer design’, ‘safety by design’ and the legislative duties on designers.

The further challenge is to document and share knowledge of these risks, throughout the lifecycle of the project, the built asset and across the wider construction industry.

The opportunity is presented in this PAS to integrate H&S information into the models, processes and applications which are common to BIM. This includes the opportunity to contribute to and benefit from wider knowledge and experience. All stakeholders can contribute to efficiently manage and mitigate H&S risks and improve outcomes, as part of the collaborative BIM process. The integration of H&S and BIM enables the output health & safety file (HSF) as part of the BIM information model to be transferred to asset owners, operators and users via a consistent integrated digital open standard format.

Risk can be identified earlier using information models, and controlled better, through collaboration around these models. This PAS is intended to support collaboration and encourage the opportunity that appropriately shared structured information can offer. Incorporated within this PAS are recommendations, potential approaches and proven techniques as to how information management, BIM processes and applications can be adopted to improve H&S standards and reduce the potential for harm.

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1 Scope

This PAS specifies requirements for the collaborative sharing of structured H&S information throughout the project and asset life-cycles.

The PAS supports the development of structured H&S information for all construction projects progressively from the outset.

The PAS provides guidance on how H&S information is produced, flows and can be used throughout the project and asset lifecycle. Whilst all H&S risk information can be included within an information model, this PAS requires the contextualization and filtering of hazards and risks to prioritize the elevated risks and aspects that are safety critical.

The PAS sets out a framework (risk information cycle) for the application of H&S information-use through BIM processes and applications. The principles and requirements of this PAS can be applied equally to non-BIM projects.

The PAS specifies how to use H&S information in order to:

- a) provide a safer and healthier environment for end-users;
- b) mitigate the inherent hazards and risks across the asset lifecycle;
- c) result in improved construction H&S performance, fewer incidents and associated impacts;
- d) provide for clearer, more assured and relevant H&S information to the 'right-people' at the 'right time';
- e) reduce construction and operational costs.

The exchange and use of H&S information is intended to support:

- 1) representation of the nature and characteristics of the project, site and built asset;
- 2) representation of H&S hazards, risks and associated factors;
- 3) the generalization, dissemination and re-use of H&S knowledge and experience.

The PAS is applicable to individuals and organizations that contribute to and influence the definition of design, construction, use (including maintenance) and end of life of a built asset.

This PAS does not define or change the duties set out in any relevant statutory provisions.

This PAS does not cover the commercial, operational or political risks nor risks which relate to the security threats associated to projects, built assets, sites or personnel.

NOTE *This PAS may be applied in conjunction with the duty holder's own management systems, policies and arrangements.*

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

PAS 1192-2, *Specification for information management for the capital/delivery phase of construction projects using building information modelling*

BS 1192-4, *Collaborative production of information – Part 4: Fulfilling employer's information exchange requirements using COBie - Code of practice*

PAS 1192-5, *Specification for security-minded building information modelling, digital built environments and smart asset management*

BS 8536-1, *Briefing for design and construction – Part 1: Code of practice for facilities management (Buildings infrastructure)*

BS 8536-2, *Briefing for design and construction – Part 2: Code of practice for asset management (Linear and geographical infrastructure)*

3 Terms and definitions

For the purposes of this PAS, the following terms and definitions apply.

3.1 harm

injury or damage to the health of people, or damage to property or the environment

NOTE 1 Definition taken from ISO / IEC Guide 51:2014(E).

NOTE 2 Realization of a hazard with the potential to cause harm, to the:

- a) construction workforce;
- b) built asset operators and maintainers, and users; and/or
- c) general public.

This definition is often colloquially referenced in H&S publications and learning material.

NOTE 3 Figure 1 illustrates the relationship between harm and a hazard.

3.2 hazard

potential source of harm (3.1)

NOTE 1 Definition taken from ISO / IEC Guide 51:2014(E).

3.3 risk

combination of the probability of occurrence of harm (3.1) and the severity of that harm

NOTE 1 Definition taken from ISO / IEC Guide 51:2014(E).

NOTE 2 This includes H&S risks such as:

- known residual risks;
- temporary states and works;
- demolition, re-use and re-cycling;
- substances and materials hazardous to health;
- hazard and risk controls required by legislation;
- dangerous activities in use and in operation;
- maintenance and cleaning risks;
- critical equipment;
- emergency situations;
- functional hazards.

NOTE 3 The likelihood and consequence of incident(s) scenarios and to damage to health arising from working methods and end-user exposure may be evaluated and assessed.

3.4 mitigation

informed decisions, measures and activities undertaken to remove or manage the identified, known or perceived risks based on the general principles of prevention

NOTE 1 Attention is drawn to, Managing health and safety in construction (Design and Management) Regulations 2015 [2], Guidance on Regulation L153, Appendix 1, The general principles of prevention.

NOTE 2 See PD ISO Guide 73:2009, 3.8.1, definition of risk treatment.

NOTE 3 Figure 1 illustrates the opportunities for mitigation in the likelihood arising from risk sources associated to a hazard and the mitigation of the subsequent consequences.

3.4.1 agreed mitigation

actions and changes to mitigate a risk that have been agreed and incorporated

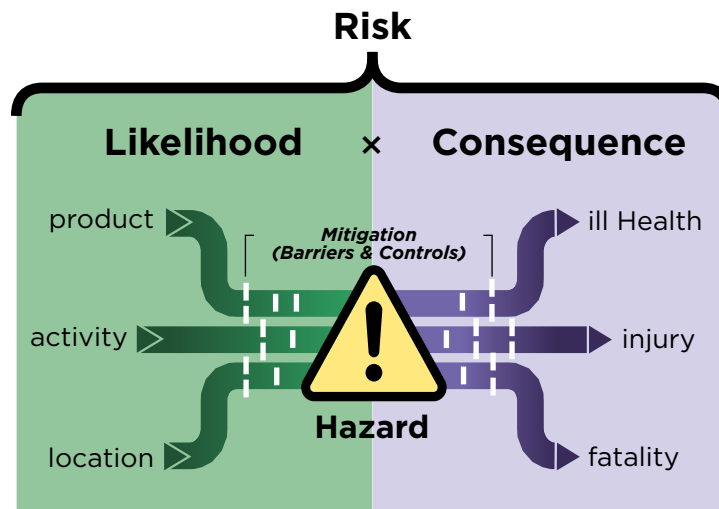
3.4.2 proposed mitigation

actions and changes to mitigate a risk that are proposed but have not been agreed or incorporated

NOTE 1 Action or change under discussion, under review, or that may require input from others; includes options and alternatives.

NOTE 2 Mitigation (barriers or controls) can operate either on the likelihood of a hazard being realized, or on the consequences of that realization being harmful.

Figure 1 – Mitigation of likelihood and of consequence



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3.5 risk management task

specified or required task, or series of tasks, undertaken to examine and act on specific H&S information and/or risk(s) as part of a project delivery strategy, or a stand-alone activity dependent on the level of the risk(s)

NOTE 1 This may be an activity, review, study or workshop with clear intentions and objectives.

NOTE 2 This may be specified by a participant as a requirement to fulfil a specific duty, expectation or deliverable within the remit of their role.

NOTE 3 For example, a client may want a specific hazard study undertaken to examine in a structured format the complex lift of a critical and costly piece of equipment with a long procurement period, seeking a high degree of certainty on a positive outcome of the task.

NOTE 4 For example, this may include specific hazard evaluation technique formats and formal safety assessments such as constructability reviews, HAZIDs, HAZOPs, HAZCONs, root cause, event bow tie analysis and others specific to particular industries.

3.6 information

representation of data in a formal manner suitable for communication, interpretation or processing by human beings or computer applications

NOTE 1 Definition taken from PAS 1192-2:2013.

3.6.1 context information

information or information model relating to a built asset, site and/or project indicative of the level of risk to be taken as moderate

NOTE 1 It is reasonable to expect the moderate level of H&S risk may be managed and controlled effectively by those with the requisite skills, knowledge and experience.

3.6.2 risk information

information of records relating to hazards, risks, opportunities, assessments, and mitigations

NOTE 1 Risk information should inform H&S risk information, and vice versa.

NOTE 2 Risks should be tagged to enable specific H&S risks to be extracted for identification, use and communication.

NOTE 3 Pre-construction information (PCI) is a set of information to improve risk management associated to the project lifecycle. Definition taken from, Managing health and safety in construction, Construction (Design and Management) Regulations 2015 [2], Guidance on Regulation L153, Appendix 2, Pre-construction information - information about the project that is already in the client's possession or which is reasonably obtainable by or on behalf of the client. PCI provides the H&S information needed by those preparing for a construction project to fulfil their CDM duties and obligations.

NOTE 4 Construction phase plan (CPP) is a set of information to improve risk management in the construction phase. Definition taken from, *Managing health and safety in construction, Construction (Design and Management) Regulations 2015 [2], Guidance on Regulation L153, Appendix 3, The construction phase plan*; the plan should record the arrangements for managing the significant health and safety risks associated with the construction phase of a project. It is the basis for communicating these arrangements to all those involved in the construction phase.

NOTE 5 Health and safety file (HSF) is a set of risk information related to the built asset. Definition taken from, *Managing health and safety in construction, Construction (Design and Management) Regulations 2015 [2], Guidance on Regulation L153, Appendix 4, The health and safety file*; The health and safety file is defined as a file appropriate to the characteristics of the project, containing relevant H&S information to be taken into account during any subsequent project. The file should contain information about the current project likely to be needed to ensure health and safety during any subsequent work, such as maintenance, cleaning, refurbishment or demolition.

3.7 risk source

entity which alone or in combination has the intrinsic potential to give rise to risk

NOTE 1 Definition taken from PD ISO Guide 73:2009 ISO GUIDE 73:2009(EIF).

NOTE 2 The entity may be taken as a causal factor of an identified hazard.

3.7.1 product association

source associated to the hazards and risks of a physical product (including elements and components of a product and prefabrications), material or substance, system or production processes

3.7.2 activity association

source associated to an activity, procedure, job or task, project or work packages

3.7.3 location association

source associated to a place, location, route, space, zone, level, region or site

3.7.4 quality association (latent defect)

source associated with a potential for failure resulting from works as built or materials used not fulfilling the design intent or specification

NOTE Other source associations include hazards referenced by legislation and consideration of changing risks during an emergency event and response.

3.8 risk analysis

systematic use of available information to identify hazards and to estimate the risk

NOTE Definition taken from ISO / IEC Guide 51:2014(E).

3.8.1 likelihood

chance of something happening

NOTE 1 See Figure 1.

NOTE 2 Definition taken from ISO / IEC Guide 51:2014(E).

NOTE 3 This may depend on risk sources such as location, physical and process entities and may be affected by the number of opportunities for the hazard to be realized.

3.8.2 consequence

outcome of an event affecting objectives

NOTE 1 See Figure 1.

NOTE 2 Definition taken from ISO / IEC Guide 51:2014(E).

NOTE 3 Particularly ill-health, injury or fatality; it may be affected by the number of realizations of the hazard.

3.8.3 level of risk

magnitude of risk or combinations of risks, expressed in terms of the combination of consequences and their likelihood

NOTE Definition taken from ISO / IEC Guide 51:2014(E).

3.8.4 risk matrix

tool for ranking and displaying risks by defining ranges for consequence and likelihood

NOTE 1 Definition taken from ISO / IEC Guide 51:2014(E).

NOTE 2 See ISO 31010, for other tools and Table 3 for consequences-probability matrix.

3.8.5 elevated risk

risk whose information is shared because of its exceptional nature or raised level given the agreed mitigation and context of the project

NOTE 1 This includes risks judged to:

- a) have potential consequence of single or multiple fatality, life changing or serious injuries, long lasting detriment to physical health, mental health and well-being
- b) be not obvious to a competent and experienced participant or outside of normal expectations
- c) remain a concern because of its potential occurrence within the asset lifecycle.

NOTE 2 Information about other risks, typically those below 'moderate', may also be shared

3.9 asset lifecycle

full life of an asset including creation, operation and use, maintenance and decommissioning or disposal

NOTE 1 See ISO 55000.

3.10 project lifecycle

phases of a construction project up to and including handover

NOTE The project lifecycle refers to the eight stage plan of work as defined in BS 8536-1 or BS 8536-2.

3.11 participant

person or entity fulfilling an active role in the use and sharing of H&S information and the risk management process

NOTE 1 See Clause 6.

NOTE 2 This PAS requires each participant to take into account H&S and risk management across the asset lifecycle.

NOTE 3 This PAS works in conjunction with the obligations placed on CDM duty holders with regard to construction projects.

NOTE 4 This PAS works in conjunction with the obligations placed on MHSWR duty holders with regard to business activities.

3.11.1 client

individual or organization commissioning a built asset

NOTE 1 Definition taken from PAS 1192-2:2013.

NOTE 2 The client may not necessarily be the end-user.

3.11.2 designer

any person who prepares or modifies a design relating to the construction, commissioning and use of the proposed built asset

NOTE 1 Where applicable and in accordance with CDM, a designer should be appointed as the Principal Designer.

NOTE 2 The definition of designer set out in CDM, Regulation 2 Interpretation, applies. This typically ranges from, but is not limited to, industry domain experts advising the client, architects, engineers (structural, civil, electrical, water, mechanical, materials, climate control, security) to temporary works and systems, and those who design testing and commissioning strategies and techniques.

3.11.2.1 design team

designers working in an integrated and collaborative approach to assure the constructability of an inherently safer design and safe functional performance of the asset

NOTE 1 Definition abridged from BS 8536-1:2015 and BS 8536-2:2016.

NOTE 2 Design management and coordination roles, and the CDM Principal Designer, should be included within the context of a design team.

3.11.3 contractor

any person who carries out, manages or controls construction work

NOTE 1 Where applicable and in accordance with CDM, a contractor should be appointed as the Principal Contractor.

NOTE 2 The definition of contractor set out in CDM, Regulation 2 Interpretation, applies.

3.11.3.1 construction team

contractors working in an integrated and collaborative approach to assure the safe build and functional performance of the asset

NOTE 1 Definition abridged from BS 8536-1:2015 and BS 8536-2:2016.

NOTE 2 Construction management and supervisory roles, and the CDM Principal Contractor, should be included within the context of a construction team.

3.11.4 commissioner

responsible for the test, testing and commissioning of the built solution to ensure the completed asset functions as the design solution intended

NOTE 1 This is often undertaken by the contractor(s), and planned, managed and coordinated by the Principal Contractor.

NOTE 2 Commissioning is an aspect of construction work as defined by CDM.

3.11.4.1 commissioning team

contractors and selected manufacturers and/or suppliers working in an integrated and collaborative approach to ensure the safe testing and commissioning of the built asset

3.11.5 end-user

user of the built asset, including those who operate, maintain and clean.

NOTE The application of this supports those who operate, maintain and clean the asset to comply with MHSWR duties and obligations.

4 Applying the PAS – General

4.1 Invocation

The client shall invoke this PAS through the Employer's Information Requirements (EIR) in accordance with PAS 1192-2 for the development, delivery and sharing of H&S information in a structured form for the project lifecycle, see Table 1. Where the built asset is deemed sensitive from a security perspective, whether in whole or in part, this shall be done in accordance with PAS 1192-5.

NOTE 1 *This PAS adopts a five phase approach to the project lifecycle (the need, design, construct, commission, end use) to enable application across the many and varied strategies that can be applied to projects, their contracts and commercial arrangements.*

Table 1 – Phases aligned to plan of work stages

PAS Phase	Construction Industry Council Plan of Work Stages	
Need (Initiation)	CIC 0	Strategic Definition
	CIC 1	Preparation and Brief
Design	CIC 2	Concept Design
	CIC 3	Developed Design
	CIC 4	Technical Design
Construction	CIC 5	Construction and Commissioning
Commissioning	CIC 6	Handover and Close-Out
End-use	CIC 7	In-Use (including maintenance and replacement)

NOTE 2 See BS 1192-4 and BS 8536-1.

The other participants shall use the BIM Execution Plan (BEP) (see PAS 1192-2) or other information plans to invoke or accept this PAS for the development, delivery and sharing of H&S information.

NOTE 3 *This PAS applies to adaption, decommissioning and demolition of a built asset [CDM] by considering these as a distinct construction project.*

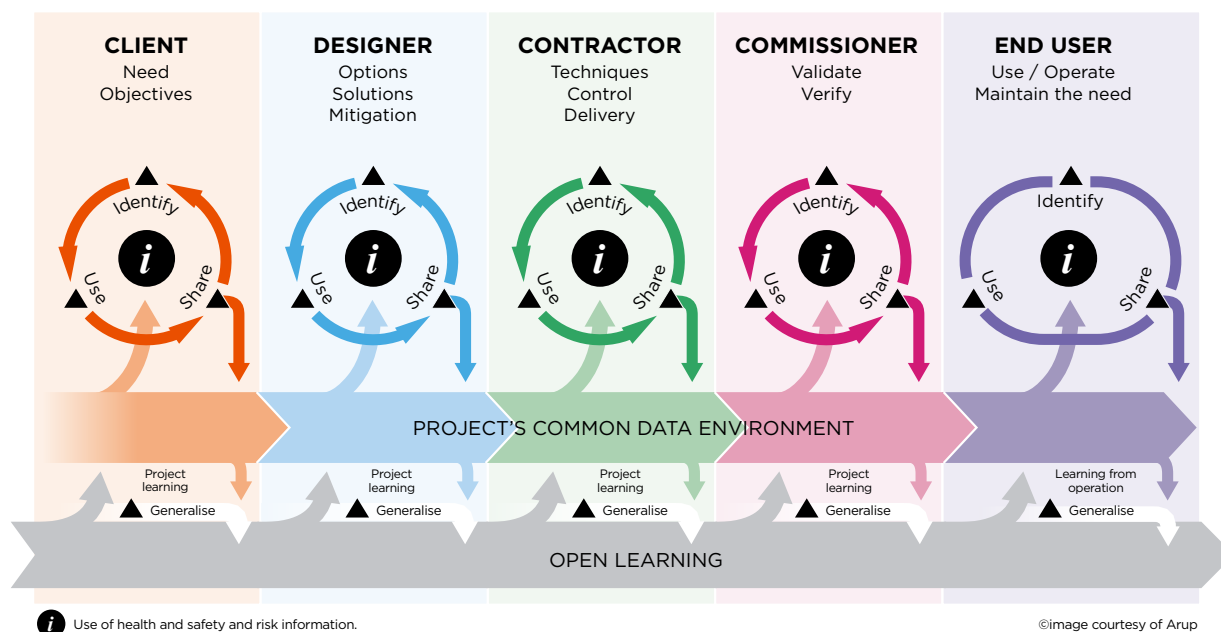
4.2 Operation

This PAS is structured to enable each participant (3.11) to, and accordingly each participant shall:

- adopt a H&S risk management strategy across the project lifecycle (see Clause 5);
- generate, use and share H&S information based on requirements, expectations and deliverables specific to each participant's role (see 6.1 to 6.5); and
- populate relevant and structured H&S information models of the project and built asset (see Clause 7) using consistent information exchange formats (see Clause 8, 9 and 10).

NOTE 1 *Figure 2 models the representation of the iterative approach progressing through the project lifecycle in a collaborative manner, accessing and developing the CDE(s), whilst benefitting from and contributing to continued learning.*

Figure 2 – Progressive development of H&S Information



Each participant shall construe and apply the requirements placed against them in a manner that reflects the nature and complexity of the project, the risks involved and the contractual scope of their services.

The participant responsible for H&S information at a particular delivery phase shall manage the processes relating to the inclusion of H&S information within the project's agreed approach (BEP), and the information exchange requirements in a manner consistent with any information security policy in place.

Through the risk information cycle (see Clause 5) H&S information shall be identified, used, shared, generalized and shared within wider community.

Each participant shall conduct a gap analysis between their internal management systems, the specific requirements of the project, the information provided and requirements of this PAS. The participant shall use the findings of the gap analysis to adopt or develop bespoke delivery strategies, procedures, processes or applications that fulfil and comply with the requirements of the project and this PAS.

NOTE 2 Each participant should be mindful that H&S and information management are independent disciplines that require different skills, knowledge and experience to fulfil effectively.

4.3 Information Management

4.3.1 BIM usage

Each participant shall establish a robust structured and managed system to record H&S information throughout the asset lifecycle; enabling proactive risk management, as required in Clause 7.

NOTE 1 The system should be designed, structured and maintained to provide, or make available, H&S information, models and documents to each participant that want, or need to use, the contained H&S information at the right time during construction and at construction completion.

Where the project is implementing BIM modelling processes, protocols, tools and applications then clauses Clause 9 and 10 shall be applied, otherwise if using a structured project document management system then Clause 8 shall be applied.

NOTE 2 Information needs varies widely across construction projects and the built asset. Each participant should identify and set out only the appropriate information they require to enable collaborative and effective sharing. Information use and sharing for a simple structure for low risk use will not be of the same magnitude for a complex high hazard operational facility. Information should not be generated for the sake of it. The need for information ownership and integrity should be respected.

NOTE 3 An information model is a collective instance of related 3D and 4D models, documents, drawings and other information needed to deliver contextual information for a stage, discipline or function e.g. H&S.

Where an asset is sensitive from a physical and/or an information security perspective, H&S information shall be managed and protected in accordance with the security requirements and policy established.

NOTE 4 An information security policy should include the security arrangements for an information system. The policy should typically include authorizations of access; barriers to unauthorized access to prevent manipulation and misuse; and procedures for information back-up and recovery. The policy and its implementation should ensure H&S information on safety critical systems and equipment, elevated risks, and key risk arrangements, is available at all times, see PAS 1192-5.

4.3.2 Use of CDE

Each participant shall:

- a) input H&S information into the CDE for use by other participants throughout design, construction, in commissioning and for end use; and
- b) expand, populate and utilize the attributes within the CDE to mitigate, manage and communicate H&S aspects, risks and controls.

Each participant shall use the CDE to ensure that the risk information is SHARED with the other participants. Formal H&S deliverables shall be PUBLISHED. Superseded information shall be held as ARCHIVE.

NOTE 1 Each participant should review and evaluate all the H&S information and risk management task requirements, and maintain, input and update the CDE in compliance with the EIR and project specific BEP, see PAS 1192- 2.

NOTE 2 The early involvement of an Information Manager can significantly benefit each participant in their determination of H&S information requirements and usage through the CDE.

NOTE 3 Where the client operates a parallel Asset Information Model (AIM) CDE, information including H&S information can be SHARED and/or PUBLISHED to the client at any stage to ensure that all parties are informed with appropriate information.

NOTE 4 Consideration should be given to the access time required for H&S information:

- a) Available – immediately on-hand for use, such as for use by fire fighters or COSHH assessments relating to maintenance – in a maintained and managed document system (required immediately, or within minutes);
- b) Accessible – required for occasional use or comparison, such as measured noise levels – stored and easily recoverable through examination of structured file paths (hours to recover, where this timescale is of no consequence);
- c) Archived – required for future use, such as a structural alteration – retrievable through a document controlled recovery procedure (days to retrieve, where this timescale is of no consequence).

4.3.3 Use of entities and annotation in models and documents

Each participant shall exchange and share risk information in open standard structured forms.

Each participant shall include information associating the H&S risks with relevant risk sources:

- a) by use of structured tables (see Clause 8); and/or
- b) by creating a COBie Issue (see Clause 9); and/or
- c) by adding the risk information to physical, spatial and/or process entities or types in the model or to annotation entities in close proximity to physical, spatial and/or process entities (see Clause 10).

NOTE 1 Annotation objects should use BS ISO 3864-3 symbols in 2D or 3D. Annotation should highlight critical edges or interfaces. Colour may be used to emphasize the level of risk.

NOTE 2 Repeated risks should not be duplicated to the extent of obscuring other issues.

4.3.4 Use of attributes

Each participant shall establish all the attribute requirements necessary to enable H&S risk information to be inputted and used throughout the project lifecycle (see Clause 5). Each participant shall incorporate attributes that support automated assessment queries, risk related studies and the specified risk tasks to be undertaken.

NOTE 1 Exchange strategies should be adopted to ensure all parties can readily use the H&S information. This can help each participant, particularly at early stages of a project, identify foreseeable risks and appropriate mitigation strategies.

NOTE 2 Attributes enable automated queries to be developed to support clash detection applications, determine risk zones and durations of risk exposure; attributes enable the development of animated visualization of techniques, 3D method statements, 4D construction sequencing hazard studies, coordination of temporary works and lifting operations; and early stage look-ahead phasing of works may facilitate and enhance the process.

Each participant shall adopt the use of the 3D or 4D construction sequencing model(s) to support the development and visualization of safe methods of access and working, including implications of working at height, temporary works, exclusion zones, restricted areas and works with a permit system.

4.3.5 Use for communication and learning

Each participant shall ensure that the H&S risk information held is available throughout the asset lifecycle and is used to support planning, training, H&S inductions and risk awareness of those at risk, whilst complying with any security policy for sensitive assets.

NOTE 1 This may take the form of animations, renderings, marked-up drawings, method statements and permits and specific task plans.

Each participant shall release generalized information on lessons learnt, innovation and improved practices associated to significant matters of H&S and risk management for continued learning through their management system arrangements or information sharing protocol.

NOTE 2 Each participant may release generalized information internally in accordance with their organizational arrangements or may share externally with industry, trade or professional associations, to raise awareness and improve learning for the benefit of current and future projects.

Each participant shall develop outputs that realise the benefits of an information model relating to H&S risks.

NOTE 3 Outputs extracted during the design phase from the information model may typically be:

- a) visualization of design assumptions, sequences and preferred methods of work;
- b) visual representation and duration of elevated risks, including designed-in provisions;
- c) information models for hazard evaluation and risk studies;
- d) clash detection, including auto-assessment of hazard zones, limitations and conflicts;

- e) structured risk assessments on the proposed or completed design mitigation;
- f) design in preparation for temporary works.

NOTE 4 Outputs extracted during the construction phase from the information model may typically be:

- a) construction technique selection, including options and evaluation;
- b) digital method statements, including 3D and 4D animations;
- c) digital permit to work systems, including auto-generation based on specific risk sources;
- d) verifying safe access routes and restricted areas, including conflicts and controls;
- e) temporary works requirements and restrictions;
- f) denoting real-time danger zones; and
- g) validation of as-built information.

NOTE 5 Outputs extracted during the commissioning phase from the information model may typically be:

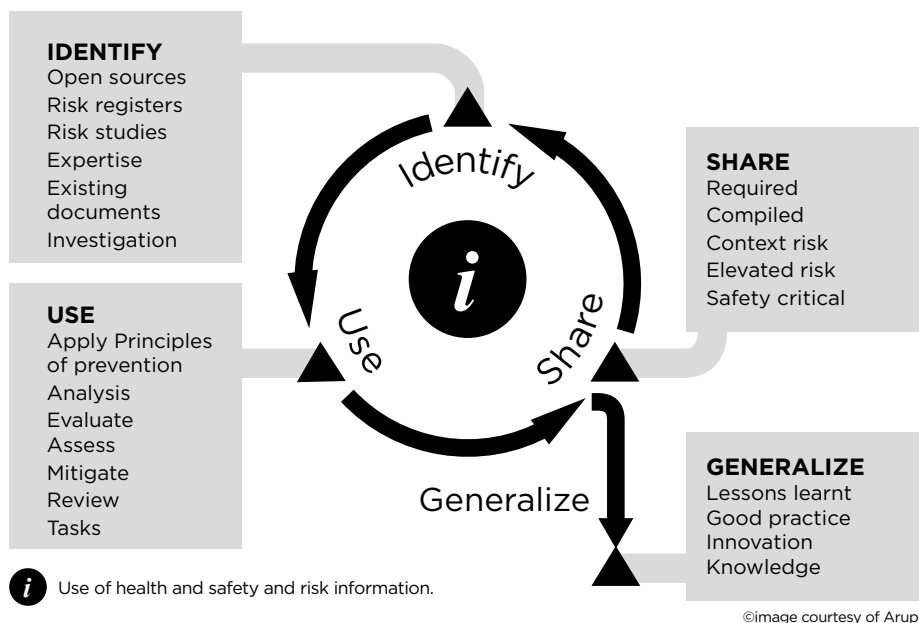
- a) digital test and commission procedures, including 3D and 4D animations;
- b) digital permit to test systems, including auto-generation based on specific risk sources;
- c) comparisons of design-intent against functional performance;
- d) denoting real-time exclusion zones; and
- e) verifying as-built information.

5 Risk Information cycle

5.1 Overview of risk information cycle

Each participant shall implement four components that provide the foundation and structure for the collaborative use of H&S risk information on a progressive, iterative and sharing basis throughout the project's lifecycle (see Figure 3).

Figure 3 – Risk information cycle



NOTE 1 Figures 4, 5, 6 and 7 expand on the four aspects of the risk information cycle and reference potential opportunities to benefit H&S.

NOTE 2 The techniques and solutions referenced in Figure 4, 5, 6 and 7, and others that evolve, are subsequently developed and become beneficial, can be applied appropriately by each participant in conjunction with the strategies and requirements as set out in Clause 6.

Each participant shall apply the four elements of the risk information cycle (see Figure 3):

- as an interface across each other – where an aspect in one has, or may in the future have, an impact in another;
- across all those associated to a project – each participant, associated project teams, project stakeholders, project management, facilities management, information management, supply chain, maintenance organizations; and
- throughout the asset lifecycle – from project outset, key project transitions, continuously.

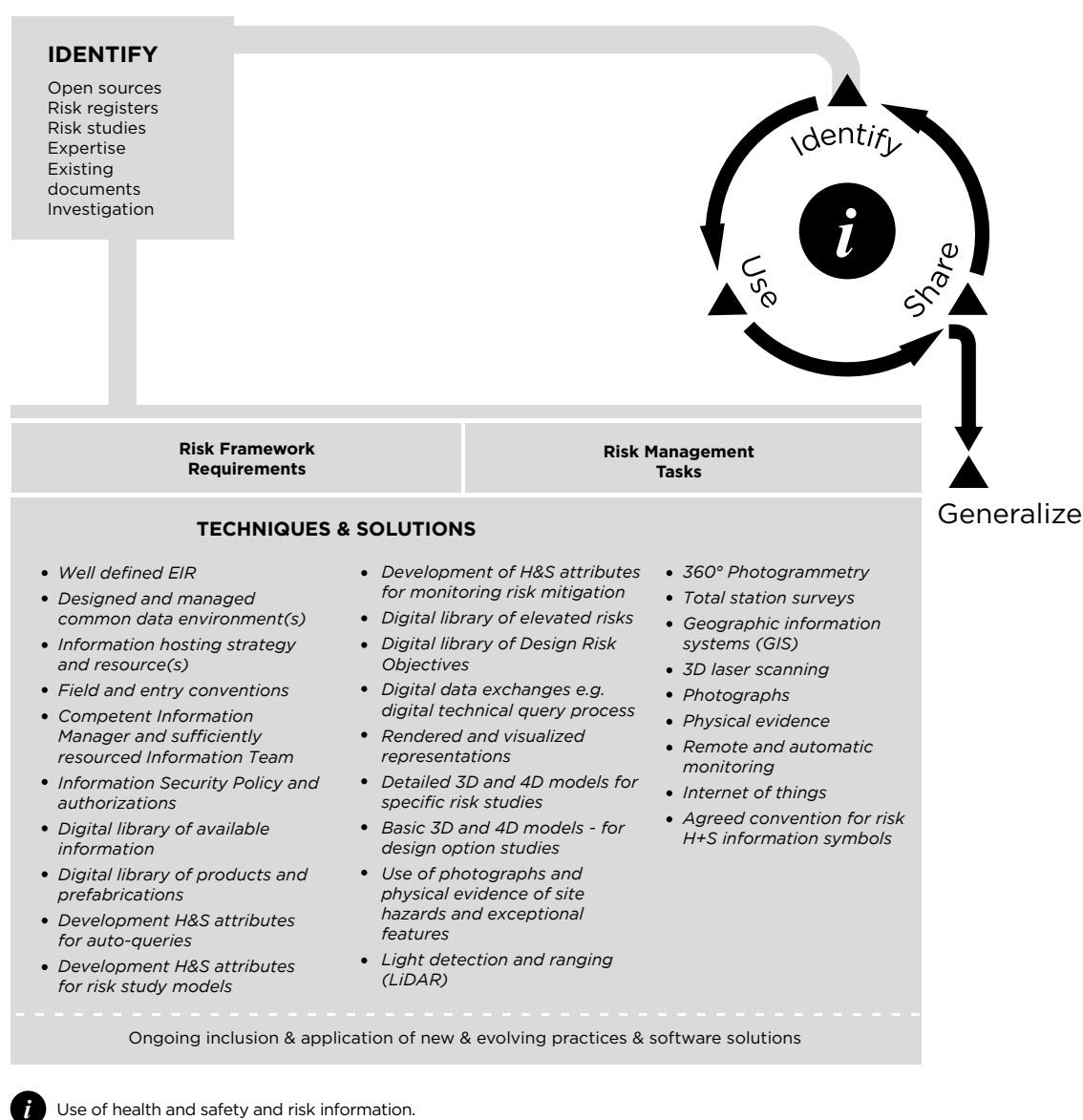
5.2 Risk identification

Each participant shall consult and involve other relevant participants, design and construction teams and where appropriate the supply chain early in the development and planning stage.

NOTE *Early engagement is a source of additional H&S information and identification of other major risks that can be used, mitigated and communicated throughout the project lifecycle.*

Each participant shall access and reference publicly available information and be familiar with H&S and risk issues being communicated from within their own organization, industry, professional and statutory bodies, and evaluate the relevance and benefit with regard to the nature of works. The identified elevated risks and associated H&S information shall be recorded for risk management and sharing through the CDE and/or information models.

Figure 4 – Means of identification and sources of information

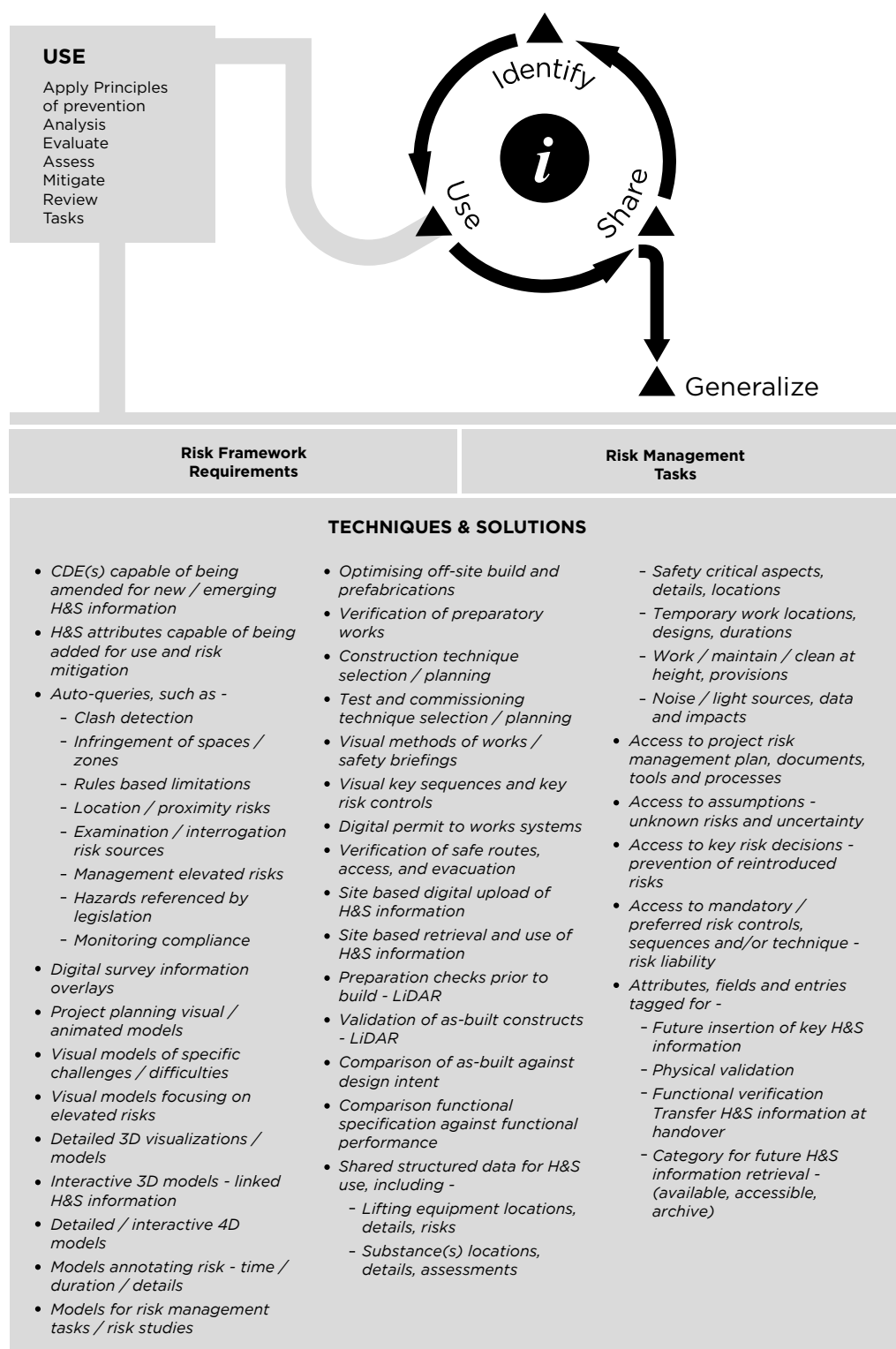


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5.3 Risk information use

The participants shall apply the 'Principles of Prevention', and an approach to 'inherently safer design' and 'safety by design', to the developing design solution and shall include the H&S and risk aspects of end use, commissioning and construction.

Figure 5 – Means and approaches to use



i Use of health and safety and risk information.

©image courtesy of Arup

Each participant shall provide H&S information for other participants and design and construction teams to assess and manage the:

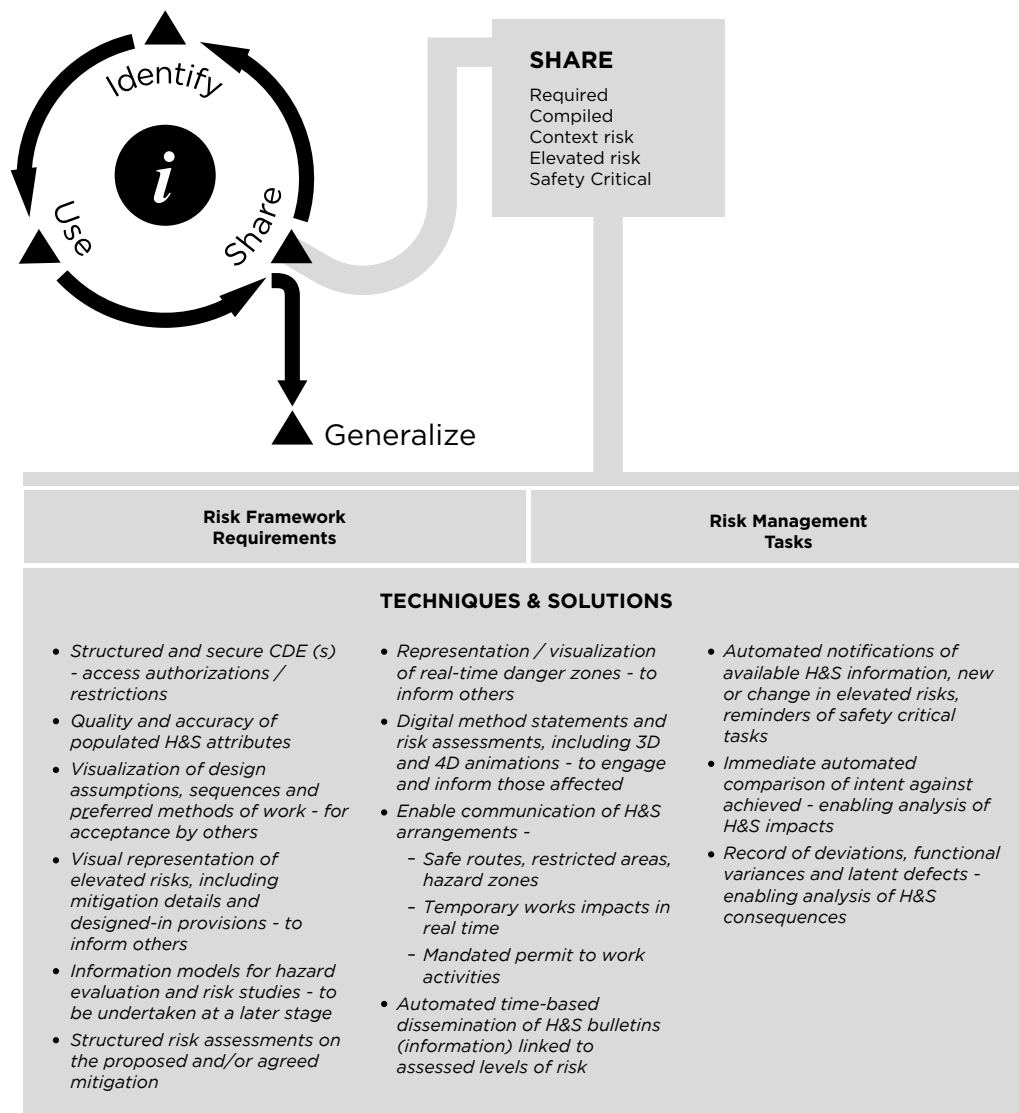
- provisions, arrangements and controls designed-in;
- key features designed-in;
- design assumptions, including design required sequences and techniques; and
- zones, areas and allocated spaces.

5.4 Risk information sharing

Each participant shall:

- undertake a critical examination of their contract documents, the EIR, the CDE and information models, and identify and schedule the H&S information wanted, needed or required by other participants;
- determine the type and purpose of the H&S information wanted, needed, or required by other participants;
- develop and implement information management processes that provides accurate and pertinent H&S information.

Figure 6 – means and approaches to share



i Use of health and safety and risk information.

©image courtesy of Arup

Each participant shall determine, agree and document with the information manager (or client) the specific requirements they need to be included within the EIR and/or the CDE with regard to:

- where or how H&S information is to be used;
- what H&S information is to be provided or communicated;
- the risk management tasks relating to elevated risks or critical mitigation.

Each participant shall implement a process that enables H&S information to be inputted, maintained and extracted through the CDE and/or information models throughout the project lifecycle.

5.5 Generalization for re-use

NOTE 1 The PAS recognises and reflects the need for lessons learnt, good practices and innovative improvements to be generalized and shared for immediate and future use as continued learning.

NOTE 2 Continued learning may be through an organization's internal arrangements, through an industry, trade or professional association, or statutory body.

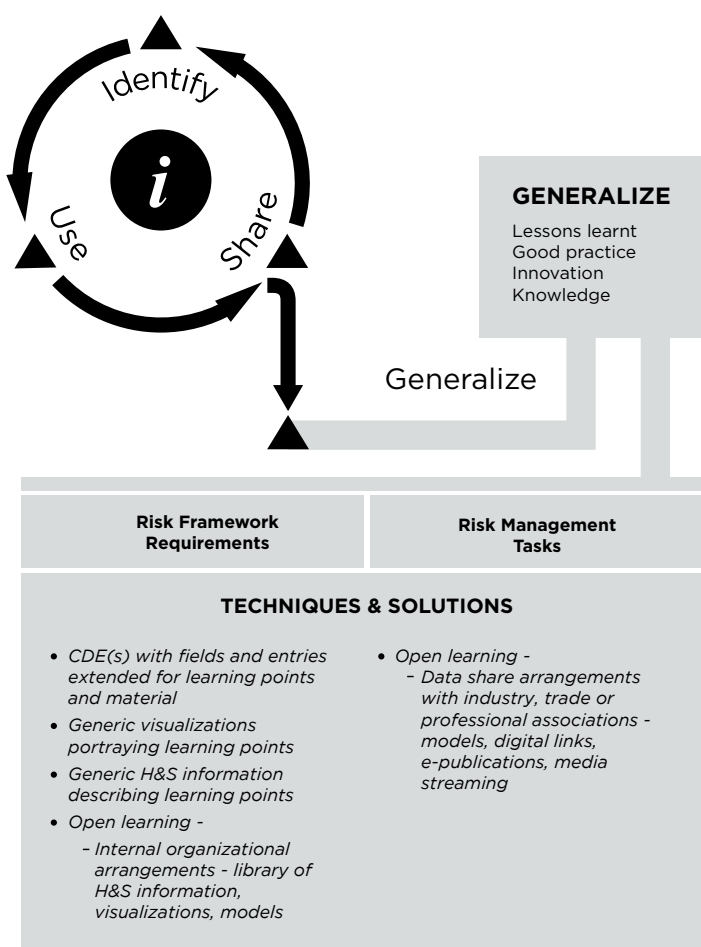
Each participant shall implement a process to generalize learning points relating to the elevated risks for sharing and for re-use by others. The process shall include:

- deciding on project and/or external publication;
- level of generalization; and
- generalization of mitigation taken from specific to generic recommended actions.

NOTE 3 Soft-landings and knowledge capture requires capture of good practice and lessons learned from past projects and publications. This opportunity arises for all participants irrespective of role.

NOTE 4 Supports the scope of BS 8536-1:2015 and BS 8536-2:2016.

Figure 7 – Learning and improving through generalization



i Use of health and safety and risk information.

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6 Participant implementation strategies

6.1 General

Each participant shall incorporate and implement the requirements, processes and deliverables in 6.2 to 6.6 into their approach to fulfil their obligations to gather, collaboratively share and use H&S information. The approach adopted shall complement the specific information requirements of the project, the participant's own management systems and legislative duties. The approach shall be proportionate to the nature and complexity of the work and risks, and scope of services to be provided.

NOTE 1 *The strategies set out for each participant reflect their different needs for H&S information and different opportunities they have to address risks.*

Each participant shall evaluate the EIR, the existing information management system and the requirements for the project's CDE, and shall implement any enhancements necessary to incorporate and collaboratively share H&S information.

Each participant shall ensure attributes relating to H&S aspects and risk are included that support risk management and H&S information sharing; and that also support automated queries, design studies or triggers of use by others.

The participant responsible for the CDE shall develop and maintain the agreed project CDE and establish procedures for its use as means to identify, share and use H&S information and to release the benefits of risk management.

NOTE 2 *Outcomes, H&S information and risks generated by the participant's actions (see 6.2 to 6.7) should be incorporated into the CDE and information models so as to support:*

- a) *effective management of risks;*
- b) *use across the asset lifecycle;*
- c) *project management, monitoring, compliance and acceptance.*

NOTE 3 *Each participant should examine the EIR and H&S information requirements and when producing, using and sharing H&S information, should be mindful to provide information that is proportionate and pertinent to H&S.*

NOTE 4 *Early engagement of an information manager may be beneficial in the determination of an appropriate information management system or CDE construct for the project and the End User.*

Each participant, in using, managing and sharing H&S information, shall implement information security measures. Each participant shall comply with the information security requirements set out in the EIR and any information security strategies or policies.

NOTE 5 *Each participant should be mindful of the potential risks associated to unauthorized use of accessible and sensitive H&S information by those with malicious intent. An example could be the open access to the inventory of substances stored on a chemical process plant (7.4.2).*

6.2 Strategy for clients

6.2.1 General

At the initiation of a construction project, the client shall establish the H&S information and risk management required and the H&S information they require to be provided throughout the asset lifecycle.

The H&S information and risk management requirements shall be proportionate to the nature and complexity of the work, the risks and scope of services to be provided.

The H&S information to be provided, H&S information required and the essential risk management tasks shall be retrievable from the CDE.

NOTE 1 *Early participant involvement in the project initiation process can significantly benefit the client in determination of their H&S information and risk management requirements.*

NOTE 2 *Where multiple designers (design team) are required to work on a project, the client should ensure a designer has been nominated as the CDM Principal Designer. The client should provide the CDM Principal Designer with the authority and responsibility to manage and coordinate the use and sharing of H&S information, and effective implementation of risk management tasks. The client should require the CDM Principal Designer to develop, implement and maintain the H&S aspects of a project specific design plan (6.3.4) and approach to design risk management (6.3.5).*

NOTE 3 The client should embed into the contract a requirement for all designers to support the development and comply with the project's design plan and approach to design risk management.

NOTE 4 Where multiple contractors (construction team) are required to work on a project, the client should ensure a contractor has been nominated as the CDM Principal Contractor. The client should provide the CDM Principal Contractor with the authority and responsibility to manage and coordinate the use and sharing of H&S information, and effective implementation of risk management tasks. The client should require the CDM Principal Contractor to develop, implement and maintain a project specific construction plan (6.4.4) and approach to construction risk management (6.4.5).

NOTE 5 The client should embed into the contract a requirement for all contractors to support the development and comply with the project's construction plan and approach to construction risk management.

NOTE 6 Where multiple testing and commissioning contractors and specific manufacturers (commissioning team) are required to work on a project, the client should ensure a contractor has been nominated as the CDM Principal Contractor. The client should provide the CDM Principal Contractor with the authority and responsibility to manage and coordinate the use and sharing of H&S information, and effective implementation of risk management tasks. The client should require the CDM Principal Contractor to develop, implement and maintain a project specific commissioning strategy (6.5.4) and approach to commissioning risk management (6.5.5).

NOTE 7 The client should embed into the contract a requirement for all those who are to undertake testing and commissioning to support the development and comply with the project's commissioning strategy and approach to commissioning risk management.

NOTE 8 Client H&S information and risk management requirements should be incorporated into the project specific CDE, as soon as is practicable.

The client shall place a requirement for each remaining participant to collate and record lessons learnt, innovation and good practices to facilitate the release of generalization of H&S information and risk management for sharing, learning and the benefit of future use (4.3.5).

NOTE 9 Where appropriate, the client may benefit from the appointment of an owner's representative as set out in BS 8536-1:2015 and BS 8536-2:2016. The owner's representative should have the appropriate expertise and skills, with knowledge of the client's organization and understanding of the asset's future. The owner's representative is not the project manager, facilities manager or part of the design and construction team.

6.2.2 Providing information – the asset need

The client shall record and provide information on the key decisions made that enabled the asset need (see Table 1) to progress to become a construction project.

The client shall record and provide information on the major hazards and risks, including known elevated risks, that were identified in the decision making process.

The client's rationale about what risks are acceptable for end-users to inherit shall be set out in the information provided.

NOTE 1 Notwithstanding the sensitivity of business risks and decisions, the provision of risk and decision information applicable to technical, environmental and H&S aspects is essential.

NOTE 2 This information is required and to be used by project managers, project planners, the design team and each designer in the realization of the client's intentions and objectives.

NOTE 3 The term 'asset need' refers to the objectives of a project that has a business and/or not-for-profit end-use and purpose, such as charity or public amenities and/or infrastructure.

6.2.3 Providing information – asset knowledge and experience

The client shall draw on their knowledge of difficulties and risks encountered in the functional use and maintenance of existing or similar business assets; and shall determine, contextualize and set-out the H&S aspects and risks to be avoided or reduced.

The H&S aspects and risks to be mitigated shall be retrievable from the project's CDE.

NOTE 1 Difficult work processes, equipment risks, known tasks with high risks, cause of historical improvements, system defects, continuous problematic occurrences, incident records, maintenance access restrictions and other functional related challenges can be considered and specified by the client for avoidance by design.

NOTE 2 Where the client may have little or no awareness or knowledge of functional deficiencies, the appropriate industry, trade and professional bodies may provide beneficial H&S information (see Figure 7).

6.2.4 Providing information – site locations, known conditions and existing information

The client shall determine and set out known significant H&S hazards and risks, and dangerous conditions, relating to existing assets and location(s) or proposed site locations. The client shall examine the known conditions and set out the risks that they deem unacceptable.

The known and potential significant H&S issues relating to asset and site conditions shall be retrievable from the project's CDE.

The client shall make available all pertinent H&S information relating to existing assets, services and materials affected by the proposed project. These shall be collated and listed.

The available H&S information and list shall be retrievable from the project's CDE.

NOTE 1 Details about the available listed H&S information should be fully annotated, such as: title, version, date, reference number, type, format and brief synopsis.

6.2.5 Use of Information – early hazard evaluation

The client shall conduct and record an early preliminary hazard analysis and safety review to determine the primary and major challenges, difficulties and risks affecting the project.

NOTE 1 The preliminary hazard analysis and safety review combines the H&S information to be provided with the knowledge and experience of stakeholders, project planners and the design team; and where appropriate, early contractor representation.

The client shall use the generated information to make key decisions on the elimination of risk, or the acceptable level of risk, at the initiation stage of the project. The decisions and any required management of the risks shall be included in the contract documentation as client specific requirements.

NOTE 2 The preliminary hazard analysis and safety review should be facilitated by the client in support of the asset need.

NOTE 3 The decisions and level of acceptable risk determined by the preliminary hazard analysis and safety review can be developed into design risk objectives for inclusion in the CDE (see 6.2.12). Identified critical H&S aspects may require specific risk management tasks (see 6.2.6).

6.2.6 Design risk management tasks

The client shall determine and set out any design risk management tasks that are to be undertaken in design or in construction planning to ensure and demonstrate the mitigation of specific major project hazards and risks, and known elevated risks.

The requirement for design risk management tasks shall be based on the specific major hazards and risks, and known elevated risks, associated to construction and end use of the asset.

NOTE 1 The number of design risk management tasks should be proportionate to the nature of the risks associated to asset use and the construction work. For example, the design of a small portal frame building on a new industrial estate with no predetermined end-use may require few if any client required design risk management tasks; whereas a major chemical storage and processing plant may require many to ensure the client's obligations and duties are fulfilled.

The client shall specify any required design risk management tasks in the contract documentation.

The client shall provide a brief scope of the purpose and objective for the specified design risk management tasks within the contract documentation.

The client required design risk management tasks shall be retrievable from the project's CDE.

NOTE 2 Design risk management tasks are most effective when undertaken early in the project lifecycle.

NOTE 3 Design risk management tasks may typically include risk studies, formal safety assessments, option evaluation and risk comparison, risk specific reviews, design risk assessments and recognised hazard evaluation techniques, such as, Hazard Identification Study (HAZID), Hazard and Operability Study (HAZOP), bow-tie assessments, Layers of Protection Analysis (LOPA) and Constructability Reviews.

6.2.7 Required information – functional performance of the asset

The client shall determine and set out the H&S information required, after commissioning (post-handover), to monitor the performance of the asset in use.

Where the asset relates to a business use, the client shall determine and set out the H&S information needed to manage and support business performance, equipment and material assets, and building and land assets.

Where the asset is available to other end-users (not the business' workforce), the client shall determine and set out the H&S information needed to manage and support end-user activities, equipment and associated assets.

6.2.8 Required information – asset as workplace

The client shall determine the H&S information required to enable the safe management and control of the asset in use.

Where the built asset requires maintenance, cleaning and/or the operation of equipment, the client shall determine the H&S information required to enable the management and control of occupational H&S of the asset as a workplace; as the workplace employer.

NOTE The client may need H&S information for the following:

- Legal requirements – relating to, e.g. workplace risk assessments, developing safe systems of work, safety management systems and policies;
- Legal requirements – relating to, e.g. public-use risk assessments, H&S controls and restrictions, provision and publication of pertinent H&S information, emergency response;
- Safety critical equipment and systems – relating to, e.g. safe operation, location, zones, functional reliability, testing frequency, tools, spares, required resource skills, human factors, hierarchical acceptance.

6.2.9 Required information – client requirements for/ from commissioning

The client shall determine and set out the H&S information and evidence required from the commissioning team, to accept:

- a) the functionality of the built asset;
- b) safety critical systems and equipment are working properly;
- c) compliance with the project brief and objectives; and

- d) compliance with legislative obligations and duties.

NOTE The requirement to collate and provided the H&S information and evidence may be placed on the CDM Principal Contractor; with all those testing and commissioning contributing in a collaborative manner.

6.2.10 Required information – client requirements for/ from construction

The client shall determine and set out the H&S information and evidence required from the contractor(s) to:

- a) ensure the built asset is as designed;
- b) monitor H&S performance and standards;
- c) ensure effective risk management and control; and
- d) comply with their legislative obligations and duties.

NOTE 1 The requirement to collate and provided the H&S information and evidence may be placed on the CDM Principal Contractor; with all contractors contributing in a collaborative manner.

NOTE 2 In determining the information required the client should consider the critical H&S aspects associated to:

- a) the likely methods of construction work;
- b) how harm to persons may occur during construction;
- c) construction activities and locations of work that are potentially difficult and/or dangerous; and
- d) the elevated inherent construction risks.

NOTE 3 In addition, other factors related to monitoring the management of H&S and mitigation of risks can be considered and specified:

- a) status of approval of safe systems of work prior to high risk construction activities commencing;
- b) compliance with H&S performance indicators;
- c) status and effectiveness of H&S objectives;
- d) compliance with contractual H&S requirements;
- e) H&S proactive and reactive performance data; and
- f) compliance with H&S programmes and status of improvement actions.

NOTE 4 Client required construction information should be appropriately tagged for project management, monitoring and compliance purposes.

6.2.11 Required information – client requirements for/ from design

The client shall determine and set-out the H&S information and evidence required from the design team to:

- a) demonstrate risk mitigation by design of the built asset for end-user(s);

- b) demonstrate risk mitigation by design for safe testing and commissioning;
- c) demonstrate risk mitigation by design of a safe place of work for the contractor(s);
- d) demonstrate the avoidance or reduced potential for latent defects; and
- e) comply with their legislative obligations and duties.

NOTE 1 *The requirement to collate and provided the H&S information and evidence may be placed on the CDM Principal Designer; with all designers contributing in a collaborative manner.*

The client shall set out clear design risk objectives with regard to major H&S hazards and elevated risks that are specifically required to be:

- eliminated and/or avoided – by design;
- reduced to an accepted level – by design; and
- controlled by features designed into the solution, to facilitate later stage risk management.

NOTE 2 *Design risk objectives should be set out by the client at the beginning of the project and are required to be included in the Design Plan (6.3.4). The client may seek the input and co-operation of the CDM Principal Designer in setting out and defining the design risk objectives. A requirement may be placed on the Principal Designer to monitor and manage the design risk objectives and provide information to the client on their status, compliance and effectiveness*

Where the client has established any specific design risk management task (6.2.6) the client shall set-out the H&S information required to monitor delivery, compliance and level of mitigation achieved.

NOTE 3 *In determining the H&S information and design risk management tasks required the client should consider the critical H&S aspects associated to:*

- a) *the likely methods of construction, means to commission and activities in end-use;*
- b) *aspects and features that could be difficult to mitigate by design;*
- c) *the required level of effort to mitigate the hazards and risks by design;*
- d) *the potential residual major hazards and elevated risks inherent in the design solution;*
- e) *potential catastrophic events.*

NOTE 4 *Other factors related to monitoring and management of H&S information and risks may be specified:*

- a) *status of mitigation of known elevated risks;*
- b) *details of new / emerging elevated risks;*
- c) *status and effectiveness of risk identification tasks;*
- d) *status, effectiveness and outcomes of design risk management tasks;*
- e) *status and findings of design risk assessments and risk studies;*
- f) *status of information shortfalls relating to H&S;*
- g) *compliance with H&S performance indicators;*
- h) *status and effectiveness of H&S objectives;*
- i) *compliance with contractual H&S requirements; and*
- j) *status of H&S design deliverables.*

NOTE 5 *Client required design information, design risk management tasks and design risk objectives should be appropriately tagged for project management, monitoring and compliance purposes.*

6.2.12 Specification and sharing H&S information

The client shall include H&S information requirements in the EIR and risk management tasks in the contract documents.

NOTE 1 *Specific client requirements for H&S information may include:*

- a) *what is important to them; and/or*
- b) *what has a useful purpose; and/or*
- c) *what is safety critical; and/or*
- d) *what relates to elevated risk; and/or*
- e) *what will be of benefit in the management of asset lifecycle risks.*

The client shall specify the frequency, format and range of H&S information to be provided by the each remaining participant throughout the key stages.

NOTE 2 *The required H&S information and risk management tasks wanted throughout the project lifecycle can inform the contract, the EIR and the PCI (CDM preconstruction information).*

NOTE 3 *On projects where there is an engaged Information Manager and/or appointed CDM Principal Designer early consultation with them may be significantly beneficial in the determination of the appropriate use of the CDE, and information models for the project and the End User (asset management); including the HSF (CDM health and safety file).*

The client shall re-evaluate and confirm their H&S information and risk management task requirements prior to the construction stage.

6.3 Strategy for designers

6.3.1 General

The design team shall use the H&S information, provided by the client and others throughout the design process, to identify hazards, mitigate the apparent risks and produce an inherently safer design solution for end-use, commissioning and construction.

The design team shall undertake the design risk management tasks set out by the client and those needed to support the design process, and record the findings and any actions generated. The design team shall use the H&S information generated to develop the production of an inherently safer design solution.

The design team shall provide and make available H&S information required by the client and as needed by others for their use in developing an inherently safer design solution.

The design team shall implement an approach that enables the early involvement of representatives from the end-user(s), commissioning and construction in support of hazard identification, risk mitigation and development of an inherently safer design solution.

The design team shall engage and consult with the supply chain from the outset to incorporate and use H&S information relating to the installation, functionality and maintenance of products to be included in the design solution.

NOTE 1 Early involvement of project stakeholders and representation from across the asset lifecycle in the design process can significantly benefit the design team in their identification, evaluation and mitigation of hazards and risks, and provision of design H&S information pertinent to each key stage.

NOTE 2 The identification of risk and coordinated approach to the principles of prevention underpin and support the duties of the CDM Principal Designer.

NOTE 3 A CDM Principal Designer should implement a structured approach to design team collaboration and H&S information sharing, coordinating the early involvement and consultation with stakeholders and the supply chain.

6.3.2 Early evaluation of information requirements

Each designer shall examine and evaluate their contract documents for completeness and identify H&S information shortfalls and gaps that prevent or compromise effective design delivery and design risk management. Each designer shall seek instruction from their client, typically through a query process, with regards to the actions necessary to address such H&S information shortfalls or gaps.

NOTE 1 Where such actions require design surveys or investigations, then the designer should implement suitable H&S management arrangements; and coordinate such H&S matters with the CDM Principal Designer or Principal Contractor.

Each designer shall examine the H&S information requirements set out in their contract and the EIR to:

- a) identify and include the stated and apparent hazards and risks in their approach to design risk management (6.3.5).
- b) identify and include the client specified design risk management tasks in their approach to design risk management (6.3.5).
- c) identify and schedule the H&S information required by the client; and determine the purpose of the H&S information required and the criteria for providing such information to the client (6.2.12).

NOTE 2 Typically H&S information is wanted for:

- a) monitoring compliance with project requirements and the objectives;
- b) facilities asset and operational management purposes required by the end user;
- c) monitoring the designer's performance; and
- d) supporting the Client's legal duties relating to construction projects;

NOTE 3 The design team should be mindful of the type of contractors to be engaged, the cultural practices to be adopted in construction and in use, the type and traditions of asset users, and expected and likely shortfalls in skills, when determining the style, format and content of H&S information to be provided.

6.3.3 Early identification of hazard and risk

The design team shall review and evaluate the findings of the preliminary hazard analysis and safety review undertaken by the client. Each designer shall embed into their design strategy as design risk objectives, the hazards and risks the client wants eliminated or reduced to an acceptable level.

NOTE 1 *Each designer should agree with the CDM Principal Designer the design risk objectives that are applicable and those they are responsible for.*

NOTE 2 *The CDM Principal Designer should include all design risk objectives in the project design plan (6.3.4).*

NOTE 3 *It is a recommendation on the client that the preliminary hazard analysis and safety review should be developed periodically at key transitions in the project lifecycle.*

Each designer shall conduct a constructability review at the outset of their design scope to identify and evaluate the:

- a) hazards to be eliminated by informed design decisions;
- b) the hazards that require the risks to be reduced through proactive design risk management; and
- c) key H&S information and risks to be shared with others.

NOTE 4 *Involvement of the CDM Principal Designer, members of the design team, supply chain and representatives of other participants in the constructability review can significantly benefit the design team in their identification and mitigation of hazards and risks at the earliest possible stage.*

NOTE 5 *Constructability reviews should include the use of 3D or 4D time-lined models. The information models should have a sufficient level of detail to identify, evaluate and action:*

- a) soft clashes;
- b) significant temporary works;
- c) lifting operations;
- d) major excavations;
- e) hazard zones and areas;
- f) ground support solutions;
- g) working at height and access routes;
- h) quality critical items.

NOTE 6 *Specialized temporary works (Category 2 or 3) should be modelled and incorporated into the information models prepared for the constructability review, including their duration.*

NOTE 7 *Sufficient detail should be provided as to why alternative strategies and potential options were not developed, so as to inform those who are not involved, prevent re-introduction of risk and promotion of discarded solutions as 'value engineering'.*

6.3.4 Design Plan

The design team shall develop, implement and adhere to a project specific design plan that sets out the management and technical aspects that will deliver an optimal approved inherently safer design solution. The design plan shall embed the project's required approach to design risk management to enable hazard and risk identification, use, sharing and generalization.

The design plan shall embed the design risk objectives including those in the design team responsible for fulfilling them.

NOTE 1 *There is a recommendation on the client (6.2.1, NOTE 2) to require the CDM Principal Designer to establish and manage the H&S aspects of the project design plan.*

NOTE 2 *The design plan in addition to the management and technical aspects should include the approach to design risk management.*

NOTE 3 *The design plan should provide the basis and means for each designer to collaboratively develop designs in a common and unified approach; and should describe a process for hazards and risks to be included, shared and mitigated within design delivery across the project.*

The design plan shall be accepted by the client and be periodically reviewed to ensure it remains relevant to the project delivery strategy and objectives.

The design plan and any subsequent updates shall be issued to each designer at their commencement on the project.

NOTE 4 *The design plan should be issued to potential designers with their tender documents or procurement enquires.*

6.3.5 Design Risk Management

The design team shall develop, implement and adhere to an approach to design risk management that is applicable to the project and the different elements of design. The approach shall ensure design elements interface, design team collaboration and coordination is enabled, and H&S information and risks are shared through the CDE and information models.

Each designer shall establish and implement an approach to design risk management as an integral part of their own design strategy.

NOTE 1 *There is a recommendation on the client (6.2.1, NOTE 2) to require the CDM Principal Designer to establish and manage the approach to design risk management.*

NOTE 2 *Design risk management is the inherent philosophy within the approach to design that implements and actions the principles of prevention in the development of the design solution. Design risk management requires each designer to proactively take every reasonable opportunity to identify hazards, mitigate the risks and share H&S information through effective design procedures, studies, assessments, reviews, meetings and appropriately skilled people.*

NOTE 3 *Design risk management enables informed design decisions to be made with regard to the level, extent and magnitude of the hazards and risks that are to be designed-in and that become inherent in the design solution.*

NOTE 4 *Design risk management should take into account and be mindful of the culture, traditions, practices and abilities of those who will be affected by the design solution.*

Each designer shall evaluate their design element as it develops to identify, assess and mitigate any risks that evolve. The designer shall incorporate the elevated risks and associated H&S information into the CDE, relevant information models and notify those affected.

The design team shall, based on their skills, knowledge and experience, as well as the H&S information provided in the contract, determine and set out the design risk management tasks and other suitable design applications necessary to develop an inherently safer design solution.

NOTE 5 *The design team should determine which project design risk management tasks and elevated risks would benefit from an input from other participants or representatives with expertise associated to end-use, commissioning or construction risks and work practices.*

In both an iterative and progressive manner within the approach to design risk management the design team shall identify and evaluate the:

- process and/or product hazards;
- activity hazards;
- location hazards;
- hazards referenced by legislation; and

- hazards during an emergency event.

NOTE 6 *Process, activity and location hazards should be considered both independently and together in the determination of the overall risk, see Figure 1.*

NOTE 7 *Hazards specifically referenced by legislation should be incorporated into the approach to design risk management. Asbestos, ionising radiation and explosive atmospheres are some example hazards with specific legislation.*

The design team shall identify the hazards and risks that arise during an emergency event in construction, commissioning or end-use, and mitigate them through the approach to design risk management.

NOTE 8 *Where a fire pond has been specified to deluge a heat source during an unplanned event, a designed-in buried pipework system with fire appliance connection points could be considered over an expectation to manually handle surface laid hoses during the event occurrence. This example mitigates several hazards and risks and improves response time to control thermal radiation.*

NOTE 9 *Design risk management should take into account that the occurrence of the risk(s) may be subject to time lags and the duration of exposure may vary. Visualizations and animated models should be used to highlight the elevated risks aligned to the programme, point-in-time and duration of exposure.*

6.3.6 Designing for end use

The design team shall produce an inherently safer design solution that can be built and will function to meet the objectives of the client and needs of the asset in use.

In developing an inherently safer design solution the design team shall proactively mitigate the risks associated with end-use and the built asset.

NOTE *The use of a built asset applies to general users of the asset for the intended purpose; and also as a workplace for employers and employees who are to maintain, clean and/or operate the asset.*

The design team shall identify, mitigate and record H&S risks related to, and provide H&S information on:

- a) functional performance;
- b) equipment and systems;
- c) materials and substances; and
- d) fixed assets, property and land.

The design team shall set out and detail the elevated risks inherent in the design solution and any 'designed-in' H&S provisions.

The design team shall collate and compile all H&S information relating to the development of the design solution that will assist end-users to comply with their H&S obligations and duties.

The design team shall determine and set out the H&S information and tasks they require from the commissioning phase, to verify functional performance of their constructed design solution before handover to the client and/or end user.

6.3.7 Designing to commission

The design team shall produce a design solution that has been mitigated to enable testing and commissioning to be undertaken safely through accepted risk control techniques.

The design team shall set out and detail the inherent elevated risks associated to testing and commissioning and any 'designed-in' H&S provisions.

The design team shall collate and compile all H&S information relating to testing and commissioning that will enable the commissioning team to comply with legal H&S obligations and duties as both an employer and a contractor.

The design team shall determine and set out the H&S information and tasks they require to:

- a) validate – the physical build, technical options, design changes and accepted deviations of their constructed design solution prior to the commencement of testing and subsequent commissioning; and
- b) verify – functional performance of their constructed design solution to their specified criteria before handover to the client and/or end user.

NOTE 1 *Laser scans of the constructed asset may be compared against the 'approved for construction' 3D model to validate the as-built record, and identify deviations for resolution.*

The design team shall conduct a commissioning review at an appropriate point during the design to identify and evaluate the significant testing and commissioning hazards that require the risks to be reduced through the proactive design risk management; and to determine where controls shall be designed-in and provision for temporary works included.

NOTE 2 *As part of the commissioning review, the hazards and risks introduced due to phased and/or sectional commissioning and handover should be assessed and included.*

NOTE 3 *Commissioning review(s) should include visualizations (such as: 3D, 4D time-lined and animation models) for phased, sectional and full commissioning and handover, to visualise interface risks:*

- a) *between ongoing project work and users of handed over assets;*
- b) *affecting shared areas and thoroughfares;*
- c) *project related hazard zones overlapping and impacting user occupied areas; and*
- d) *the impact of energized systems and final commissioning.*

NOTE 4 *Based on the type of the functional aspects designed-in, the design team should identify and mitigate H&S risks related to, and provide H&S information on:*

- a) *designer intentions – including performance criteria and limitations, etc;*
- b) *equipment/systems to be tested – including sequences, phases and repeats, etc;*
- c) *test requirements – including pre-checks, isolations, techniques, mimics and responses, etc;*
- d) *test acceptance – including sampling, witnessing, certification and documentation, etc;*
- e) *test deviations – including failure events, failure provisions, out of tolerance, re-test requirements, etc;*
- f) *test provisions – including space to test, hazard zones, temporary arrangements, etc;*
- g) *commissioning – including post-test requirements, evidence, critical documentation, etc.*
- h) *legislation – including pressure equipment, explosive atmospheres, energized systems etc.*

6.3.8 Design for construction

The design team shall provide a design solution that can be constructed safely with regard to the residual inherent risks in the designed configuration and potential construction techniques; and which mitigates the risks as a construction place of work for contractors.

The design team shall identify and mitigate H&S risks related to and provide H&S information with regard to design aspects, on:

- a) *the design solution (new build, refurbishment, extension, renovation);*
- b) *designed-in and accepted construction challenges, including complex configurations, critical sequences of work, difficult locations and/or access, key features, etc;*
- c) *existing aspects, including asbestos, buried features, substances, services, etc.*

The design team shall identify and mitigate H&S risks related to and provide H&S information with regard to construction techniques, on:

- a) methods of work, including – assumed methods, specific installation techniques required by design, complex techniques to be mitigated and managed by the contractor, factors making routine activities more dangerous, etc;
- b) temporary works, including – specific temporary works required by design, the categorization of temporary works, soft clashes and conflicts, restrictions affecting temporary works, designed temporary works, provisions designed-in for temporary works installation, etc;
- c) lifting operations, including – provision of space; complex lifts, large load placement, buried features, ground stability, protection of built assets, etc.

NOTE 1 *Designers may be required to fully design complex temporary works (Category 3). Where this is a requirement, designers should include all such H&S information about these temporary works and mitigate the risks as though they were permanent works; and apply the requirements of this PAS.*

The design team shall identify and mitigate H&S risks related to and provide H&S information with regard to construction as a place of work, on:

- 1) the site as a place of work including assumed materials, plant storage and standing areas, etc;
- 2) site facilities, including assumed welfare, parking, fabrication yard, offices, etc;
- 3) movements, including assumed routes, large load routes, external infrastructure, etc;
- 4) difficult tasks, space to work, means to access, fall protection, protective equipment, etc.

The design team shall conduct a constructability review towards design completion to identify, evaluate and record the significant construction hazards inherent in the design solution that will, and may in the future, need to be mitigated, managed and controlled by the contractors.

NOTE 2 *For elements of construction where sequence, technique or a location is critical to H&S, constructability review(s) should include the use of 4D time-lined models and/or modelled construction animations. The information models should be sufficiently detailed to identify, evaluate and examine:*

- a) *the inherent and known risks;*
- b) *the unusual risks;*
- c) *the design assumptions and sequences affecting construction and commissioning;*

- d) *the perceived or specified risk controls;*
- e) *designed-in provisions;*
- f) *significant and designed temporary works;*
- g) *complex lifting operations;*
- h) *major excavations;*
- i) *ground support solutions;*
- j) *working at height;*
- k) *hazard zones;*
- l) *staged commissioning, sectional handover; and*
- m) *early essential maintenance.*

NOTE 3 *Involvement of construction personnel in the constructability review can significantly benefit the design team in their communication, sharing and understanding of the inherent, known and unusual hazards and risks. The involvement of construction personnel enables design intentions to be understood, clarifications sought and addressed, and the avoidance of confusion and mis-interpretation.*

NOTE 4 *Early involvement of construction personnel enables models developed for the constructability review to positively influence the design assumed sequences, techniques and timescales, and refinement of subsequent models.*

NOTE 5 *The constructability review may consider the elevated risks associated to alternative strategies and options.*

6.3.9 Specification and sharing of H&S Information

The design team shall:

- a) ensure the elevated risks relating to the design solution are included in the CDE:
NOTE *This may include safety-critical aspects and the elevated risks where additional controls are required above those of normal accepted practices;*
- b) communicate the elevated H&S risks that have been designed-out and H&S provisions designed-in;
NOTE *This may include key sequences, mandatory controls and design assumptions for inclusion in H&S and risk management.*
- c) share any relevant visualizations, animations, 3D or 4D time-lined models developed during the design process with others who require them;
- d) include and record the expected service life of safety critical equipment, components and systems; and
- e) identify aspects of construction work where quality in the constructed work, materials used and assurance controls are critical with regard to the integrity of the asset; and where failure due to poor quality could result in H&S risks with significant consequences.

6.4 Strategy for Contractors

6.4.1 General

The construction team shall:

- a) use the H&S information provided by the client and design team to mitigate, manage and control the risks inherent in the design solution;
- b) use the H&S information provided by the client and design team to establish safe systems of work to construct the design solution;
- c) undertake and record the risk management tasks required by the client and design team, and those required to support planning and mitigation of challenging construction work;
- d) use the information generated to support the development of safe systems of work and risk assessments;
- e) provide and make available H&S information required by the client and as needed by others to monitor and achieve high standards of construction safety;
- f) provide and make available H&S information required by the client and design team to validate and verify the constructed asset;
- g) implement working practices that ensures those who are commissioning and those responsible for the asset after handover, are included as part of the construction team as the construction works progress to completion; and
- h) consult with the supply chain prior to and during construction to incorporate and use H&S information relating to the use, application, placement, protection and preparation of products for installation during construction.

NOTE 1 *Early involvement of project stakeholders, other contractors and workforce representation in the construction process can significantly benefit the contractor in their mitigation of hazards and risks, development of construction techniques and sequences, the management and control of risks, the appropriate development of H&S information to communicate the risk and techniques to workers, and provision of construction H&S information pertinent for the remaining key stages.*

NOTE 2 *The control of risk, coordination of work and adherence to the construction plan underpin and support the duties of the CDM Principal Contractor.*

NOTE 3 *A CDM Principal Contractor should implement a structured approach to construction team collaboration and H&S information sharing, and coordinating the early involvement and consultation with contractors as they are engaged, construction personnel, those testing and commissioning, the supply chain, temporary work designers, representatives of the design team, and end-users.*

6.4.2 Early evaluation of information requirements

Each contractor shall examine and evaluate their contract documents and provide design information for completeness and identify H&S information shortfalls and gaps that prevent or compromise safe construction delivery.

Each contractor shall seek instruction from the client or clarification from the design team, typically through a query process, with regard to the actions necessary to address such H&S information shortfalls or gaps.

NOTE *The CDM Principal Designer has a duty to assist in the provision of information, where possible provide information and liaise with the Principal Contractor. H&S information shortfalls or gaps may be resolved through the CDM Principal Designer of CDM Principal Contractor.*

Each contractor shall examine the contract and design information provided to:

- a) identify and contextualize the inherent hazards and risks, especially with regard to complex configurations, dangerous activities and difficult locations; and ensure they are included in the CDE and information models for construction planning and mitigation purposes;
- b) identify and evaluate the assumed methods of construction; and ensure they are included in the CDE and information models for construction evaluation, review and adoption or amendment, subject to change control;
- c) identify H&S provisions designed into the solution to assist the management and/or mitigation of construction and commissioning risks; and ensure they are included in the CDE and information models for planning purposes and adoption or amendment, subject to change control.

The construction team shall assess the construction techniques and controls specified by the design team, including the risk mitigation factors recorded by the designers; and ensure they are included in the CDE and information models for acceptance and adoption, or amendment, subject to change control, by the construction team.

Where the H&S information provided by the design team is inadequate, incomplete or not relevant, the construction team shall conduct a thorough examination, evaluation and assessment of the proposed design solution. The construction team shall record the findings and use the information to support construction planning and construction risk management (6.4.5).

The construction team shall identify aspects of work where accepted construction practices become more difficult, dangerous or challenging, with elevated risks, due to a combination of activities and/or the location of the work involved. The construction team shall detail and record these elevated risks in the CDE and information models for construction planning and mitigation purposes.

6.4.3 Early identification and evaluation of hazards and risks

The construction team shall review and evaluate the findings of the preliminary hazard analysis and safety review undertaken by the client, or any updated version developed with the design team. The construction team shall embed into the construction plan (6.4.4), as construction risk objectives, the hazards and risks the client wants eliminated or reduced and managed to an acceptable level.

NOTE 1 *It is a recommendation on the client that the preliminary hazard analysis and safety review is developed periodically at key transitions in the project lifecycle.*

The construction team shall conduct a construction hazards review prior to the construction works commencing. The review shall examine, evaluate and record the risk mitigation, risk controls and safe systems of work to manage the inherent design risks and risks related to the intended construction activities and techniques.

NOTE 2 *Construction hazard reviews should include the use of data-rich interactive 4D time-lined models. The information models should be appropriately annotated to identify, evaluate and examine:*

- a) *the hazards and risks aligned to the program and duration of exposure;*
- b) *safe systems of work and specified risk controls;*
- c) *activities requiring special skills;*
- d) *critical sequences;*
- e) *incorporated H&S provisions;*
- f) *temporary works;*
- g) *lifting operations;*
- h) *working at height;*
- i) *major excavations;*
- j) *ground support solutions;*
- k) *hazard zones;*
- l) *stored energy systems and equipment;*
- m) *emergency scenarios and responses; and*
- n) *catastrophic events.*

NOTE 3 *The construction hazard review information model(s) should have the ability to show different entities such as displaying the buried services, or hazard zones or contents of risers.*

NOTE 4 *The construction hazard review should include other data-rich 3D or 4D time-lined models specific to risks or elements of work that require the demonstration of techniques, sequences and resources allowing an evaluation and acceptance by those affected and controlling the work and risks.*

NOTE 5 *Involvement of the project stakeholders, other contractors and workforce personnel and design team representatives in the construction hazard review will significantly benefit the construction team in their sharing and understanding of the risks, provisions for H&S and development of safe systems of work.*

6.4.4 Construction plan

The construction team shall develop, implement and adhere to a project specific construction plan that embeds the required approach to construction risk management (6.4.5) and appropriate monitoring that will deliver construction work through good H&S standards, communication, workforce engagement and safe systems of work.

The construction plan shall embed the construction risk objectives including those in the construction team responsible for fulfilling them.

NOTE 1 *The construction plan should include the approach to construction risk management, planned and designed construction techniques and methods, and temporary works design and management.*

NOTE 2 *The construction plan should be dynamic, linking and utilizing the use of the H&S information systems, models and risk tools incorporated in the project's CDE.*

NOTE 3 *Construction activities benefit through the use of animated visualization of techniques, 3D and 4D method statements, portraying risk zones, occurrence and duration of risk exposure, coordination of temporary works and services, and improving risk awareness.*

NOTE 4 *Shortfalls and gaps in H&S information should be referenced in the information model where practicable, and the potential risks associated to such detailed.*

NOTE 5 *The construction plan and CDM construction phase plan may be aligned in one document.*

The construction plan shall be accessed and be subject to acceptance, by the client, and be periodically reviewed to ensure it remains relevant to the project delivery strategy and objectives.

The construction plan and any subsequent updates shall be issued to each contractor at their commencement on the project.

NOTE 6 *The construction plan should be issued to potential contractors with their tender documents or procurement enquires.*

6.4.5 Construction risk management

The construction team shall develop, implement and adhere to an approach to construction risk management that is applicable to the project and the different elements of construction. The approach shall ensure construction elements interface, construction team collaboration and coordination is enabled, and H&S information and risks are shared through the CDE and information models.

Temporary works designers shall comply with the project's approach to design and construction risk management.

Each contractor shall establish and implement an approach to construction risk management as an integral part of their own construction strategy.

NOTE 1 *There is a recommendation on the client (6.2.1, NOTE 4) to require the CDM Principal Contractor to establish and manage the approach to construction risk management.*

NOTE 2 *Construction risk management is the inherent philosophy within the approach to construction to implement the principles of prevention in the planning and development of construction techniques, sequencing and resourcing. Construction risk management takes every reasonable opportunity to identify hazards, mitigate the risks and share H&S information through effective construction planning, good techniques, work activity studies, risk assessments, safe systems of work, worker engagement and appropriately skilled workforce.*

In both an iterative and progressive manner within the approach to construction risk management the construction team shall identify, evaluate and record the:

- a) procedural and/or methods of work hazards;
- b) activity hazards;
- c) location hazards;
- d) hazards referenced by legislation; and

e) hazards during an emergency event.

NOTE 3 *Procedure/method, activity and location triggers should be considered both independently and together in the determination of risk control.*

NOTE 4 *The construction team should consider where quality is a critical factor, especially where poor quality or 'not-to-specification' work or materials subsequently introduces or results in hazards with elevated risks.*

NOTE 5 *The construction team should incorporate the hazards and risks specifically referenced by legislation into their approach to construction risk management.*

NOTE 6 *Asbestos, ionising radiation, explosive atmospheres, working at height and lifting are some examples of hazards with specific legislation.*

The construction team shall examine the likely consequences that may in the future arise during a significant emergency event in construction, and assess and mitigate them. The construction team shall make provisions to respond to them, through the approach to construction risk management and planning.

NOTE 7 *Where the emergency services response time will be protracted, or work locations are remote or fairly inaccessible, the construction team should consider additional resource, training and procedures to ensure expeditious support is provided to injured persons. This example demonstrates how examining, evaluating and making provision for an emergency situation may benefit an injured person(s) or preserve life by improving response times and not being reliant on others.*

Where the construction team chooses not to adopt a design recommendation, the construction team shall examine the design risk factors, mitigation and reasons that resulted in the recommendation, and ensure risks are not re-introduced or they are assessed as part of the work method selected. The construction team shall record the design risks that affect the construction team's preferred method of work.

The construction team shall record and register the elevated risks and H&S information that become apparent during the construction works; enabling proactive risk mitigation and controls to be shared and implemented at the point of risk.

NOTE 8 *Construction risk management should take into account that the occurrence of the risk(s) may be subject to time lags and the duration of exposure may vary. Visualizations and animated models should be suitably tagged to highlight the elevated risks aligned to the programme, point-in-time and duration of exposure.*

6.4.6 Construction completion into commissioning

The construction team shall construct the design solution that delivers the structural integrity and functional requirement specified in the design information; and fulfils the client's objectives.

NOTE 1 *Including and involving those who are to test and commission throughout the construction phase can assist the construction team in making H&S provisions and providing H&S information that will significantly benefit the commissioning stage.*

The construction team shall record the unforeseen encountered risks that become apparent during construction and record them for evaluation and mitigation by those who are to test and commission, and others who may be affected.

The construction team shall compile and collate all H&S information that will enable those testing and commissioning to comply with their legal H&S obligations as both an employer and a contractor.

NOTE 2 *The construction H&S information for testing and commissioning typically includes:*

- a) *as constructed / as built records;*
- b) *conformity certificates;*
- c) *product, material and substance data sheets;*
- d) *inspection, witness and certified records from an authorized person;*
- e) *pre-test records;*
- f) *materials and tools supplied specifically for testing and commissioning; and*
- g) *increased risks in areas of construction work that were not envisaged.*

Where staged or sectional handover is required, the construction team shall identify, mitigate and record the risks associated to remaining construction works and where the interface impacts with the occupying users and shared areas.

NOTE 3 *Where staged or sectional handover is required, the construction team should compile and record the relevant H&S information for use by those who are to test and commission the remaining works and those using the area(s) handed over.*

6.4.7 Specification and sharing of H&S information

The construction team shall:

- a) identify and record construction activities and their location where additional controls were required to manage unexpected levels of risk;

- b) detail and record the construction risk controls where they relate to future elevated risk maintenance activities for the benefit of the end user;
- c) determine and record the key learning points, for future use, in the delivery, management and control of the construction works, typically:
 - 1) encountered hazards and risks that were difficult to mitigate;
 - 2) elevated risks that were not foreseen in design or construction planning;
 - 3) improved techniques that control activities with elevated risks;
 - 4) innovation and new techniques that reduce risk;
 - 5) design shortfalls that introduced risk uncertainty; and
 - 6) findings of investigations associated to accidents and incidents.

The construction team shall input the H&S information into the CDE and information models, where necessary, creating additional attributes and fields.

6.5 Strategy for commissioning

6.5.1 General

The commissioning team shall use the H&S information provided by the client, design team and construction team to:

- 1) mitigate, manage and control the risks inherent in the design solution and constructed works;
- 2) establish safe systems of work to test and commission the constructed works; and
- 3) support planning and mitigation for the testing and commissioning of complex and/or safety critical functional systems.

The commissioning team shall provide and make available H&S information required by the client and as needed by others to monitor and achieve high standards of safety throughout testing and commissioning.

The commissioning team shall provide and make available H&S information required by the client and design team to validate and verify the constructed asset.

The commissioning team shall engage and consult with the supply chain prior to and during testing and commissioning to clarify H&S information relating to the use, functional performance, post-test maintenance and safety critical aspects.

NOTE 1 *Early project stakeholder, client and supply chain involvement in the testing and commissioning process can significantly benefit the commissioning team in their mitigation of hazards and risks, development of test, testing and commissioning techniques and sequences, and provision of H&S information pertinent for handover and the end-user(s).*

NOTE 2 *The control of risk, coordination of testing and commissioning work and adherence to the commissioning plan underpin and support the duties of the CDM Principal Contractor.*

NOTE 3 *A CDM Principal Contractor should implement a structured approach to commissioning team collaboration and H&S information sharing, and coordinating the early involvement and consultation with contractors and manufacturers as they are engaged, commissioning engineers, the supply chain, temporary work designers, representatives of the design team, and end-users.*

6.5.2 Early evaluation of information requirements

The commissioning team shall examine and evaluate the contract, design and construction documents for completeness and identify H&S information shortfalls and gaps that prevent or compromise safe test, testing and commissioning (TTC) related activities. The commissioning team shall seek instruction from the client or clarification from the design team, typically through a query process, with regards to the actions necessary to address such H&S information shortfalls or gaps.

The commissioning team shall undertake a critical examination of the H&S information requirements, functional specification and construction information provided to, identify and contextualize the inherent TTC hazards and risks, especially with regard to:

- a) complex and/or safety critical equipment and systems; and
- b) staged or sectional handover.

6.5.3 Early identification of hazard and risk

The commissioning team shall conduct a testing and commissioning (T&C) risk study as part of the TTC planning phase to identify, evaluate and record the hazards, risks and dangerous tests; and to set out the mitigation and controls necessary to manage the inherent risks related to TTC activities, techniques and failures.

NOTE 1 *For complex projects the study should be repeated prior to the commissioning stage.*

NOTE 2 *T&C risk study should include the use of data-rich interactive 4D time-lined models. The study should include other data-rich 3D or 4D time-lined models specific to elevated risks or particularly complex elements of work. The information models should be appropriately annotated to identify, evaluate and examine - the hazards and risks aligned to the TTC schedule and duration of exposure, planned TTC techniques and safe systems of work, specified restrictions and zones, and critical sequences.*

NOTE 3 *the T&C risk study information model should have the ability to show different elements of TTC such as displaying the affected services, or hazard zones or required temporary TTC provisions by switching information 'layers' off and on.*

NOTE 4 *Involvement in the T&C risk study of all those testing and commissioning, contractors, manufacturers and those responsible post-handover will significantly benefit the commissioning team in their communication, sharing and understanding of the inherent, known and unusual hazards and risks. The involvement of those responsible post-handover facilitates understanding and familiarization of safety critical systems, equipment and essential maintenance requirements.*

6.5.4 Test, testing and commissioning strategy

The commissioning team shall examine and evaluate the design solution and functional specification to plan, develop and implement an effective TTC strategy. The TTC strategy shall set out the approach to coordinate and detail all necessary pre-checks, checks, tests and testing necessary to safely commission and verify functional performance prior to handover.

The commissioning team shall:

- a) evaluate the functional complexity and assess and record the temporary risks, hazard zones and controls necessary as they occur and vary throughout TTC;

- b) identify and record the stresses, loads and imbalances that occur uniquely during TTC, and develop mitigation measures and controls to manage the risks, temporary conditions and potential consequences; and
- c) identify and evaluate the risks associated to staged or sectional handovers, and establish the necessary arrangements to manage H&S in the occupied and/or shared areas.

NOTE 1 The TTC strategy should also include the:

- temporary supplies, systems and works required;
- simulations for functional variances;
- different foreseeable conditions and external influences;
- hazard zones and safety critical controlled areas;
- key sequences and durations required;
- out of tolerance, failure and emergency responses;
- post-test maintenance and initial-run maintenance;
- specialist resources and equipment;
- provision and availability of spares; and
- conformity certification and documentation requirements.

NOTE 2 Including and involving the design team and construction team in TTC planning may assist the commissioning team in the preparation of an effective strategy and safe systems of work.

NOTE 3 Providing a summary of the TTC strategy and elevated risks to the client (owner's representative), design team and construction team is a good practice and provides focus for handover.

NOTE 4 Shortfalls and gaps in H&S information should be referenced in the information model where practicable, and the potential risks associated to such detailed.

NOTE 5 The commissioning strategy should be included in the CDM construction phase plan.

The commissioning strategy shall be accepted by the client and be periodically reviewed to ensure it remains relevant to the project delivery strategy and objectives.

The commissioning strategy and any subsequent updates shall be issued to each contractor or involved supplier at their commencement on the project.

NOTE 6 The commissioning strategy should be issued to potential contractors and manufacturers with their tender documents or procurement enquires.

6.5.5 Commissioning risk management

Commissioning risk management shall implement the principles of prevention in the planning and development of TTC techniques, sequencing and resourcing.

NOTE 1 Commissioning risk management is the inherent philosophy in the approach to TTC that takes every reasonable opportunity to identify hazards, mitigate the risks and share H&S information through effective TTC planning, good techniques, TTC studies, assessments, safe systems of work, and highly skilled personnel.

NOTE 2 Commissioning risk management should be dynamic and utilize the information systems, models and risk tools incorporated in the project's CDE and information models.

NOTE 3 There is a recommendation on the client (6.2.1, NOTE 6) to require the CDM Principal Contractor to establish and manage the approach to commissioning risk management.

In both an iterative and progressive manner within the approach to commissioning risk management the commissioning team shall identify and evaluate the:

- a) process hazards for TTC;
- b) activity hazards;
- c) location hazards;
- d) hazards referenced by legislation; and
- e) hazards during an emergency event.

NOTE 4 Process, activity and location hazards should be considered both independently and together in the determination of risk control.

NOTE 5 The commissioning team should incorporate the hazards and risks specifically referenced by legislation into their approach to commissioning risk management.

NOTE 6 Explosive atmospheres, pressure vessels and electricity are some examples of hazards with specific legislation that will have elevated risks if associated unplanned events occur during testing and commissioning.

The commissioning team shall identify the hazards and consequences that arise during a significant emergency event in testing and commissioning, and mitigate through their approach to commissioning risk management and planning.

The commissioning team shall incorporate an approach to record defects identified and latent defects (quality hazards) as they become apparent during TTC. The commissioning team shall consult and seek direction from the client and design team on their acceptability for the defect to remain or the actions necessary to mitigate.

NOTE 7 *The commissioning team should consider where deviations in expected performance introduces new hazards with elevated risks.*

6.5.6 Commissioning completion and handover

The commissioning team shall:

- a) test, commission and demonstrate the functional performance of the built asset that delivers the structural integrity and functional expectations specified in the design information and project objectives;
- b) compile and collate all H&S information that will enable the end user at handover to comply with their legal H&S obligations; and
- c) compile and collate H&S information to meet the requirements of the EIR and be available for use by asset managers, maintainers and users of the asset through the CDE and/or AIM.

NOTE 1 *H&S information and associated models should be accessible to approved users through the CDE and/or AIM defined for the remaining life of the asset.*

NOTE 2 *Handover H&S requirements may typically include:*

- a) *an inventory of critical spares, specialist tools and equipment that are to be transferred;*
- b) *post-handover performance tests that are required to maintain integrity and safe use;*
- c) *the safety critical equipment and systems tests that are to be witnessed by the end user;*
- d) *acceptance forms to be completed;*
- e) *security arrangements that are to be transferred; and*
- f) *unforeseen hazards and risks encountered in TTC that will impact end use and maintenance.*

NOTE 3 *Those who are to maintain the asset after handover would benefit in being present and included throughout testing and commissioning, as it would enable them to become familiar and skilled in the functionality and maintenance of safety critical equipment and systems.*

6.5.7 Specification and sharing H&S information

The commissioning team shall:

- a) identify and record TTC activities and their location where additional controls were required to manage unexpected levels of risk;
- b) detail and record the risk controls required to mitigate and manage TTC activities that relate to elevated risk maintenance activities for the benefit of the end user;
- c) determine and record the key learning points, for future use, in the delivery, management and control of TTC works, typically:
 - 1) encountered hazards and risks that were difficult to mitigate;
 - 2) significant TTC risks that were not foreseen in design, construction or in TTC planning;
 - 3) TTC performance outcomes that changed or introduced new elevated risks;
 - 4) improved techniques that control activities with elevated risks;
 - 5) innovation and new techniques that reduce risk;
 - 6) design shortfalls that introduced risk uncertainty; and
 - 7) findings of investigations associated to TTC failures.

The commissioning team shall input the finalized H&S information into the CDE and/or AIM.

6.6 Strategy for End-Users

NOTE 1 *In this sub-clause the reference to End-User(s) refers to the end users responsible for the asset in use, in operation and for maintenance.*

Pre-determined or established end-user (asset operators) at the outset of the project lifecycle shall:

- a) establish the H&S information they require to be transferred to them during key transitions in the project and after commissioning (at handover), when the end-user(s) takes proportionate responsibility as an asset owner and/or as a workplace employer;
- b) determine and set out aspects they want to inspect, the functional performance they want to witness and the evidence required, for acceptance purposes, before handover.

End-users that become apparent during the project lifecycle shall:

- a) review and evaluate for suitability the EIR and intended asset information to be provided, and identify and record potential shortfalls;
- b) communicate and resolve the additional H&S information they require with the client's representatives and information manager responsible for the CDE and compliance with the EIR, and change control procedures.

NOTE 2 *Early involvement of known end-users, facility managers and maintenance organizations can significantly benefit the development and implementation of H&S arrangements, the management and control of risks, and provision of H&S information pertinent for end-users.*

NOTE 3 *End-users referenced in this PAS relate to those that are known about when developing the need and become apparent during the project lifecycle, not future end-users where the original objective or purpose of the built asset is changed or the nature of their activities is not known.*

NOTE 4 *End-users include those who are responsible for an asset, employers and their employees engaged in business activities related to the asset.*

NOTE 5 *End-users can benefit from early consultation, coordination and clarification with the participants and information manager at each key stage pertaining to the requirements, acceptance and transfer of H&S information.*

The end-user responsible for the asset and before accepting their responsibilities for the built asset, shall:

- a) confirm the design team has validated the built asset and verified functional performance, and has accepted any deviations or changes, where contractually applicable;
- b) confirm the client has accepted the built asset and functional performance in compliance with the brief and instructed changes, where contractually applicable;
- c) examine and confirm suitability of the H&S information collated and compiled in the CDE and AIM to be transferred for their use;
- d) determine and establish the necessary maintenance procedures and programmes to be implemented immediately after handover, especially for safety critical systems and equipment.

NOTE 6 *The H&S information collated should be examined and evaluated with regard to:*

- *fixed assets – permanently fixed elements, structures;*
- *functional assets – equipment, systems, components, fittings;*

- *procedural assets – bespoke processes, procedures, responses;*
- *consumable assets – substances, materials, utility services;*
- *time-based assets – product obsolescence, planned maintenance, fabric, finishes;*
- *specified hazards and risks;*
- *operational aspects – risks, safe systems of work;*
- *maintenance aspects – risks, safe systems of work;*
- *cleaning aspects – risks, safe systems of work;*
- *emergency aspects – installed provisions, evacuation; and*
- *security aspects.*

The end-user responsible for the asset shall:

- a) ensure all H&S recommendations are assessed, acted on and monitored for effectiveness;
- b) evaluate the H&S information to ensure all skills, training and safe work practices are developed to maintain, clean and operate the asset;
- c) use the H&S information to develop, implement and maintain arrangements for the management and control of H&S relating to their use of the asset and the use of the asset by others;
- d) verify the functional performance, pertinence of the H&S information and effectiveness of the risk controls throughout their duration of use of the asset;
- e) identify and record any additional elevated risks that arise throughout the life and use of the asset, using the information to implement mitigation measures and H&S improvements;
- f) update and maintain the H&S information associated to their use, and input new H&S information they generate.

NOTE 7 *The provision of H&S information relating to the built asset may assist end-users comply with duties and obligations contained in the MHSWR and other applicable legislation, and support the development of risk assessments and safe systems of work to operate, maintain, clean and use.*

NOTE 8 *The H&S information transferred should be used to establish suitable:*

- a) *risk assessments;*
- b) *safe systems of work;*
- c) *procedures and rules for H&S in use;*
- d) *instruction and training programmes;*
- e) *testing and recertification programmes;*
- f) *supervision and monitoring protocols;*
- g) *objectives and improvement strategies;*
- h) *roles and responsibilities;*
- i) *Safety Management Systems.*

The end-user responsible for the asset shall maintain a historic record of maintenance activities, failures and defects, and H&S related events, for analysis, improvements and future learning.

The end-user responsible for the asset shall maintain the CDE and AIM, and implement processes that allow designated end-users to appropriately access, update and input H&S information associated to their use, in accordance with BS 8536-1, BS 8536-2, BS 1192-2 and PAS 1192-3.

6.7 Strategy for the supply chain

The supply chain shall:

- a) establish the H&S information that is required to be made available to the project during the key stages and at handover;
- b) provide H&S information applicable to their product with regard to:
 - 1) basic data – weight, size, base materials, substances, finishes, isolations, energy requirements;
 - 2) functional data – operating criteria and range, limitations, temperature, pressure, power demands, cycles;
 - 3) test, testing and commissioning data – basic checks, functional checks, calibrations, sequence, duration, acceptance and failure criteria, hazard zones, records required, tools and essential spares, and post-test maintenance requirements;
 - 4) maintenance data – routine, planned, preventative, essential and time dependent (based on usage within specific environments); skills, instructions and training requirements;
 - 5) replacement data – means to change parts of or whole units; tools, skills and space required, by products and waste categories;
 - 6) documentation – data sheets, H&S related assessments, certificates, conformity, warranties;
 - 7) known H&S risks relating to installation, testing and commissioning, maintenance and in use.

The supply chain shall consult with the information manager responsible for the CDE, to ensure H&S information and related key documents are transferred in an agreed electronic format.

NOTE 1 *The data and related key documents should be structured and compiled into electronic formats from which the H&S information can be easily referenced and used.*

The supply chain, based on the agreed Intellectual Property Policy, shall transfer product data and H&S information to a level of detail pertinent to the development stage of the project. For detail design, or on procurement, the product data and H&S information shall enable full integration of the product's attributes, effective mitigation of associated risks and provision of asset information set out by the EIR.

NOTE 2 *The supply chain can benefit from early clarification, coordination and consultation with the participants; and when requested, the supply chain should provide pertinent H&S information, and consequences of deviations in use, promptly.*

NOTE 3 *Where the supply chain consider there are risks associated to their services or products that are of significance they should communicate these risks to the design team and construction team.*

The supply chain shall:

- a) provide sufficient and appropriate H&S information on storage, handling, placement, installation, testing, commissioning, use and maintenance, to enable the design team and construction team to apply the principles of prevention on the inclusion and specification of the product into the design of the asset; and
- b) set out the risk mitigation provisions designed and manufactured into their products.

NOTE 4 *Data requirements included in procurement enquiries and supplier's ability or willingness to deliver such data, should be assessed as a part of the evaluation of the supplier's response to their enquiry. The lack of ability or willingness to provide data for input into the CDE and information models for use by others can be detrimental to the H&S outcomes and risk mitigation.*

7 Implementation of the information requirements

7.1 Delivery of risk information

Each participant shall ensure that there are clear data conventions established to enable the inclusion and use of H&S risk information.

NOTE 1 *The H&S risk information includes the context defining the scope of work (7.2), and the elevated H&S risks (7.3). Specific risk assessments should be documented as defined in 7.4.*

NOTE 2 *In 7.2 and 7.3 the information is held as multiple 'entries' (synonyms: records, rows, property sets) made up of multiple 'fields' (synonyms: cells, values, attributes, columns).*

NOTE 3 *Each participant may hold information about the context and risks in any suitable form that is able to deliver the sharable H&S information, when required.*

Each participant shall share appropriate H&S information about the context and elevated risks (see Figure 8) in a consistent, re-usable, non-proprietary form as detailed in Clause 8, 9 and 10.

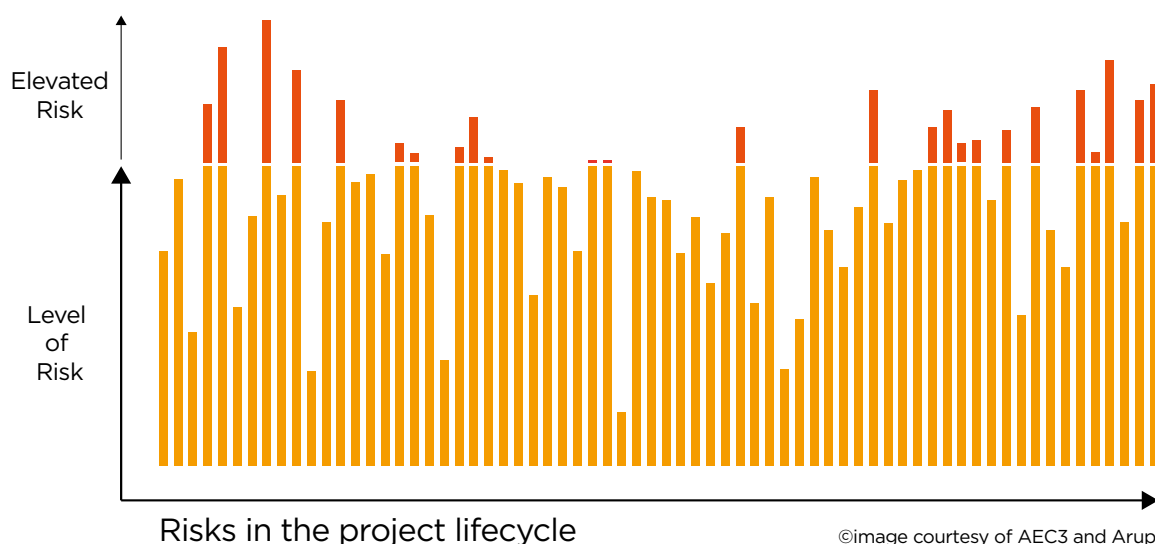
The following forms/formats shall be used:

- a) Document table or spreadsheet (see Clause 8 for layout and examples);
- b) COBie (see Clause 9 for usage and examples);
- c) BIM authoring and project planning applications (see Clause 10 for usage and examples).

NOTE 4 *It is important that the H&S information is:*

- 1) *consistent, in that all entries should follow the same structure;*
- 2) *re-usable in that all entries should be editable and transformable; and*
- 3) *non-proprietary in that all entries should be viewable and editable using open formats without any licenced application.*

Figure 8 – Context risk and elevated risk



Any agreed mitigation shall be included and the level of risk reassessed.

NOTE 5 The re-use of context information and risk information may require the generalization of project specific information. This may lead to the creation and use of H&S information by embedded queries or rules (such as proximity distances or permissible spacing) and for use or interpretation via competent person(s) (such as risk studies or design and planning reviews).

NOTE 6 A non-editable form may also be prepared and delivered for contractual record purposes.

Each participant shall share and generalize both context information and risk information using the attributes and enumerated values in the order set out in Annex A.

Context and Risks shall be classified as defined in Annex B.

7.2 Context information

7.2.1 General requirements

Each participant shall:

- a) establish a consistent benchmark to judge elevated risks by documenting the context prior to developing the risk information (see 7.3), based on the reasonably expected skills and competences;
- b) document and develop the context information alongside the risk information.

NOTE In preparing for, or at, handover the context information may inform the introductory material to the O&M and HSF information.

7.2.2 Entries

Each participant shall share appropriately the context information as either:

- a) identically structured entries and fields. Each context entry shall describe one aspect of the context of the project, site and built asset; or
- b) an information model.

7.2.2.1 Mandatory context entries

The project, site and built asset shall be described.

7.2.2.2 Recommended context entries

NOTE Further information may detail the individual zones, systems and packages. If relevant to the establishment of the benchmark, specific spaces, equipment or tasks may be documented.

7.2.2.3 Optional context entries

NOTE Additional entries may be included to document other aspects of the context. These need not be shared if they do not affect the risk context.

7.2.3 Fields

Each context entry shall be made of identically formatted fields.

7.2.3.1 Mandatory context fields

Each record shall consist of the name, description, risk type as 'context' and associated location, product and activity, as detailed in Annex A.

7.2.3.2 Recommended context fields

NOTE There are no additional recommended context fields.

7.2.3.3 Optional context fields

NOTE Additional fields may be included to amplify the context or to support the internal management processes. These need not be shared if they do not modify the risk context, for example, each record may include date and authorship fields.

7.3 Risk information

7.3.1 General requirements

The risk information shall document the elevated risks associated to the project, site and built asset.

7.3.2 Entries

The risk information shall be composed of identically structured entries, each entry documenting one elevated risk.

7.3.2.1 Mandatory risk entries

Every elevated risk shall be included.

7.3.2.2 Recommended risk entries

NOTE Any risk that has been identified and assessed may be included.

7.3.2.3 Optional hazard entries

NOTE 1 Additional entries may be included to document risk other than H&S such as commercial, social, environmental and operational risks, (which are not considered further within this standard). Elevated H&S risks that arise from these risks should be documented.

NOTE 2 Commercial risks need not be shared.

7.3.3 Fields

Each entry shall be made of identically formatted fields.

7.3.3.1 Mandatory risk definition fields

Fields necessary for documenting a risk shall be provided, including a name, description, risk type as detailed in Annex B, and mitigated level of risk as detailed in Annex A.

Any agreed mitigation shall be included.

NOTE Any proposed mitigation may also be documented.

Level of risk, likelihood and consequence shall be rated on qualitative scale as shown in Table 2.

7.3.3.2 Mandatory risk sources

The following Information associating risks to one or more risk sources or combinations of risk sources shall be provided:

- a) Product associations: generic or specific products, assemblies, and materials, including production processes;
- b) Activity associations: generic or specific activities (in construction and asset in use);
- c) Location associations: generic or specific locations, routes and spaces.

NOTE 1 See Annex C for examples.

Table 2 – Likelihood, consequence and level of risk grade terms and example descriptions

Scale	Likelihood	Scale	Consequence	Scale	Level of Risk
Very High	Very probable or repeated	Very High	Catastrophic	Very High	Exceptional, including the highest possible
High	Probable or frequent	High	Severe	High	Above moderate
Moderate	Possible	Moderate	Serious	Moderate	Typical or normal
Low	Unlikely or remote	Low	Marginal	Low	Below moderate
Very Low	Remote	Very Low	Minor	Very Low	Well below moderate including the lowest possible

These associations shall be described by the name, classification or description of the risk source entity or by a link to the risk source entity.

NOTE 2 Generalized entries as a resource for re-use should not use project-specific names of the risk sources.

7.3.3.3 Recommended risk assessment fields

Additional information relating to likelihood and consequences shall be provided.

NOTE 1 Consensus may be more easily achieved if the likelihood and consequence are assessed separately, as then the level of risk can be looked up.

Each of these shall be rated on a five-term qualitative scale.

NOTE 2 Qualitative scales are more easily reviewed and less ambiguous in exchanges than quantitative scales. Five-term scales have the advantage over three-term and multiple-term scales of being sensitive to prioritizing but without the need for overly specific definition of the terms.

A risk assessment matrix shall be chosen, and documented. This matrix shall remain constant throughout the project lifecycle unless explicitly changed and the participants notified.

7.3.3.4 Supplementary risk information

NOTE 1 Additional fields may be included to amplify the risk/hazards or to support the internal management processes. Fields relating to internal management need not be shared.

NOTE 2 Fields that document delegation, disciplines or persons to be consulted may be inappropriate for sharing including, for example, dates relating to the development of the entry or its management.

7.4 Information requirements relating to legislation and emergency planning

7.4.1 General requirements

The risk information shall include the collation of regulatory data.

NOTE 1 Specific risk information pertinent to hazards referenced specifically by H&S legislation should be determined, generated and incorporated into the information model.

Table 3 – Standard risk assessment matrix

Likelihood						Consequence
Very High	Moderate	Moderate	High	Very High	Very High	
High	Moderate	Moderate	Moderate	High	Very High	
Moderate	Low	Moderate	Moderate	Moderate	High	
Low	Very Low	Low	Moderate	Moderate	Moderate	
Very Low	Very Low	Very Low	Low	Moderate	Moderate	
	Very Low	Low	Moderate	High	Very High	Consequence

NOTE 3 Other risk assessment matrices may be used that are weighted towards higher or lower risks, likelihoods or consequences.

NOTE 4 Exceptional or specific risks may be subjected to specific risk assessments such as a Quantitative Risk Analysis technique (QRA). Each outcome should be added to the H&S information with appropriate reference to the QRA documentation.

The requirements set out for substances (7.4.2), incidents (7.4.3) emergency planning (7.4.4) and lifting (7.4.5) shall also be applied to noise, working at height and other H&S regulations in context.

The risk type shall be documented in accordance with Annex B.

NOTE 2 *These risks may have specific risk assessment processes and reports associated to them.*

7.4.2 Substances

The risk information shall include or reference risk arising from harmful substances.

NOTE 1 *For Example, COSHH information, asbestos information.*

Harmful substances if causing an elevated risk shall be recorded information on the associated product, activities and/or location(s).

NOTE 2 *Attention is drawn to the Control of Substances Hazardous to Health Regulations, 2002 (COSHH) [7].*

Attributes relating to harmful substances shall be applied through automated queries, or through manual interrogation, to mitigate the associated risks.

NOTE 3 *Supports duties defined in CDM 2015 [2].*

Attributes and information shall be applied by substance users to complete COSHH assessments and manage the use of the substance.

NOTE 4 *This supports duties defined in COSHH.*

NOTE 5 *Substance schedules support the on-going management of harmful substances in the built asset.*

The substance involved shall be documented as the product association.

Substances associated to an identified security threat shall be managed in compliance with the security policy. Access to sensitive H&S information relating to substances shall be managed through an authorization procedure on a need-to-know basis.

NOTE 6 *The presence of substances associated to an asset may be deemed sensitive from a security perspective; especially substances stored and used in production processes. Access to H&S information relating to inventories, product data and safety critical systems and equipment may compromise security measures that are to be implemented. Refer to PAS 1192-5.*

7.4.3 Incidents

The risk information shall include or reference incidents generalized for future reference.

NOTE 1 *For example, RIDDOR information.*

The likelihood shall be documented as the chance of a repetition. Any risk sources shall be documented.

Reportable workplace incidents shall be recorded as a risk with information on the circumstances, type and consequences; and associated product, activities, and location.

NOTE 2 *This supports duties within the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations, 2013 (RIDDOR) [13].*

Subsequent investigation findings, corrective actions and lessons learnt shall be recorded.

NOTE 3 *This supports the requirements to generalize information for sharing, learning and the benefit of future use.*

NOTE 4 *The format and fields for workplace incidents can be duplicated for incidents relating to the use of the built asset. Such information may be used for trending and continual improvement of safety measures.*

NOTE 5 *This supports duties within the Management of Health and Safety at Work Regulations, 1999 [3] (MHSWR) and other legislation applicable to other asset users.*

7.4.4 Emergency planning including fire and evacuation

The risk information shall include or reference emergency response and fire and evacuation information.

NOTE 1 *Examples include The Regulatory Reform (Fire Safety) Order 2005, Construction (Design and Management) Regulation 2015 (especially Part 4, Regulations 30, 31 and 32) and Dangerous Substances and Explosive Atmospheres Regulations 2002 [4] (DSEAR).*

Specific risks associated to fire, explosions and energized systems, particularly if covered by legislation, shall be recorded as a risk with information on the circumstances, type and consequences; and associated products, activities, and locations.

The mitigation applied and safety measures designed-in shall be detailed with the recorded risk.

NOTE 2 *This supports duties defined within CDM, MHSWR and The Regulatory Reform (Fire Safety) Order, 2005 [6].*

Attributes relating to emergency hazards and potential consequences shall be applied through automated queries, or through manual interrogation, to mitigate the associated risks and identify required controls for emergency preparedness.

Emergency arrangements designed into the asset that triggers an associated security threat shall be managed in compliance with the security policy. Access to sensitive H&S information relating to emergency arrangements shall be managed through an authorization procedure on a need-to-know basis.

NOTE 3 *The presence of emergency arrangements associated to an asset may be deemed sensitive from a security perspective; especially means of access and egress, safe routes and places during an event, control centres and critical systems and equipment that can be compromised, elevating the security risk. Refer to PAS 1192-5.*

7.4.5 Lifting

The risk information shall include or reference specific lifting issues.

The risk shall be associated to:

a) Product;

NOTE *May include weight, size, shape and any eccentricity of the centre of gravity.*

b) Activity;

NOTE *Crane or other lifting device type, the lifting capacity and reach, swing and protection measures, with the configuration, competence and organization, lifting equipment (tested and examined).*

c) Location.

NOTE 1 *Ground stability, adjacent structures and equipment, lines of sight, environmental conditions, wind strength.*

NOTE 2 *For complex lifts, engineering advice may be necessary, for example for planning tandem lifts.*

8 Representation in documents

8.1 Representation of context and risk information in documents

Tables and spreadsheets shall use the headings and field types as defined in Annex A.

NOTE 1 *Only one header row should be provided.*

NOTE 2 *Column names and table names may be without spaces (PrologCase).*

NOTE 3 *Figure 7 illustrates the use of the column headings and field types.*

8.2 Context information in documents and spreadsheets

Unless Clause 9 or 10 applies, each participant shall share the context information either as narrative text or as a table or spreadsheet.

8.3 Risk information in documents and spreadsheets

Risk information shall be appropriately shared as a table or spreadsheet, as shown in Table 4.

Tables and spreadsheets shall be sorted by decreasing level of risk.

Table 4 – Use of tabular risk information

Risk Name	Hazard Category	Risk Description	Associated Product	Associated Activity	Associated Location	Agreed Mitigation	Risk Likelihood	Risk Consequence	Level Of Risk	Risk Documentation	Date Raised
AAM05	Falls	Falling from height / Damage to building	roof light	cleaning and maintenance	atrium	A detail cleaning and maintenance strategy for the building is being developed with specialist consultant. The atrium roof will be designed to be walked on and appropriate access, drainage and slip resistance will be considered.	High	Very High	Very High		2013/05/14
AAM03	Falls	Falling from height; Items falling from height	internal and external façade glazing	replacement	cut back areas of the building	A detail cleaning and maintenance strategy for the building is being developed with specialist consultant.	Low	High	Moderate		2013/05/14
AAM06	Falls	Falling from height / Damage to building	glazing, feature lighting	cleaning and maintenance	roof, bridges,	A detail cleaning and maintenance strategy for the building is being developed with specialist consultant. A travelling beam and demountable cleaning cradle are being considered to allow safe access to all areas.	High	Moderate	Moderate		2013/05/14
AAM07	Falls	Falling from height / Damage to building	glazed screens	cleaning and maintenance	scenic lifts	A detail cleaning and maintenance strategy for the building is being developed with specialist consultant. The cleaning strategy for these screens in close proximity of the lifts will need to be developed further and co-ordinated with the lift subcontractor in due course.	High	Very Low	Moderate	AAM_DRA_07.pdf	2015/08/15
AAM08	Falls	Falling from height / Damage to building	equipment such as Photovoltaic cells, Satellite dishes	cleaning and maintenance	roof	A detail cleaning and maintenance strategy for the building is being developed with specialist consultant.	Moderate	High	Moderate		2013/06/24

Table 4 – Use of tabular risk information (*continued*)

Risk Name	Hazard Category	Risk Description	Associated Product	Associated Activity	Associated Location	Agreed Mitigation	Risk Likelihood	Risk Consequence	Level Of Risk	Risk Documentation	Date Raised
AAM09	Falls	Falling from height / Falling items / Damage to building	interior lighting	cleaning and maintenance	double and triple height t spaces	Maintenance strategy to be developed with specialist consultant. Requirement for cherry picker or other appropriate access equipment to be confirmed. Number of ceiling mounted lighting fittings at high level to be minimised.	Moderate	Moderate	Moderate		2013/06/24
AAM10	Falls	Falling from height / Falling items / Damage to building	lighting	cleaning and maintenance	exterior	Maintenance strategy to be developed with specialist consultant. Requirement for cherry picker or other appropriate access equipment to be confirmed. Number of ceiling mounted lighting fittings at high level to be minimised.	Moderate	Moderate	Moderate		2013/06/24
AAM11	Falls	Falling from height / Damage to building	passenger lift	cleaning and maintenance		A detail cleaning and maintenance strategy for the building is being developed with specialist consultant. Lift Sub-contractor also to advise once appointed.	Moderate	Moderate	Moderate		2013/06/24
AAM12	Struck by falling object	Replacement of trees / soil / other	tree, soil,	replacement	landscaping and gardens	Maintenance strategy to be devised for all landscaping - this will need to be developed with the landscape designers once appointed.	Moderate	Moderate	Moderate		2013/05/14

9 Representation in COBie

9.1 Exchange of information in COBie

The use of COBie shall be carried out in accordance with BS 1192-4.

9.2 Context information in COBie

Unless Clause 8 or 10 applies, each participant shall appropriately share context information in several of the COBie worksheets including the COBie Facility sheet which includes site and project information, and other sheets such as System, Zone and Job worksheets, as illustrated in Table 5.

NOTE 1 Further risk sources may be included with the description.

NOTE 2 The Client AIR and EIR may expect COBie information.

Table 5 – Use of the COBie Facility sheet (transposed) indicating the context of the risk assessment

Column	Facility
Name	B005
CreatedBy	role@company.com
CreatedOn	2017-02-12T11:00:00
Category	En_20_15 : Administrative office entities
ProjectName	P005
SiteName	S005
LinearUnits	millimeters
AreaUnits	squaremeters
VolumeUnits	cubicmeters
CurrencyUnits	Pounds
AreaMeasurement	Indicative
ExtSystem	AEC3 BimServices
ExtObject	IfcProject
ExtIdentifier	1TB8MXxIf6BAI7EOFPDWY8
ExtSiteObject	IfcSite
ExtSiteIdentifier	1TB8MXxIf6BAI7EOFPDWYA
ExtFacilityObject	IfcBuilding
ExtFacilityIdentifier	1TB8MXxIf6BAI7EOFPDWY9
Description	Office building 5
ProjectDescription	Design and construction of new office building 5
SiteDescription	Site 5, North London Redevelopment
Phase	CIC 6 : Handover

9.3 Risk information in COBie

Risks shall be documented in the COBie Issue sheet. The risks shall be associated to two named and fully described risk sources chosen from Component, Zone, Floor, Type, Component, System and Job worksheets, as illustrated in Table 6.

Table 6 – Use of the COBie Issue sheet (transposed) indicating a managed risk

Column	Issue
Name	AAA12
CreatedBy	role@company.com
CreatedOn	2016-11-04T11:08:38
Type	Struck by falling object
Risk	Moderate
Chance	Low
Impact	High
SheetName1	Space
RowName1	Roof Terrace
SheetName2	Type
RowName2	Large feature planter
Description	Falling branches from height in heavy wind
Owner	role@company.com
Mitigation	Wind protection and ensure distance from edge
ExtSystem	
ExtObject	HS_Risk_UK
ExtIdentifier	

10 Representation in modelling, planning, specification and 4D models

10.1 Representation

Representations shall use the headings and field types nominated in Annex A.

10.2 Context information

Unless Clause 8 or 9 applies, the context shall be conveyed by the 3D or 4D time-line information model and project program.

10.3 Risk information

Unless Clause 8 or 9 applies, each participant shall share appropriately risk information as attributes associated to the Modelling, Planning and Specification entities such as the components, spaces/locations, tasks, or their groupings as systems, types, zones, floors/regions, work-packages and job types.

NOTE 1 Implementations are shown in A.1 and C.1.

NOTE 2 Risks should be associated to the project, site and built asset, if they are reportable and visible.

The attributes shall be grouped in a property set named 'HS_Risk_UK', as shown in Figure A.1.

NOTE 3 If the application is constrained to use only official BS ISO 16739 property sets then the correspondence in the Notes column of Annex A may be used.

Annex A (normative)

Context and Risk information attributes

Table A.1 shall be used for sharing context and risk information.

Table A.1 – Attributes for shared context and risk information

Context or risk attribute	Measure and Examples	Description	Context information sharing (see 7.2)	Risk information sharing (see 7.3)	Notes and COBie Risk ¹⁾ equivalence
Risk Name	text <ul style="list-style-type: none"> • P101-AAA-001 	Short unique name, of the context or risk entry, unique to the project or library	Mandatory	Mandatory	To track the entry across sharing See 7.2 and 7.3 COBie: Issue.Name
Risk Category	enumeration <ul style="list-style-type: none"> • health issue • safety issue • other • context 	Shallow or deep classification of risk or 'context'	Set to 'context'	Mandatory	See classification table Annex B COBie: Issue.Type Pset_Risk: RiskType
Risk Description	text <ul style="list-style-type: none"> • Fall from height 	Description of the context or hazard, omitting the associated location, product and process	Mandatory	Mandatory	Only elevated risks need be shared See 7.3.2 COBie: Issue.Description Pset_Risk: NatureOfRisk

¹⁾ www.buildingsmart-tech.org/ifc/IFC2x4rc2/html/schema/ifcsharedfacilitieselements/pset/pset_risk.htm

Table A.1 – Attributes for shared context and risk information (*continued*)

Context or risk attribute	Measure and Examples	Description	Context information sharing (see 7.2)	Risk information sharing (see 7.3)	Notes and COBie Issue and IFC Pset_Risk ⁽¹⁾ equivalence
Associated Product	text or link <ul style="list-style-type: none"> • B1 • Stair treads • Pr-06-30-15 : Treads • NRM1-05-04-12 • P101-AA-XX-XX-A-00101_Stair_sections 	Product, material, type, Component, System or Facility associated. This may be a name, category, description or spec/bill or entity reference	Mandatory	Mandatory	An entity reference may be a link to a BIM or COBie or Gantt entity COBie: Issue.SheetName1 COBie: Issue.RowName1 May be blank Pset_Risk: RiskCause
Associated Activity	text or link <ul style="list-style-type: none"> • A101.02 • J101 • WP101 • Ac-03-30-30 : Planting • P101-CC-XX-XX-C-00101_Gantt 	Activity, Process, Task, Job type, Package or Project associated. This may be a name, category description or plan/Gantt or entity reference	Mandatory	Mandatory	An entity reference may be a link to a BIM or COBie or Gantt entity COBie: Issue.SheetName1 COBie: Issue.RowName1 COBie: Issue.SheetName2 COBie: Issue.RowName2 May be blank Pset_Risk: RiskCause
Associated Location	text or link <ul style="list-style-type: none"> • R1.101 • L1 • Circulation • SL-05-75-10 : Rhubarb patch • Site B • Upper floor edges • P101-AA-05-05-A-00101_GA 	Location, space, level, region, zone, or site associated. This may be a name, category, description or drawing or entity reference	Mandatory	Mandatory	An entity reference may be a link to a BIM or COBie or Gantt entity COBie: Issue.SheetName2 COBie: Issue.RowName2 May be blank Pset_Risk: RiskCause

Table A.1 – Attributes for shared context and risk information (continued)

Context or risk attribute	Measure and Examples	Description	Context information sharing (see 7.2)	Risk information sharing (see 7.3)	Notes and COBie Issue and IFC Pset_Risk ¹⁾ equivalence
Risk Assessment Methodology	text <ul style="list-style-type: none"> PAS1192p6 Figure 5 	Name of risk matrix or other methodology (see ISO 31100)	Excluded or set to 'Not applicable'	Recommended	To assess level of risk
Agreed Mitigation	text <ul style="list-style-type: none"> non-slip nosings 	Agreed mitigation (see 3.4.1)		Mandatory	Moderation assumed/taken must be shared. COBie: Issue.Mitigation Pset_Risk: PreventiveMeasures
Risk Likelihood	enumeration <ul style="list-style-type: none"> Very low Low Moderate 	Grade of the likelihood, given the agreed mitigation		Recommended	To assess level of risk COBie: Issue.Chance Pset_Risk: AssessmentOfRisk
Risk Consequence	enumeration <ul style="list-style-type: none"> High Very High Unknown not applicable 	Grade of the consequence given the agreed mitigation		Recommended	To assess level of risk COBie: Issue.Impact Pset_Risk: RiskConsequence
Level of Risk		Grade of the risk given the agreed mitigation.		Mandatory	Needed for ongoing prioritization. COBie: Issue.Risk Pset_Risk: RiskGrade
Proposed Mitigation	text <ul style="list-style-type: none"> stair redesign 	Proposed / Possible / unplanned moderation/mitigation		Optional	For internal review and discussion

Table A.1 – Attributes for shared context and risk information (*continued*)

Context or risk attribute	Measure and Examples	Description	Context information sharing (see 7.2)	Risk information sharing (see 7.3)	Notes and COBie Issue and IFC Pset_Risk ⁽¹⁾ equivalence
Date Raised	date <ul style="list-style-type: none"> • 2016-08-01 	Date entry first logged	Optional	Optional	For internal tracking COBie: Issue.CreatedOn
Date Updated		Date entry last updated	Optional	Optional	For internal tracking
Date Review		Date entry last reviewed or due	Optional	Optional	For internal tracking
Owner Discipline	text <ul style="list-style-type: none"> • (participant) • Not applicable 	Name of relevant sub-discipline or sub-contract or trade	Excluded or set to 'Not applicable'	Mandatory	For internal tracking COBie: Issue.Owner Pset_Risk: RiskOwner
Risk Documentation	file reference or URL <ul style="list-style-type: none"> • FireAnalysis.pdf 	Documentation of any detailed risk analysis on which the entry is based.	Excluded or set to 'Not applicable'	Optional	See 7.4 for examples

Annex B (informative)

Classification of risks

Table B.1 indicates some possible risk classifications to aid the description, correlation and re-use of risk information.

NOTE *It is not intended to be definitive nor to be comprehensive. Additions may be required to reflect the context of the project.*

Table B.1 – Classification of risks

<ul style="list-style-type: none"> ▪ Health issue <ul style="list-style-type: none"> ○ Material effect <ul style="list-style-type: none"> ▪ Asbestos effect ▪ Lead effect ▪ Hazardous dust <ul style="list-style-type: none"> ▪ Wood dust ▪ Silica dust ▪ Chemical effect ○ Mechanical effect <ul style="list-style-type: none"> ▪ Noise ▪ Loss of control using hand or power tool ▪ Vibration ○ Welfare issue ▪ Safety issue <ul style="list-style-type: none"> ○ Fall <ul style="list-style-type: none"> ▪ Fall from ladder ▪ Fall from open edge ▪ Fall from scaffold ▪ Fall through fragile material ▪ Slip or trip on the same level ○ Trapped <ul style="list-style-type: none"> ▪ Confinement ▪ Crushed by excavation ▪ Unintended collapse ▪ Drowning and flooding ▪ Asphyxiation 	<ul style="list-style-type: none"> ○ Event <ul style="list-style-type: none"> ▪ Electric shock ▪ Fire or explosion ▪ Machinery Guarding ▪ Loss of control ○ Handling <ul style="list-style-type: none"> ▪ Materials handling including manual handling ▪ Mechanical lifting operation ▪ MEWP (mobile elevating work platform) operation ▪ Working overhead ○ Struck <ul style="list-style-type: none"> ▪ Struck by falling object ▪ Struck by moving vehicle ▪ Struck by machinery or part ▪ Overturning plant or moving machinery ○ Public protection issue ▪ Environmental issue (not in scope) ▪ Commercial/Economic/Insurance issue (not in scope) ▪ Operational issue (not in scope) ▪ Social issue (not in scope) ▪ Other issue (not in scope) ▪ NOTKNOWN ▪ UNSET
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Annex C (informative)

Representation of risk information

Figures C.1 to C.4 illustrates the visualization of risk information in project models.

Figure C.1 – Use of component with HS_Risk_UK attached: an information model may document risks as being associated to a product (component or type) entity

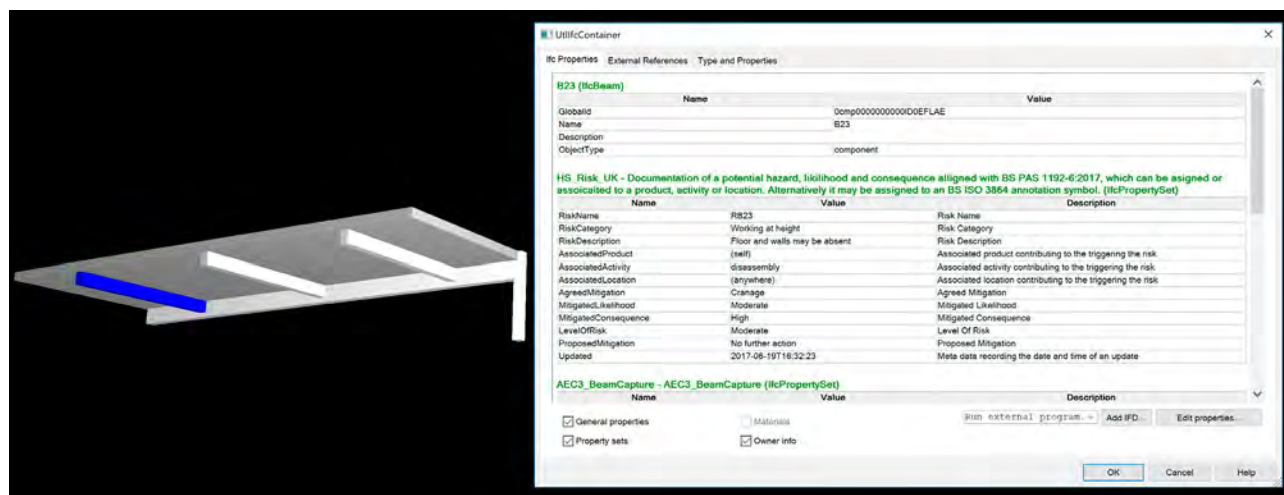


Image courtesy of AEC3

Figure C.2 – Use of a space with HS_Risk_UK attached: an information model may document risks associated to a location (space or floor or region)

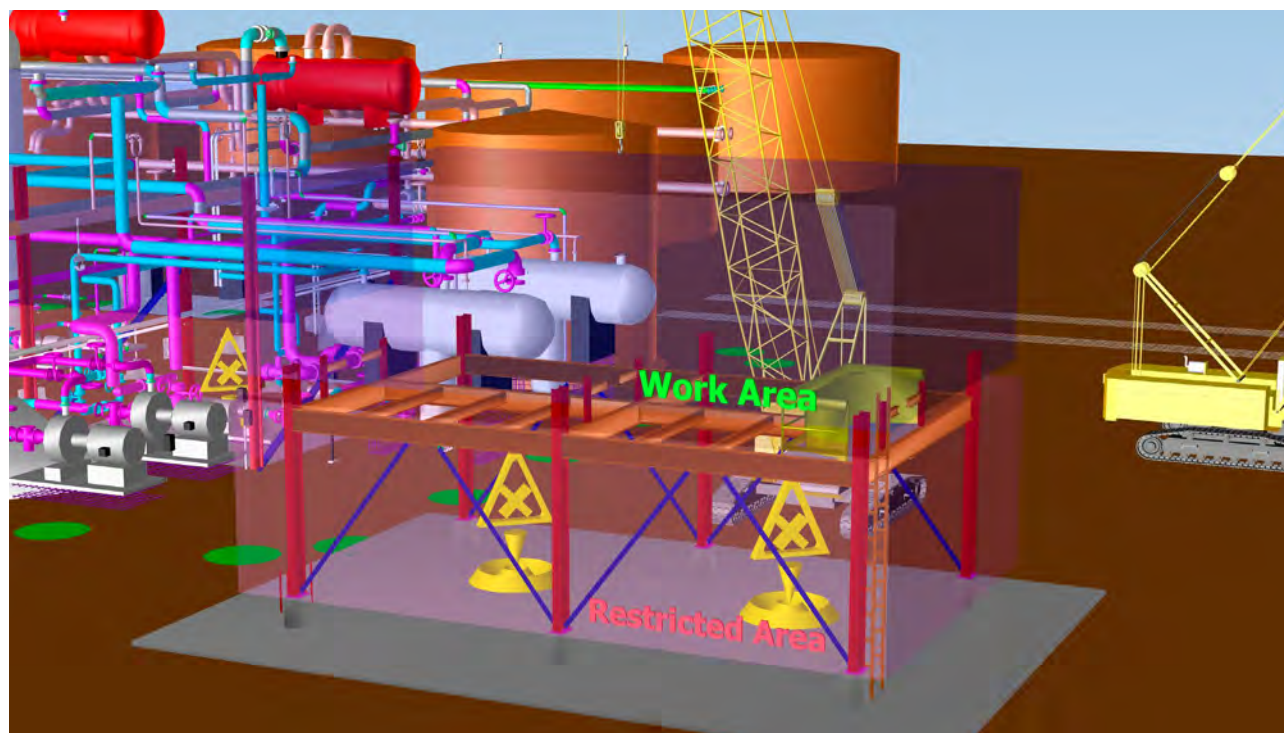


Image courtesy of Synchro Limited

Figure C.3 – Use of a project plan (Gantt chart) with a risk associated to a specific task entity

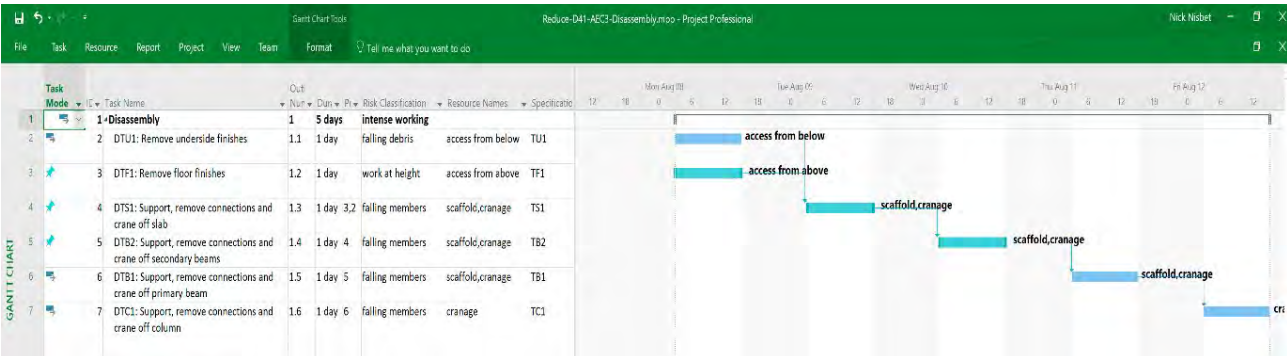


Image courtesy of AEC3

NOTE Further associations to location or to product entities may be documented as additional text attributes.

Figure C.4 – Use of risk symbol annotations used for emergency planning

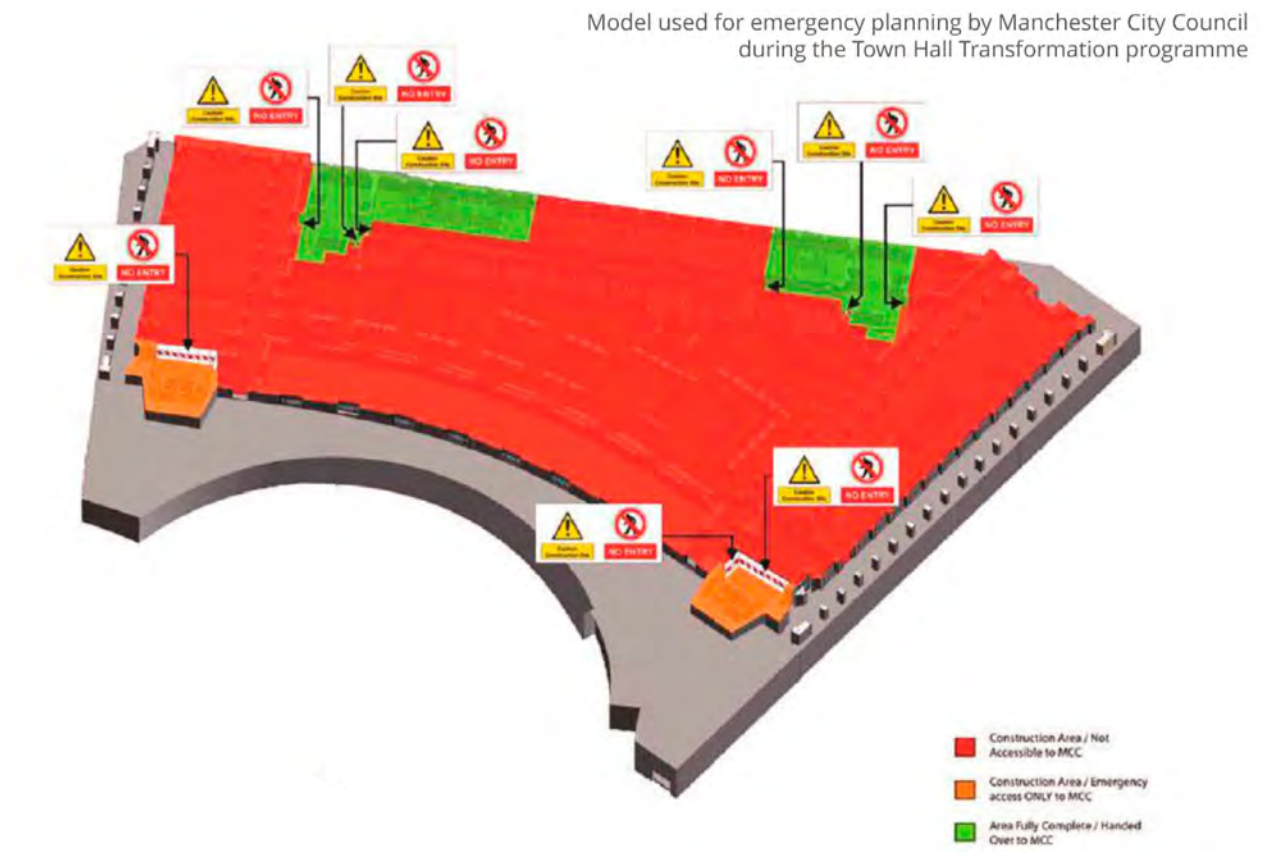


Image courtesy of Manchester City Council and Kier Group

Bibliography

Standard publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

PAS 1192-3, *Specification for information management for the operational phase of assets using building information modelling (BIM)*

BS ISO 16739, *Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries*

BS ISO 3864-3:2012, *Graphical symbols – Safety colours and safety signs – Part 3: Design principles for graphical symbols for use in safety signs*

ISO 31010, *Risk management – Risk assessment techniques*

ISO / IEC Guide 51:2014(4), *Safety aspects – Guidelines for their inclusion in standards*

PD ISO Guide 73:2009, *Risk management – Vocabulary*

ISO 55000, *Asset management – Overview, principles and terminology*

[5] GREAT BRITAIN. The Regulatory Reform (Fire Safety) Order, 2005. London: The Stationery Office.

[6] GREAT BRITAIN. The Regulatory Reform (Fire Safety) Order, Work at Height Regulations 2005. London: The Stationery Office.

[7] GREAT BRITAIN. Control of Substances Hazardous to Health Regulations 2002. London: The Stationery Office.

[8] GREAT BRITAIN. Control of Asbestos Regulation 2012. London: The Stationery Office.

[9] GREAT BRITAIN. The Ionising Radiations Regulations 1999. London: The Stationery Office.

[10] GREAT BRITAIN. The Dangerous Substances and Explosive Atmospheres Regulations 2002. London: The Stationery Office.

[11] GREAT BRITAIN. The Lifting Operations Lifting Equipment Regulations 1998. London: The Stationery Office.

[12] GREAT BRITAIN. The Electricity at Work Regulations 1989. London: The Stationery Office.

Other publications

[1] GREAT BRITAIN. The Health and Safety at Work etc. Act 1974. London: The Stationery Office.

[2] GREAT BRITAIN. The Construction (Design and Management) Regulations 2015 (CDM). London: The Stationery Office.

[3] The Management of Health and Safety at Work Regulations (MHSWR) 1990 – SI. 1999 No.3242

[4] GREAT BRITAIN. Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR). London: The Stationery Office.

Further reading

BS 7000-4, *Design management systems – Guide to managing design in construction*

BS ISO 31000, *Risk management – Principles and guidelines principles for graphical symbols for use in safety signs*

The Temporary Works Forum Client Guide: www.twforum.org.uk

Mordue, S and Finch, R. *BIM FOR Construction Health and Safety*, RIBA Publication (2014)

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