Workplace Safety and Health Guidelines

Design for Safety

WSHCOUNCIL

Tripartite Alliance for
Workplace Safety and Health

Year of issue: 2022

Contents

1. Introduction

1.1 Design for Safety (DfS)

The Workplace Safety and Health (DfS) Regulations 2015 require stakeholders such as Developers, Designers and Contractors to work together at the earliest opportunity from the planning and design phases onwards, to identify and eliminate or reduce all foreseeable risks to an Affected Person's safety or health throughout the life cycle of a structure being designed, from its construction, operation and maintenance, until its demolition. The Regulations aim to:

- Place responsibility of the safety and health of workers in the construction industry on those who create the risks;
- Achieve sustained workplace safety and health (WSH) improvements through better coordination amongst all stakeholders by managing the WSH risks upstream at the design and planning phase; and
- Improve the planning and effectiveness of the management of safety and health risks throughout every phase of the construction project, i.e. from design and construction stages through to the maintenance of the completed building.

The Regulations also aims to direct stakeholders to work together and perform their DfS duties, and promote safe execution of construction and maintenance works so that structures (refer to Annex A for definition of "structures") can be safe workplaces.

Note:
This set of guidelines replaces the

- Guidelines on Design for Safety in Buildings and Structures (first issued in 2008, first revision in 2011).
- Workplace Safety And Health Guidelines Design for Safety (published in August 2016).

1.2 Key stakeholders and their duties

Refer to Annex B for a summary of the key stakeholders and their duties.

1.2.1 Developers

Developers are individuals or organisations for whom or on whose behalf a construction project is carried out. They are at the top of the construction value chain and have the greatest influence on the project. Developers also include the subsidiary management corporation of the subdivided building who undertake modification projects on existing structures.

Homeowners who engage Contractors to build their homes or undertake projects to build or rebuild houses for personal dwelling not intended for use as a business, are not covered under the WSH (DfS) Regulations.

1.2.2 What is a Developer's duty?

The Developer engages professionals to design and construct a structure using allocated resources. As the key stakeholder in the construction project, the Developer selects the scheme and makes key decisions in the design of the structure. As such, the WSH (DfS) Regulations prescribe specific statutory duties to the Developer which are summarised in Annex B. Among the statutory duties, it is the Developer's duty to ensure that foreseeable design risks in the project are eliminated. In the event that it is not reasonably practicable to eliminate the design risks, the Developer has to work with the other stakeholders to ensure that the design risks are reduced to as low as reasonably practicable.

When reducing a design risk, it must be reduced at its source and collective protective measures must be used as far as reasonably practicable instead of individual protective measures. Individual protective measures refer to measures such as the usage of personal protective equipment (PPE). Collective protective measures protect more workers. For the case an open edge, an example of individual protective measure is Personal Fall Arrest System with lifelines while collective protective measure can come in the form of guardrails.

1.2.3 Designers

Designers are individuals or organisations who prepare a design plan relating to a structure. This include Engineers, Architects and Contractors or Developers if they prepare a design plan for permanent or temporary structures.

A design plan includes drawings, building information modelling (BIM), design details, specifications, materials and bills of quantities (including specifications of articles or substances) relating to a structure, and calculations prepared for the purpose of a design.

See Annex C for a list of persons deemed as Designers.

1.2.4 What is a Designer's duty?

Decisions made by a Designer have significant impact on the safety and health of workers, particularly to those who construct, maintain, repair, clean, refurbish and eventually demolish or remove the structure. Modifications to the design during construction are additional work and such efforts may not be cost-effective. As such, Designers have to consider the people affected and eliminate the risks from the start of the design, before key decisions are made, to prevent reworking of the design.

Example:
The distribution box of a multi-storey carpark was designed to be located at the wall of a carpark next to the traffic lanes. This location puts workers in the path of traffic during maintenance work. To reduce the risk of being hit by vehicles, the distribution box was relocated further down the carpark eliminating the risk of workers being hit by a vehicle during maintenance.

As such, it is a Designer's duty to prepare a design plan for a structure that eliminates, so far as is reasonably practicable, foreseeable design risks to the safety and health of any affected person.

In addition to core design capabilities relevant to the Designer's role, a Designer should also have:

- Reasonable understanding and awareness of significant design hazards that construction, operation and maintenance workers can be exposed to;
- Knowledge of work health and safety legislation, codes of practice and other regulatory requirements;
- An understanding of the intended purpose of the structure;
- Knowledge of risk management processes;
- Knowledge of technical design standards;
- An appreciation of construction methods and their impact on the design; and
- The ability to source and apply relevant data on human dimensions, capacities and behaviours.

Many design projects are large and complex. Various persons with specific skills and expertise may need to be included in the DfS review team or consulted during the design process to fill any knowledge gaps; for example ergonomists, landscape specialists, facility engineers, occupational hygienists and WSH professionals.

Example:

When deciding on the structural scheme for a 10-metre-high column-free atrium, a designer (e.g. architect or structural engineer) considers the associated design hazards for the different schemes.

For instance, where a cast in-situ transfer beam/slab atrium scheme is selected, the designer (e.g. architect or structural engineer) consults a specialist formwork/falsework supplier at an early stage, even before the contractor is on-boarded to the project. This consultation confirms the availability of a suitable falsework system to construct the atrium. If such a falsework system is not available, then the requirements of customised heavy-duty falsework components have to be included into the tender specifications for contractors. Amongst the suppliers, in order to mitigate work-at-height risks, the designer (e.g. formwork supplier) selects a falsework design which is the safest to erect, use and dismantle, and equipped with built-in fall prevention measures that can be erected on the ground before being lifted. These requirements are also to be specified in the tender requirements.

On the other hand, where a precast/prefabricated structural scheme is selected, the designer (e.g. structural engineer) considers all load-bearing elements, regardless of whether these are temporary, permanent or mechanical, such as pot bearings. The designer (e.g. architect or structural engineer) evaluates these elements and connected structures carefully and carries out interim stability assessments to account for variances both in loading and support conditions during a staged construction process.

Challenges which maintenance workers may face when required to carry out facilities maintenance (e.g. lights and fans servicing) located at the top of the atrium are also considered by a building service designer. Design provisions such as, permanent ceiling walkway, retractable access or retractable light and fan ceiling fixtures are considered for enabling the maintenance works to be carried out in a safe manner. If Mobile Elevated Work Platforms are required to be deployed for such maintenance works, appropriate floor loading capacities, proper equipment and access/egress provision are provided for in the design by a structural engineer.

Discussion with those carrying out the work is also important because they may have methods of working, specific needs or suggestions which Designers will need to consider in their design. For example, the use of Mobile Elevated Work Platforms (MEWPs) for maintenance of internal structures, or use of suspended scaffolding or industry rope access system for maintenance of building facades.

See Annex D for some areas where Designers have influence over.

Example:
A Designer designed a 10-metre high external green wall façade for a building which requires regular maintenance. To eliminate risks of falling from height during maintenance, the Designer designed the green wall with rotatable panels that could be accessed via a walkway inside the building.

1.2.5 Contractors

Contractors are individuals or organisations who have entered into contracts for the purpose of carrying out any construction, maintenance and demolition work. As such, the duties of Contractors would also apply to both Main and Sub-contractors.

1.2.6 What is a Contractor's duty?

A Contractor is directly responsible for the safety and health of the construction and maintenance workers who carry out any construction, maintenance and demolition work. As such, it is a Contractor's duty to inform the person who appointed the Contractor of any foreseeable design risk that the structure poses or will pose to an affected person.

The person who appoints a Contractor may refer to a Developer, Facility Manager, Main Contractor or any other stakeholder who appoints the Contractor.

1.2.7 DfS Professionals

DfS Professionals are individuals or organisations who are delegated by the Developers to undertake two of the Developers' duties, specifically to:

- Convene DfS review meetings; and
- Maintain DfS Registers.

A DfS Professional can be a Developer's own employee or an external third party.

When the above two duties have been delegated out (to be named as "delegable duties"), formally in writing, to external DfS Professionals, the Developers will not be responsible for their performance. The other statutory duties of a Developer (see Annex B: Summary of duties under the WSH (DfS) Regulations) are not delegable and remain with the Developer.

When a Developer delegates the delegable duties to an employee, this employee will then be personally liable for the performance of these duties. It is recommended to formally delegate the duties in written form so that the employee is aware of his duties and the legal implications. When a Developer directs (i.e. not delegated formally in writing) one or more of his/her employees to, as part of their jobs, perform the delegable duties, legal liability will continue to remain with the Developer.

The delegation of the Developer's delegable duties to the internal or external DfS Professional will only take effect if the Developer:

- Assesses that the DfS Professional is competent to perform those duties;
- Delegates its delegable duties directly to the DfS Professional; and
- Communicates directly with the DfS Professional when the DfS Professional performs its duties.

Once the Developer has delegated its delegable duties to the DfS Professional, the DfS Professional will be legally responsible for the duties. The delegated DfS Professional also cannot further delegate its duties to another DfS Professional. Any redelegation can only be done by the Developer.

1.2.8 What is a DfS Professional's duty?

If delegated by a Developer, a DfS Professional has the duty to convene DfS review meetings and maintain the DfS Register including associated documents.

In addition, the DfS Professional is also responsible to communicate to the Developer as soon as possible after each DfS review meeting, all relevant information on each foreseeable design risk identified and how each design risk can be eliminated or reduced. This is important so as to ensure that the Developer has an accurate oversight of the project's design risks and is able to make the right decisions on how the design risks are to be mitigated.

1.2.9 Registered Proprietors and Subsidiary Management Corporations

Registered Proprietors refer to building owners.

Subsidiary Management Corporations refer to Management Corporation Strata Title (MCST) engaged by building owners to manage the maintenance and upkeep in the common areas of a building. It is defined in the Building Maintenance and Strata Management Act as, in relation to any limited common property comprised in a strata title plan, the subsidiary management corporation constituted for that limited common property under the Land Titles (Strata) Act.

1.2.10 What is a Registered Proprietor's and a Subsidiary Management Corporation's duty

Registered Proprietors (for a structure that is not a sub-divided building) and Subsidiary Management Corporations (for a sub-divided building) are required to keep the DfS Register so that information on residual risks is available to those who will use the structure as a workplace, particularly those who clean or maintain the structure, or during the demolition of the structure.

Example:
Upon completion of a condominium development project, the Developer hands over the property to the new owner who has bought over the property. The Developer is required to hand over the DfS Register to the MCST.

In situations where Registered Proprietors or Subsidiary Management Corporations have Managing Agents to manage their properties, the Registered Proprietors or Subsidiary Management Corporations are to ensure that the Managing Agents have access to the DfS Register and informed of the residual risks. When Managing Agents engage Contractors to carry out any work, Managing Agents are required to inform Contractors of any residual risks involved in their scope of works.

Example:
A Registered Proprietor owns a shopping centre and engages a Managing Agent (MA) to manage the property. The Registered Proprietor is required to keep the DfS Register and inform the MA of the residual risks. The MA then engages a landscaping Contractor to carry out maintenance and pruning works on a green wall on the shopping centre's facade. The MA is required inform the Contractor of all residual risks involved in carrying out landscaping works on the shopping centre's facade.

2. Pre-requisites for a Successful DfS

2.1 Engage competent stakeholders

DfS stakeholders must be competent to carry out their duties to ensure an effective and efficient DfS review process. Hence, Principals i.e. those who engage another under a contract for service, must engage competent stakeholders. This applies in multiple scenarios, for instance, when a Developer engages a Designer or a Contractor, or when a Developer engages a DfS Professional, or when a Main Contractor engages a Sub-Contractor, etc.

The competency of a person is defined as the experience and training that one has which helps one to carry out one's duties. To assess the competency of a person for the job, the Principal must check that the person has the relevant DfS-related training and experience in the DfS role that is required, and is able to not just fulfil his or her contractual requirements, but also able to perform the legal duties. To assess if a company is capable to do the job, the Principal must check that the company has the relevant track records and experienced personnel to adequately fulfil the competency requirements expected of it.

Example:
Using the Building and Construction Authority (BCA)'s Quality-Fee Method (QFM) as reference, here are some examples of areas that the Principal can check to assess an individual's or a company's competency:

- Company's or individual's track record including awards attained (e.g. bizSAFE level);
- Relevant expertise and experience of the proposed DfS review team;
- How the proposed DfS review team intends to deal with the project's design risks communicated to them (e.g. using technology and Building Information Modelling to manage WSH); and
- Safety and risk management capabilities of the construction project team (where applicable).

Example:
After assessing that he does not have any employee who was competent to carry out the DfS roles of a Developer, a Developer decides to engage and delegate a DfS Professional to facilitate the DfS Review process for his construction project. The Developer has to ensure that the delegated DfS Professional is competent in terms of experience and DfS-related training to perform the tasks. The candidate must have:

- Reasonable exposure and experience in safety and health matters in the construction industry; and
- Attended and passed the assessment on the Design for Safety for Professional Course (formally known as the DfS Coordinator Course) conducted by professional bodies, industry associations or statutory boards or attain equivalent qualifications.

The candidate must be a registered Professional Engineer (PE) or architect with a practicing certificate or:

- Have 10 years of relevant experience in the design (at least five years in design which includes contributions to designs, writing specifications) and supervision of the construction of structures; and
- Have a degree accepted by PE Board or Board of Architects or construction-related degree accepted by Singapore Institute of Surveyors and Valuers.

2.2 Sufficient time and resources

When engaging Designers and Contractors, Developers have to consider the resources (e.g. staff, equipment, time) needed to plan and do the work properly. All pre-construction information as well as all known risks involved in the project should be made clear by the Developers to the Designers and Contractors in the tender documents, for them to understand the design risks and helped them determine if they are able to undertake the project and comply with the legal requirements.

At the tender stage, Developers should take into consideration the minimum time period Contractors need to plan and prepare before construction work begins onsite. After they are appointed, Contractors should be given sufficient time to plan the work and mobilise the necessary staff and equipment (e.g. cranes, piling rigs) so that work can proceed without risk to workers' safety and health. This is particularly important when the project involves demolition work. Contractors must be given sufficient time for the planning and safe execution of any demolition activities.

The design of a structure is not a one-step operation, but one that often requires modifications to address thoroughly what could go wrong during construction or maintenance phase of the structure. This would include design modifications as a result of discussion between designers and the other stakeholders along the way and as more information becomes available.

In the event of changes in the project leading to safety and health issues, the Developer should discuss with the Designers and Contractors if the time and resources agreed earlier are sufficient for the project. Managers and WSH personnel can help this process by providing their leaders with appropriate and timely information. This could include, identifying design options which support both business outcomes and WSH objectives, assessing the risks and providing short- and long-term cost-benefit analysis of the recommended controls to manage these risks, and identifying what

decisions need to be taken, when and by whom to effectively design and implement the agreed changes. All parties should come to a mutual agreement on the resources and time allocated such that the project can proceed safely.

Example:
A Developer awarded a contract to a Contractor for the construction of a new development on a lot with an exist ing building. While it was unknown during the tender stage, it was later discovered that the building that was to be demolished contained materials with asbestos. With this new information, the main Contractor would need more time to engage and work with contractors who are specialists in asbestos removal. Hence, the developer should provide the main Contractor with additional time and resources to resolve this situation.

2.3 Attend and participate actively in DfS review meetings

The design of a structure comprises a wide set of design objectives that include structure safety, occupant safety, practicability, aesthetics, cost and functionality. Often, the design process will occur over various stages and involve different people who make financial, commercial, specialist or technical decisions over a design. These sometimes competing objectives need to be balanced so that they do not compromise the health and safety of affected persons who work on or use the structure throughout its life cycle.

DfS review meetings are the platforms for stakeholders to consult, collaborate, coordinate and communicate among one another, with the objective of resolving design risks and issues, and deciding how a structure can be constructed, maintained, cleaned and demolished safely.

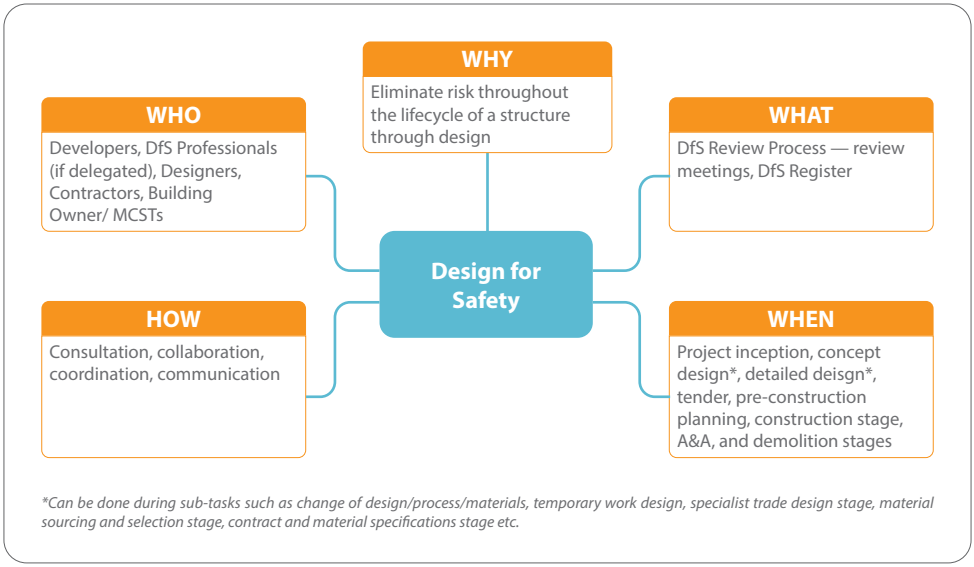


Figure 1: Sample considerations during DfS Review Meeting.

The Developer must conduct DfS review meetings with relevant stakeholders, as early as possible, during the project design and pre-construction stages. Early consultation and identification of design risks allow for more options to eliminate or minimise risks and reduce associated costs. This will result in better planning of the project's work processes and construction methods in the pre-construction phase. The very first DfS review meeting may even be conducted only among representatives of the Developer at the project inception stage, before any external Designer or Contractor has been engaged.

During the construction stage of the project, the Developer may still conduct DfS review meetings to:

- Review any new or revised design (e.g. variations, designs for temporary works, and designs by specialist contractors); and
- Provide necessary briefings and clarifications to the Contractor as part of passing-on information of residual design risks from the DfS review meetings.

3. DfS Implementation

3.1 GUIDE process

In order to assist stakeholders in the conduct of DfS reviews, a systematic process called GUIDE is recommended. Stakeholders are free to adopt, adapt or use other processes they deemed fit for their respective projects.

GUIDE stands for:

Group together a DfS review team consisting of main stakeholders.

Understand the full design concept by looking at drawings and calculations, or have designers elaborate on the design.

Identify risks that arise as a result of the design or construction method. The risks can be evaluated using existing risk assessment methodology and recorded in design risk assessment form.

Design around the risks identified to eliminate or to mitigate the risks.

Enter into the DfS Register all information including residual risks to be mitigated and information on vital design change that would affect safety and health of affected persons.

During a DfS review meeting, every stakeholder should exchange information and work together in a cooperative and coordinated way so that design risks are eliminated or minimised as much as reasonably practicable.

3.2 DfS tools

Some DfS tools that can be used together with the GUIDE process to facilitate effective DfS exercises.

The 2016 version of the WSH Guidelines on Design for Safety recommends implementing the GUIDE process in 3 phases, namely GUIDE-1 (Concept Design Review), GUIDE-2(Detailed Design, Maintenance and Repair Review) and GUIDE-3 (Pre-construction Review). However, in order to promote holistic implementation of the DfS process and provide added flexibility, these guidelines now recommend other available DfS tools that can help DfS stakeholders identify, eliminate and reduce foreseeable design risks.

These DfS tools can be deployed at any stage of the DfS implementation process at the stakeholders' discretion. They are examples for consideration and not meant to be a one-size-fits-all solution and may have to be used in combinations.

3.2.1 DfS considerations based on life cycle stages of a building/ construction project

Hazards and DfS considerations can also be systematically categorised according to the life cycle stages of a building/construction project, i.e. when a design progresses from project inception to concept and detailed designs, and finally to pre-construction planning and construction stage.

Please refer to Annex E for sample DfS considerations at the various design stages. **These are samples only; workshops and discussions can be incorporated into the DfS review process to identify the hazards that are 'in scope'.** It is important that the right personnel be involved in such workshops and discussions. Examples are:

- Personnel who work on similar structures within the developer's company, including health and safety representatives;
- Experienced personnel who will construct and maintain the new structure; and
- Specialist consultants and experts in the identified hazards.

3.2.2 Designer's Red Amber Green (RAG) list

The UK's Health & Safety Executive (HSE) recommends the Red, Amber and Green lists (RAG lists) as practical aides to Designers on what to eliminate/avoid, and encourage. The HSE stresses these are not "right" or "wrong" ideas but are a basis for a debate forum to take design safety to the next level and can be amended to be more specific to what a particular design organisation does.

Depending on their own specific design areas, Designers can identify design elements, materials and processes which are either to be avoided, because they are judged to represent significant risk to construction personnel, maintenance and demolition workers, or to be preferred because they represent a reduction in such risks.

Refer to Annex F for one example of a RAG list. **This is only one example and every Designer should develop his/her own specific RAG list that is relevant to his/her own areas of design.** For instance, a RAG list developed by a structural engineer who designs temporary earth retaining structures may not be applicable for a building architect.

- **Red list items**
  Hazardous elements, materials or processes are prohibited and must be eliminated from the project, except only where no alternatives can be found. If a Red list item is to be used, it requires formal justification within the design documentation.

- **Amber list items**
  Hazardous elements, materials and processes are to be used in a careful and sparing way because they represent significant risks (although they may be justified on a risk management basis). If any item on the Amber list is to be used, it requires information within the design documentation on its minimisation and should require advice and guidance to be provided as part of the design for the safe execution of that design.

- **Green list items**
  Elements, materials and processes which are preferred because they represent significant risk reduction.

3.2.3 DfS checklist based on hazards

The Code of Practice on safe design of structures published by Safe Work Australia recommends that hazard identification should take place as early as possible in the project inception and design stages. It is important that the hazard identification is systematic and not limited to a person's experience.

Annex G provides a checklist that is based on broad groupings of hazards that should be identified before design scoping begins. Designers and others involved in the preliminary hazard analysis should then decide which hazards are 'in scope' of the steps of the risk management process, and should be considered in the design process. A hazard is 'in scope' if it can be affected, introduced or increased by the design of the structure. At this early stage, consideration should be given to possible ways that risks from hazards could be eliminated or minimised.

3.3 Design risk evaluation

After identifying the design-related hazards, risks from these hazards have to be evaluated, and then reduced, if not eliminated, as much as is reasonably practicable through collective protective measures instead of individual protective measures. These can be summarised in a design risk assessment form (see Annex H for a sample).

Risk evaluation processes are well established and will not be covered in this Guidelines. For reference, please refer to The Code of Practice on Workplace Safety And Health Risk Management, published by the Workplace Safety And Health Council.

3.4 DfS Register

The DfS Register is a collection of documents generated through DfS reviews and needs to stay with the structure for its entire life cycle i.e. from project inception until its demolition. The DfS Register serves two key purposes:

- The DfS Register is a record and evidence that the DfS review process has been properly undertaken.
- It contains vital information which needs to be communicated to affected persons so that they are aware of any identified risks that they ought to address, why certain decisions were made with respect to the design or design modifications, and the control measures if available to implement.

Information in the DfS Register has to be reviewed and updated from time to time to ensure its relevance. Irrelevant or outdated information should be discarded. The DfS Register must be shared among all the stakeholders. This would then allow them to look into and mitigate the design risks accordingly.

These items can be included in the DfS Register (non-exhaustive):

- Pre-construction information, generally provided by the Developer, including but not limited to:
  - site plans and photographs of the project location;
  - relevant drawings or plans (e.g., architectural plans, structural plans, as-built plans, etc);
  - utilities and services plans;
  - soil investigation reports, where applicable;
  - existing DfS Register (if any); and
  - information on risks associated with the project, where applicable.

- DfS review records such as minutes (including attendance records) of DfS Review meetings and the design risk assessment form.
- Advisory notes that can be transferred to drawings such as construction and as-built drawings, wherever applicable. These notes are to be made available immediately to those carrying out the work. They should be direct, concise and annotated, and updated to be current (see Annex J for examples). Users can refer to other documents if more details are needed.
- Written notes eventually forming the Maintenance Strategy Report[1] (MSR). Such notes are to be project-specific and contain only information useful to those maintaining thestructure (see Annex L for an example). The intent is for the MSR to be part of the DfS Register that will be eventually handed over to parties who acquire interest in the building.

For practical reasons, at the pre-construction stage, the DfS Register should be kept in the premises of either the Developer or the DfS Professional if delegated. At the construction stage, the DfS Register should be kept in the project worksite for ease of reference. Alternatively, electronic modes of information sharing, and storage or filing can be used, subject to appropriate document control measures being in place.

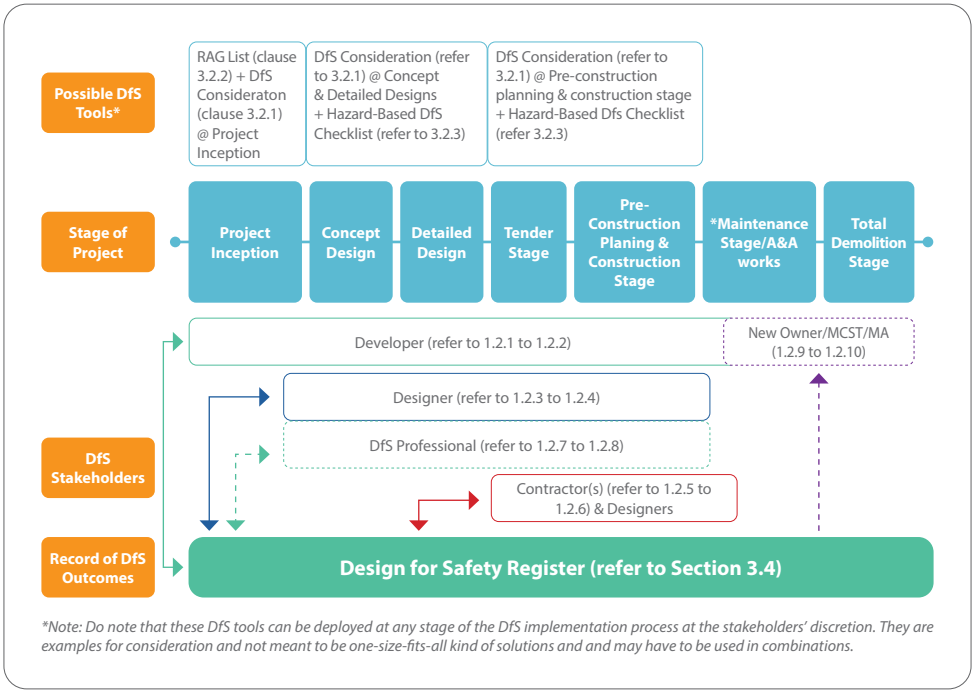
Upon completion of a structure, the DfS Register must contain information about the structure that is likely to be needed to ensure safety and health during any subsequent work such as maintenance, cleaning, Addition & Alteration (A&A), refurbishment or demolition. The DfS register should not include things that will not help in the planning of future construction work, such as the earlier construction phase plan, construction phase risk assessments or contractual documents.
At the maintenance and A&A stage, the existing building owner must ensure that the DfS Register is available to relevant stakeholders such as the maintenance, A&A and demolition contractors.

In the event the Developer disposes his or her interest in the structure, the Developer is required to hand over the DfS Register to the next person who acquires the interest in the structure, such as the Registered Proprietors or Subsidiary Management Corporations. Similarly, if the Registered Proprietors or Subsidiary Management Corporations subsequently disposes his or her interest in the structure, the DfS Register is to be given to the person who next acquires interest in the structure.

[1] The Building & Construction Authority (BCA) recommends that designers prepare a Maintenance Strategy Report at the early stage of the design process to document their maintenance philosophy and operational assumptions. For more information, refer to BCA's Design for Maintainability checklist.

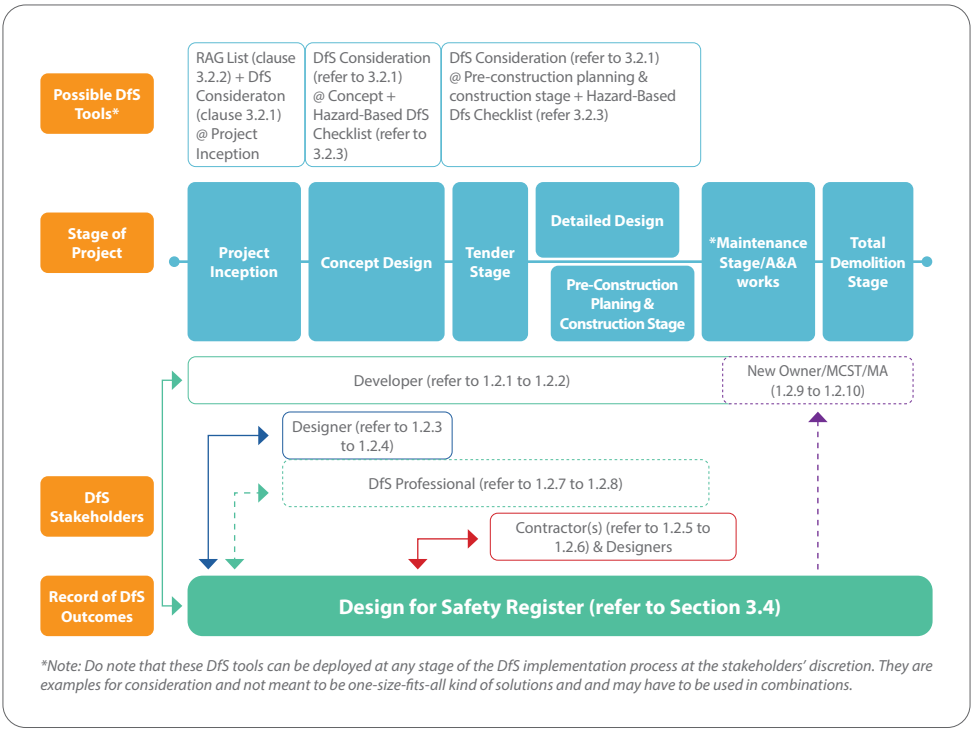
3.5 Pictorial illustrations of DfS implementations

Contract arrangements for construction projects are often complex. The following are two examples of how stakeholders can consult, collaborate, coordinate and communicate in an effective manner on DfS matters.



**Note: Do note that these DfS tools can be deployed at any stage of the DfS implementation process at the stakeholders' discretion. They are examples for consideration and not meant to be one-size-fits-all kind of solutions and and may have to be used in combinations.*

Figure 2: Sample DfS process for a typical construction project (New Build).



**Note: Do note that these DfS tools can be deployed at any stage of the DfS implementation process at the stakeholders' discretion. They are examples for consideration and not meant to be one-size-fits-all kind of solutions and and may have to be used in combinations.*

Figure 3: Sample DfS process for a DESIGN & BUILD (D&B) project (New Build).

4. References

Legislations

- Workplace Safety and Health (WSH) Act (Chapter 354A)
  (Visit https://sso.agc.gov.sg/Act/WSHA2006 for more details about the WSH Act)

Subsidiary legislations under the WSH Act

- WSH (Abrasive Blasting) Regulations
- WSH (Asbestos) Regulations
  (Visit https://sso.agc.gov.sg/Act/WSHA2006?ViewType=SI for the full list of subsidiary legislations)
- WSH (Confined Spaces) Regulations
- WSH (Construction) Regulations
- WSH (Design for Safety) Regulations
- WSH (Explosive Powered Tools) Regulations
- WSH (First Aid) Regulations
- WSH (General Provisions) Regulations
- WSH (Incident Reporting) Regulations
- WSH (Medical Examinations) Regulations
- WSH (Noise) Regulation
- WSH (Operation of Cranes) Regulations
- WSH (Registration of Factories) Regulations
- WSH (Risk Management) Regulations
- WSH (Safety and Health Management System and Auditing) Regulations
- WSH (Scaffold) Regulations
- WSH (Work at Heights) Regulations
- WSH (Workplace Safety and Health Committees) Regulations
- WSH (Workplace Safety and Health Officers) Regulations
- Building Maintenance and Strata Management Act
- UK HSE CDM 2015 The Construction (Design and Management) Regulations 2015 — Industry Guidance for Designers

Other Publications

- Workplace Safety and Health Council — Code of Practice on Workplace Safety and Health (WSH) Risk Management
- Building and Construction Authority — Price Quality Method (PQM)
- UK Health and Safety Executive — The Construction (Design and Management) Regulations
- Safe Work Australia — Code of Practice for Safe Design of Structures
- Safe Work Australia — A Work Health and Safety Handbook on Principles of Good Work Design

5. Acknowledgements

The Workplace Safety and Health Council and Ministry of Manpower would like to thank the DfS Workgroup for their valuable assistance and involvement for this revision of the publication. The Workgroup include representatives from the following organisations:

S/No.	Organisation	Name	Workgroup Designation
1	Real Estate Developers' Association of Singapore	Mr Paul Lau	Chairperson
2	JTC Corporation	Mr Koh Chwee	Dy Chairperson
3	Nee Soon Town Council	Mr Soon Min Sin	Member
4	Singapore International Facility Management Association	Er Chian Chieh Sheng (Jackson)	Member
5	The Singapore Contractors Association Limited	Mr Kenneth Siew	Member
6	Institute of Engineers Singapore	Er Steve Yeung	Member
7	Society of Project Managers	Mr Bernard Ho	Member
8	Housing and Development Board	Er Goh Keng Cheong	Member
9	Housing and Development Board	Mr Han Kam Siew	Member
10	Building and Construction Authority	Er Dr Tran Chi Trung	Member
11	Association of Consulting Engineers Singapore	Er Gwee Siong Mong	Member
12	Singapore Institute of Architects	Ar Jason Lee	Member
13	Singapore Institute of Architects	Ar Foo E-Jin	Member
14	Ministry of Manpower	Mr Goh Chin Keong	Member
15	Ministry of Manpower	Mr Lim Cheong	Member
16	Workplace Safety and Health Council	Mr Chan Yew Kwong	Member
17	Workplace Safety and Health Council	Mr Royston Lim	Member
18	Workplace Safety and Health Council	Mr Muhd Hafiz Md Jamil	Member

Annex A: Key Definitions

<table>
<tr><th>Term</th><th>Description</th></tr>
<tr><td>Application of WSH (Design for Safety) Regulations</td><td>
The WSH (DfS) Regulations do not apply to a project where a Designer is appointed before 1 August 2016.

The WSH (DfS) Regulations is applicable to all projects:
• undertaken by a Developer in the course of his or her business;
• with contract sum of $10 million or more; and
• that involve development under section 3(1) of the Planning Act (Cap. 232).

Any modification carried out on a building or structure that has an existing DfS Register and falls under the definition of "Development" under the Planning Act will have to comply with the DfS Regulations. This is regardless of the contract sum value.

Contract sum in relation to any construction work, means the value specified in a contract of the works to be carried out by the Contractor undertaking the construction work; it includes goods and services tax payable in relation to the supply of the work. Variation orders are not considered in contract sums.

The following examples illustrate applications of the DfS Regulations:

<table>
<tr><th>Scenario</th><th>Do the DfS Regulations apply? (Yes/ No)</th></tr>
<tr><td>1. I am building a good class bungalow with a contract sum of $12 million for my own occupation. Do the DfS Regulations apply to me?</td><td>No</td></tr>
<tr><td>2. Our company is developing a residential condominium project with a contract sum of $20 million. Do the DfS Regulations apply to our project?</td><td>Yes</td></tr>
<tr><td>3. We are developing a commercial building with a contract sum of $9 million. However, due to variation orders during the design phase, the contract sum is now $10.5 million. Are we required to comply with the DfS Regulations?</td><td>No</td></tr>
</table>
</td></tr>
</table>

Term	Description
	<table><tr><td>4. We appointed a Designer for our development project in 2015. Are we still required to comply with the DfS Regulations?</td><td>No</td></tr><tr><td>5. Alteration works with a contract sum of $6 million on a building which already has a DfS Register. Do we need to continue updating the DfS Register and comply with the Regulations?</td><td>Yes</td></tr><tr><td>6. We are carrying out Addition & Alteration works on an existing building built before 1 August 2016 and it does not have a DfS Register. The contract sum for this project amounts to more than $10 million and falls under the definition of the term "development" as specified in the Planning Act. Do we need to comply with the DfS Regulations?</td><td>Yes</td></tr></table> **Note:** Despite the ambit of DfS application, the WSH Council encourages Developers, Designers and Contractors to apply DfS to all building projects. This restricted applicability of the Regulations should not be construed as prohibiting or discouraging the practice of DfS to all building projects.
Affected Person	An Affected Person is defined as anyone: • carrying out or is liable to be affected by construction work (including additions, alterations and demolition) for the structure, or • working in a completed structure as a workplace, particularly an individual who maintains or cleans the structure, or anything in or on the structure.
Design Risk	In relation to a structure, Design Risk means anything present or absent in the design of the structure that increases the likelihood of an affected person to suffer bodily injury when constructing, working in or demolishing the structure.

Term	Description
Foreseeable Design Risk	The danger or threat to the safety and health of an Affected Person, which a reasonable person should anticipate, due to anything present or absent in the design of the structure.
Hazard	Anything with the potential to cause bodily injury, and includes any physical, chemical, biological, mechanical, electrical or ergonomic hazard.
Principal	An organisation or person who, in connection with any trade, business, profession or undertaking carried on by him, engages any other person otherwise than under a contract of service: (a) to supply any labour for gain or reward; or (b) to do any work for gain or reward.
Reasonably Practicable	A risk in a particular situation that can be balanced against the time, trouble, cost and physical difficulty of taking measures to avoid the risk. An action is considered to be practicable when it is capable of being done. To decide if an action is reasonable, one has to consider: • the severity of any injury or harm to health that may occur; • the likelihood of that injury or harm occurring; • how much is known about the hazard and the ways of eliminating, reducing or controlling it; and • the availability, suitability and cost of the safeguards. The severity and likelihood of injury needs to be weighed against the overall feasibility of the safeguards needed to remove the risk. The greater the likelihood and/or severity, the more reasonable it is to go to considerable expense and effort to reduce it. The cost of putting safeguards in place needs to be measured against the consequences of failing to do so. The judgement is an objective one. Whether an employer can afford to put in the necessary safeguards in place is not a consideration, particularly when there is a chance of serious injury, or frequent but less severe injury. Common practice and knowledge in the relevant industry are sometimes taken into account when one is deciding whether a safeguard is considered "reasonably practicable". Employers cannot claim that they do not know what to do about certain hazards if those hazards and their safeguards are widely known in the same industry. For information on safety and health measures considered to reasonably practicable, refer to the WSH-related Singapore Standards published by SPRING Singapore, and WSH materials published by the WSH Council.
Risk	Likelihood that a hazard will cause a specific bodily injury to any person.

Term	Description
Structure	Any permanent or temporary structure. A reference to a structure includes any part of the structure and any product, architectural works or mechanical or electrical system intended for the structure. For permanent structures, this would include any building, timber, masonry, metal, composite or reinforced concrete structure, structure designed or used to provide support or means of access, railway line or siding, dock, harbour, inland navigation, tunnel, shaft, bridge, viaduct, waterworks, reservoir, pipe or pipe-line, cable, aqueduct, sewer, sewage works, gasholder, road, airfield, sea defence works, river works, drainage works, earthworks, lagoon, dam, wall, caisson, mast, tower, pylon, underground tank, earth retaining structure or structure designed to preserve or alter any natural feature, fixed plant and any structure similar to those listed. For temporary structures, this would include any formwork, falsework, scaffold or other structure designed or used to provide support or means of access during construction work.

Annex B: Summary of Duties under the WSH (DfS) Regulations

The table below shows duties of various stakeholders under the WSH (DfS) Regulations:

Stakeholders	Duties
Developers **Refer to WSH (DfS) Regulations 4 to 8**	**General duties** • Ensure that all foreseeable design risks are eliminated if reasonably practicable. • Where not reasonably practicable to eliminate foreseeable design risks, the Developer shall ensure that the design risks are reduced to as low as reasonably practicable. • When reducing risks, design risks shall be reduced at its source and collective protective measures shall be used instead of individual protective ones. • Ensure that all Designers, Contractors and delegated DfS Professionals are competent to perform their duties. • Plan and manage the project such that all appointed Designers and Contractors have sufficient time and resources to perform their duties. • Provide relevant information to all appointed Designers and Contractors. **DfS Review Meeting** • Convene DfS review meetings to identify all foreseeable design risks and discuss how each foreseeable design risk can be eliminated or reduced when it is not reasonable practicable to eliminate. • Ensure that the DfS review meetings are attended by all relevant Designers and Contractors. **Maintaining a DfS Register** • Keep a DfS Register containing information and records on all DfS review meetings and every residual design risk for the project. • Ensure that the DfS Register is up-to-date. • Ensure that all appointed Designers and Contractors for the project have access to the DfS Register. • Ensure that the DfS Register is available for inspection by registered workplace inspectors. **Delegation of Developer's Duties to DfS Professional** • Developer may delegate the following duties to a DfS Professional: - convening DfS review meetings; and - maintaining a DfS Register. • The Developer must provide a DfS Professional with information necessary for him or her to perform his or her duties.

Stakeholders	Duties
Developers **Refer to WSH (DfS) Regulations 4 to 8**	**Passing on the DfS Register** • If Developer disposes his or her interests in the structure, ensure that the DfS Register is given to the person who acquires his or her interests in the project. The Developer is then responsible for informing him/her the nature and purpose of the DfS Register. • For sub-divided buildings, ensure that the DfS Register is given to the subsidiary management corporation of the subdivided building. The Developer must inform them of the nature and purpose of the DfS Register.
DfS Professional **Refer to WSH (DfS) Regulations 6 to 8**	**DfS Review Meetings** • Convene DfS review meetings to identify foreseeable design risks and discuss how each foreseeable design risks can be eliminated or reduced. • Ensure that DfS review meetings are attended by relevant Designers and Contractors. **Maintaining a DfS Register** • Keep a DfS Register containing information and records on all DfS review meetings and every residual design risk for the project. • Ensure that the DfS Register is up-to-date. • Ensure that all appointed Designers and Contractors for the project have access to the DfS Register. • Ensure that the DfS Register is available for inspection by registered workplace inspectors. **Updating the Developer** • Ensure that the Developer is provided, as soon as practicable after DfS review meetings, with relevant information on all foreseeable design risks identified and how they can be eliminated or reduced • Provide the Developer with the updated DfS Register after new information or records are added.
Designers and Delegated Designers **Refer to WSH (DfS) Regulations 9**	• Prepare a design plan that eliminates, as far as reasonably practicable, all foreseeable design risks. • Where not reasonably practicable to eliminate foreseeable design risks, propose to the person who appointed him/her, a modification to the design plan that would reduce design risks to as low as reasonably practicable. • When reducing risks, design risks shall be reduced at its source and collective protective measures shall be used instead of individual protective ones. • Provide information relevant to the design, construction or maintenance of the structure to the person who appointed the Designer. • Attend and participate in DfS Review Meetings when required by the Developer.

Stakeholders	Duties
Designers and Delegated Designers **Refer to WSH (DfS) Regulations 9**	• Ensure that any appointed Designer (called Delegated Designer) is competent to perform his/her duties under the Regulations. • Ensure that Delegated Designers are provided with relevant information. • A Designer is still responsible for his/her duties even if a Delegated Designer is appointed.
Contractors (Main Contractors and Subcontractors) **Refer to WSH (DfS) Regulations 10**	• Inform the person who appointed the Contractor of any foreseeable design risk. • Ensure that any Designer he/she appoints is competent. • Ensure that any Designer he/she engages is provided with relevant information to assist him/her with his/her duties. • Ensure that any subcontractor he/she engages is competent. • Ensure that any subcontractor he/she engages is provided with relevant information to assist him or her with his/her duties. • Attend and participate in DfS Review Meetings when required by the Developer.
Registered Proprietors **Refer to WSH (DfS) Regulations 11**	• For a structure that is not a sub-divided building, keep the DfS. Register and ensure that the DfS Register is available for inspection upon inspectors' request. • Provide the DfS Register to the person who next acquires the interest in the structure. • Ensure that the person who acquires the interest in the structure is aware of the nature and purpose of the DfS Register.
Subsidiary Management Corporations (For a subdivided building) **Refer to WSH (DfS) Regulations 11**	• Keep the DfS register. • Ensure that DfS Register is available for inspection upon inspectors' request.

Aside from complying with the duties stated in the WSH (DfS) Regulations, the duty holders are required to comply with the WSH Act and its other subsidiary legislation. See References Section for a list of the subsidiary legislation.

Annex C: List of Typical Designer

Designers can include but not limited to the following:

1. Architects, civil, geotechnical and structural engineers, building designers, engineers, interior designers, landscape architects, town planners and all other design practitioners contributing to, or having overall responsibility for, any part of the design (e.g. drainage engineers designing the drain for a new development);
2. Building services designers, M&E Engineers, fire safety engineers and other designers of services that are part of the permanent structure (e.g. a commercial building) such as, lifts, escalators, building maintenance units, water services, sewerage system, refuse system, heating, cooling, ventilation system, lighting, electrical systems, electrical appliances, switch gear, transformer, fire extinguisher installations, pump, pipelines, fixed plant and machinery;
3. Other specialists, such as façade designers, feature wall/green wall designers, roof designers, architectural features designers, prefabricated bathroom units/prefabricated prefinished volumetric construction designers, steel work designers, precast and post tensioning work designers;
4. Anyone who specifies or alters a design, or who specifies/approves the use of a particular method of work or material, including a Developer's or a Contractor's representative, such as, design managers, material engineers, quantity surveyors, contract managers, procurement managers, project managers, construction managers (e.g. who specify or insists on specific materials or who stipulates a particular layout for a new building);
5. Those who purchase materials and those approving the purchase where the choice has been left open, e.g. those purchasing building blocks and so deciding the weights that bricklayers must handle;
6. Contractors carrying out design work as part of their undertaking (e.g. an engineering contractor providing design, procurement and construction management services);
7. Temporary works engineers, including those designing formwork, falsework, scaffolding, sheet piling, ERSS, curtain wall facade retention schemes, temporary office, quarter, temporary access/ ramp etc; and
8. Interior designers, including shop fitters who also develop the design.

Note

"Designer" can include individual designers and/or a designer company.

Annex D: Areas which the Designer has Influence Over

The following are some design areas the Designer has direct influence over to aid him/her in carrying out DfS reviews. The list is not exhaustive, nor is every item relevant to every project.

1. Consider risks from site hazards:
   - Underground services;
   - Vehicle traffic movements to and within the site;
   - Pedestrian movements within and around the site; and
   - Condition and proximity of adjacent buildings.

2. Design out health hazards:
   - Specify less hazardous materials (e.g. solvent-free or low solvent adhesives and water-based paints);
   - Avoid processes that create hazardous fumes, vapours, dust, noise or vibration, including disturbance of existing asbestos, cutting chases in brickwork and concrete, breaking down cast-in-situ piles to level, scabbling concrete, manual digging of tunnels, flame cutting or sanding areas coated with lead paint or cadmium; and
   - Specify materials that are easier to handle, (e.g. lightweight building blocks, limiting the weight of formwork for easier handling).

3. Design out safety hazards:
   - Remove the need to work at height wherever possible, particularly where it requires work from ladders or where safe means of access cannot be provided;
   - Remove fragile roofing materials or designing access route to the roof (e.g. a working platform);
   - Eliminate deep or long excavations in public areas or on highways; and
   - Eliminate materials that could create a significant fire risk during construction.

4. Consider prefabrication to minimise hazardous work on site:
   - Incorporate design elements like steel structures that be prefabricated and assembled on ground, and safely lifted for installation;
   - Specify cutting of steel members to be done off-site, under controlled conditions, to reduce the amount of dust created; and
   - Minimise site welding to reduce fire or burn risks and using prefabricated bolt and nuts as connections.

5. Features that reduce or eliminate the risk of falling should be introduced where it is not possible to remove the need to work at height:
   - Early installation of permanent access (e.g. ceiling-mounted work platforms, walkways and stairways), to reduce the use of ladders or scaffolds;
   - Edge protection or other features that increase safe access and construction; and
   - Anchor points for installation of lifeline or safety harnesses when a work platform cannot be installed.

6. Design to simplify safe construction:
   - Provide lifting points on prefabricated elements and marking the weight and centre of gravity of heavy or bulky items on drawings and on prefabricated items;
   - Provide for temporary works required during construction;
   - Design for joints in vertical steel structure members to ensure that bolting can be easily done by someone standing on the floor using seating angles to provide support while bolting is being done;

- Design connections to minimise risk of incorrect assembly and clear directions on drawings on how to do so; and
- Design for safe installation of external cladding (e.g. installation of cladding from the inside of the building).

7. Identify worst credible scenarios and implement preventive control measures:
   - Design adequate safety factors so that overloading (static, dynamic and impact) and collapse of permanent or temporary structure are not possible;
   - Put in place monitoring instruments to provide early warning of possible collapse or ground movements; and
   - Establish an emergency route for mass evacuation in the event of emergency.

8. Design to ease future inspections, maintenance and cleaning work:
   - Provide safe permanent access, including to roofs and M&E spaces;
   - Provide safe temporary access to allow for painting and maintenance of facades, re-application of fire protection material on steel structures etc;
   - Provide adequate working space in M&E areas;
   - Use paints or materials that require less frequent maintenance or replacement;
   - Design features on facades that allows cleaning from the inside, e.g. windows, vertical greenery etc;
   - Place all controls and electrical boxes at accessible locations; and
   - Consider safe movement of pedestrian and vehicle traffic flow during occupancy.

9. Identify unusual demolition hazards for future plans:
   - Sources of substantial stored energy, such as pre- or post-tension cables;
   - Unusual stability concepts;
   - Alterations that have changed the structure significantly; and
   - Embedded materials, utilities, or artefacts whose exposure or removal may introduce new hazards.

Designers have to note that their creativity should not be limited by the above. Designers need not design out every hazard identified, but they should weigh the risk level of the hazards and as far as reasonably possible, design out the risks either by eliminating the hazards or incorporating control measures to reduce the risks to acceptable levels.

Annex E: DfS Considerations Based on Life Cycle Stages of a Building/Construction Project

Design Stage	Source of Hazards	Considerations
Project Inception (To consider broad information such as project location, basic positioning and orientation of the structures/ facilities, linkage to existing facilities, etc)	Siting of Structure	• Has the soil profile of the proposed project's site been studied by Qualified Persons (QPs)? • Are there buildings or structures that may have shallow foundation in the vicinity of the proposed project? • Will the ground water table be lowered as a result of the proposed construction? • Will there be possible settlement due to the proposed project? • Are there preventive measures to ensure that settlement is minimal?
	Underground Services	• Are there underground services in the site that need to be removed or relocated for the project? • Will the removal or relocation of these services, if any, be a hazard to workers?
	Development Type	• Are there features that require special arrangements during construction? • Are there features such as facade, roof and skyrise greenery features that require special arrangements during maintenance?
	Weather	• Is there a possibility of floods happening in the site? If so, how can the hazards be minimised in the temporary and permanent stages? • Is there a possibility of lightning strikes happening in the site? If so, how can the hazards be minimised in the temporary and permanent stages? • Are there other adverse weather conditions that can affect workers' safety and health onsite? • What are the effects of extreme temperature or humidity on instrumentation?
	Others	• Can the method of construction or sequence be identified at present? • Are there hazards associated with the method of construction or sequence that can be dealt with at present? • Are there any foreseeable hazards that can be identified and eliminated? • Will the commencement of the project affect the public? • Will the commencement of the project affect traffic?

Design Stage	Source of Hazards	Considerations
Concept & Detailed Designs (More rigorous considerations of the proposed sites and facilities requirements, traffic, type of structures in the surroundings, and other general constraints. Considers the structure's detailed architectural and structural design. The review should determine risks involved in the construction methods, access and egress, etc.	In-situ works (vs Prefabrication off-site)	• Can elements such as steel structures be prefabricated, assembled on ground and then lifted to position for installation? • Can the cutting of steel members be done off-site, under controlled conditions to reduce the dust created? • Can site welding be reduced to minimise fire or burn risks? • Can prefabricated nuts and bolts be used as connections? • Can prefabricated elements be provided with designed lifting points, and the weight and centre-of-gravity marked on the drawings and prefabricated items? • If the prefabricated structure is required to be temporarily suspended for a period of time before final installation, are there means to ensure the hazards arising from this are removed? • Can joints in vertical steel structure members be designed such that bolting can be done on the ground? • Can connections be designed to minimise risk of incorrect assembly (e.g. unique bolt layout for each connection)? • Are instructions provided on drawings clear? • Can site conditions be verified by the Designer to allow for lifting cranes to be positioned safely before deciding on prefabrication as the method of construction?
	Heavy Lifting	• Can the building layout be optimised to allow heavy lifting by tower cranes during construction; or heavy lifting using mobile cranes to carry out subsequent maintenance/replacement works? • Consider the work process and equipment required for heavy lifting. Is the position for parking these equipment finalised and cordoned off? • Does the lifting equipment need a customised foundation to minimise settlement and failure of support? • Consider the worst credible scenario. Can this scenario be prevented or managed to minimise injuries?
	Working at Height	• Can the need for work at height be removed? E.g removing the need to work at height when a safe means of access cannot be provided. • Can fragile roofing materials be removed or can an alternative access route to the roof (e.g. a work platform) be designed?

Design Stage	Source of Hazards	Considerations
Concept & Detailed Designs (More rigorous considerations of the proposed sites and facilities requirements, traffic, type of structures in the surroundings, and other general constraints. Considers the structure's detailed architectural and structural design. The review should determine risks involved in the construction methods, access and egress, etc.	Working at Height	• Can skylights be substituted with other innovative technologies? If skylights are needed, can they be manufactured to withstand human impact or point load? If not, can safety barricades be provided to prevent falling through the skylight? • Can an early installation of permanent access (e.g. ceiling mounted work platforms, walkways and stairways) reduce the use of ladders or scaffolds? • Can edge protection or other features that allow safe access and construction be designed and installed? • Can permanent anchor points and lifelines be provided for travel restraint or fall arrest purposes when work platforms cannot be installed? • Can floor openings, if any, be minimised?
	Temporary Works and Sequencing	• Can a safer means of access or egress, instead of temporary means, be used? • Can the permanent staircase and lifts be completed first so that they can be used during the construction stage? • Will the design affect the work process during construction? • Can temporary works required during construction be planned for earlier? E.g. specifying the type and position of temporary works required to ensure that spatial considerations are taken into the account during the design stage. • Are there special construction considerations that need to be highlighted to the Contractor? • Does the sequence of construction create any temporary unstable working platform that requires additional bracing? • Can adequate safety factors be incorporated in the design so that overloading or collapse of the permanent or temporary structure is prevented?
	Traffic Management	• Can the layout be optimised to prevent any accidents arising from the flow of traffic, pedestrians, equipment, etc within and around the site during the construction stage? • Consider the flow of traffic, pedestrians, and equipment within and around the site during the permanent stage. Can the layout be optimised to prevent accidents? • Is there a need to designate specific flow diagrams for materials, equipment, vehicles and human traffic movement?

Design Stage	Source of Hazards	Considerations
Concept & Detailed Designs (More rigorous considerations of the proposed sites and facilities requirements, traffic, type of structures in the surroundings, and other general constraints. Considers the structure's detailed architectural and structural design. The review should determine risks involved in the construction methods, access and egress, etc.	Confined Space	• Does the design create confined spaces in the permanent or temporary stage? E.g. the design and construction of Stormwater Detention Tank System and/or Urban Water Harvesting System. • Can the confined space be removed from the design? • Can the need to enter the confined space be minimised by removing vital equipment or controls out of the confined space?
	Access for Maintenance (see Annex K: Maintenance Strategy Report)	• Are there features such as facade, roof and skyrise greenery features that require special arrangements during maintenance? • Does the provision of access take into account the safe and efficient movement of maintenance workers and the tools and equipment needed to carry out maintenance work? • Can temporary means of access (e.g. scaffolding, makeshift ladder, etc.) be eliminated by providing workers with permanent safe access to areas requiring regular maintenance? • Does the design incorporate permanent safety lines, anchorage and hoisting points into structures for maintenance work that needs to be carried out at height? • Can durable materials that require lower frequency of maintenance be used (e.g. powder-coated aluminium materials versus mild steel materials that require regular repainting)? • Can the maintenance work be carried out at ground level in a safe and productive manner? E.g. locating air-conditioning units at ground level, placing luminaires within reachable height etc. • Does the design create low headroom that reduces the safety and efficiency of workers carrying out the maintenance work? • Does the design minimise the need for maintenance workers to enter ducts and crawlspaces? • Does the design minimise the need for the deconstruction of bulkheads, claddings, casings, etc during routine inspection and maintenance? • Does the design allow sufficient space for vehicles (e.g. cranes, cherry-pickers) to operate safely and efficiently during the maintenance and operation of the building? • Does the design allow for sufficient working space in M&E rooms and around M&E equipment for inspection, maintenance, repair and replacement of equipment?

Design Stage	Source of Hazards	Considerations
Concept & Detailed Designs (More rigorous considerations of the proposed sites and facilities requirements, traffic, type of structures in the surroundings, and other general constraints. Considers the structure's detailed architectural and structural design. The review should determine risks involved in the construction methods, access and egress, etc.	Access for Maintenance (see Annex K: Maintenance Strategy Report)	• Does the design provide maintenance access at every level if there are vertical greenery systems that span a few storeys? • For residential buildings and landed properties where air conditioning systems are required, does the design incorporate easily accessible and barricaded air conditioning unit service ledges to facilitate safe maintenance and servicing?
	Emergency Route	• Is the emergency route for the temporary and permanent stages the shortest and most direct? • Are there adequate lighting, directions, warning and backup power for mass evacuation of people along the emergency routes?
	Health Hazards	• Can less hazardous materials be used (e.g. solvent-free or low solvent adhesives and water-based paints? • Can materials that create significant fire risk be removed? • Can processes that create hazardous fumes, vapours, dust, noise or vibration be avoided? E.g. disturbing existing asbestos, cutting chases in brickwork and concrete, breaking down cast-in-situ piles to level, scrabbling concrete, hand-digging tunnels, flame-cutting or sanding areas coated with lead paint or cadmium.
	Others	• Are there other major hazards that need to be dealt with? • Can sources of substantial stored energy, such as pre- or post-tension cables, be specified in the drawings and highlighted for future demolition? • Can alterations that have significantly changed the building or structure be highlighted? • Can disruptions to existing utilities within occupied • buildings be avoided? • Will the commencement of the project affect the public? • Will the commencement of the project affect traffic?

Design Stage	Source of Hazards	Considerations
Pre-Construction planning and Construction stage Considers temporary works design, design by specialist contractors, site arrangement and facilities, etc., and design residual risks. Identify risks involved in maintenance, repair, cleaning methods, etc. Identify risks involved in decommissioning, demolition, etc	Temporary Works and Sequencing	• Can a safer means of access or egress, instead of the temporary means, be used? • Can monitoring instrumentation that provides early warning of possible collapse or ground movements be installed? • Can the permanent staircase and lifts be completed first so that they can be used during the construction stage? • Will the design affect the work process during construction? • Can temporary works required during construction be planned for earlier? E.g. specifying the type and position of temporary works required to ensure that spatial considerations are taken into the account during the design stage. • Are there special construction considerations that need to be highlighted to the Contractor? • Does the sequence of construction create temporary unstable stages that require additional bracing? • Can adequate safety factors be incorporated in the design so that overloading or collapse of the permanent or temporary structure is prevented? • Will there be possible basal heave and piping during excavation? • Will there be settlement due to the proposed project? • Has a proper schedule for monitoring of instrumentation been provided? • Will there be adverse effects on adjacent structures during the removal of temporary works? • Are there alternatives or measures that could reduce or minimise such adverse effects?
	Specialist Design	• Are there safety concerns on elements of specialist design to be considered by the Contractor? • Can alternative safe work practices be used to mitigate such concerns?

Annex F: Red Amber Green (RAG) Lists

The RAG List is only one example; Designers should develop their own specific RAG list that is relevant to their own areas of design.

Red Lists

Hazardous procedures, products and processes that should be eliminated from the project where possible

- Lack of adequate pre-construction information (e.g. asbestos surveys, details of geology, obstructions, services, ground contaminations etc).
- Hand-scabbing of concrete (e.g. 'stop ends').
- Demolition by hand-held breakers of the top sections of concrete piles (pile cropping techniques are available).
- Specification of fragile roof lights and roofing assemblies.
- Processes giving rise to large quantities of dust (e.g. dry cutting, blasting, etc).
- On-site spraying of harmful substances.
- Specification of structural steelwork which is not purposely designed to accommodate safety nets.
- Design of roof-mounted services that require access (for maintenance etc), without provision for safe access (e.g. barriers).
- Glazing that cannot be accessed safely. All glazing should be anticipated as requiring cleaning replacement, so a safe system of access is essential.
- Entrances, floors, ramps, stairs and escalators not specifically designed to avoid slips and trips during use and maintenance, including taking into account the effect of rain and spillages.
- Design of environments involving adverse lighting, noise, vibration, temperature, wetness, humidity and draughts or chemical and/or biological conditions during use and maintenance operations.
- Designs of structures that do not allow for fire containment during construction.

Amber Lists

Products, processes and procedures to be eliminated or reduced as far as possible and only specified or allowed if unavoidable, including amber items would always lead to the provision of information to the contractors

- Internal manholes and inspection chambers in circulation areas.
- External manholes in heavily used vehicle access zones.
- Specification of 'lip' details (e.g. trip hazards) at the tops of pre-cast concrete staircases.
- Specification of small steps (e.g. risers) in external paved areas.
- Specification of heavy building blocks (e.g. those weighing more than 20kg).
- Large and heavy glass panels.
- Chasing out concrete, brick or blockwork walls or floors for the installation of services.
- Specification of heavy lintels (slim metal or hollow concrete lintels are better alternatives.)
- Specification of solvent-based paints and thinners, or isocyanates, particularly for use in confined areas.
- Specification of curtain wall or panel systems without provision for tying or raking scaffolds.
- Specification of a blockwall more than 3.5 metres high using retarded mortar mixes.

- Site traffic routes that do not allow for one-way systems and/or vehicular traffic segregated from site personnel.
- Site layout that does not allow adequate room for delivery and/or storage of materials, including site-specific components.
- Heavy construction components which cannot be handles using mechanical lifting devices (because of access restrictions/floor loading and so on).
- On-site welding, in particular for new structures.
- Use of large piling rigs and cranes near live railways and overhead electric power lines or where proximity to obstructions prevents guarding of rigs.

Green Lists
Products, processes and procedures to be positively encouraged.

- Adequate access for construction vehicles to minimise reversing requirements (one-way systems and turning radii).
- Provision of adequate access and headroom for maintenance in plant room, and adequate provision for replacing heavy components.
- Thoughtful location of mechanical and electrical equipment, light fittings, security devices and so on to facilitate access, and placed away from crowded areas.
- Specification of concrete products with pre-cast fixings to avoid drilling.
- Specification of half board sizes for plasterboard sheets to make handling easier.
- Early installation of permanent means of access, and prefabricated staircases with handrails.
- Provision of edge protection at permanent works where there is a foreseeable risk of falls after handover.
- Practical and safe methods of window cleaning (e.g. from the inside).
- Appointment of a temporary works co-ordinator (BS 5975).
- Off-site timber treatment if PPA- and CCA-based preservatives are used (boron or copper salts can be used for cut ends on site).
- Off-site fabrication and prefabricated elements to minimise on site hazards.
- Encourage the use of engineering controls to minimise the use of personal protective equipment.

Annex G: DfS Checklist Based on Hazards

The following may be used to assist in identifying hazards and controlling risks associated with the design of a structure throughout its lifecycle.

Electrical safety
- Earthing of electrical installations
- Location of underground and overhead power cables
- Protection of leads/cables
- Number and location of power points

Fire and emergencies
- Fire risks
- Fire detection and fire fighting
- Emergency routes and exits
- Access for and structural capacity to carry fire tenders
- Other emergency facilities

Movement of people and materials
- Safe access and exit, including for people with disability
- Traffic management
- Loading bays and ramps
- Safe crossings
- Exclusion zones
- Site security

Working environment
- Ventilation for thermal comfort and general air quality and specific ventilation requirements for the work to be performed on the premises
- Temperature
- Lighting including that of plant rooms
- Acoustic properties and noise control, for example noise isolation, insulation and absorption
- Ergonomics
- Seating
- Floor surfaces to prevent slips and trips
- Spaces for occupants

Plant
- Tower crane locations, areas for loading and unloading
- Mobile crane loads on slabs
- Plant and machinery installed in a building or structure
- Plant and equipment for material handling
- Access for maintenance of plant and equipment
- Guarding plant and machinery
- Lift installations

Amenities and facilities
- Access to various amenities and facilities such as storage, first aid rooms/sick rooms, rest rooms, and meal, accommodation and drinking water areas

Earthworks
- Excavations (e.g. risks from earth collapsing or engulfment)
- Location of underground services

Structural safety
- Erection of steelwork or concrete frameworks
- Load-bearing requirements
- Stability and integrity of the structure

Manual tasks
- Methods of material handling
- Accessibility for material handling
- Loading docks and storage facilities
- Workplace space and layout to prevent musculoskeletal disorders, including facilitating use of mechanical aids
- Assembly and disassembly of prefabricated fixtures and fittings

Substances
- Exposure to hazardous substances and materials including insulation and decorative materials
- Exposure to volatile organic compounds and off-gassing through the use of composite wood products or paints
- Exposure to irritant dust and fumes
- Storage and use of hazardous chemicals, including cleaning products

Falls prevention
- Guardrails
- Window heights and cleaning
- Anchorage points for building maintenance and cleaning
- Access to working spaces for construction, cleaning, maintenance and repairs
- Scaffolding

Annex H: Sample Design Risk Assessment Form

Sample Design Risk Assessment Form												
Project tittle												
Company												
Review						Conducted by						
Review date Next Review Date Process / Location												
S/N	Design Cosideration	Hazards	Risk Assessment			Can these hazards be designed out?	Proposed Control Measures	Residual Risk Assessment			Further Review Required?	Action By
			Severity	Likelihood	Risk			Severity	Likelihood	Risk		

Note
Other formats may be used if deemed suitable.

Annex J: Advisory Notes

It is recommended to use advisory notes for effective communication of residual risks. Designers must give adequate information of the following to each person who is provided with the design:

- Purpose/s for which the structure was designed;
- The results of any calculations, testing, analysis or examination, carried out in accordance with the WSH Act; and
- Any condition necessary to ensure that the structure is without risks to health and safety when used for a purpose for which it was designed or when carrying out some activities related to the structure, e.g. construction, maintenance and demolition.

Such advisory notes should appear in the documents the affected person would refer to in the natural course of their work, for example:

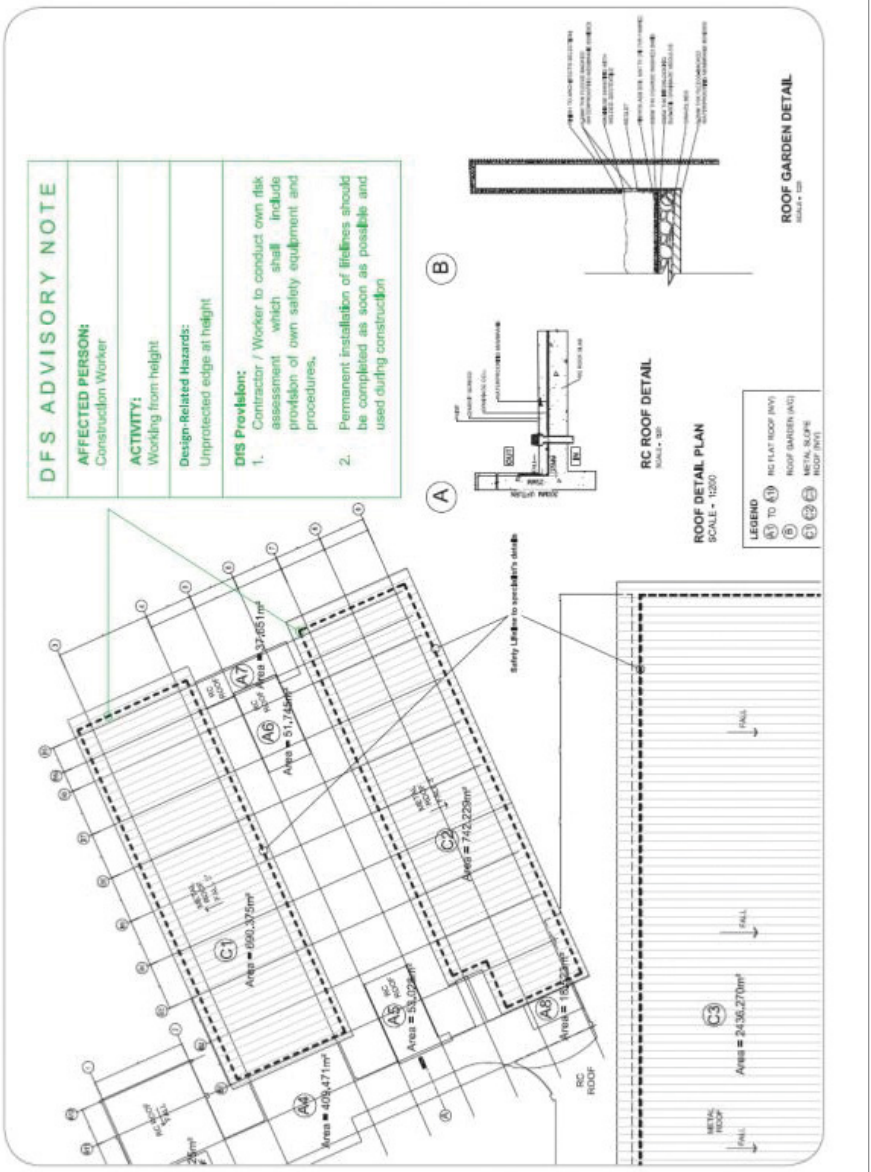
1. **Construction**: Advisory notes should be provided in the contract documents (including working drawings and details, specifications, preliminaries, etc). The Contractor should transfer such advisory notes onto shop drawings, method statements, construction planning documents, etc that would be disseminated to workers on the ground.
2. **Maintenance**: Advisory notes should be provided in the Operations and Maintenance Manual (including As-Built drawings) typically provided to building owner upon handover of the building.
3. **Occupancy** (of a building used as a workplace): The advisory notes should be provided in the Standard Operating Procedures that may be provided, if applicable, to building owner upon handover of the building.

Points for Designers to consider when providing information:

- Hazardous substances or flammable materials included in the design;
- Heavy or awkward prefabricated elements likely to create handling risks;
- Features that create access problems;
- Temporary work required to construct or renovate the building as designed, e.g. bracing of steel or concrete frame buildings;
- Features of the design essential to safe operation;
- Methods of access where normal methods of securing scaffold are not available;
- Any parts of the design where risks have been minimised but not eliminated; and
- Noise and vibration hazards from plant.

Example of an advisory note on drawings:

Residual Risk Information on Roof Garden Details



Annex K: Maintenance Strategy Report

During early design processes, Designers should document their proposals and requirements regarding access strategies for maintenance tasks, some examples of which include safe access to cleaning, delivering or removing heavy parts, such as chiller plants, water tanks, or diesel where standby generators are mounted on roof level, with provision of minimum space to carry out maintenance safely and ergonomically. Another example is to incorporate easily accessible and barricaded air-conditioning unit service ledges to facilitate safe maintenance and servicing for residential buildings and landed properties where air-conditioning systems are required.

All such considerations should be addressed in a Maintenance Strategy Report, which should then be collated into the DfS Register. Designers should identify key features relating to maintenance activities that:

- Are carried out in a particular manner;
- Affect the health and safety of maintenance workers or building users; and
- Entail a disciplined approach, for example, in scheduling, coordination and execution.

In developing access strategies and maintenance work methods, Designers should consult relevant people who have specialised knowledge and/or capacity to control or influence the design (e.g. the client, engineers, contractors, facility managers, DfS Professional and products specialists or manufacturers) to identify risks and appropriate solutions.

A typical report should contain sufficient details to inform those undertaking the maintenance tasks. The content of the report should include but not limit to:

- Key building features relating to maintenance tasks;
- Anticipated maintenance tasks and their frequencies;
- Proposed work equipment and methods employed for achieving accessibility and productivity in maintenance; and
- Specific safety measures.

Example of a Maintenance Strategy Report.

Facade Maintenance Strategy

A. External Areas

	Building Area/ Element	Routine Maintenance	Major Maintenance	Solution		Comments
1	Tower block: Facade curtain wall • Full height from ground level to roof • All elevations including recesses and protrusions	• Facade cleaning and inspection	• Glass replacement • Curtain wall repairs • Facade lighting repairs	• Routine maintenance • Major maintenance	A	• Permanent suspended platform with monorail system to access all facade surfaces • Integrated restraints in facade system
2	Tower block: External planters	• Routine inspection and cleaning • Planting, pruning and fertilising	• Plant or soil replacement • Drainage or irrigation repairs	• Routine maintenance • Major maintenance	A	• Permanent suspended platform with monorail system to access all planters • Integrated restraints in facade system • Protection rail for hanging planters
3	Tower block: • Entrance glass canopy • Top and underside including structural element	• Cleaning • Luminaire replacement	• Glass replacement • Building services repair (drainage, electrical, etc)	• Routine maintenance • Major maintenance	B	• Access using self-propelled access platform • Accessible via paved fire engine access • Fall arrest system provided on surface of canopy

	Building Area/ Element	Routine Maintenance	Major Maintenance	Solution		Comments
4	Covered walkways	• Cleaning	• Cladding repairs • Building services repair (drainage, electrical, etc)	• Routine maintenance • Major maintenance	C	• Accessible via ground level walkway • Fall arrest system provided on surface of canopies

B. Internal Areas

	Building Area/ Element	Routine Maintenance	Major Maintenance	Solution		Comments
5	Atrium	• Glass cleaning • Cleaning shading devices • Luminaire replacement	• Glass repair or replacement • Ceiling or shading devices repair • Building services repair	• Routine maintenance • Major maintenance	D	• Personnel lifting hoists for suspended platforms

Legend

Solution A – Suspended platform with monorail system
Solution B – Self-propelled access platform
Solution C – Rope access
Solution D – Personnel lifting hoists or other suitable means

More details on *Maintenance Strategy Report* can be found in the Design for Maintainability Checklist by the Building and Construction Authority.

Published in **August 2022** by the Workplace Safety and Health Council in collaboration with the Ministry of Manpower.

This publication is available on the
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