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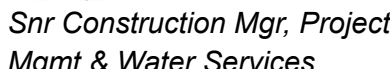
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00	01-Oct-2021	Initial Release
01	01-Aug-2022	Reviewed with no changes

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1. Purpose

To establish the guidelines for Design for Safety (DfS) to Keppel Infrastructure, KI Global for compliances and implementation. All the relevant stakeholders such as developers, owners, consultants, vendors, suppliers, operators, and other relevant stakeholders to work together to address the risk, hazards during the entire cycle of the project, that is conceptual, preliminary and detail design, pre-construction, construction, testing & commissioning, operation & maintenance, extension/upgrading and demolition.

2. Objectives

The objectives for DfS guidelines are:

- To eliminate, if not possible to reduce all foreseeable risks as far as it is reasonably practicable during design stage.
- To implement holistic reviews, identify potential risk at source during early stage of project, continual review during construction and further enhancement during operations.
- To plan for the safety of any person who are carrying out the construction work, operating & maintaining the installations, for future upgrading/ extension and carrying out the demolition work.

3. Scope

This DFS guidelines apply to the following:

- KI Global company workplaces including project sites, pipelines, storage yards and plant facilities.
- Operating plant facilities which are having existing DFS register.
- The projects, plant facilities which are required under local regulations; KI shall comply with requirements that are more stringent.

4. Act, Regulations and Relevant References

- WSH (Design for Safety) Regulations 2015 - Section 3.1 (a)
- Planning Act (Cap. 232) - Section 3(1)
- WSH Guidelines Design for Safety (2016)
- "DFS Good Practice Guide, REDAS, Singapore (2019)
- Keppel GHSE DfS Guidelines

5. Definitions

AFC – Approved for Construction
ATP - Accredited Training Provider
Blue Book – Good design practices to be followed
C&S – Civil & Structures
CEO, KI – Chief Executive Officer, Keppel Infrastructure Holdings Pte Ltd
DFS or DfS – Design for Safety
DFSP – Design for Safety Professional
E&ICA – Electrical, Instrument, Control and Automation
GHSE – Group Health, Safety & Environment
HSE – Health, Safety & Environment
KI – Keppel Infrastructure
KI BU – Keppel Infrastructure Business Units
MECH- Mechanical
MOM – Minister of Manpower
MSRA – Method Statement and Risk Assessment

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O&M – Operation & Maintenance
 REDAS - Real Estate Developers' Association of Singapore
 Red Book – Bad design examples to be avoid
 SO – Safety Officer
 SOP – Standard Operation Procedure
 T&C – Testing and Commissioning
 WSH – Workplace Safety and Health
 WSHC – Workplace Safety and Health Council

6. Procedures

1. Definition and regulatory requirement of DFS

1. Requirement under WSH (Design for Safety) Regulations 2015 with effective from 1 Aug 2016
2. Applicable to:
 1. all construction Projects with contract value of \$10 million and above
 2. is undertaken by a developer in the course of the developer's business
 3. involves development under section 3(1) of the Planning Act (Cap. 232)
 4. a project to modify a permanent structure, in respect of which a design for safety register has been kept under regulation 7, that involves development under section 3(1) of the Planning Act
3. DFS Regulations require stakeholders such as Developers, Designers and Contractors to work together to address risk at source and plan for safe work in regard to a building or structure as a workplace. By working together, they can identify and eliminate or reduce, as far as reasonably practicable, all foreseeable design risk(s) of any person's safety or health. Design for Safety (DFS) is about identifying and managing risk right from the start to end of project phases including:
 1. Eliminate at source
 2. Reduced design risk
 3. Improved productivity
 4. Better coordination
 5. Safer and healthy worker
4. The term "Reasonably Practicable" means that the degree of risk in a particular situation 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 degree of risk (or likelihood) of that injury or harm occurring
 - how much is known about the hazard and ways of eliminating, reducing or controlling it
 - the availability, suitability and cost of the safeguards
5. Under the WSH (DFS) Regulations, the failure to make available the DFS Register for inspection by a registered workplace inspector will result in a fine of not more than \$10,000 upon conviction. The penalties for failure to perform other duties under the WSH (DFS) Regulations will result in a fine of not more than \$20,000 or imprisonment for a term not exceeding 12 months or to both. This is the maximum penalty for the contravention of each duty.

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6. For projects sites, storage/yards, plants facilities which are not in Singapore context, and/or not categorise under clause 6.1.2 above, this DFS procedure shall serve as a general guideline to comply and any exclusion, deletion or amendment on this guideline shall subject to management approval.

7. KI BU shall also make reference to the documents under Clauses 6.7, List of standard KI HSE requirements and under Clauses 6.8, Checklist for inspection / audit by DFS consultant / DFS coordinator below to comply with and any exclusion, deletion or amendment shall subject to management approval.

8. For avoidance of doubt, the management refer in Clause 6.1.6 and Clause 6.1.7 shall base on the development, project contract value subject to the MOA responsibility.

2. Selection & registration of DFS Professional (DFSP) or DFS Coordinator

DFS professional:

1. The selection & registration of Design for Safety Professional, DFSP shall be done via the KI Supplier Assessment in Ariba system.

2. A Suitably, Qualified DFSP is required to assist / facilitate the team to perform all roles & duties under the Regulations and Guidelines.

3. The DFSP shall be familiar with the design, construction and operation of C&S, E&IC, MECH. He/she shall have attained the qualification of "Certificate of Completion" for the Design for Safety for Professional Course issued by a training provided accredited under the MOM Accredited Training Provider, ATP scheme or other equivalent training provider oversea subject to approval.

4. The selected DFSP shall have reasonable exposure in safety and health for construction, operation & maintenance, upgrading, demolition

5. The DFSP shall be a registered PE or Architect with a practising certificate or have 10 years relevant experience in the design

6. For projects sites, storage/yards, plants facilities which are not in Singapore context, and/or not categorise under clause 6.1.2 above, instead of using DFS professional, DFS coordinator could be considered.

DFS coordinator:

7. Project Director, Manager, Coordinator, or Plant Manager shall select a representative from the team with relevant DFS experience and / or qualification to act as DFS coordinator

8. The DFS coordinator shall refer to this DFS guideline, implement and comply with the requirement stated.

9. The DFS coordinator shall be given authorities to access and coordinate with different discipline within the team and relevant stakeholder to facilitate him/her in DFS process.

3. Roles and Responsible as Stakeholders

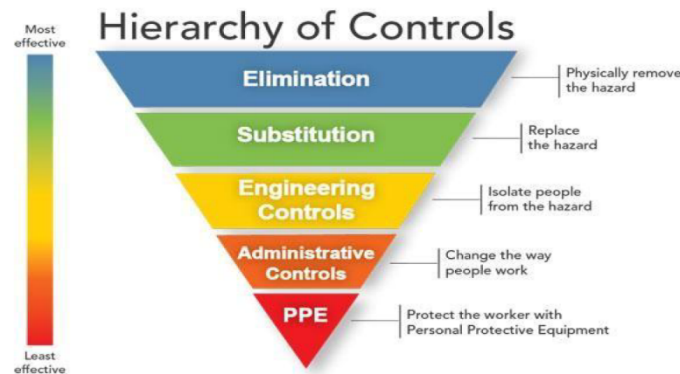
Developer:

1. By law developer will require to engaged DfS Professionals base on the WSH (design for safety) regulations and Planning Act (Cap. 232)

2. Ensure that all foreseeable design risks are eliminated and/or mitigated as far as it is reasonably practicable.

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3. Ensure that as far as possible to eliminate, reduce the risk at source basing on the hierarchy of controls below.



4. Ensure relevant projects, plant facilities information, to be made available for DFSP. And share with the relevant stakeholders the risk registry and the residual risk registered in the registry.
5. To ensure, allow and support DFSP fulfil his obligation and responsibility throughout the entire life cycle of the project.
6. To ensure DFSP conduct regular DFS review meeting and encourage the owner, designer, contractor to actively participate in the hazard identification, constructability, maintainability, and safe approaches.

DFS Professional / DFS coordinator:

7. Convene DFS meetings to identify all foreseeable design risks in the project and plant facilities and brainstorming how each of the foreseeable design risk can be eliminated or reduced.
8. Ensure that each DFS Review Meeting is attended by all the relevant designers and contractors appointed
9. Prepare, develop and submit an updated DFS Register containing information and records on every DFS Review Meeting convened and every residual design risk in the project, / plant facilities with the names of those responsible against action items.
10. To ensure that all relevant parties (designers and contractors etc.) have access to the Risk Register and that all action items are completed in a timely manner.
11. To ensure that the DFS Register is kept up to date
12. To give guidance and facilitate the Contractor's and his Designer's preparation or updates to the design plan that eliminates all foreseeable design risks
13. Assist in the review of the Contractor's proposals to the SO to modify the design plan to minimise the risks for design risks that could not be eliminated
14. To ensure that the Contractor provides all information relevant to design, construction or maintenance of the Works to the designer and owner.
15. To coordinate the stakeholders (Authority, designers, contractors, etc.) and to facilitate the communication of vital information that could affect safety and health risks in the project and plant facilities.

Designer:

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16. Identify hazards, associated risk, residual risk during phases of designs.
17. To ensure all foreseeable design risks are eliminated and/or mitigated as far as it is reasonably practicable in the design consideration
18. To ensure the design is reasonably practicable considering of constructability and maintainability.
19. Ensure Risks are eliminated and reduced with necessary mitigations measures
20. To update and follow up with mitigation action registered in the DFS registry (Guide 1, 2, 3)
21. To highlight and register in any new risk, hazards during the course of design phase and design changes.
22. To coordinate with other designers within the same area, interfacing systems by taking into consideration of DFS aspect inter design discipline.
23. By using design coordination tools such as BIM 360 or equivalent more advance software to progressively update the interfacing, clashes, incompatible works by considering in engineering solution for design hazards
- Contractor:
24. Inform of foreseeable risks and ensure competent person hired to carry out works
25. Participate in DFS Guide 2 and Guide 3 and facilitate Designer in their relevant design input and outcome.
26. Sharing information required by Designer example the practical sequence of works, methodology to be used for Designer to consider in their detail design and temporary work design during construction.
27. Sharing the project constraints base on cost, contract specification, requirement, schedule, stakeholders, agencies constraints with the designer and developer during pre-construction planning in order to incorporate those constraint into the detail design stage

Owner / Operator:

28. Participate in DFS Guide 1, Guide 2, and Guide 3 to provide inputs from end user/operator's perspectives.
29. Receiving DFS risk register after construction.
30. Upkeep of the risk register within the organisation.
31. Understand the residual risk and have a SOP in place to mitigate the residual risk.
32. Further reduce residual risk whenever possible and update the risk register.
33. Collecting operation inputs for improvement of future projects.
34. Handover of the register to future owner or operator.

4. Workshop / audit on implementation of DFS
(During design & pre-construction stage)

Implementation for DFS shall be carried out in three phases base on the WSH Guideline for DFS. The three phases consist of Guide 1, Guide 2 and Guide 3.

Guide 1 – Concept Design Review Stage
 Guide 2 – Detailed Design, Maintenance and Repair Review Stage
 Guide 3 – Pre-Construction Review Stage

DFSP shall guide the stakeholders through 5 steps approach

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Step 1 : - **G**roup together a review team consisting of main stakeholders
 Step 2 : - **U**nderstand the full design concept by looking at the 3D BIM model, drawings and calculations, and/or have designers elaborate on the design
 Step 3 : - **I**dentify risks that arise as a result of the design or construction method. The risks should be recorded and analysed to see if they can be eliminated by changing the design
 Step 4 : - **D**esign around the risks identified to eliminate or to mitigate the risks
 Step 5 : - **E**nter all the information including information on vital design changes that would affect safety and health or remaining risks to be mitigated into the DFS registry.

Repeat the step 3 and 4 until the review team is satisfied that the design can no longer be changed to totally eliminate all risk.

At final steps after following the requirement of the **G.U.I.D.E.**, DFSP / DFS coordinator shall record all the residual risk in the registry and signed off by the project team. This will be the final registry to share among stakeholders and for documentation.

1. Guide 1 (Concept Design Review)
 1. Concept design review base on the project's general location, traffic, type of buildings in the surroundings, and other general constraints
 2. Typically, to consider the safety issues related to the nature of the proposed development
 3. Considering the location of the project by analysing the potential sites include but not limiting to major consideration such as soil assessment, the public, traffic, existing services and placement of major machines & equipment.
 4. Considering the site feasibility analysis such as below:
 - i. Impact on site or development by existing surroundings
 - ii. Impact on site or development by environment factors
 - iii. Impact on site or development on surroundings or passer-by
 - iv. Existing site conditions
 - v. Conceptual or schematic site planning – constraints and opportunities
 - vi. Feasibility of construction operations and site management
 - vii. Adjacent structures
 - viii. Ground or soil conditions
 5. To record and agreed on the Guide 1 DFS risk registry
 6. To transfer those residual risk to Guide 2 DFS risk registry
2. Guide 2 (Detailed Design, Maintenance and Repair Review)
 1. Detail design review base on the residual risk from Guide 1 DFS registry
 2. Detail design review base on building's detailed architectural, structural design / layout, Building services, process equipment etc
 3. Identify risk involve in the construction methods, access and egress, confined space, other hazards

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4. Identify risk related to the maintenance, cleaning, upgrading and repair requirement of the building.

5. For more complex projects, it will subject to discretion of DFSP / DFS coordinator and/or KI management to sub divide Guide 2 detail design into 3 parts:

- i.30% Detail Design Stage
- ii.60% Detail Design Stage
- iii.90% Detail Design Stage

6. The criteria of subdivision can be referred to the suggestion stated in the Annex A in this document

7. To record and agreed on the Guide 2 DFS risk registry

8. To mitigate and update during detail design during construction stage for application at the project execution stage

9. Update and safe keep the Risk Registry periodically.

3. Guide 3 (Pre-construction Review)

1. To conduct design review the risk associate to pre-construction works such as temporary works design.

2. Identify the risk of temporary works design such as shoring, trenches, deep excavation, ERSS, confined spaces, falsework/formwork.

3. To record and agreed on the Guide 3 DFS risk registry

4. To mitigate and update the design of the temporary works prior to execution on the temporary works during pre-construction stage.

5. Engineer/PIC to inspect/verify those mitigation base on the Guide 3 DFS risk registry whether implemented on site.

6. Update and safe keep the Risk Registry periodically.

5. Workshop / audit on implementation of DFS
(During construction and T&C stage)

1. Designer will finalise the design drawing base on the mitigation suggested in the DFS Guide registry.

2. Designer will issue the AFC drawings for the contractor to implement / construct on site

3. Contractor shall base on the AFC Construction drawings to construct and inspect by Designer representative on site.

4. During construction stage, contractor will provide the MSRA and shall approved by the designer base on the GUIDE 3 register plan.

5. In the event of any deviation or changes during construction due to whatever reason, contractor shall revert to designer for their review and approval.

6. Designer will require to check back the DFS GUIDE registry to change and update the registry base on the changes and new mitigation.

7. The similar approach shall be applied to T&C stage during the construction.

8. Upon completion of construction, It is important for contractor to update the as-built drawings and obtain approval from the designer.

9. Designer will then record all mitigation completed in the as build drawings for the project.

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10. DFSP will conclude the DFS registry and record down any residual risk, together with as built drawings, hand over to Developer and Owner / Operator.

6. Workshop/ audit on implementation of DFS
 (After construction during operation stage and future upgrading / demolition)

1. Any upgrading/demolition during operation stage, Owner/Operator should review DFS Risk Registry Guide 1, 2 and 3 and follow section 6.4 above.
2. During operation stage, in a yearly basis, to review residual risk or risk not mitigated and update in the Risk Registry for Guide 1, 2, and 3 with as build drawings updated

7. List of standard KI HSE requirements
 For KI standard (recommended) and good practise, KI standard (design to avoid) of HSE DFS requirement, please refer to KI HSE Guidelines, Doc No. HSEP-017b

8. Checklist for inspection / audit by DFS consultant / DFS coordinator
 For KI DFS checklist for inspection / audit, please refer to KI HSE Guidelines, Doc No: HSEP-017b

9. Project tender stage to incorporate Safety by Design procedure, DFS requirement and procedure will be incorporate in the tender document base on criteria stated in section 6.1

10. Annexes
 Annex A – Suggestion of Criteria for Guide 2 Sub Division HSEP-017b

1.0 Appendices

NIL