New Zealand DEFENCE FORCE
Te Ope Kātua O Aotearoa

C.H.E.S.S.

DEI CONSTRUCTION HEALTH ENVIRONMENT & SAFETY SPECIFICATION

Volume 4 - Health & Safety by Design

Version 2.0

June 2024

A FORCE FOR NEW ZEALAND

New Zealand Defence Force

Te Ope Kātua O Aotearoa

Headquarters
New Zealand Defence Force
34 Bowen Street
Wellington
New Zealand
Phone +64 4 496-0999
Facsimile +64 4 496-0869
NZDF Website: www.nzdf.mil.nz

Version Number	Publish Date	Approver	Update description
Draft		DD Health & Safety	Initial draft
Draft		DD Health & Safety	Review updates
Final Draft		DD Health & Safety	Finalise draft

Title	Name	Signature
Vice Chief of Defence Force	**AVM Tony Davies**	
Head of Defence Estate and Infrastructure	**Mark Brunton**	
General Manager Estate Delivery Defence Estate and Infrastructure	**Walter Butt**	
Deputy Director Health and Safety, Defence Estate and Infrastructure	**Rian Engelbrecht**	

Original Document Authors
Technical Writer & Policy Analyst: André Chatvick
Process Analyst: Brian Matthews

For the purposes of continual improvement, this document will be reviewed at least every 12 months from the last publish date.

Next review date: November 2025

This electronic media based document is *UNCONTROLLED* when printed!

If any of the content of this document is no longer current, contact DEI Health & Safety Coordinator via email at *DEIH&S@nzdf.mil.nz* to make updates.

Chief of Defence Force

HEALTH & SAFETY STATEMENT

TE OPE KĀTUA O AOTEAROA DEFENCE FORCE

OUR SAFETY MISSION

Together we preserve military capability by planning, enacting, and learning from safety, health and wellbeing practices.

THE NZDF COMMITMENT

Under my direction, we commit to fostering an environment where continual improvement drives the resilience of the safety, health, and wellbeing of everyone involved in our activities.

We commit to maintaining an integrated system of health and safety. All those who assist in making NZDF work safer will be celebrated.

Leadership will grow a culture of safe and cohesive teams, which progressively eliminate unacceptable, harmful and unsafe behaviours.

WE WILL

- **Engage** with our people to identify how our work is actually done, and why;
- **Enact** a just and fair culture, which allows any individual to contribute, free from the fear of unwarranted discipline;
- **Encourage** our people who recognize unsafe practices, and act to prevent harm;
- **Enable** health and safety as a fundamental element of how we work; and
- **Ensure** commitment to Operation Respect and Operation Stand.

Ki te kotahi te kākaho,
ka whati ki te kāpuia, e kore e whati.
If a reed stands alone it can be broken;
if it stands in a group, it cannot.

AM Tony Davies
Chief of Defence Force
24 January 2025

New Zealand DEFENCE FORCE Te Ope Kātua O Aotearoa

DEFENCE ESTATE & INFRASTRUCTURE

COMMITMENT TO WORKSITE HEALTH AND SAFETY

SAFE PLACE, SAFE PEOPLE, SAFE ESTATE

Mark Brunton
Head of Defence Estate and Infrastructure
July 2025

OUR COMMITMENT:

Defence Estate and Infrastructure (DEI) is committed to achieving excellence in safety through effective worksite safety systems and processes for all workers on the Estate.

To achieve this, DEI applies the Construction Health Environment and Safety (CHESS) health and safety management framework. It is an all-encompassing worksite safety management system designed to enable work while mitigating against critical risks.

CHESS integrates health and safety into everyday business seeking continual improvement to drive Estate resilience and improve the health, safety and wellbeing of all workers.

OUR OBJECTIVES:

- Support NZDF operational activities through the supply and maintenance of safe and healthy Estate infrastructure.
- Maintain and ensure safe systems of work for Estate related infrastructure contractor activities to reduce risk related harm.

WE WILL:

- Demonstrate, support and reinforce NZDF's Core Values in the operation of worksite safety systems.
- Support DEI's worksite health and safety framework and clearly set out everyone's responsibilities for worksite safety within DEI.
- Resource DEI's personnel through effective health and safety training and fit for purpose systems.
- Mitigate critical risks by recognising current and future infrastructure hazards and the best ways of managing those risks.
- Apply DEI's health and safety by design system to all projects.
- Understand how work is actually done.
- Ensure contractors have appropriate qualifications and competencies to work safely.
- Empower and support our contractors to manage their worksite and workers to succesfully mitigate health and safety risks.
- Empower our contractors to stop work when they feel the risks to health and safety are too great to continue.
- Investigate incidents thoroughly to learn from events and prevent reoccurrences, and share learnings with contractors and wider industry.
- Report regularly and openly on our health and safety performance against our objectives.
- Regularly review health and safety controls, processes and systems to continually improve the health and safety performance of DEI staff and our contractors.
- Enact a just and fair safety culture through positive engagement.

EVERYONE GOES HOME SAFE AT THE END OF EVERY DAY

A FORCE FOR NEW ZEALAND

UNCLASSIFIED

PREFACE

1. Defence Estate & Infrastructure (DEI) is responsible for the planning, design, construction, operation, maintenance, renovation, refurbishment or redecoration and ultimately demolition of Defence Force buildings and facilities. For all these processes, it must comply with Section 39 of the Health and Safety at Work Act 2015: setting out the duties of the PCBU responsible for designing structures or plant.

2. After meeting Defence Force functionality objectives, DEI expects building and facility designs to maximise the health and safety of users and workers by minimising the likelihood of incidents through eliminating or reducing systemic health and safety risks caused by the building or facility design to construction personnel, users and maintenance personnel.

3. Systemic health and safety risks encompass a project's construction materials, the hardware it uses, the systems and equipment required to make it work, the energy controls it incorporates and refurbishments and refits occurring during the building or facility's life as well as the processes and procedures those design elements impose on building or facility workers.

4. In line with that objective, DEI requires the application of health and safety by design principles when planning, designing, constructing, operating and maintaining Estate buildings and facilities.

5. DEI's approach is premised on the presumption that planners, designers, and contractors/FM Providers create the systemic health and safety risks to building or facility users and workers and those systemic health and safety risks must be identified and eliminated or mitigated throughout a project's planning, design and construction phases.

6. The core of that approach involves a series of processes that:

   a. Apply CHESS' fourteen hazard types and five systemic failure categories to holistically identify a project's systemic health and safety risks;

   b. Apply Top Event Analysis to identify those specific systemic health and safety risks;

   c. Apply a cost/benefit analysis to evaluate specific systemic health and safety risk mitigation measures (where beneficial);

   d. Record Safety by Design decisions over the total life of a project; and

   e. Reduce the systemic health and safety risks inherent in Defence Estate buildings and facilities to users and maintenance personnel over those total life spans.

7. This runs counter to the often unsystematic 'what about that' Safety in Design approach applied during building and facility design phases that adopts less effective and/or less expensive engineering, administration or PPE solutions because the main design features are too difficult or expensive to change.

8. *CHESS - Health and Safety by Design* requires DEI's planners, designers and contractors/FM providers to apply DEI's Hazard and Systemic Health and Safety Risk Management Tool to:

   a. Identify critical systemic health and safety risks that may affect a project's viability, e.g. site geology, contaminated land, or emissions from the development;

   b. Recognise and document systemic health and safety risks generated during a project's planning, design and construction phases to people constructing, operating, using, maintaining, repairing, refurbishing, or demolishing an Estate building or facility;

   c. Apply the hierarchy of hazard controls throughout those phases to eliminate or minimise those systemic health and safety risks;

   d. Record the 'why' and 'how' decisions made during the continuum of a project's planning, design, construction and post-construction phases; and

   e. Record what the outcomes of the decisions were.

9. DEI also requires its planners, designers, and contractors/FM Providers to work with subject matter experts when identifying and documenting systemaic health and safety risk mitigation measures.

10. The same expectation exists during the construction phase, with contractors/FM Providers working with project planners and designers, and using the tool when making system design and materials changes because of:

    a. Changes in client requirements;

    b. Contractor/FM Provider advice on alternative materials and construction systems, and/or

    c. Design variations driven by materials availability.

11. Similarly, DEI requires its planners, designers, and contractors/FM providers must consider a building or facilities occupation and use and ensure that users are not exposed to systemic health and safety risks generated during the planning, design or construction phases.

12. During a project's post-construction phases, refurbishments and refits may also alter design elements to the point that the original hazard analysis and risk mitigation approaches are no longer applicable and new systemic health and safety risks result and new systemic health and safety risk elimination and mitigation approaches are required.

13. When buildings and facilities reach disposal/demolition, the demolition contractor must have access to the records of all of the building or facility's construction and design elements. This means effective documentation throughout the planning, design and construction phases of those elements.

14. Adopting these changes will reduce the presence of systemic systemic health and safety risks in Defence Estate buildings and facilities, and reduce the systemic health and safety risks for the people using and working in or demolishing those buildings and facilities.

15. Finally, DEI recognises that certain elements of the DEI Safety by Design model are presently not as achievable as it would prefer, particularly use of the Net Present Value model and predictive analysis database, and that its design teams have adopted workarounds instead. In due course, further work on Safety by Design will deliver those elements, making the whole model usable by its design teams, achiving the promise of better safety by design outcomes to all of DEI's stakeholders.

16. CHESS – Health and Safety by Design Version 2.0 includes a range of changes aimed at assisting designers to meet its objectives, and reflects both the uptake of Version 1.0 and the subsequent maturity achieved in safety by design functionality of the Capital Delivery Framework since Version 1.0's adoption.

Rian Engelbrecht

Deputy Director Health and Safety

Defence Estate and Infrastructure

June 2024

CONTENTS

Glossary

Term	Definition/Description
Asset	The vertical (i.e. building designed for human use and as a working space) and horizontal (typically subterranean infrastructure although it may be above ground e.g. fuel tanks, piping etc.) structure designed to meet a specific NZDF objective.
Building	A structure with a roof and walls, such as a house or maintenance facility, designed to be human occupied.
CHESS	**C**onstruction **H**ealth, **E**nvironment and **S**afety **S**pecifications. CHESS sets out the NZDF/DEI requirements and expectations from contractors in the areas of health and safety, in order to meet its primary duty of care obligations and responsibilities in the *Health and Safety at Work Act 2015.*
Construction	**Construction**, alteration, conversion, fitting out, commissioning, renovation, repair, upkeep, redecoration or other maintenance (including cleaning which involves the use of water or an abrasive at high pressure or the use of corrosive or toxic substances), decommissioning, demolition or dismantling of a structure: **Preparing** for an intended structure, including site clearance, exploration, investigation (but not site survey) and excavation, and the clearance or preparation of the site or structure for use or occupation at its conclusion; **Assembly** on site of prefabricated elements to form a structure or the disassembly on site of prefabricated elements which, immediately before such disassembly, formed a structure; **Removal** of a structure or of any product or waste resulting from demolition or dismantling of a structure or from disassembly of prefabricated elements which immediately before such disassembly formed such a structure; and **Installation**, commissioning, maintenance, repair or removal of mechanical, electrical, gas, compressed air, hydraulic, telecommunications, computer or similar services which are normally fixed within or to a structure.
Construction Project Manager	The DEI official responsible for managing the a construction project.
Contractor, the	A *PCBU* as defined in Section 17 of the *Health and Safety at Work Act 2015*, and the Contractor engaged directly by DEI on a NZDF worksite who is primarily responsible for delivering a project and hiring and managing sub-contractors for it.
Control	A mechanism or method for removing or reducing the probability of an identified risksystemic health and safety risk.
Corrective Actions	Corrective measures that may include: • Eliminating the hazard; • Engineering alternative outcomes to lower the risksystemic health and safety risk; • Minimising the risksystemic health and safety risk; • Improving risksystemic health and safety risk management measures; or • Providing worker training to reduce the risksystemic health and safety risk.

TERM	DEFINITION/DESCRIPTION
Cut Sets	Sets consisting of the smallest number of basic events that result in the occurrence of the Top Event.
DDMS	Defence Document Management System
Defence Force	New Zealand Defence Force
DEI	Defence Estate and Infrastructure. The New Zealand Government body charged with managing and maintaining the New Zealand Defence Force Estates.
Design	Means a project site plans, Building Information Modelling projections or paper-based designs, working notes and all other documents and drawings contributing to a project's implementation as it evolves through the planning, design and construction phases.
Design Elements	The elements or components of a building or structure necessary to support its basic function. It includes the basic components of a building or facility structure – foundation, floors, walls, beams columns, roof, stairs that support, enclose and protect the building structure and the building or facility layout and systems, e.g. electrical systems, lifts, ventilation systems, fire alarms and sprinklers, and lighting systems. May also include fit out elements such as paint colours, floor surfaces and coverings, internal partitions, and communication and information technology.
Contract Administrator (Engineer to Contract)	The professional engineer, architect, surveyor, or other one natural person named or identified in the 3910 Special Conditions or such other natural person as may be subsequently appointed by the Principal (NZDF) under (NZS 3910:2023) to act as Contract Administrator (Engineer to the Contract). The Contract Administrator shall not be a body corporate or firm.
Facility	A vertical or horizontal asset, generally equipment installed and used for a particular purpose, e.g. water treatment and reticulation utility system which is not designed or used for human habitation or occupation, although may be human accessible for maintenance purposes. May also include any steel or reinforced concrete construction, railway line or siding, tramway line, dock, harbour, inland navigation channel, tunnel, shaft, bridge, viaduct, waterworks, reservoir, pipe or pipeline ((whatever it contains or is intended to contain), structural cable, aqueduct, sewer, sewerage works, gasholder, road, airfield, sea defence works, river works, drainage works, earthworks, constructed lagoon, dam, wall, mast, tower, pylon, underground tank, earth-retaining construction, fixed plant, construction designed to preserve or alter any natural feature, and any other similar structure.
Fault Tree Analysis	A top down, deductive failure analysis showing the relationship between a particular system failure and its contributing causes.
FM Provider	A company contracted by NZDF to provide and manage Facilities Management activities on NZDF Camps and Bases.
FMSMP	Facilities Maintenance Safety Management Plan – prepared by the FM Provider for the camp or base
Hazard	A source or situation with the potential for injury or harm, property or environmental damage, or a combination of these. For the purposes of Safety by Design treat hazards as immutable universal constants, i.e. they never change, are always there, and cannot be reduced.

TERM	DEFINITION/DESCRIPTION
HRCR	**H**azard/Risk/Control **R**egister. A register of a projects likely collective hazards, systemic health and safety risks and hazard management solutions derived from a HAZID analysis performed before a projectwork commences.
Incident	An unwanted event where there is a loss of control of the hazard leading to harm.
Monitoring	The process for tracking the implementation of risksystemic health and safety risk control measures, and measuring their effectiveness.
Must and Should	'Must' refers to requirements that are mandatory for compliance with legislation and CHESS requirements. 'Should' refers to matters that are recommended.
Planning/Design/Construction and Facilities Maintenance	The continuum of activity required to plan, design,construct and maintain DEI Estate assets.
Real Cost Reduction	The achievement of real and permanent reduction in the unit cost of goods manufactured or services rendered without impairing their suitability for the use intended or diminution in the quality of the product.
Regulation	A rule or directive made and enforced by a legally empowered entity.
Residual Systemic health and safety risks	Remaining systemic health and safety risks after identified risksystemic health and safety risks are eliminated or mitigated.
Risk	The effect of uncertainty on objectives. The effect can be positive, negative or different from what was expected.
Safe	Meaning 'safe, so far as is reasonably practicable'.
Safe Design	The results after the application of hazard identification and risksystemic health and safety risk assessment methods during the design process that eliminate or minimise the risks of injury throughout a project's life. It encompasses design elements including facilities, hardware, systems, equipment, products, tooling, materials, energy controls, layout, and configuration.
Sub-Contractor	A PCBU sub-contracted by a contractor to deliver specific tasks on a worksite.
Subject Matter Expert (SME)	A person who is an authority on a particular area or topic. During the planning and design phases, the planning and design leads, and the Engineer to Contract during the construction phase, are responsible for ensuring inputs from relevant subject matter experts are sought and acted upon to ensure that appropriate health and safety by design decisions are made during the totality of the planning/design/construction continuum.
System	A complex whole comprised of interconnected mechanisms and procedures working together
Systemic Approach	A method for analysing interrelationships in complex systems
Systemic Design	A design process which integrates systems thinking and human-centred design to help designers manage complex design projects. Systemic design applies methodologies and approaches that integrate design towards sustainability at the environmental, social and economic levels.
Systemic Failure	A situation originating from a design failure occurring in a deterministic predictable fashion from a root cause or a confluence of or interactions

TERM	DEFINITION/DESCRIPTION
	between several root causes in a complex system which can only be eliminated by modifying the design, or operational procedures, documentation of other relevant factors.
Systemic Failure Types	**Environment** – The circumstances, objects or conditions surrounding the proposed building or facility, including factors such as terrain, climate, soil, living things, waterways, that affect the proposed building or facility. Also includes the internal environment of the building or facility. **Management** – Processes involving managing workers or machines necessary to accomplish desired goals and objectives. **Materials** – The materials used to make a thing. In the context of a building or facility, it refers to the building materials that planned or used to construct it. **Personnel** – People employed in an organisation or engaged in an organised undertaking to undertake specific tasks. **Task** – The actions required to achieve a specific objective.
Systemic Problem	A problem which is a consequence of issues inherent in the overall system rather than due to a specific factor.
Systemic Health and Safety Risk	A risk created by the confluence of process or system elements.
Task	Any discrete activity on a worksite, e.g. erecting scaffolding, installing a window, laying a concrete floor.
Top Event	The point where there is no longer any satisfactory control over the hazard that leads to the hazard manifesting itself in a harmful manner. Also known as the first undesired or hazardous event.
Unit	NZDF administrative or military unit.

NOTE: Project risk management processare are separately managed as per DFI 0.81.

1 Introduction

1.1 Defence Estate & Infrastructure Role

1. Defence Estate and Infrastructure (DEI) is the New Zealand Defence Force unit responsible for managing the Defence Estate. That includes CAPEX and OPEX funding for the planning/design/construction continuum of Estate buildings and facilities and their subsequent management, renovation, refurbishment, redecoration, maintenance and ultimate demolition. Its role includes all Defence Estate buildings, services, roads, runways, wharves, fuel farms, berths, cranes, etc.

2. From 2020 to 2040 DEI is managing the regeneration and transformation the Defence Estate through the Defence Estate Regeneration Programme (DERP). DERP includes:

    a. Constructing new buildings such as barracks, hangars, and headquarters;

    b. Upgrading workshops and hangars and constructing a range of new logistics facilities; and

    c. Decommissioning and demolishing old, unsafe and redundant buildings and facilities.

3. DEI is also responsible for ongoing Facilities Maintenance on camps and bases through its Facilities Maintenance Providers, whose role involves a mix of Planned Maintenance Projects, scheduled and unscheduled maintenance works and minor new works.

4. The Health and Safety at Work Act 2015 places significant duties on DEI, as the organisation responsible, on behalf of the Defence Force, for constructing and managing Defence Force Estate assets, to ensure that, building and facility construction personnel, users and maintenance personnel have the 'highest level of protection' when undertaking their duties.

5. Delivering that level of protection does not start with construction and the implementation of a contractor's Construction Safety Maangement Plan (CSMP) or the application of the FM Provider's Facilities Management Safety Management Plan (FMSMP). Rather, that level of protection starts with planning and designing construction projects, and continues after construction and throughout the life of the Defence Estate's building or facility.

6. That requires recording design information, including design decisions taken to enhance the health and safety of building or facility workers, and making it readily available throughout the life of the structure.

7. Achieving that outcome means taking a new approach to current safety in design processes.

1.2 CHESS – Health and Safety by Design

8. *CHESS – Health and Safety by Design* is a rule set and process/procedure system (within DEI's larger *Construction Health Environment & Safety Specification* system). It aims to ensure Defence Estate building or facility design, construction, occupation and use, maintenance, refurbishment, refitting and ultimately disposal occurs in the safest manner possible by minimising systemic health and safety risks capable of causing occupational fatalities, injuries, and health conditions caused by the design of building and facilities.

9. It sets out a new method based for applying defined hazard classes (as defined by the Health And Safety Professionals Alliance) and systemic failure categories as well as net present value and predictive analytics methodologies to identify issues in project designs and to prepare cost/benefit analysis for individual or collective health and safety by design elements. It also sets out a new approach to capturing design data, with the objective of effectively recording the progress and purpose of individual design decisions during the planning, design and construction phases.

10. It applies to the design of facilities, equipment, systems, and work processes that limit the impact of hazards on work. The underlying premise is that worker health and safety is factored into design processes for buildings and facilities over their lifecycles i.e. concept, planning and design, construction, occupation and operation, mid-life refits, maintenance and disposal.

11. It exists to assist DEI's designers, contractors, Facilities Maintenance providers, and building and infrastructure managers and workers design, build, support, maintain and operate healthy and safe Defence Force buildings

and infrastructure. It does so by replacing existing Safety in Design methods, and enabling consistent Health and Safety outputs across Estate building and facility projects.

2 Health and Safety by Design Principles

2.1 Principles

12. Achieving *CHESS - Health and Safety by Design* aims requires the application of the following principles:

Application of Systemic Approach

a. DEI and its planners, designers, and contractors must apply the Systemic Hazard and Safety Risk Assessment and Analysis Process to identify, document, eliminate or minimise systemic health and safety risks.

Shared and Defined Responsibilities

b. All the participants in the planning, design, construction and facilities management continuum have shared and defined responsibilities to reduce the systemic health and safety risks associated with the construction, use, and maintenance of the building or facility.

c. Integration of efforts to reduce the likelihood of health and safety incidents across the planning, design, and construction phases and not progressed in silos.

d. SMEs involved in the Health and Safety by Design process must have the necessary knowledge, skills and capability.

Collaboration

e. Planners, designers and contractors/FM Providers must collaborate and communicate with subject matter experts to:

   i. Identify and document health and safety systemic health and safety risks; and

   ii. Prepare systemic health and safety risk elimination and mitigation measures.

Planning/Design/Construction Continuum

f. Planners, designers and contractors/FM Providers must treat planning, design and construction and facilties management as a continuum of activity requiring them to work together rather than handing a project off from one team to the next as if each has done their bit on the production line. They have not, as their specific involvement, while it may lessen over the course of a project, does not end until a project's handover to the end user and FM Provider.

g. That means the parties working as a team as a project advances. Those parties include:

   i. Design professionals such as architects, engineers, industrial designers;

   ii. Suppliers (including manufacturers, materials importers, plant-hire), constructors, installers and trades/maintenance personnel;

   iii. Other groups with design involvement, such as managers, health and safety professionals and ergonomics practitioners;

   iv. Contractors (particularly where a project features innovative techniques);[1]

   v. Project occupants;

[1] The Capital Delivery Framework currently engages the Contractor after completion of the asset's detailed design. This necessarily limits the Contractor's involvement in developing Health and Safety by Design solutions, although CHESS Volume 1 does provide an opportunity for the Contractor through the development of the project's HAZID analysis (which informs Constructions Safety Management Plan development) to address health and safety issues associated with the construction phase. The Planned Maintenance Programme uses a broadly similar approach, although Scheduled, Unscheduled Maintenance and Minor New Works does not, as their focus is on maintaining the asset at whatever the norm happens to be at the time.

vi. FM Providers, including the personnel who work in and/or maintain the asset; and

vii. Territorial authorities.

h. Collectively, the leads in the planning, design and construction phases must:

i. Ensure the participation of the relevant subject matter experts at each phase of the planning, design and construction process

ii. Identify, manage and record systemic health and safety risks and mitigation measures as they emerge and evolve over the life of a project, with a clear recognition that solutions to systemic health and safety risks identified in a project's initial phases may generate new systemic health and safety risks during the later phases of the planning/design/construction continuum.

i. Each phase of the continuum requires an iterative review of Health and Safety by Design issues using the Systemic Hazard and Health and Safety Risk Assessment and Analysis Process.

Holistic Approach to Health and Safety by Design

j. Practical design and construction difficulties means that adopting a typical linear risk management method is counter-productive, as it does not cope well with the:

i. Demands of a complex and dynamic planning/design/construction process;

ii. New systemic health and safety risks appearing during the course of a project; and

iii. Early systemic health and safety risk mitigation measures and design solutions generating their own systemic health and safety risks and mitigation measures later in the planning/design/construction/facilties management continuum.

k. To address this, DEI requires planners and designers to look at project issues holistically. That means looking at a project and its surrounds as an interconnected whole rather than a collection of individual design elements.

l. The aim of the iterative reviews is to not just identify and mitigate systemic health and safety risks, but also to look at them side-by-side and identify linkages and synergies between the systemic health and safety risks and mitigation mechanisms that supports a holistic approach.

Health and Safety by Design applies to the Entire Projected Asset Lifecycle

m. *CHESS - Health and Safety by Design* applies to every stage in a project lifecycle - from concept through to disposal. It involves eliminating hazards and/or minimising systemic health and safety risks as early as possible through design solutions.

Record Keeping and Data Management

n. Planners, designers, contractors/FM Providers must record:

i. Identified health and safety hazards and associated systemic health and safety risks;

ii. How they were assessed during the planning/design/constructionfacilities management process;

iii. The elimination and control measures selected;

iv. Why specific decisions were made; and

v. Applicable standards and decision pathways recorded throughout the planning/design/construction process.

o. Planning and design decisions must be recorded in a manner which allows asset users, FM Providers, and the designers of future modifications to know:

i. Building or facility materials composition: e.g. materials types used, volumes and related technical data; and

ii. Building or facility systems information.

p. Planners, designers, contractors/FM Providers must:

i. Ensure effective communication of building or facility data and documents between project phase participants;

ii. Record the hazards and systemic health and safety risks encountered during the planning, design, construction and facilities management phases and the actions taken to eliminate and mitigate those hazards and systemic health and safety risks;

iii. Record how and why hazard and systemic health and safety risk elimination and mitigation decisions are made, and what alternative options were rejected;

iv. Provide an assessment of systemic health and safety risk to those subsequently involved in a project, e.g. planners must advise designers, designers must advise contractors, contractors must advise the client who must notify asset users and FM Providers who must in turn notify subsequent planners, designers,contractors asnd FM Providers working on the Estate asset; and

v. Provide a breakdown of actions taken to eliminate or minimise identified systemic health and safety risks, including design and materials changes and unresolved issues, in a matter and format usable by DEI and its planners, designers, and contractors.

Generating Intelligent Design Solutions

q. For the purposes of health and safety planners, designers, contractors/FM Providers must incorporate three basic activities in their planning and design processes. They are:

i. Compliance with legislation and relevant standards and other statutory guidance;

ii. Applying intelligent health and safety solutions to hazards and systemic health and safety risks arising during the planning, design and construction phases; and

iii. Ensuring the resulting designs incorporate effective forethought on the potential systemic health and safety risks facing future asset operators, users, maintainers, cleaners, and construction workers.

Ongoing Hazard/Systemic Health and Safety Risk Assessment and Management Plan

r. Managing the building or facility over its lifespan requires the development of a health and safety management plan lasting over the building or facility's life. Starting from handover from the Contractor the plan must encompass hazards and residual systemic health and safety risks resulting from:

i. Potential top events identified during planning, design and construction;

ii. Planning and design decisions;

iii. The building or facility as constructed;

iv. Ongoing maintenance requirements;

v. The effects of refurbishments, refits and repurposing the building or facility may experience over its lifespan; and

vi. Details of building or facility:

a. Materials;

b. Systems,

c. Processes;

d. Maintenance over time; and

e. Applicable technical advice.

3 Hazard and Systemic Health and Safety Risk Assessment and Analysis Process

3.1 Typical Risk Assessment and Management Approaches

13. Typical risk assessment and management approach aims to reduce the likelihood of health and safety risks to tolerable levels. To achieve that, planners, designers and contractors usually ask some or all of the following questions:

    a. What about that?

    b. What can go wrong with that?

    c. How bad can it get?

    d. Which solution shall we use?

    e. What is going to involve the least amount of design change?

    f. How much is it going to cost?

    g. How do we know if it's going to work?

    h. Can't someone else do it?

14. The typical approach starts with an element of the design and identifies potential health and safety risks associated with that element. Typically, this approach occurs in an non-systematic manner during individual safety-in-design meetings, generating non-systematic safety-in-design records that may or may not flow through to future activity involving the building or facility.

15. For example, the approach for a retaining wall might identify potential risks such as:

    a. **Workers Falling off the Retaining Wall** –with mitigation measures including limiting wall height and using split walls rather than a single wall on a sloping site to reduce potential fall injuries;

    b. **Ground stability risking stuff falling on workers** – with mitigation measures aimed at preventing back slope collapse such as removing upslope loose objects, and spacing out auger holes; and

    c. **Poor wall stability for construction loading -** where the weight of workers and machines risk a retaining wall collapse – with mitigation measures including designing the retaining walls to support construction loading rather than end use.

16. However, from a system perspective, all the systemic health and safety risks fall within the scope of the Gravity hazard. The designers should, as their start point, look at the overall project design and decide where the Gravity hazard is affecting it, such as the retaining wall, and everywhere else the Gravity applies, and under what conditions it applies, such as determining the maximum weight the retaining wall can support, and ensuring equipment weighing more is not loaded on it.

3.2 A Systemic Failure Scenario

17. The difficulty experienced by clients, planners, designers, contractors, FM Providers and workers is that entirely rational design decisions spaced out over time can have unexpected and unwanted consequences.

18. To avoid that is the responsibility of everyone involved in the planning, design, construction, operation, use, and maintenance of a building or facility to consider the building or facility as an interconnected and complex system. To illustrate that point, consider the following scenario.

    a. Replacing the lights in a building involve a series of choices.

    b. The first choices are design choices. The architect selected the ceiling height based on the client's needs, the functions its spaces perform, and the nature and levels of illumination occupants or machinery users need for those spaces.

c. The second set of choices relates to the type of illumination chosen, and the accessibility of the lighting systems for basic maintenance such as replacing illuminators such as incandescent bulbs, halogen incandescent bulbs, fluorescent tubes or compact fluorescent bulbs, or LEDs. The lifespan of the illuminator choice affects the replacement process, as some LED fittings require whole fitting replacement rather than replacing a bulb or tube.

d. The third set of choices relates to the processes and procedures adopted to service the lighting system. This may range from standing on a chair, using a ladder or using a powered lifting system like a scissor-lift. The lighting system may also require electrical isolation before undertaking the work.

e. The associated systemic health and safety risks associated with replacing the lights in a working space are the result of the inherent hazard, in this example Gravity, modified by the systemic health and safety risks imposed by materials, environment, the task, the level of management control or guidance for the work, and the training and expertise of the personnel involved, possibly enhanced by PPE.

f. So when the worker replacing light bulbs **dies** after falling four metres off the ladder onto a concrete floor, who is at fault? Is it the:

   i. Worker falling off a ladder while leaning out to reach a light fitting while not using PPE systems such as a fall arrest system, a hard hat or injury prevention mats;

   ii. Building manager who agreed that a ladder was sufficient for the task of replacing a difficult- to-reach light bulb;

   iii. Building owner who decided that a lower cost lighting system requiring more frequent maintenance activity was sufficient when specifying the building fit out;

   iv. Building fit-out designer for making no provision for fall arrest systems and for placing heavy machinery or fixing desks directly under the lights, thus preventing the safe use of ladders or the effective placement of injury prevention mats;

   v. Lighting designer for fixing the lighting system four metres above the floor;

   vi. Architect for ensuring that no alternative system for accessing the lights could be moved into the space aside from a ladder; or is it

   vii. A systemic failure?

19. What DEI wants is to ensure that rational planning, design, and construction decisions occur in the context of the full knowledge of prior design decisions, and planners, designers and construction contractors are not operating without being able to see the full consequences of their decisions.

3.3 Applying the Hazard and Systemic Health and Safety Risk Assessment and Analysis Process

Requirement

Planners, designers,contractors/FM Providers must use the:

a. *Systemic Hazard and Health and Safety Risk Assessment and Analysis Process* to identify systemic health and safety risks, mitigation measures and calculate residual systemic health and safety risks; and the

b. Systemic Hazard/Systemic Health and Safety Risk Management Tool to record systemic systemic health and safety risks, the chosen systemic health and safety risk mitigation measures and the resulting residual systemic health and safety risks.

Premise

20. The premise of the *Process* is to:

a. Identify the systemic systemic health and safety risks created during the planning, design, construction, operation, maintenance, and demolition phases of a building or facility project;

b. Identify effective systemic health and safety risk mitigation measures;

c. Record systemic health and safety risks and associated systemic health and safety risk mitigation measures; and

d. Ensure effective transmission of that information over a project's life phases to the entities responsible for those particular phases.

21. The key difference between the standard hazard assessment and management approach and the new approach is that DEI identifies project systemic systemic health and safety risks as the sum of any of the fourteen hazards classes plus one or more of the Systemic Failure Categories overlaid against the building or facility design.

22. To avoid the inadvertent creation of systemic systemic health and safety risks in project designs, DEI requires planners, designers, contractors/FM Providers to:

a. Stop looking at a project as a collection of discrete individual design elements;

b. Look at a project as a system of interconnected planning, design and construction decisions;

c. Recognise that the universal constants of the fourteen hazard classes and the variable influences of the five systemic failure categories influence the system's health and safety; and

d. Record systemic health and safety risk mitigation decisions in a structured and readily recoverable format.

23. DEI recognises that this is a significant shift from the standard approach, requiring a structured approach to identifying and recording planning, design and constructions decisions over the course of a project.

Systemic Failure Categories

24. DEI recognises five types of systemic failure categories applicable to its projects. They are:

a. **Environment** – The circumstances, objects or conditions surrounding the proposed building or facility, including factors such as terrain, climate, soil, living things, waterways, that affect the proposed building or facility. Also includes the internal environment of the building or facility.

b. **Management** – Processes involving managing workers or machines necessary to accomplish desired goals and objectives.

c. **Materials** – The materials used to make a thing. In the context of a building or facility, it refers to the building materials that planned or used to construct it.

d. **Personnel** – People employed in an organisation or engaged in an organised undertaking to undertake specific tasks.

e. **Task** – The actions required to achieve a specific objective.

25. Systemic failures are the unintended consequences generated by the confluence of hazard classes and the systemic failure categories within a complex system, rather than the result of a specific, individual or isolated factor.

26. The underlying premise, as illustrated in the scenario above, is that while the hazard classes are immutable, they only come into effect when one or more of the systemic failure categories apply. This occurs when the decision-makers do not foresee the confluence, and enable the hazard to come into effect by generating the circumstances where the systemic health and safety risks of the applicable hazard or hazards goes beyond manageable levels.

The Process

27. The process requires users to undertake a multi-step analysis, consisting of:

a. Identify systemic hazards (i.e. the 14 hazards combined with the systemic failure categories) in the design/construction;

b. Calculate likelihoods of systemic health and safety risks occurrence applying to the building or facility as designed and applicable during construction (identifying potential Top Events and their likelihood and consequences);

c. Based on the results from (b) and (c) calculate the raw systemic health and safety risk rating using the DEI Construction Hazard Systemic Health and Safety Risk Matrix and assign a Red, Amber, Yellow Green value to the systemic health and safety risk;

d. Identify measures to eliminate or minimise the systemic health and safety risk;

e. Run cost/benefit analysis of proposed mitigation measure/s (where beneficial);

f. Implement the selected measure/s;

g. Document the results of all the work in the Systemic Hazard/systemic Health and Safety Risk Management Tool; and

h. Assign a Red, Amber, Yellow Green value to the residual systemic health and safety risk after implementing the systemic health and safety risk elimination or minimising measure/s.

Applying Top Event Analysis

28. Top Event Analysis is a logical modelling technique that explores the consequences resulting from a single initiating event, and sets out paths for assessing the probability of the outcomes and for an overall system analysis. It also predicts potential system issues, and in this model supports negative outcomes prevention by providing the probability and consequences of an incident.

29. Top Event Analysis uses a top-down (bottom up) approach to analysing incidents starting with (leading to) the undesirable event called the *Top Event* and determining what decisions, other influences, and situational circumstances led to the *Top Event* occurring. See Annex 2 for examples of potential top events.

30. For the purposes of the *Project Systemic Hazard and Systemic Health and Safety Risk Assessment and Analysis Process,* the *Top Event* is part of the systemic health and safety risk analysis phase of the Process.

31. It requires participants to identify potential top events from the Hazards, the Systemic Failure Categories and the building of facility Design as parts of the fault tree. This is similar to typical risk identification approaches in terms of identifying risks, but differs in requiring the systematic application of the Process, and data recording in the framework of the spreadsheet Tool. The key benefit of the spreadsheet is that it allows participants to:

    a. Group potential Top Events under Hazards;

    b. Align them with Systemic Failure Categories; and

    c. Identify similar potential Top Events in the Design; and

    d. Apply common solutions to issues.

32. The basic steps of Top Event Analysis are:

    a. Identify the relevant Hazard and the accompanying systemic health and safety risk Categories in the Design;

    b. Create the Fault Tree;

    c. Identify the Cut Sets;

    d. Identify relevant systemic health and safety risk mitigation measure/s; and

    e. Develop a better understanding of the system under analysis;

Top Event Analysis Steps

Identify the Hazards and the Relevant Systemic Failure Categories

33. Use the fourteen hazard classes and the five Systemic Failure Categories to identify potential top events. The Top Event needs to have a description of the potential impacts of each potential top event.

DEFINING THE EVENTS AND CONDITIONS LEADING TO THE POTENTIAL TOP EVENTS

34. Determine the events and conditions that most directly lead to the potential top events.

EXPLORE EACH EVENT BRANCH

35. Determine the events and conditions that most directly lead to each intermediate event. Repeat the process at each successive level of the tree until complete.

SOLVING THE FAULT TREE

36. Examine the fault tree model to identify all possible combinations of events and conditions causing the top event/s. The combination of events and conditions *sufficient* and *necessary* to generate the top event is the *Minimal Cut Set*.

IDENTIFY IMPORTANT DEPENDENT FAILURE POTENTIALS AND ADJUST MODEL

37. Study the fault model tree and the list of minimal cut sets to identify potentially important dependencies among events. Dependencies are single occurrences that may cause multiple events or conditions at the same time.

PERFORM QUANTITATIVE ANALYSIS

38. Use statistical characterisations regarding the failure and repair of specific events and conditions in the fault tree model to predict future system performance.

APPLY THE RESULTS TO DECISION-MAKING

39. Apply the Fault Tree Analysis results to identify the system vulnerabilities and to identify systemic health and safety risk mitigations measures.

UNDERSTANDING THE SYSTEM–THE CONTEXT OF THE HAZARD/SYSTEMIC SYSTEMIC HEALTH AND SAFETY RISK CATEGORY ANALYSIS

40. This output means the participants in the process effectively understand the system under analysis. That means a project's draft plans, or a project business case, depending on a project phase. It also means a project's physical environment and the applicable legislation, regulations, standards, Building Code requirements, and any other relevant information related to the planned structure.

COST/BENEFIT ANALYSIS

RETURN ON INVESTMENT/COST/BENEFIT ANALYSIS

41. The biggest issue building or facility planners, designers or constructors face is identifying the dollar value returns on investment accruing to building or facility owners from individual specific health and safety by design options. Essentially, it is very hard to quantify in dollar values the benefits of improvements in building or facility utility or ambience and the potential lower likelihoods of injury causing incidents.

42. Designers struggle to convince clients that spending more on a building or facility to enhance its health and safety features represents a long-term saving rather than a sunk cost that may never deliver the promised savings

43. Thus, the big issue when applying a comprehensive health and safety by design approach is identifying future cost benefits from what amounts to extra spending on a project. Clients are averse to spending on what they consider 'Rolls-Royce' solutions in their building or facility designs, instead applying the 'close enough is good enough' model.

44. That model has designers and owners reluctant to spend beyond the essential requirements of a space, with lower-cost labour replacing the up-front capital commitment needed for low-maintenance solutions, i.e. It is cheaper to hire someone to change the lights than install long-life lighting systems.

45. However, there are two problems with this approach. They are:

    a. Building in lower-cost and quality materials means expensive maintenance and/or refits during the life of the building or facility (essentially 'you pay for what you get'); and

b. Real cost reduction of low-maintenance design element prices, e.g. LED lighting costs have significantly reduced since introduction of the technology, and a ten-year life cycle means that it is cheaper to buy LEDs than pay people to frequently replace cheaper fluorescent bulbs.

46. The challenge for designers is to:

a. Design more resilient buildings less reliant on expensive mid-life refits; and

b. Identifying and implementing ways of designing humans out of building and facility maintenance.

47. Designers can address this by:

a. Using low-maintenance systems such as more designing buildings and facilities with sensible roof designs with effective water removal systems – i.e. installing roof and rain water management systems good for the life of the building or facility;

b. Using resilient exterior and interior wall surfaces and using higher-quality paint systems requiring fewer reapplications over the life of the building or facility;

c. Installing grime resistant window systems needing less or no cleaning;

d. Designing offices with clear space under office fittings to enable the use of robot floor cleaners;

e. Installing lighting systems good for the life of the building or facility; and

f. Providing access for working/rising platforms to difficult spaces.

NET PRESENT VALUE APPROACH

48. Expenditure on a specific health and safety by design feature consists of the initial expenditure during construction followed by ongoing maintenance expenditure to support that feature.

49. The Net Present Value (NPV) model allows effective cost modelling over time to allow the building or facility owner to calculate future costs associated with that feature over the life of the building or facility.

50. The difficult part is determining what the health and safety benefits of that initial and over-time expenditure is to the owner in terms of effective savings resulting from reduced injury incidents from that expenditure. Are those potential savings greater than the initial and over-time investment or are they lower? Leaving aside the intangible benefits of reduced injury incidents, the NPV model supports slotting those potential savings into the NPV table, and answering that question during a project's design stage.

51. Where predicted savings exceed predicted expenditure then a clear benefit applies. Where the predicted costs exceed predicted savings, the owner may choose an alternate approach, or simply choose to systemic health and safety risks the costs of a higher incident of injury incidents.

52. The issue becomes how to predict those savings. One approach to do that is Predictive Analytics.

PREDICTIVE ANALYTICS FOR WORKPLACE INCIDENTS

Data Sources and Application

53. DEI must develop a database of workplace incidents for the predictive analysis process. Potential data sources may include national and international databases such as SEMT, JARS, ACC, WorkSafe, Kāinga Ora, and Ministry of Education construction and building maintenance incident data, Canterbury reconstruction incident data, and international data sources such as NIOSH Fatality and Control Evaluation Reports.

54. The larger the database the more reliable it will be for costing potential savings resulting from the introduction of systemic health and safety risk mitigation measures into a design. The data would include material such as:

a. Description of reported incidents from buildings or facilities with and without the proposed health and safety by design feature;

b. Recorded historical incident rate;

c. Costs applicable to the FM Provider or equivalent company;

d. Safety training and compliance data;

e. Worksite safety incidents;

f. Fleet accidents with details;

g. Tools and equipment in use;

h. Specific design elements;

i. WorkSafe actions taken against the Defence Force or FM Providers;

j. Incident details; and

k. Experience of relevant staff or contractors.

55. Planners, designers and constructors would apply a predictive analysis process that uses a range of historical data that support predictions of future accidents and their associated costs

56. Using an appropriate application and a database, planning, design and construction leads feed in the details of the proposed health and safety design feature, and use the application's algorithm and database to predict the frequency of injury accidents avoided by with the proposed feature over a projected life of the building or facility. Using that estimate, the relative savings associated with that specific health and safety by design feature offset the sunk and maintenance costs also associated with the feature.

57. Where predicted savings are higher than the sunk and maintenance costs, then the proposed feature has achieved a positive benefit to costs ratio.

58. Where the reverse applies, then the feature has achieved a negative benefit to costs ratio.

59. In either scenario, decision participants must factor the cost/benefit analysis outcomes into whether to include the proposed feature or not in the building or facility design.

Annex 1 – Systemic Hazard and Risk Assessment and Analysis Process

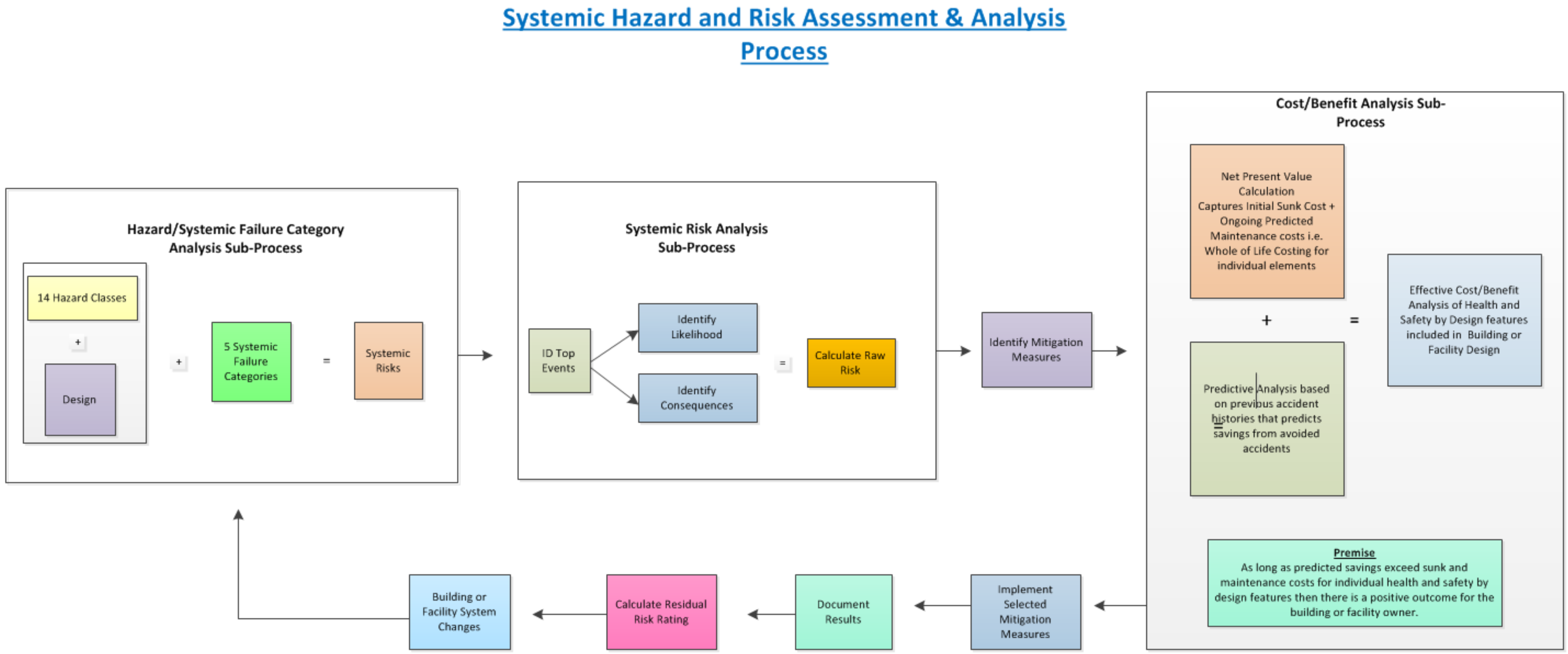

Figure 1 - Systemic Hazard and Systemic Health And Safety Risk Assessment & Analysis Process

Biological	Biomechanical	Chemical	Ecological	Electrical	Gravity	Mechanical
• Airborne fibres/ particulates e.g. Asbestos • Bacteria • Blood-borne Pathogens • Contaminated Soil • Contaminated Water • Fungi/ mould • Hygiene concerns • Insect/ Animal bites or stings • Vapours/ Dust/ Fumes/ Exhausts • Viruses • Water immersion	• Body position, uncomfortable position • Eye strain • Muscular overexertion/ manual handling • Repetitive operations • Working Posture	• Chemical transfer activities • Contamination dust, chemicals, sediment, effluent non segregated waste • Corrosives • Depleted oxygen • Explosives • Flammable vapours/ materials • Gasses (Oxygen, Carbon Monoxide/ Dioxide/ Hydrogen Sulphide/ Ammonia) • Piping/ tanks containing chemicals • Potential for trapped gases (Pockets of gas) • Pyrophoric materials (ignites in Oxygen) • Toxic gases/ carcinogens • Unapproved chemical	• Equipment dropped to water • Soil contamination • Spill/ Chemical to water • Windblown litter	• Compressors and transformer • Exposed energized systems • Lighting and batteries • Overhead power lines • Portable electrical equipment • Static Electricity • Underground/ buried electrical cables • Unguarded or exposed electrical equipment	• Anchor point/ lifting equipment (chains/ slings/ harness) • Cave–In • Converging/ sloping/ slippery surfaces • Fall from height /climbing • Inadequate/ restricted entry & exit • Moving/ dropped/ falling objects • Roof/ walkway/ platform/ handrails • Scaffolding /Elevated Work Platform/ Roof Collapse • Shifting Loads/ Materials • Structural collapse (incl. adjacent) • Suspended in harness • Uneven ground/ same level fall	• Equipment Failure (Brakes, lights, pumps, valves and tools) • Equipment under tension e.g., springs • Exposed drive belts/ conveyors • Exposed Rotating Machinery/ Rollers/Screw conveyors

Motion	Noise	Pressure	Psychosocial	Radiation	Temperature	Vibration
• Aircraft transportation • Anchoring / deck lines / ropes • Congested Work Area • Ejected debris/tool parts • Equipment/ Crane Overloading • Excavation Equipment • Foreign body in eye • Line of fire & Pinch points -Hands/ fingers/ feet/ legs • Line of fire -Body position -Shifting and swinging loads • Marine vessel transportation • Moving Vehicles/ Plant • Road conditions • Vehicle/Plant turnover • Water ingress	• Equipment noise e.g. grinding, chipping, engines • High-pressure release • Impact noise • Sirens and alarms	• Cylinders/ Tanks/ Vessels • Exposed piping • Hoses • Pneumatic/ Hydraulic • Underground piping	• Aggression, violence • Bullying, harassment • Heavy workload • Human factors (Fatigue, lapses in focus) • Lone worker • Low resource/ inadequate skills • Monotonous tasks • Poor communications • Stress • Unpleasant tasks	• Ionising - X-Ray (Sources) • Ionising- Lasers • Ionising- Radon • Non-ionising - Radio frequency and microwaves • Non-ionising- Crack detection equipment • Non-ionising- Lasers • Non-ionising- Power Lines • Non-ionising- Radiant heat • Non-ionising- UV e.g. Sun, lighting, water treatment • Non-ionising -Welding arc	• Cooking and heating appliances • Exposure to extreme weather conditions (wind, rain, fog) • Flammable/ Combustible material (incl. vegetation) • Friction (Ignition Source) • Hot/ Cold Surfaces • Ignition Sources (Process/ Tools/ Vehicles) • Steam • Thermal discomfort	• Whole body vibration • Hand/arm vibration

Table1 – CHESS Hazard Reference Tables

Category	Definition
Environment	The circumstances, objects or conditions surrounding the proposed building or facility, including factors such as terrain, climate, soil, living things, waterways, that affect the proposed building or facility. Also includes the internal environment of the building or facility.
Management	Processes involving with managing workers or machines necessary to accomplish desired goals and objectives.
Materials	The materials used to make a thing. In the context of a building or facility, it refers to the building materials that planned or used to construct it.
Personnel	People employed in an organisation or engaged in an organised undertaking to undertake specific tasks.
Task	The actions required to achieve a specific objective.

Table 2 - Systemic Failure Categories

DEI Construction Hazard Risk Matrix

(e.g. Risk rating VERY HIGH (3,5), where '3,5' indicates impact level 3 (Major) and likelihood level 5 (Almost Certain)).

IMPACT →

	Minor	Moderate	Major	Extreme
Environment	Temporary damage contained within Defence Estate; short-term, local detrimental effect.	Localised damage with some impact on external environment; serious detrimental effect that requires remedial action.	Extensive or serious damage to the environment; long term detrimental effect requires immediate remedial action.	Extensive, irreversible damage to the environment; extensive long term detrimental impact.
People/ Health & Safety	First aid injury. Minimal lost time. Temporary partial disability. No long term effects.	Medical attention required. Short term lost time. Permanent partial disability. Medium to long term effects.	Fatality. Serious injury/illness/mental harm. Long term lost time. Permanent total disability. Long term effects.	Multiple fatalities. Multiple instances of serious physical or mental incapacity or ill health. Multiple cases of long term lost time. Multiple permanent total disability. Long term effects.

Likelihood ↑		Minor	Moderate	Major	Extreme	
Could be expected to occur in most circumstances.	**Almost Certain**	MEDIUM (1,5)	HIGH (2,5)	VERY HIGH (3,5)	VERY HIGH (4,5)	5
Could probably occur in most circumstances.	**Likely**	LOW (1,4)	HIGH (2,4)	VERY HIGH (3,4)	VERY HIGH (4,4)	4
Could occur at some time.	**Possible**	LOW (1,3)	MEDIUM (2,3)	HIGH (3,3)	VERY HIGH (4,3)	3
Could occur at some time, but is improbable.	**Unlikely**	LOW (1,2)	MEDIUM (2,2)	MEDIUM (3,2)	HIGH (4,2)	2
Could occur in exceptional circumstances.	**Rare**	LOW (1,1)	LOW (2,1)	MEDIUM (3,1)	HIGH (4,1)	1
		1	2	3	4	

Figure 3- DEI Construction Hazard Risk Matrix

Risk Level Descriptions

VERY HIGH	HIGH	MEDIUM	LOW
Intolerable. Further treatment required as matter of priority. Action required: Develop treatment strategies or introduce appropriate controls, with the objective of reducing the risk to a lower level. Activities with a residual risk level of *VERY HIGH* must not proceed. Review at least monthly or if a significant change occurs.	**Generally Intolerable.** Further treatment required to be identified as matter of priority. Action required: Develop treatment strategies or introduce appropriate controls, with the objective of reducing the risk to a lower level. Activities with a residual risk level of High requires consultation and collaboration with relevant parties on the camp or base through a forum such as SIMOPS.	**Generally Tolerable.** Further treatment may be required where practicable. Action required: Develop treatment strategies or introduce appropriate controls, with the objective of reducing the risk to a lower level. Activities with a residual risk level of Medium or higher requires approval from the Site Health and Safety Adviser before work can commence on the task.	**Tolerable.** Unlikely to require further treatment. Action Required: The risk may be able to be managed by routine procedures. Minimal resource allocation or management effort required. In most cases these risks need no special precautions or actions, other than periodic monitoring of controls to ensure that the level of the risk has not changed.

Figure 4 - Risk Level Description

Figure 5 - Hierarchy of Hazard Controls

Annex 2 – Potential Top Events

Potential Top Event Examples						
Exposure to (resulting in Inhalation / Ingestion / Skin Contact)	**Over stresses / Over-exertion / Poor Technique**	**Contact With / Loss of containment / Exposure to**	**Loss of Containment / Loss of control**	**Contact With**	**Loss of grip / Structural Failure / Loss of Balance**	**Contact With / Loss of Integrity / Structural Failure**
Biological	**Biomechanical**	**Chemical**	**Ecological**	**Electrical**	**Gravity**	**Mechanical**
Airborne fibres/ particulates e.g. Asbestos Bacteria Blood Bourne Pathogens Contaminated Soil Contaminated Water Fungi/ mould Hygiene concerns Insect/ Animal bites or stings Vapours/ Dust/ Fumes/ Exhausts Viruses Water immersion	Body position, uncomfortable position Eye strain Muscular overexertion/ manual handling Repetitive operations Working Posture	Chemical transfer activities Contamination dust, chemicals, sediment, effluent non segregated waste Corrosives Depleted oxygen Explosives Flammable vapours/ materials Gasses (Oxygen, Carbon Monoxide/ Dioxide/ Hydrogen Sulphide/ Ammonia) Piping/ tanks containing chemicals Potential for trapped gases (Pockets of gas) Pyrophoric materials (ignites in Oxygen) Toxic gases/ carcinogens Unapproved chemical	Equipment dropped to water Soil contamination Spill/ Chemical to water Windblown litter	Compressors and transformer Exposed energized systems Lighting and batteries Overhead power lines Portable electrical equipment Static Electricity Underground/ buried electrical cables Unguarded or exposed electrical equipment	Anchor point/ lifting equipment (chains/ slings/ harness) Cave–In Converging/ sloping/ slippery surfaces Fall from height /climbing Inadequate/ constrained entry & exit Moving/ dropped/ falling objects Roof/ walkway/ platform/ handrails Scaffolding /Elevated Work Platform/ Roof Collapse Shifting Loads/ Materials Structural collapse (incl adjacent) Suspended in harness Uneven ground/ same level fall	Equipment Failure (Brakes, lights, pumps, valves and tools) Equipment under tension e.g., springs Exposed drive belts/ conveyors Exposed Rotating Machinery/ Rollers/Screw conveyors

Potential Top Event Examples						
Contact With / Caught by / Exposure to	**Exposure To**	**Loss of containment / Loss of Pressure / Release of Stored Energy**	**Exposure to / Loss of Concentration**	**Exposure To / Contact With**	**Exposure To / Contact with**	**Exposure To**
Motion	**Noise**	**Pressure**	**Psychosocial**	**Radiation**	**Temperature**	**Vibration**
Aircraft transportation Anchoring / deck lines / ropes Congested Work Area Ejected debris/tool parts Equipment/ Crane Overloading Excavation Equipment Foreign body in eye Line of fire & Pinch points - Hands/ fingers/ feet/ legs Line of fire -Body position -Shifting and swinging loads Marine vessel transportation Moving Vehicles/ Plant Road conditions Vehicle/Plant turnover Water ingress	Equipment noise e.g. grinding, chipping, engines High-pressure release Impact noise Sirens and alarms	Cylinders/ Tanks/ Vessels Exposed piping Hoses Pneumatic/ Hydraulic Underground piping	Aggression, violence Bullying, harassment Heavy workload Human factors (Fatigue, lapses in focus) Lone worker Low resource/ inadequate skills Monotonous tasks Poor communications Stress Unpleasant tasks	Ionising - X-Ray (Sources) Ionising- Lasers Ionising- Radon Non-ionising - Radio frequency and microwaves Non-ionising- Crack detection equipment Non-ionising- Lasers Non-ionising- Power Lines Non-ionising- Radiant heat Non-ionising- UV e.g. Sun, lighting, water treatment Non-ionising - Welding arc	Cooking and heating appliances Exposure to extreme weather conditions (wind, rain, fog) Flammable/ Combustible material (includingvegetation) Friction (Ignition Source) Hot/ Cold Surfaces Ignition Sources (Process/ Tools/ Vehicles) Steam Thermal discomfort	Whole body vibration Hand/arm vibration

DOCUMENT CONTROL

Document Authorisation

Document	Name or person	Title
Owner	Rian Engelbrecht	Deputy Director, Health and Safety (DE&I)
Author	André Chatvick	Technical Writer & Policy Analyst
Endorsers	Wally Butt	
Reviewers		

Document Criteria

Document criteria	Details
Security classification	Unclassified
Status	Draft
Template version	
Storage location	http://ddms-r/ds/D0-0221/14/Forms/AllItems.aspx

Document History

Version	Authors	Date	Amendments or changes
V0.01	André Chatvick		Initial Draft
V1	André Chatvick		Final Draft
V2	André Chatvick		Update/Final Draft

Document Dependencies

The following related documents may require review or amendment if this document changes.

Document name	Location (link/path)
CHESS – DEI Health and Safety Guide	http://ddms-r/ds/D0-0221/14/Forms/AllItems.aspx
CHESS – Processes and Procedures	http://ddms-r/ds/D0-0221/14/Forms/AllItems.aspx
CHESS Templates	http://ddms-r/ds/D0-0221/14/Forms/AllItems.aspx

This electronic media based document is *UNCONTROLLED* when printed!

If any of the content of this document is no longer current, contact DEI Health & Safety Coordinator via email at *DEIH&S@nzdf.mil.nz* to make updates.