

# SAFETY IN DESIGN – HOW TO ENSURE THAT SAFETY MATTERS IN WATER TREATMENT PLANT DESIGN

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## ABSTRACT

This study reviews the approach to safety in design within the New Zealand health and safety framework and compares it to that adopted in the UK, USA and Australia. Health and safety statistics from the construction and water industries in New Zealand indicate that there is a need for a holistic review of our health and safety system, and with overseas evidence suggesting an intrinsic link between project design and the number of health and safety incidents that occur, it is recommended that safety in design be a key strategic initiative moving forward.

## KEYWORDS

Safety in design, New Zealand health and safety framework

## 1 INTRODUCTION

Safety in design is a concept that is open to interpretation within the New Zealand health and safety framework. Whereas overseas this concept has been formalised within the legal system and is supported by clear guidance and accountabilities, in New Zealand, safety in design is largely left to the individual designer's professional ethics, experiences and awareness of potential risks during construction, use, maintenance and demolition. In the case of some international design consultancies, stricter legal obligations overseas have led to the employment of safety in design processes within their New Zealand offices. This is creating better cultures for health and safety within these organisations and consequently their clients' organisations also benefit.

New Zealand employs a passive approach to health and safety, which utilises a voluntary compliance system backed up by statutory enforcement mechanisms (Allen & Clarke, 2006). There are five organisations with inspectorate and enforcement powers – the Department of Labour, Maritime New Zealand, the Civil Aviation Authority, The Commercial Vehicle Investigation Unit, and the Ministry of Health - which in itself reduces the efficacy of any one agency to uphold its specific obligations, compared with having a single enforcement body. Health and safety in New Zealand is highly reactionary, where although construction projects may be notified to the Department of Labour during contractor mobilisation, there is little active involvement from this agency unless an accident occurs.

Whilst the design phase is a high opportunity period to identify and possibly eliminate potential hazards that may eventuate during the later construction, habitation and demolition phases of an asset's life, it is being left to individual designers and design companies to develop their own approaches to minimise the risks. The purpose of this study is to review the New Zealand legislation with regard to safety in design, and, by considering international models, to raise awareness on how to ensure that safety matters in order to reduce the number of work place safety incidents that occur in the water industry and beyond.

## 2 THE STATE OF HEALTH AND SAFETY IN NEW ZEALAND

### 2.1 WATER INDUSTRY STATISTICS

Health and safety statistics captured by the New Zealand Department of Labour provide a breakdown of fatalities and serious harm notifications by industry. The industry is based on the nature of the employer so whilst a water industry incident may have occurred on a construction site, the incident would be captured under the Water Services industry as opposed to the Construction industry.

Statistics for the water industry are therefore encapsulated within the Electricity, Gas, Water and Waste Services and the Construction industries. Given that the construction figures are not further broken down to industry, it is unclear how many fatalities and serious harm notifications relate to water construction projects; however one report indicated that “the water industry as a whole appears to have higher recordable incidence rates, lost workday incidence rates, and severity rates when compared to other utilities (i.e. electrical utilities)” (AWWA Research Foundation, 2003).

Figures 1 and 2 illustrate the numbers of fatalities and serious harm notifications respectively in recent years. Whilst construction fatalities peaked in 2009, they have generally been decreasing since then. In the same period, fatalities in the Electricity, Gas, Water and Waste Services industries have stayed relatively constant.

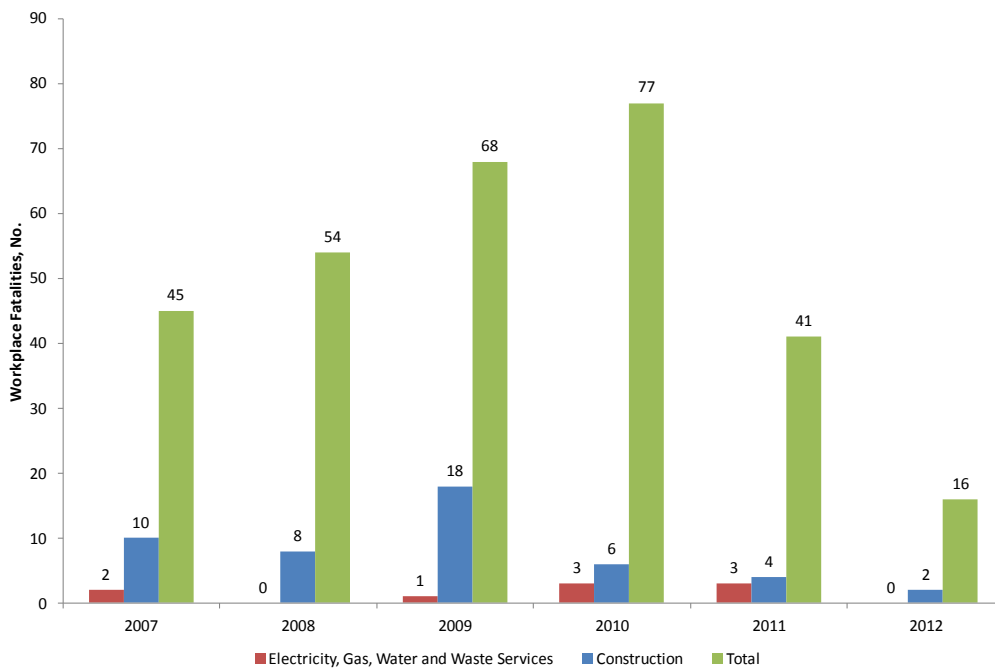


Figure 1: Workplace Fatalities in New Zealand since 2007 (Source: New Zealand Department of Labour)

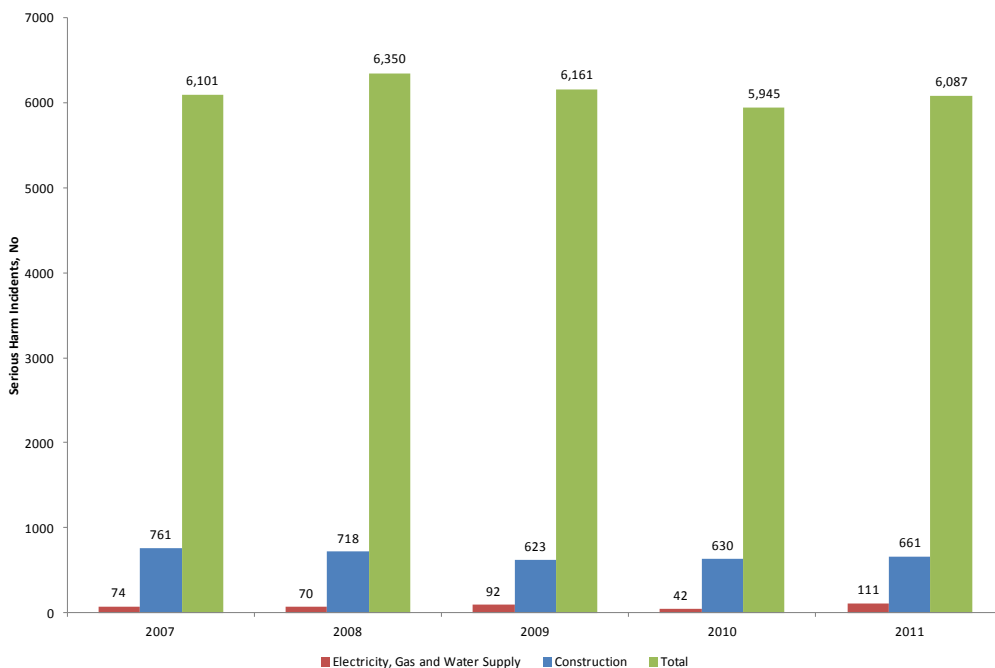


Figure 2: Serious Harm Notifications in New Zealand since 2007 (Source: New Zealand Department of Labour)

Figure 2 illustrates that Serious Harm Notifications have not shown a marked change in the Construction or Electricity, but in the Gas and Water Supply industries, the number has almost trebled between 2010 and 2011.

## 2.2 HOW NEW ZEALAND IS PERFORMING AT AN INTERNATIONAL LEVEL

New Zealand's health and safety record is relatively poor compared to other countries, as illustrated in Figure 3. Whilst our fatality rates are generally falling, they are considerably higher than other countries who have taken a more proactive stance on safety, particularly the UK. Australia's performance is also better than that of New Zealand, despite the higher percentage of typically high-risk sectors such as mining.

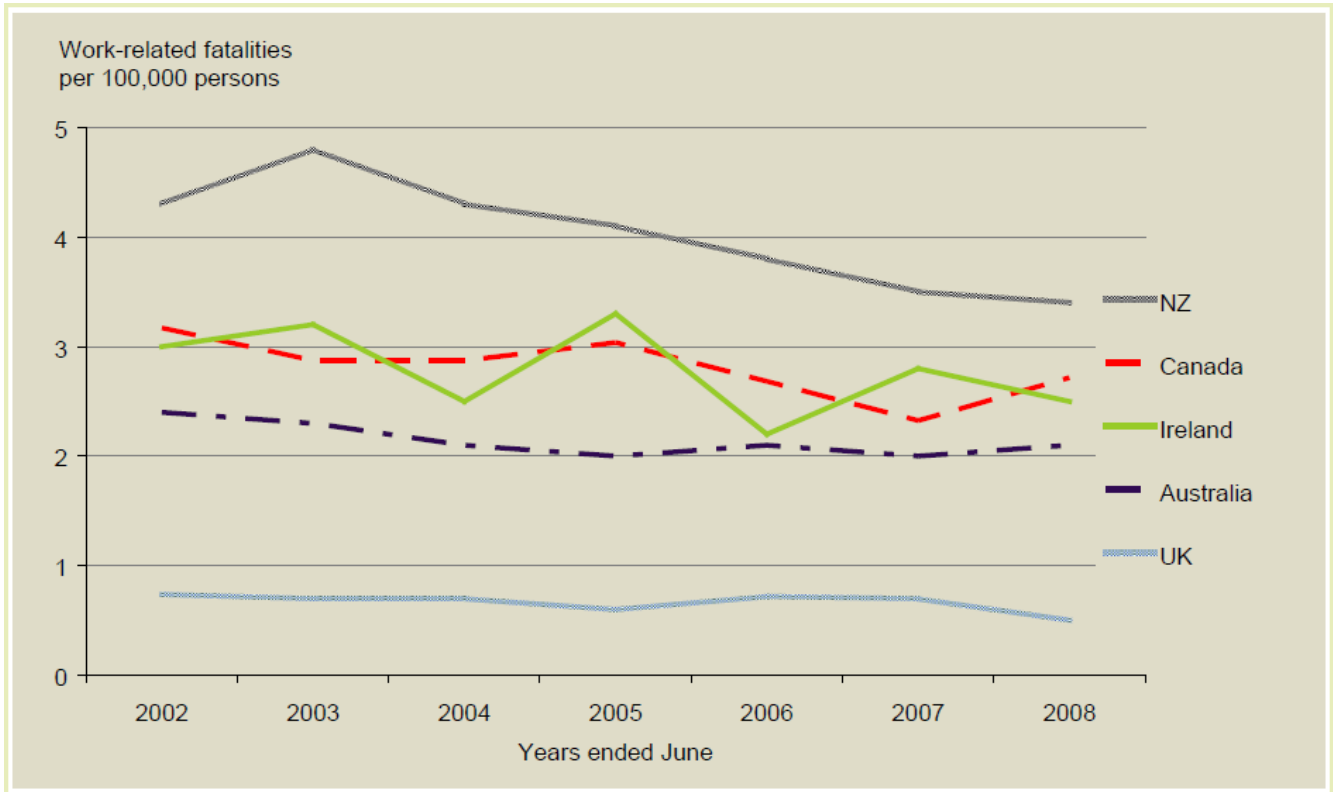


Figure 3: International Comparison of Health and Safety Statistics (Source: New Zealand Department of Labour 2011)

## 3 A DIRECT RELATIONSHIP BETWEEN DESIGN AND HARM

A number of international studies have investigated and confirmed the influence of design on workplace accidents.

In Australia, the National Occupational Health and Safety Commission (NOHSC, now Safe Work Australia) reviewed the role of design in work-related injuries between 1997 and 2002. The study found that of the 2705 cases reviewed, 47% of workplace fatalities definitely or probably occurred as a result of poor design (NOHSC 2004).

In the United Kingdom, HSE studies have shown that poor planning and management and a general lack of coordination are significant factors in the majority of construction injury and probably ill-health cases (HSE 2004). An interrogation of the causes of construction accidents found that nearly half of all accidents recorded in the construction specialist reports could have been prevented by designer intervention and that at least 1 in 6 were at least partially the responsibility of the lead designer, in that opportunities to prevent incidents were not taken.

In the USA, a study was conducted that analysed 450 reports of construction workers' deaths and disabling injuries to determine whether addressing safety in the project designs could have prevented the incidents (Behm 2006). The study found that that about one-third (151) of the 450 incidents reviewed for this study were determined to be linked (or maybe linked) to the design.

There is strong evidence of the significant role of design in workplace incidents overseas and whilst a study has not been conducted in New Zealand, the likelihood is that the situation is the same here.

## 4 SAFETY IN DESIGN FRAMEWORKS WITHIN AUSTRALIA, UNITED KINGDOM AND UNITED STATES OF AMERICA

### 4.1 AUSTRALIA

Australia has historically had a complicated health and safety system based on laws and regulations for each state, but it is currently midway through implementing a national harmonisation process for its health and safety framework. The Commonwealth, states and territories have committed to implement the new work health and safety laws on 1 January 2012. Following implementation, Safe Work Australia will monitor and evaluate the harmonised national work health and safety framework.

The National Occupational Health and Safety Strategy 2002–2012 will conclude this year and Australia’s national policy body, Safe Work Australia, is developing a new national strategy to set the direction for work health and safety in the coming decade. The Draft Australian Work Health and Safety Strategy 2012 – 2022 has a strong emphasis on designing safely, with “Healthy and Safe by Design” one of seven action areas as shown in the figure below.



Figure 4: Overview of the Vision, 2022 Outcomes and Seven Action Areas of the Draft Australian Work Health and Safety Strategy 2012 – 2022. (Source: Safe Work Australia)

The goal for the Healthy and Safe by Design action area is that hazards are eliminated or minimised by design. To achieve this, structures, plant, equipment and substances are designed to eliminate or minimise hazards or risks before they are introduced into the workplace, and work and work processes and systems of work are designed and managed to eliminate or minimise hazards or risks.

Australia has also proactively developed the Construction Hazard Assessment Implication Review (CHAIR) Safety in Design Tool, the primary aim of which is to identify and eliminate or minimise risks in a design as soon as possible in the life of a project.

There are three phases of CHAIR:

- CHAIR 1 is performed at the conceptual stage of a design, which is the best opportunity to make fundamental change, even though much of the design is still to be determined.
- CHAIR 2 focuses on construction and demolition issues and is performed just prior to construction, when the full detailed design is known.
- CHAIR 3 focuses on maintenance and repair issues and is performed at the same time as the CHAIR 2 study.

By proactively considering construction, maintenance, repair and demolition issues, the CHAIR framework should not only help reduce the number of construction industry incidents, but also assist in improving constructability and reducing the life cycle costs associated with building and civil design projects (WorkCover NSW 2001).

## **4.2 USA**

The USA's health and safety system is similar to Australia's pre-harmonisation situation in that there are laws, regulations and enforcement agencies specific to each state. Whilst safety in design is not specifically mentioned in the current overarching strategy document, the Department of Labour's strategic plan 2011 – 2016 (DoL 2011), a national movement known as Prevention Through Design has gained considerable momentum since about 2007. The National Institute of Occupational Safety and Health (NIOSH)'s Prevention Through Design: Plan for the National Initiative 2007 – 2014 is aimed at implementing a nationwide standard and guidelines for designing safely (NIOSH 2007).

According to the plan, the mission of the PtD National Initiative is to prevent or reduce occupationally related injuries, illnesses, fatalities, and exposures by including prevention considerations in all designs that affect individuals in the occupational environment. The initiative's goals are organised around the five overarching areas of research, education, practice, policy and small business, within which there are a number of strategic goals.

Since the Prevention Through Design Plan was produced in 2007, considerable work has been done to change the safety culture within organisations. An American National Standard - Prevention Through Design: Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes (ANSI/ASSE 2011) – came into effect in January 2012. Recently, technical guidelines have also been released to assist users of the standard.

## **4.3 UK**

The UK implemented a safety in design framework with the Construction (Design Management Regulations) in 1994. These regulations were considerably re-written in the 2007 edition, which includes an approved code of practice that provides practical guidance on complying with the duties set out in the regulations. The CDM2007 aims to integrate health and safety into the management of the project and to encourage everyone involved to work together to:

- a) Improve the planning and management of projects from the very start;
- b) Identify hazards early on, so they can be eliminated or reduced at the design or planning stage and the remaining risks can be properly managed;
- c) Target effort where it can do the most good in terms of health and safety; and
- d) Discourage unnecessary bureaucracy.

The regulations have particular requirements for projects over 30 days in duration or 500 person days' duration. These projects are classified as "notifiable". Such projects are notified to the Health and Safety Executive (HSE, the UK enforcement body), a CDM coordinator (CDMC) must be appointed for the project and a principal contractor is required. The regulations place a considerable importance on the competency of individuals involved with the project, and it is generally expected that the CDMC, designers and contractors will provide evidence of the level of competency of staff. For notifiable projects, a project-specific Health and Safety file is

provided by the client to designers and contractors during tendering, and this file is maintained and updated for return to the client upon completion of the project (HSE 2007).

## **5 SAFETY IN DESIGN IN NEW ZEALAND**

A report was commissioned by the New Zealand Construction Industry Council in 2006 to provide an international picture of current international safety in design practice, offering an international base from which to consider the issue in a New Zealand context (New Zealand Construction Industry Council, 2006). The CIC report considered the strategic framework, legislation, education and practices and protocols for safety in design within Australia, the UK and the USA. The report recommended that based on international evidence, the construction industry in New Zealand should consider the value of explicitly incorporating safety in design concepts into future strategies, legislation, practices and protocols relating to the design and construction of buildings and structures. There has been little momentum for change at a government level since the CIC report was commissioned

### **5.1 AVAILABLE GUIDELINES**

A number of guidance documents have been produced by New Zealand institutions and professional bodies which relate to safety in design.

#### **5.1.1 IPENZ CODE OF ETHICS**

The Institute of Professional Engineers New Zealand (IPENZ) has a code of ethics that must be abided by professional engineers within its membership (IPENZ 2005). In relation to safety it says that:

*Members shall recognise the need to protect life and to safeguard people and in their engineering activities shall act to address this need. This includes:*

*1.1 Giving priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.*

*1.2 Ensuring that reasonable steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.*

*1.3 Drawing the attention of those affected to the level and significance of risk associated with the work.*

*1.4 Assessing and taking reasonable steps to minimise potential dangers involved in the construction, manufacture and use of outcomes of your engineering activities.*

#### **5.1.2 IPENZ PRACTICE NOTE 07: DESIGN FOR SAFETY IN BUILDINGS AND OTHER STRUCTURES**

The IPENZ Practice Note 07: Design for Safety in Buildings and Other Structures (IPENZ 2006) is intended to be a guide to demonstrating compliance with a designer's responsibilities under the Health and Safety in Employment Act 1992. It seeks to clarify the relative roles and responsibilities that architects, consulting engineers and constructors (contractors and subcontractors) have within the very wide subject of designing for safety.

#### **5.1.3 NZCIC DESIGN DOCUMENTATION GUIDELINES**

The New Zealand Construction Industry Council (NZCIC) began to develop design documentation guidelines in 2002 following growing concerns about the impact (and limited understanding) of poor documentation on the building industry in New Zealand. These concerns were also confirmed by studies undertaken in other countries. The guidelines have been the subject of wide industry consultation, as well as an international search on best practice. They have been comprehensively trialled by practitioners in a variety of disciplines to ensure their practical application. The guidelines include specific safety in design activities and indicate specific points in the project lifecycle at which these activities should take place.

#### **5.1.4 SITE SAFE HEALTH AND SAFETY GUIDE FOR THE TENDERING PROCESS**

The Site Safe Health and Safety Guide for the Tendering Process (Site Safe 2000) is a best practice guideline for health and safety in the construction tendering process. This guide is intended as a useful tool for all those involved in the tendering process – including clients, their agents, designers/advisers, contractors and suppliers. It provides all parties involved in the tendering process with a better understanding of what they can do to introduce health and safety into the tender stage of a project.

#### **5.1.5 SITE SAFE CONSTRUCTION SAFETY MANAGEMENT GUIDE**

The Site Safe Construction Safety Management Guide (Site Safe 1999) is a best practice guideline for the management of health and safety in construction, which includes numerous responsibilities for designers.

### **5.2 ACTIONS BEING TAKEN BY INDIVIDUAL ORGANISATIONS**

Some individual organisations have taken the initiative to develop internal processes that address health and safety risk on construction projects.

In 2004, Manukau CC identified physical works as a major risk area for health and safety (New Zealand Department of Labour 2010). A dedicated team was established to manage health and safety in contracts to ensure statutory requirements were being met. An independent consultant was engaged to assess risks and recommend a process for improvement, with new arrangements being implemented in 2005. The process required contractors and professional services consultants to undertake a health and safety pre-approval before being able to work on MCC projects. The pre-approval check reviewed the contractor's health and safety management system and level of competency for conducting hazardous activities.

A number of consultancies who also conduct business overseas have implemented internal processes for safety in design. Such processes require hazard assessments throughout the life of projects to ensure that hazards arising from the design are proactively managed during the design stages and through to construction.

Unless an alliance contract model has been used, contractors are often involved in the project too late to have a significant impact on safety in design. They can however be employed earlier in the project lifecycle as “constructability consultants”, with the goal of reviewing the design deliverables with respect to ease of construction but also safety of workers during construction.

## **6 THE WAY FORWARD IN NEW ZEALAND**

### **6.1 GOVERNMENT TASKFORCE**

On 16 April 2012, the New Zealand government agreed to the establishment of an independent taskforce to undertake a strategic review of whether the New Zealand workplace health and safety system remains fit for purpose. The strategic review is timely as it has been 20 years since the enactment of the Health and Safety in Employment Act 1992 and 10 years since the last significant review of the regulatory framework.

The objectives of the review are as follows:

- a) To identify whether the overall workplace health and safety system remains fit for purpose
- b) To recommend a package of practical measures that would be expected to result in at least a 25 percent reduction in the rate of fatalities and serious injuries by 2020.

Whilst safety in design is not specifically mentioned in the taskforce terms of reference, it is likely that this will be considered as one of the potential “practical measures” given that design is so intrinsically linked to health and safety statistics (refer section 3 above).

### **6.2 POTENTIAL INITIATIVES FOR NEW ZEALAND BUSINESSES**

In the absence of legislative requirements, New Zealand businesses should take proactive steps to integrate safety in design principles into business culture. Given the nature of the commercial environment, this will be driven by clients who decide that safety in design will be proactively addressed within their procurement process. To drive a change towards including safety in design in the water industry, clients could:

- Share resources, tools and ideas with other clients (particularly important for smaller councils);
- Include safety in design activities (such as CHAIR and HAZOP studies) in future project briefs;
- Request and monitor robust safety communication channels within the design and construction team throughout the life of the project.

In addition to abiding by their ethical obligations as professional engineers, designers could:

- Recommend to clients that projects include safety in design activities (such as CHAIR and HAZOP studies) at appropriate stages in the design phase;
- Implement robust safety in design procedures within their standard design guidelines;
- Actively drive the flow of safety information within the project team (including client and contractor) at all stages of the project.

In order to proactively manage health and safety risk on construction sites and to contribute to the safety of the project's end user, contractors could:

- Request information relating to the inherent safety risks associated with the designs (if not already presented to them);
- Communicate with designers and clients to eliminate, avoid or reduce these safety risks during construction;
- Consider any safety risks to those maintaining and using the end product that have not already been identified and communicate these to the project team.

All parties should take key safety in design learning from each construction project forward to the next project. This will allow future projects to benefit and help to prevent incidents from occurring more than once.

## **7 CONCLUSIONS**

Safety in design is a concept that is open to interpretation within the New Zealand health and safety framework. Whilst the UK, USA and Australia have acknowledged its importance at a national level and employed varying degrees of legislation, guidance and education, in New Zealand it is left to individual organisations to develop and implement systems and processes relating to its consideration and control.

Not all of the countries mentioned have made it a legislative requirement to actively implement safety in design processes on projects. Whilst the UK's CDM Regulations include clear responsibilities for duty-holders which are actively enforced by the HSE, the USA and Australia have chosen to pursue strategic programmes whereby safety in design will be a strongly recommended project activity with clear guidelines for implementation, but is not a legal requirement.

The New Zealand government taskforce reviewing the health and safety framework may well look to overseas evidence and models for guidance on implementing safety in design initiatives here, but this will take some time to implement. It is therefore recommended that New Zealand businesses preempt these government initiatives by implementing their own internal processes to embed safety in design cultures within their organisations. Clients should be proactive and insist that designers include safety in design activities (such as CHAIR and HAZOP studies) in project implementation. In order to meet their professional code of ethics, designers should look to implement these processes within their project delivery guidelines. Contractors should continue to communicate with clients and designers about the safety risks associated with their projects, and should identify and communicate any new risks that arise to the project team.



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