# IF YOU SEE $ID … TELL HIM

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## ABSTRACT

Aren't we all a little overwhelmed with the new legislation, the Health & Safety at Work Act (2015) that just came into effect on 4th April 2016? What do we need to do to meet our legal obligations under the Act?

The term Safety in Design (SiD) is being used more often in conversations around the new Act. Will this cost us more money?

I have been overseas for a number of years working for a contractor engineering, procuring and constructing multi-million dollar power plants in the United Kingdom and Ireland. In both countries legislation requires SiD to be carried out.

The key message from a Contractor's point of view is very simple:

- Neglect your duty of care for health and safety on capital plant and you are out of business
- Embrace local legislation early in the design, which will lead to capital cost savings

We have been practicing this approach for a long time already in the water industry in New Zealand. Our tools are established around the latest industry standards and are in daily use.

This paper outlines the following:

- Where does New Zealand stand in the health and safety space compared worldwide?
- Provides overseas lessons from a Contractor's perspective
- Presents good practice Safety in Design principles
- Elaborates on potential cost savings
- Presents a case study.

## KEYWORDS

**Safety in Design, SiD, Health & Safety at Work Act (2015), Contractor, capital cost saving, health & safety of persons, legal obligations**

# 1 INTRODUCTION

The Health & Safety at Work Act (HSWA) 2015 came into effect in New Zealand on 4th April 2016. This legislation replaced the Health and Safety in Employment Act 1992.

How does this all affect us in designing "structures, plant, or substances", a term used in the new legislation?

This paper gives a brief overview of our legal framework, puts this into a worldwide perspective and outlines an approach on how to comply with the new legislation.

Having worked for large European construction contractors for a number of years in Europe under UK and European legislations, this paper outlines similar legal frameworks in action overseas. It also illustrates how designing safe structures is beneficial to the health and safety of all project stakeholders and can have capital cost savings in all associated project life cycle stages.

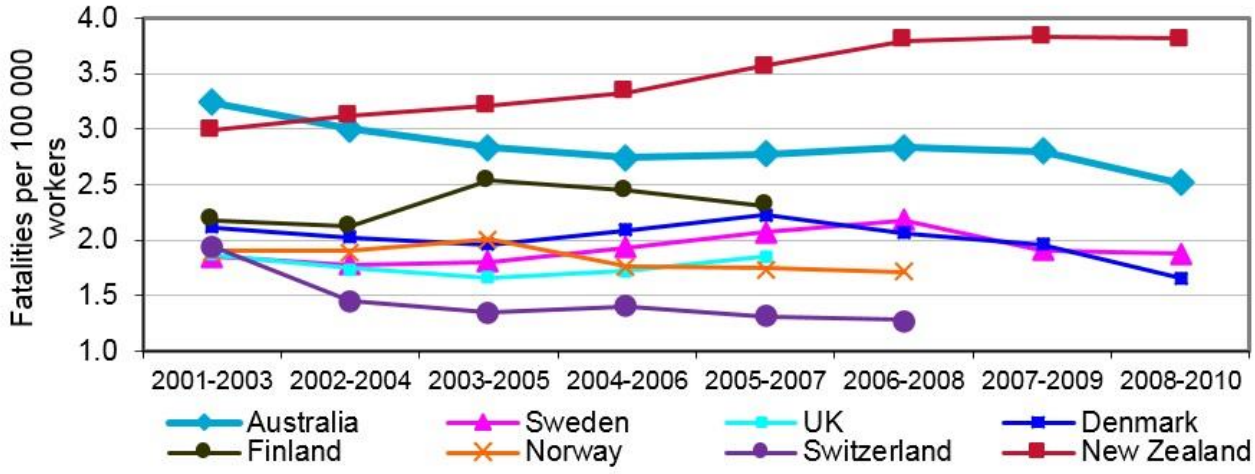
# 2 WHAT IS NEW ZEALAND'S STANDING IN THE HEALTH AND SAFETY SPACE?

## 2.1 WORLDWIDE STATISTICS

The worldwide statistics shown below were compiled by Safe Work Australia in 2014. Safe Work Australia had set out the target to be the lowest work-related traumatic injury fatalities in the world by 2009. Figure 1 shows a comparison of work-related injury fatalities per 100,000 workers.

While Australia's fatalities reduced by 23% during a 9 year timeframe, New Zealand's fatalities increased by 25%. The best performing countries are shown to have less than half of New Zealand's fatalities.

*Figure 1: Comparison of work-related injury fatality rate of selected countries including New Zealand*[1]




[1] Key Work Health and Safety Statistics 2014, Australia

## 2.2 LEGISLATIVE FRAMEWORK WORLDWIDE

New Zealand's trend of work-related fatalities per 100,000 workers in Figure 1 is very alarming. What is the legislative background in some of these better performing countries? Is there a correlation between their declining fatalities trend and their health and safety legislative framework?

**AUSTRALIA:**

Australia's legal system is based on common law, which is developed around court cases by judges. The current Model Work Health and Safety Act was under development since September 2009 and came into force in June 2011.

While “Safety in Design” is now widely practiced in Australia, the Act does not prescribe its use. However Safe Work Australia does provide guidance on “Safe Designs”. Also, the independent body “Consult Australia” has developed extensive industry research and provided guidance on Safety in Design for its members.

**UNITED KINGDOM:**

The UK’s legal system is also based on common law. Its’ Health and Safety at Work Act is supported by the Construction (Design and Management) Regulation 2015, also known as CDM. The CDM regulations have been supporting the Act similarly to the Australian regulations since 1994.

The designer’s duties are very similar to those in the New Zealand legislation. CDM highlights the importance of addressing health and safety in designs from the outset of each project.

**SWITZERLAND:**

In contrast to the Commonwealth legal system, Switzerland’s legal system is based on civil law, where codified statutes govern the legal system. The health and safety act is a more prescriptive legislation. Also, the onus is put on individuals, rather than a collective.

## 2.3 NEW ZEALAND’S LEGISLATION

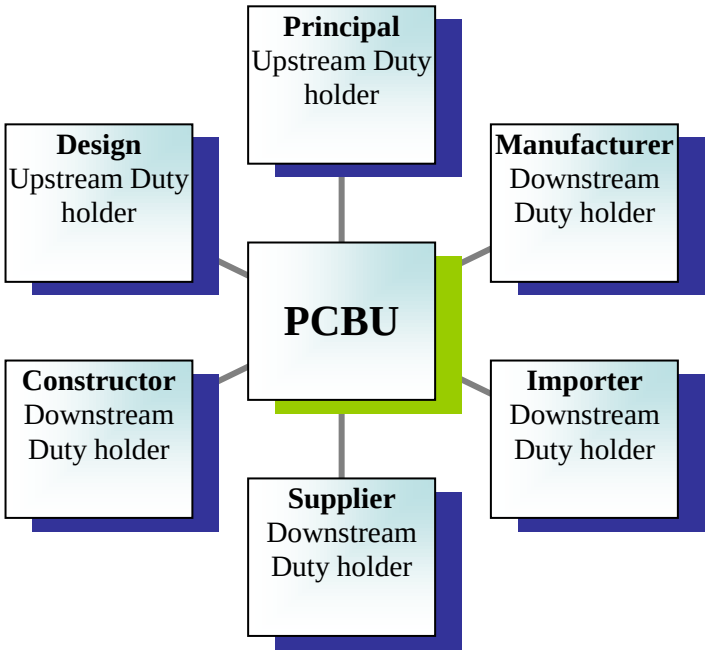
What is New Zealand’s health and safety legislation in a nutshell?

New Zealand Health and Safety Act is based on Australia’s legislation. Due to its similar legislative framework, New Zealand will be able to adopt Safety in Design guidelines.

The judicial system will be able refer to Australian court cases for precedents, when our legislation will be enforced.

The Act requires a more rigorous approach to Health and Safety management. The new act defines a new legal concept – a Person Conducting a Business or Undertaking (PCBU). The PCBU will be ultimately responsible for workplace safety. On a conventional client design, construction tender project the following PCBU are defined:

*Figure 2: PCBU for a traditional client design construction tender project*




All above stakeholders have a primary duty for workplace health and safety at different project life cycle stages. Both the Principal and the Designer will be generally involved right from project conception and can influence project outcomes from the very beginning.

It is defined in the HSAW that "the designer must, so far as is reasonably practicable, ensure that the plant, substance, or structure is designed to be without risks to the health and safety of persons".

## 2.4 WHAT IS SAFETY IN DESIGN?

It appears that a Safe Design approach adopted in Australia and the UK has contributed in the decline of work related fatalities.

Safety in Design (SiD) can be best described by this statement: *Safety in Design is a strategy aimed at preventing injuries and disease by considering hazards as early as possible in the planning and design process and enhancing safety through choices of controls in the design sequence.*

Designers, as upstream duty holders are in a unique position to eliminate or reduce the risks that arise during the life cycle of the asset. Early design decisions may influence later design choices, and considerable rework may be required if it is necessary to unravel earlier decisions. It is therefore vital to address health and safety during the design phase. Changing the design philosophy is a lot more cost effective than undertaking retrospective changes in the field. It also avoids costs associated with incident management and clean up.

It is the duty of designers to provide all health and safety related information to all persons involved in construction, commissioning, operation, maintenance and demolition of the plant.

### WHAT ARE THE BASIC SID PRINCIPLES?

Safety in Design relies on a few simple principles. These include:

- Early design involvement of all relevant (and engaged) project stakeholders
- Relying on competent and experienced engineers during the design process
- Planning and executing inter-disciplinary design reviews at all appropriate project stages
- Planning and executing intra-disciplinary design reviews at all appropriate project stages
- Integrating all relevant stakeholders in the design decision making process
- Reviewing early design decisions as the project evolves
- Communicating design intent and health and safety considerations to downstream stakeholders

Adhering to these basic principles will not only ensure compliance with the HSAW, but could also result in project life cycle cost savings.

### SID VERSUS HAZOP

Hazard and operability studies (HAZOPs) have been commonly used in the process industry to identify potential hazards and operational issues with a plant design. A HAZOP study would generally be carried out after the concept, preliminary and detailed design stage. Depending on the facilitator HAZOP studies can incorporate plant maintenance and access. HAZOP studies often focus on finding detailed solutions rather than challenging fundamental assumptions.

In contrast Safety in Design has been developed to work around the local health and safety legislation and consider the entire design life cycle from conception, construction, commissioning, operation, maintenance, through to demolition. The main focus is to bring all relevant project stakeholders together to identify hazards early in the design process and come up with innovative solutions collaboratively.

Safety in Design can be used across industries, while HAZOP studies are generally used in the process plant industry only. However an extended HAZOP study could be used in lieu of Safety in Design, given all relevant aspects in the legislation are met.

# 3 CONTRACTOR STRATEGIES TO COMPLY WITH HEALTH AND SAFETY LEGISLATION

Through professional experience with large contractors ("our downstream duty holders") in the UK and Ireland I have come across different contractor strategies to comply with local health and safety legislations. Those are:

- Exit market
- Embracing legislation and competitiveness.

## 3.1 EXIT MARKET

One extreme contractor strategy is to discontinue operating in this market. This is what large multinationals like Bosch and ABB have done with their solar thermal construction businesses in 2012.

For large firms operating in both the component supplier and the construction contractor markets, the business risk is elevated in a more stringent health and safety legislation. Additionally, most construction contractors operate on very low profit margins, as low as 4% in Europe, whereas component supplier margins can be as high as 50%.

The project construction risks outweigh any financial gains and an exit market strategy can be the most viable option. This does come at a cost – €1,000 million for Bosch[1] and US$350 million for ABB[2] in write offs.

[1] http://uk.reuters.com/article/bosch-solar-idUKWEB001X520130322

[2] http://www.abb.com/cawp/seitp202/3d3621c7e336e939c1257ad30057df23.aspx

## 3.2 EMBRACING LEGISLATION AND COMPETITIVENESS

Due to the high financial exit barrier, this strategy is not available for most construction contractors. Embracing health and safety legislation and using this as a competitive advantage can be a sustainable strategy. Here is how a contractors' application of health and safety legislation can work to its advantage.

My contractors' experience comes from a worldwide leading Energy from Waste turnkey contractor, who provides complete plant and system solutions for energy recovery from waste. Project plant sizes ranged from NZ$150 to NZ$500 million.

### 3.2.1 ARRANGEMENT PLANNING

Every design starts with arrangement planning of the overall plant. Together with the plant lead engineer, the project director, the plant lead arrangement planner is the client key contact.

The lead arrangement planner takes responsibility for the following:

- Local health and safety legislation implementation
- Plant maintenance access and operational access, including plant lifting arrangements
- Ensures coordination between all discipline arrangement planners and all external arrangement planners
- Coordinates civil construction interfaces
- Presents the developed plant model to the client on monthly basis

3D plant modelling software is a standard tool to aid the construction process, demonstrate plant progress to the client and to coordinate various internal and external resources.

While arrangement planning is vital for any plant project, discipline accountability is equally important.

### 3.2.2 DISCIPLINE ACCOUNTABILITY

Each engineering discipline is held responsible for its design outcomes. This includes budget accountability.

The key message here is: “Design issues need to be raised and addressed in the early design stages, otherwise design budgets will be severely compromised.”

This message focuses the attention of all disciplines to ensure that appropriate attention to design detailing is provided.

All engineering, procurement or construction disciplines are packaged into robust workflows. Workflows are summarized as work procedures and it must be ensured that all relevant disciplines are using those in their processes.

### 3.2.3 ROBUST WORKFLOW

#### QUALITY GATE REVIEWS

Engineering activities are split into concept design, basic design, extended basic design and detailed design. Each design stage is marked with a final quality gate review meeting. All disciplines department heads, including the non-engineering functions procurement, scheduling, arrangement planning, controlling, construction and project management are attending these review meetings. Where design flaws or issues are discovered these are addressed. Once all open items are addressed, all responsible department heads are signing off the protocol and the next design stage can commence.

#### EARLY CLIENT INVOLVEMENT

The client is involved in all project stages right from contract award. Face to face client meetings are held on a monthly basis, where project progress and plant design aspects are discussed.

Having this early client involvement ensures all client drivers are addressed and no surprises arise during the construction period.

#### EARLY SUB-CONTRACTOR ENGAGEMENT

In the detailed engineering design phase, relevant engineering packages get tendered among pre-qualified sub-contractors. While the detailed design responsibility is transferred to the sub-contractor for the respective work packages, the overall project accountability rests with the head contractor. To ensure the sub-contractor performs to the outlined contract specifications, design review processes and manufacturing inspections are planned and agreed on contract award.

A collaborative engagement with the sub-contractor is key in achieving a successful project outcome.

### 3.2.4 DESIGN DECISION REGISTER

Finally any design decisions agreed during the course of the engineering design process are recorded and reviewed against the outset design parameters and local legislation. This design decision register is reviewed on a monthly basis by the governance group, including client stakeholders and project sponsors.

## 3.3 A GOOD DESIGN WITHSTANDS THE TEST OF TIME

The above approach demonstrates how an engineering, procurement and construction contractor embraces the legislative environment and turns this attention into good plant designs.

A good plant design that meets all health and safety requirements, ensures maintainability and operability, decreases plant operating costs, prevents downstream warranty and compliance claims and increases the likelihood of solid financial returns to the business.

Competitors with less rigorous processes and attention to detail risk decreasing market share and lower repeat business.

# 4 WHAT ARE ASSOCIATED COSTS WITH SAFETY IN DESIGN?

Even though several countries have promoted safety in design, research into associated costs are not available. However, other industries can be used for comparison purposes.

## 4.1 INDUSTRY SIMILARITIES

The automotive industry have successfully used Design for Assembly (DFA) to reduce development time and with this reduce manufacturing and development costs. At the same time product quality has increased. "DFA methodologies were developed to support the designer by generating feedback on the consequences of design decisions on product assemblies"[1]. Safety in Design is based on a similar principle.

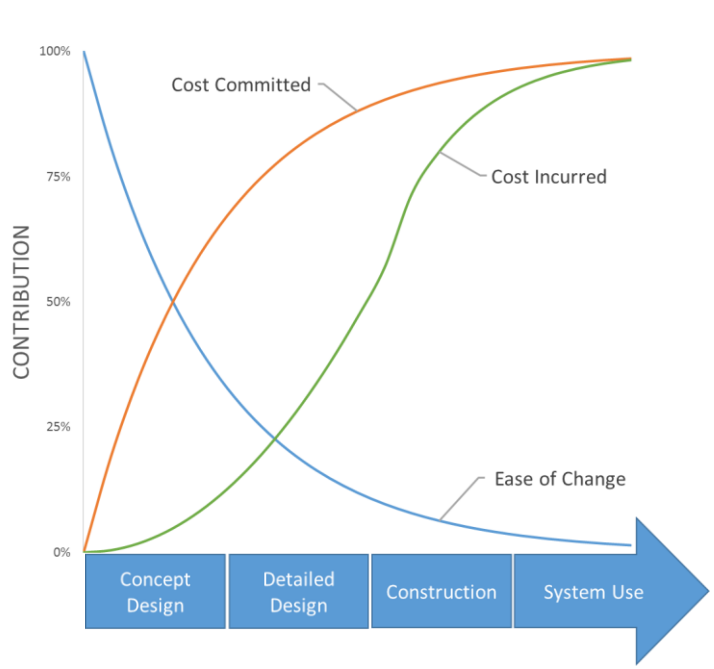
Figure 2 below shows how ease of design change in the DFA process relates to incurred and committed cost during the product development life cycle.

The concept design phase will influence the downstream project life cycle phases – construction, commissioning, operation, maintenance and demolition. Design changes taken in the further downstream project phases will incur higher additional capital costs.

This highlights the importance of spending sufficient time on health and safety related features in the early design phase. Getting any relevant input from the downstream project phase stakeholders will add value to the project and can reduce the project life cycle cost.

Design for Assembly studies have shown inventory cost reductions by 40%, operator demand by 17%, and idle time about 80% [2]. Safety in Design capital cost savings may reach similar levels.

*Figure 2: Design change versus cost*




[1] http://www.hullhistorycentre.org.uk/discover/mapp/sandpit/dfa.aspx

[2] Artun Toerenli (2009) 'Assembly line design and optimization' Master of Science Thesis, Department of Production and Production Development, Goeteborg, Sweden 2009

## 4.2 WHAT HAPPENS IF SAFETY IN DESIGN IS NOT APPLIED IN THE EARLY STAGES?

Applying SiD in the early project stages does prevent downstream construction claims and design rework. For example for a chlorine store the standard "AS/NZS 2927:2001 The storage and handling of liquefied chlorine

gas" is applicable. For indoor chlorine store installation, this standard requires the walls to be "non-combustible".

Conducting a SiD workshop with a competent designer and contractor present, such requirements would be easily be picked up and the correct construction materials specified accordingly. Having to rectify this during the construction stage will bring additional costs as design rework, contractor variations for additional work, contractor variations for extension of time, insurance claims only to name a few.

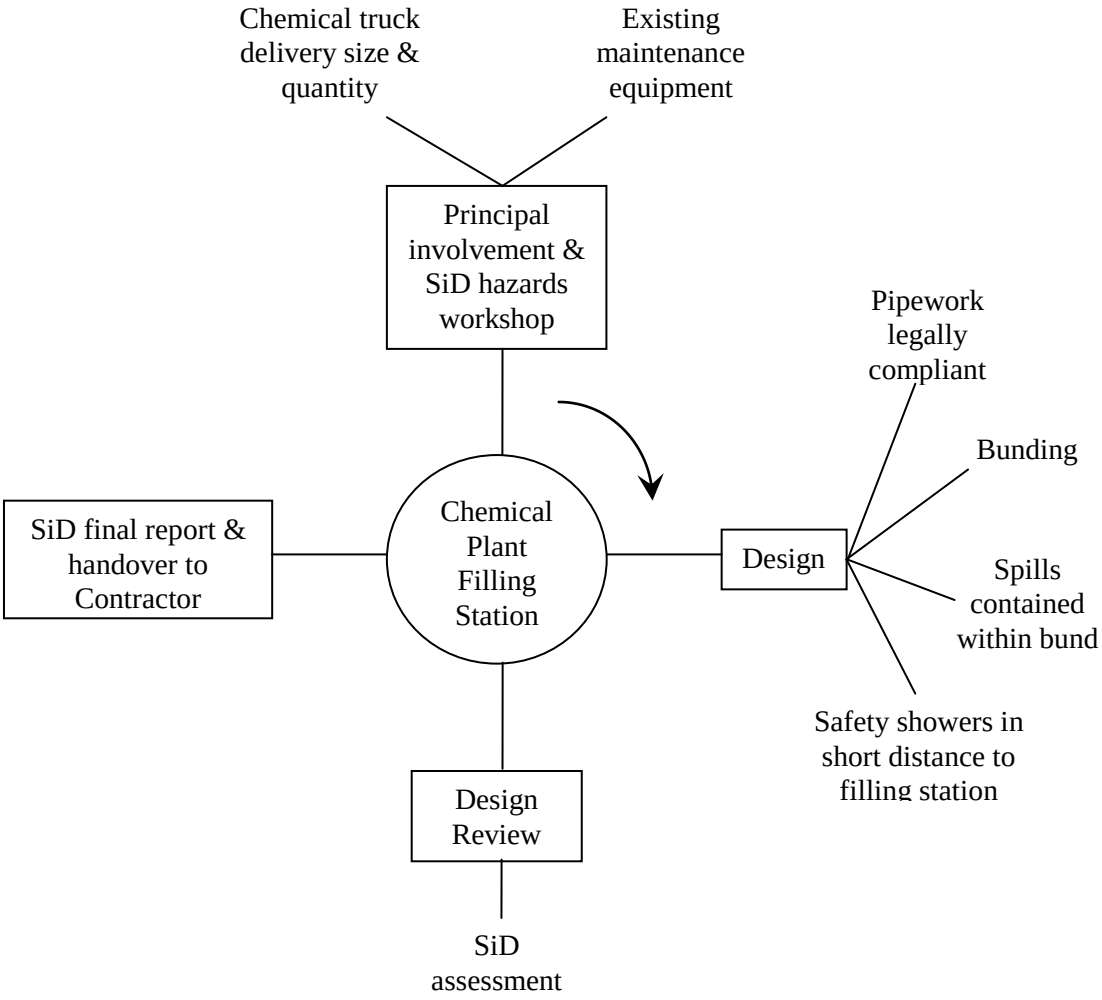
Depending on the magnitude of the design flaw, this could add a significant percentage increase to the total project value.

# 5 CASE STUDIES

**WTP BROWNFIELD SITE UPGRADE – CHEMICAL STORAGE**

The below mindmap shows the SiD approach for a water treatment plant (WTP) upgrade. In this mindmap the design process has been simplified into one stage only. Generally we progress through concept, preliminary and detailed design.

*Figure 3: Chemical Storage Filling Station Mindmap*




This simplified design process illustrates a safe design approach:

1. Principal involvement with known SiD project specific hazards identification

2. Plant design considering acceptable standards and mitigated project specific hazards

3. Plant design review and a SiD hazard assessment in collaboration with the Principal

4. Final SiD report and handover to downstream stakeholder – the Contractor

For this particular project a site visit was scheduled prior to the SiD workshop. Operators and a representative maintenance contractor were also present for this workshop. As site access to this brownfield site was restricted, vehicle access and safe equipment handling as well as constructability issues had to be considered from the outset of the project.

The design then incorporated the workshop findings, applied all relevant standards and previous plant experience. Inter- and intra-disciplinary reviews were scheduled during project execution and the design was tested by the senior design review team.

After the design was fully developed an external review, including the relevant stakeholders was conducted. All design changes were scrutinized by the workshop group to ensure no new hazards were introduced to the design.

Once all workshop agreed design improvements were implemented, the final SiD report was prepared. This report informed the downstream project stakeholder, the Contractor, of the design intent and any remaining anticipated construction risks.

# 6 CONCLUSIONS

The newly introduced Health and Safety at Work Act 2015 will make a positive contribution to our industry. Similar legislation overseas and the use of Safety in Design has been attributed to the reduction in work-related fatalities.

Instilling a Safety in Design approach at the onset of a project will save capital costs downstream and will ensure a safe workplace for all stakeholders.

## REFERENCES

Construction (Design and Management) Regulations 2015, United Kingdom

Health and Safety at Work Act 2015, New Zealand, Public Act 2015 No 70

Model Work Health and Safety Act 2011, Australia