GUIDANCE ON THE PRINCIPLES OF SAFE DESIGN FOR WORK

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Australian Safety and Compensation Council

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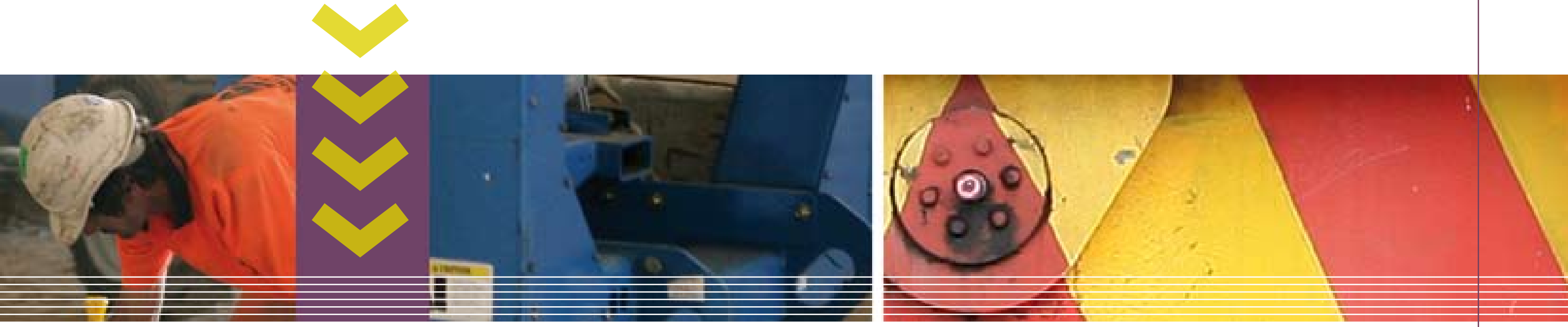

FOREWORD

The Australian Safety and Compensation Council (ASCC) leads and coordinates national efforts to prevent workplace death, injury and disease in Australia and aims to improve national workers' compensation arrangements and return to work of injured employees.

Through the quality and relevance of the information it provides, the ASCC seeks to influence the awareness and activities of every person and organisation with a role in improving Australia's occupational health and safety (OHS) performance.

The *National OHS Strategy 2002-2012,* (the National Strategy) which was endorsed by the Workplace Relations Ministers' Council on 24 May 2002, records a commitment by all Australian, State and Territory governments, the Australian Chamber of Commerce and Industry and the Australian Council of Trade Unions, to share the responsibility of ensuring that Australia's performance in work-related health and safety is continuously improved.

The National Strategy sets out five 'national priorities' to achieve short-term and long-term improvements.

The priorities are to:

> reduce high incidence and high severity risks

> improve the capacity of business operators and workers to manage OHS effectively

> prevent occupational disease more effectively

> eliminate hazards at the design stage, and

> strengthen the capacity of government to influence OHS outcomes.

Guidance on the Principles of Safe Design for Work has been developed to support the priority – eliminate hazards at the design stage. The purpose of this document is to provide guidance and information to persons who are directly or indirectly involved with the design or modification of products, buildings, structures and processes used for work. It focuses on the key principles of safe design and sets the framework for the development of further detailed and practical guidance material.

This guide aims to raise awareness of the importance of safe design and how it can be achieved and is not intended to be adopted into OHS legislation.

The Office of the ASCC acknowledges the assistance of all the persons and organisations who contributed to this guide, in particular:

> Chris Beale (Risk Manager - Sinclair Knight Merz)

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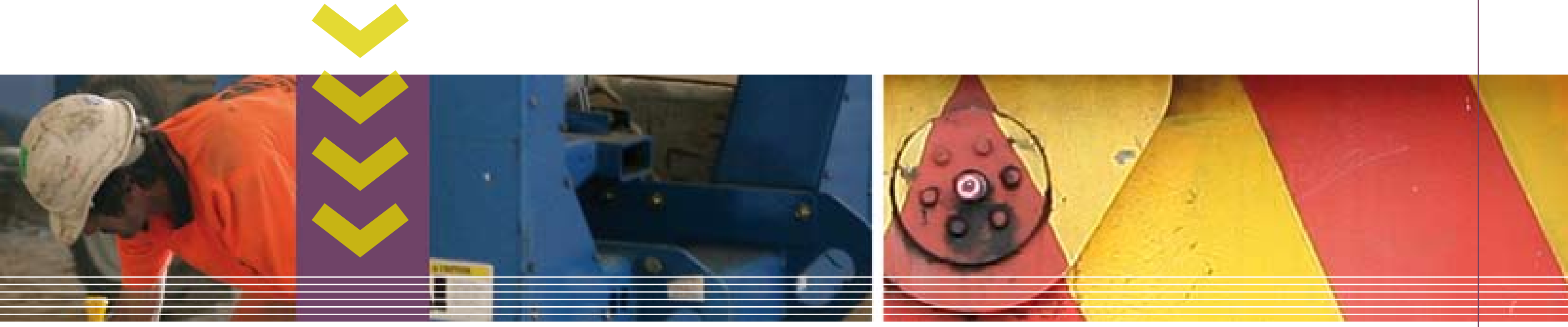


1. INTRODUCTION

This guide provides information and advice on eliminating hazards and controlling risks at the design stage to persons involved in the design or modification of products (including buildings, structures, equipment and vehicles) and processes used for work.

In response to societal demands for safer products and workplaces, governments, businesses, designers and other decision makers are seeking greater consideration of safety issues in design. There are also health and safety duties for designers in state and territory occupational health and safety laws. This document introduces the concept of safe design and the principles underpinning it.

1.1 What is Safe Design?

Safe design is a process defined as

> *the integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of injury throughout the life of the product being designed. It encompasses all design including facilities, hardware, systems, equipment, products, tooling, materials, energy controls, layout, and configuration*[1].

A safe design approach begins in the conceptual and planning phases with an emphasis on making choices about design, materials used and methods of manufacture or construction to enhance the safety of the finished product. The designer needs to consider how safety can best be achieved in each of the lifecycle phases, for example:

> Designing a machine with protective guarding that will enable safe operation, whilst also ensuring that the machine can be installed, maintained and disposed of safely.

> Designing a building with a lift for occupants, where the design also includes sufficient space and safe access to the lift well or machine room for maintenance work.

Safe design will always be part of a wider set of design objectives, including practicability, aesthetics, cost and the functionality of the product. Safe design is the process of successfully achieving a balance of these sometimes competing objectives, without compromising the health and safety of those potentially affected by the product over its life.

The design function is influenced by a range of parties at varying stages of the design process, as well as during the lifecycle of the product. They include:

- design professionals such as architects, engineers, industrial designers, software developers
- other groups who make design decisions, such as clients, developers, builders, owners, insurers, project managers, purchasers, OHS professionals and ergonomics practitioners
- suppliers (including manufacturers, importers, plant-hire), constructors, installers and trades/maintenance personnel, and
- government regulators and inspectorates.

1.2 What are the Principles of Safe Design?

The key elements that impact on achieving a safe design are.

Principle 1: Persons with Control – persons who make decisions affecting the design of products, facilities or processes are able to promote health and safety at the source.

Principle 2: Product Lifecycle – safe design applies to every stage in the lifecycle from conception through to disposal. It involves eliminating hazards or minimising risks as early in the lifecycle as possible.

Principle 3: Systematic Risk Management – the application of hazard identification, risk assessment and risk control processes to achieve safe design.

[1] Modified from, W.Christensen and F.Manuele, *Safety Through Design,* National Safety Council, 1999

Principle 4: Safe Design Knowledge and Capability – should be either demonstrated or acquired by persons with control over design.

Principle 5: Information Transfer – effective communication and documentation of design and risk control information between all persons involved in the phases of the lifecycle is essential for the safe design approach.

These principles have been derived from *Towards a Regulatory Regime for Safe Design*[2]*;* with some modification following public consultation. Further detail on each of the principles is outlined in Chapter 2.

Ergonomics and Safe Design

Safe design also incorporates ergonomics principles. Ergonomics is a scientific, user-centred discipline which plays a major role in design but it is also a philosophy and way of thinking. An ergonomic approach ensures that the design process takes into account a wide range of human factors, abilities and limitations affecting end users. Ergonomics considers the physical and psychological characteristics of people, as well as their needs in doing their tasks – how they see, hear, understand, make decisions and take action. User safety, efficiency, productivity and comfort are indicators of how effective the design is in fulfilling its purpose.

Ergonomics Principles

When analysing the need for a designed product or space, an ergonomic approach will address five main elements[3].

> The user – their characteristics, including the physical, psychological and behavioural capacities, skills knowledge and abilities.

> Job and task characteristics – what the user is required to do or actually does. This includes task demands, capacity to make decisions, work organisation and time requirements.

> The work environment – the work area and space, lighting, noise and thermal comfort.

> Equipment design and the interface with the user – including the 'hardware' needed to perform the work and including electronic and mobile equipment, protective clothing, furniture and tools.

> Work organisation – including the patterns of work, fluctuations in work load, timing of work and the need to communicate and interact with others, as well as broader industry or economic influences.

Safe design will largely focus on the 'hardware' of the work but the effectiveness of safe design will be optimised by addressing the 'hardware' within the broader system of work.

1.3 The Role of Design in Workplace Fatalities and Injuries

Research commissioned by the National Occupational Health & Safety Commission[4], (which was replaced by the Australian Safety and Compensation Council in 2005), examined the contribution that the design of machinery and equipment has on the incidence of fatalities and injuries in Australia. The study indicated that:

> Of the 210 identified workplace fatalities, 77 (37%) definitely or probably had design-related issues involved.

> In another 29 (14%) who identified workplace fatalities, the circumstances were suggestive that design issues were involved.

> Design contributes to at least 30% of work-related serious non-fatal injuries.

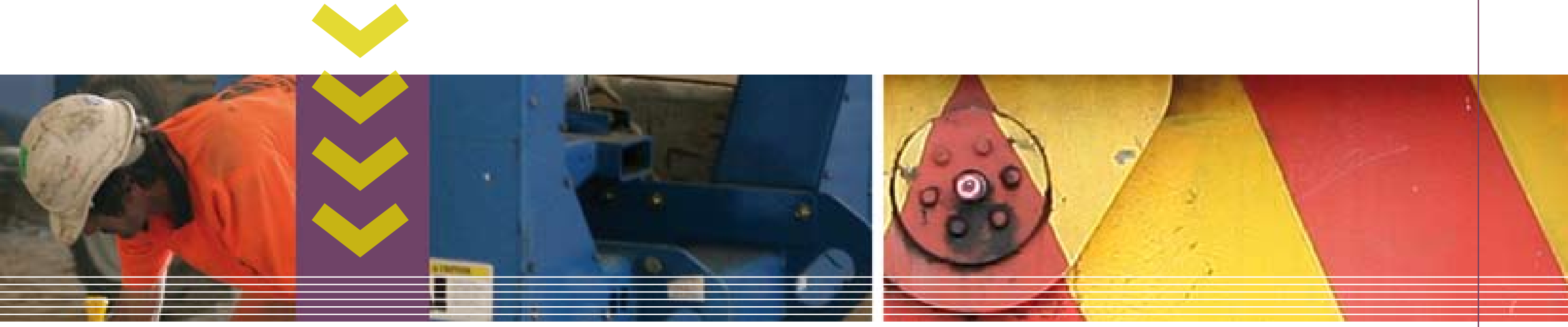
> Design-related issues were most prominent in the 'machinery and fixed plant' group, and 'mobile plant and transport' group.

> Similar design problems are involved in many fatal incidents.

[2] *Towards a Regulatory Regime for Safe Design,* 2002: part five, published by the National Research Centre for OHS Regulation (http://www.ohs.anu.edu.au/)

[3] McPhee, Barbara (2005) Practical Ergonomics - Application of Ergonomics Principles in the Workplace

[4] NOHSC (2004), *The role of design issues in work-related injuries in Australia 1997-2002.*



> Design-related issues were definitely or probably involved in at least 50% of the incidents in the agriculture, trade and mining industries with between 40-50% of the incidents in construction, manufacturing and transport/storage industries.

> Solutions already exist for most of the identified design problems (such as seat belts, rollover protection and guarding).

The main finding from the study is that inferior design continues to be a significant contributor to work-related serious injury in Australia.

Limitations of the data sources mean that the design contribution identified in this analysis is likely to be underestimated.

1.4 The Benefits of Safe Design

The opportunities to create safer workplaces are most cost effective when captured in the earliest phases of the lifecycle of designed-products or processes. The most effective risk control measure – eliminating the hazard – is often cheaper and more practical to achieve at the design or planning stage, rather than making changes later in the lifecycle when the hazards become real risks to clients, users, employees and businesses.

It is estimated that inherently safe plant and equipment would save between 5 and 10 per cent of their cost through reductions in inventories of hazardous materials, reduced need for protective equipment and the reduced costs of testing and maintaining the equipment[5].

The direct costs associated with unsafe design can be significant (for example, retrofitting, workers' compensation and insurance levies, environmental clean up and negligence claims). Since these costs impact more on parties downstream in the lifecycle who purchase and use the product, the incentive for these parties to influence and benefit from safe design is also greater.

A safe design approach results in many benefits, including:

> prevention of injury and disease

> improved useability of products, systems and facilities

> improved productivity

> reduced costs

> better prediction and management of production and operational costs over the lifecycle of a product

> compliance with legislation, and

> innovation, in that safe design demands new thinking.

1.5 Legal Obligations

Australian health and safety law is governed by a framework of acts, regulations, approved codes of practice and supporting industry guidance material. The OHS laws impose duties on a range of parties to ensure health and safety in relation to particular products, such as:

> designers of plant, buildings and structures

> building owners and persons with control of workplaces

> manufacturers, importers and suppliers of plant and substances, and

> persons who install, erect or modify plant.

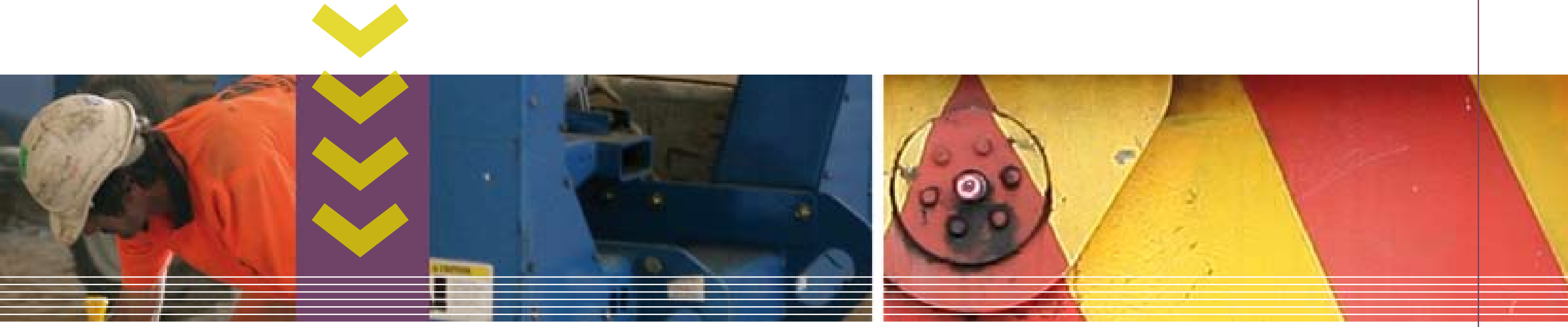
These obligations will vary depending on the relevant state or territory OHS legislation (refer to Appendix B).

Persons who make decisions that influence design, such as clients, developers, builders, directors and managers, will also have duties under OHS laws if they are employers, self-employed or if they manage or control workplaces. For example, a client who has a building or structure designed and built for leasing becomes the owner of the building and may therefore have a duty as a person who manages or controls a workplace.

[5] Trevor Kletz 1998 *Process Plants: A Handbook for Inherently Safe Design.*

There are other provisions governing the design of buildings and structures in state and territory building laws. The Building Code of Australia (BCA) is the principal instrument for regulating architects, engineers and others involved in the design of buildings and structures. Although the BCA provides minimum standards to ensure the health and safety of building occupants (such as structural adequacy, fire safety, amenities and ventilation) it does not cover the breadth of OHS matters which may arise during the construction phase or in the use of buildings and structures as workplaces.

In addition, there are technical design standards and guidelines produced by government agencies, Standards Australia and relevant professional bodies.



2. THE PRINCIPLES OF SAFE DESIGN

2.1 Persons with Control

Responsibility for achieving safe design rests with parties or individuals who control or manage design functions. This includes people who are directly involved in the design activity (such as architects and engineers), as well as those who make decisions that influence the design outcome (such as clients, developers, manufacturers, directors and managers).

Responsibilities should be consistent with the degree of control that a person has. Often, the design process will occur over various stages and involve different people who make specialist or technical decisions for incorporating into the design, which may positively or negatively affect the safety of the product. In these situations there will be a shared responsibility between the parties, depending on the level of control they have over the design function.

Some design tasks, although related, may be controlled by different designers due to contractual arrangements. Designing a product for end-use and designing the process by which it is constructed or manufactured is often undertaken by different people.

Clients play a major role in safe design. As decision makers, they can substantially influence the design outcomes, for example by specifying the budget, a particular layout or the use of certain materials for a product.

Others who have a capacity to achieve safe design include:

- architects, industrial designers or draftspersons who undertake the design on behalf of the client
- individuals who make design decisions during any of the lifecycle phases, such as engineers, manufacturers, suppliers, installers, builders, developers, project managers and OHS professionals
- anyone who alters a design
- building service designers or others designing fixed plant such as ventilation and electrical systems, and
- purchasers who specify the characteristics of products and materials (for example, in purchasing masonry blocks and so deciding the weights that bricklayers must handle during construction).

Safe design can be achieved more effectively when all the parties who control and influence the design outcome collaborate with each other on incorporating safety measures into the design.

2.2 Product Lifecycle

The lifecycle of a product (as shown in **Figure 1**) is a key concept of sustainable and safe design that provides a framework for eliminating the hazards at the design stage and/or controlling the risk as the product is:

- constructed or manufactured
- imported, supplied or installed
- commissioned, used or operated
- maintained, repaired, cleaned, and/or modified
- de-commissioned, demolished and/or dismantled, and
- disposed of or recycled.

Figure 1 - Lifecycle of Designed products[6]

Develop Concept → Design → Construct/ Manufacture → Supply/ install → Commission/ use → Maintain → De-commission → Disposal/ recycle

[6] Adapted from Christensen and Manuele (Ed.)1999 National Safety Council Through Design: Best Practices

A safer product will be created if the hazards and risks that could impact on downstream users in the lifecycle are eliminated or controlled during design, manufacture or construction. In these early phases there is greater scope to design-out hazards and/or incorporate risk control measures that are compatible with the original design concept and functional requirements of the product.

This means that a designer must have a good understanding of the lifecycle of the item they are designing, including the needs of users and the environment in which that item may be used.

New risks may emerge as products are modified or the environments in which they are used change. Safety can be further enhanced if each person who has control over actions taken in any of the lifecycle phases takes steps to ensure health and safety is pro-actively addressed, by reviewing the design and checking that the design meets safety standards in each of the lifecycle phase.

Subsequent stages of the product's lifecycle should not proceed until the preceding phase design reviews have been considered and approved by those persons with control.

The following sections outline what persons involved in each phase of the lifecycle should do to achieve safe design.

2.2.1 Concept Development or Planning

The concept development is the pre-design phase. It provides the functional specifications required for the workplace and may include a number of options about the design, methods of manufacture or construction and/or materials used to enhance the safety of the product.

The concept development phase often commences with a functional needs analysis or feasibility study.

In addition to the necessary functions of the product, the relevant safety requirements for all phases of the lifecycle should be identified in the functional specification.

This involves considering the human interaction with the product and the exposure of users to hazards associated with the work environment, equipment, substance, and/or systems.

The functional specification should be supported by research into the state of knowledge about issues for this type or similar products. Reviews of injury and fatality data, as well as risk assessments relating to similar products provide a helpful insight into the issues requiring attention.

It is important to seek the views of parties who will eventually interact with the product or system. Consultation and feedback are generally much easier for employers, as they have established channels for communicating with employees. Designers, manufacturers and suppliers, however, need to establish communication methods with users to identify and explore existing and potential hazards (see section 2.5). Building a strong customer focus and good client relationships can provide the basis for seeking health and safety input. This can be achieved in various ways by:

- conducting workshops with customers/clients at the conceptual design stage
- using models or mock-ups to facilitate user input
- receiving feedback through user surveys
- field testing or trialling proto-types with a representative group of users
- inviting specialist expertise (such as engineers) to participate in the risk assessment process, and/or
- consulting users when undertaking technical and market research.

All issues identified through research and consultation should be documented so that they can be used to inform future phases of the lifecycle.

Employers or purchasers of design services should have contractual arrangements and procurement systems that operate to minimise the OHS risk of products they purchase, and


provide appropriate resources for this. Such arrangements should ensure that:

> purchasing and contractual arrangements (for example, specifications, supplier pre-qualification and tender documentation) include a requirement to eliminate hazards as far as reasonably practicable and provide residual OHS risk information, and

> the design brief includes a requirement to apply a risk management process in the design.

2.2.2 Design

The design phase involves the development of design plans which includes:

> assessing the risk in each of the lifecycle phases

> developing risk control options

> developing a trial or evaluation plan, and

> providing instructions for safe construction/manufacture, supply/installation, commissioning/use, maintenance, de-commissioning, and disposal or recycling.

Consultation with the client or person commissioning the product at this stage can inform the designer's understanding of the requirements, and better enable the designing-out of hazards. Products should be evaluated for all reasonably foreseeable uses and misuses. This will assist in designing products that are 'error-proof'. Trial or evaluation of the product and any risk control options (for example, the design and location of emergency cut-off switches) should be undertaken in consultation with users and should extend into all phases of the lifecycle that follow, in order to:

> monitor the effectiveness of risk controls, and

> make any necessary control adjustments.

Tables 1 and 2 overpage provide examples of key considerations when designing plant and buildings.

Table 1: Design Considerations for Plant

Consider the plant's lifecycle	Consider all the phases in the lifecycle of an item of plant, from manufacture through use, to dismantling and disposal. For example, if the design allows easy access to working parts requiring regular maintenance, the risk of injury to the maintenance worker may be reduced. However, the design would also have to prevent contact with moving parts while the plant was operating.
Design for safe erection and installation	Risks relating to installing or erecting the plant can be controlled by: - designing the plant so it is stable when left freestanding prior to installation - making it structurally stable even without 'adjustment', that is, before all the nuts have been tightened, - providing special supports that can be used to give stability prior to installation, and - providing attachment points for lifting and handling.
Design to facilitate safe use	Consider the following: - the physical characteristics of users (see also below) - the maximum number of tasks an operator can be expected to perform at any one time, the complexity of those tasks, and the pace at which they can be performed - the need to minimise long periods of physical or repetitive activity and constrained posture - the layout of the workstation or environment in which the plant may be used - instrumentation and its layout (instrumentation should provide clear, accurate information on how the plant is performing, but it should not cause 'information overload' which can cause operator error, and the layout should allow the information to be seen easily from the control position) - the design of controls and operating procedures to make correct actions easier for operators to perform than incorrect actions, and - how users will respond in an emergency – consider the need for emergency stop buttons, including their design and location.
Physical characteristics of users	The plant should accommodate the range of physical characteristics of each user. Consider the range of human dimensions and capabilities such as height, reach and weight to provide an optimum match between plant and user. The principles of ergonomics should be applied to minimise the physical and mental demands on the plant operator in order to reduce potential discomfort, fatigue, error and injury under the intended conditions of use.
Consider intended use and reasonably foreseeable misuse	Misuse means that the plant is used for tasks for which it is not designed or originally intended. For example, it would be reasonably foreseeable that a forklift intended to operate on a slope no greater than 1:5 might sometimes be used on a steeper grade. The designer might incorporate a tilt alarm to control this risk.
Design for safe maintenance	Consider the difficulties workers may face when maintaining or repairing the plant. For example: - reduce the need for maintenance, the less frequently maintenance is required the less the worker is exposed to the risks, or - locate adjustment, lubrication, and other maintenance points outside danger zones, for example by extending lubrication points away from moving parts, and provide ease of access to reduce strain and discomfort during maintenance operations.
Design so the plant 'fails to safety'	Consider types of failure or malfunction and design the plant to fail in a safe manner, for example if moving parts of the plant break up, then the design should ensure that fragments are not ejected.

Table 2: Design Considerations for Buildings

Consider the building's lifecycle	Consider all the phases in the lifecycle of the building, from construction, through to use, maintenance, refurbishment or alteration to potential demolition. For example, a complex or unusual design may require specialised techniques to control the risks during construction, maintenance or demolition, which may increase the costs of undertaking these activities later in the lifecycle.
Design for safe construction	Risks relating to the construction of a building can be controlled by: - providing adequate clearance between the structure and overhead power lines by burying, disconnecting or re-routing cables before construction begins, to avoid, "contact" when operating cranes and other tall equipment - designing components which facilitate pre-fabrication off-site or on the ground to avoid assembling or erecting at heights and to reduce worker exposure to falls from heights or being struck by falling objects - designing parapets to a height that complies with guardrail requirements, eliminating the need to construct guardrails during construction and future roof maintenance - using continual support beams for beam-to-column double connections by adding a beam seat, extra bolt hole, or other redundant connection point during the connection process. This will provide continual support for beams during erection - to eliminate falls due to unexpected vibrations, mis-alignment and unexpected construction loads - designing and constructing permanent stairways to help prevent falls and other hazards associated with temporary stairs & scaffolding, and schedule these at the beginning of construction - reducing the space between roof trusses and battens to reduce the risk of internal falls during roof construction, - and choosing construction materials that are safe to handle.
Design to facilitate safe use	Consider the intended function of the building, including the likely workflows and systems of work, and the type of machinery and equipment that may be used in the building. Consider whether the workplace may be exposed to specific hazards, such as manual handling in health facilities, occupational violence in banks or dangerous goods storage in warehouses. In addition to the requirements of the BCA, risks relating to the function of a building can be controlled by: - designing traffic areas to separate vehicles and pedestrians - using non-slip materials on floor surfaces - providing sufficient space to safely install and operate the plant and machinery - designing spaces which accommodate or incorporate mechanical devices and therefore reducing manual handling risks, and - designing floor loadings to accommodate heavy machinery that may be used in the building.
Design for safe maintenance	Risks relating to cleaning, servicing and maintaining a building can be controlled by: - designing so that building maintenance can be performed at ground level or safely from the structure, for example window cleaning bays or gangways integrated into the structural frame - designing features to avoid dirt traps which use non-corrosive materials to reduce the need for cleaning and maintenance - incorporating building maintenance units into the design of multi-storey buildings to avoid the use of abseiling methods or long ladders for cleaning windows - designing and positioning permanent anchorage and hoisting points into buildings where maintenance needs to be undertaken at height, and - designing safe access and sufficient space to undertake building and plant maintenance activities.
Design for safe alteration	Some types of buildings may undergo frequent alteration or refurbishment, such as offices and shops. Design buildings to enable easy and safe re-installation or removal of fittings and fixtures.

2.2.3 Construction and Manufacturing

The construction and manufacturing phase involves constructors and manufacturers following design plans. In addition to those plans which detail the safety requirements and safety features to be included in the designed-product for eventual users it is also necessary to include plans and schedules which ensure safe construction and manufacturing.

Monitoring and evaluation of the risk controls communicated with the design plan should be factored into manufacturer's or constructor's risk assessments and OHS management systems to ensure safe production processes. In the case of plant and equipment design, trials should confirm the effectiveness of risk controls in the products before they are provided for supply or use.

During the construction and manufacturing phase it is common for people involved with the construction and manufacturing process (where they are not the original designers) to experience or identify new hazards and risks encountered that were not previously known to the designers. Such new information including any plant modifications to control the risks should be documented and communicated back to the designers.

2.2.4 Supply and Installation

The supply and installation phase involves the safe receipt, storage, handling and transfer of products to a user. Suppliers include importers, leasing or hiring agents, auctioneers and second-hand dealers. Suppliers need to be aware of the risks and should communicate the residual risk and risk control measures necessary for the safe use of any products to their clients.

Suppliers should also conduct risk assessments for the safe receipt, storage and handling of products. Risk assessments should be based on information provided by designers and manufacturers on the residual risk and risk control measures, whether the products come from within Australia or from overseas.

Suppliers should encourage their clients to discuss relevant health and safety issues associated with the products they make commercially available. The supplier should pass relevant risk information back to designers and manufacturers.

2.2.5 Commission and Usage

In the commission phase the person with control of the workplace should check and verify that the product is erected, installed or set up for use in accordance with the designer's or manufacturer's specifications, as well as any safety requirements that are unique to the site or location. Appropriate training, information and supervision should be provided to users.

During the usage phase, the person with control of the workplace needs to assess and control the risks that may arise during the operation and use of products, using the knowledge of the residual risk passed from designers, manufacturers and/or suppliers.

Any additional design issues identified at this stage should be passed back to the designer through the manufacturer, supplier and/or importer.

2.2.6 Maintain, Modify, Decommission, Dispose and Recycle

Each of these phases also requires risk assessment, based on the information obtained through the lifecycle about the residual risk and risk control measures.

Any modification of a product requires re-application of the processes detailed in the concept and design phases. Consultation with professional engineers or other experts may be necessary in order to assess the impact of any proposed modifications or changes in design, for example:

> if the speed of a materials handling conveyor is increased to improve productivity, additional stresses may be imposed on supporting structures, and

- changes in the load spread across a building floor when heavy equipment is relocated, modified or replaced.

This ensures that no new hazards are introduced, and that the safety features already incorporated into the design are not affected. Additional design issues identified in these phases should be passed back to the designer.

Designers should provide information and instructions to users on the safe dismantling and disposal of products, for example how to safely dispose of a product that is made of environmentally hazardous materials or materials that can be recycled.

2.3 Systematic Risk Management

Risk management aims to achieve an appropriate balance between realising opportunities for gains while minimising losses[7]. It is a systematic process consisting of a series of steps that, when undertaken in sequence, enable continuous improvement in decision making and OHS performance.

2.3.1 Risk Management Process

Persons involved in design activities should take the following steps:

- identify design-related hazards associated with the range of intended uses, including any foreseeable misuse of the product
- assess the risks arising from design-related hazards
- eliminate hazards and control risks
- monitor and review the risk control measures
- maintain records of risk assessments
- consult with individuals or groups involved in the lifecycle of the product, and
- provide information on the intended use of products for the benefit of users throughout the product lifecycle.

2.3.1.1 Identify hazards

There are two broad sources of hazards relevant to products.

- Hazards relating to the products themselves. For example, a patient trolley in a health care facility may involve mobility hazards, moving parts and its load-carrying capacity, while a building or structure may have access and egress hazards.
- Hazards relating to how the products will be used and the environment where they will be used. The patient trolley, for example may encounter hazards arising from the kind of loads that it moves, as well as the gradient and type of surface (such as, unstable or slippery flooring) on which it is used.

Hazard identification should take place as early as possible in the concept development and design phases, before the product is manufactured, constructed and/or installed. It is important that hazard identification activities are systematic and not limited to one or two people's experiences of situations. The following outlines systematic identification of hazards:

Research – information that can help identify hazards, assess and control the risks includes:

- analysis of customer feedback, warranty, service and repair data
- injury and incident data kept by OHS authorities, suppliers, manufacturers and/or designers of similar products, and
- records of trials previously conducted by any of these parties.

Consultation – designers will be better informed if they have consulted all parties involved in the lifecycle of products about the hazards and the ease-of-use.

Guidance material – information for hazard identification is in:

- codes of practice
- guidance notes
- technical standards, and/or
- industry protocols.

[7] Australian and New Zealand Standard 4360:2004 - *Risk Management*

Hazard identification and risk assessment tools – tools should be selected depending on the context of the hazard (is it a building, plant, substance or system of work?) and the type of hazard (is it manual handling, a confined-space or falls from height?). Examples of tools that can be used include:

- **Hazard & Operability Studies (HazOp)**[8] – is a method of identifying hazards and operability problems. It uses group review of the significance of all the ways that a particular process can deviate from its expected operation. The technique is a structured brainstorming approach using specific guide-words to examine each part of a process plant at detailed design level prior to construction. It is particularly applicable to a process plant but can be modified through the use of different guide-words to apply to other product areas of design.
- **Event Tree Analysis (ETA)**[9] – is used to identify initiating events and their frequency into possible outcomes.
- **Fault Tree Analysis (FTA)**[10] – is a technique used to identify and illustrate conditions and factors (or top events) that can lead to an undesired event. Possible causes or fault modes in functional systems (or elements of products) are identified by assessing 'what can go wrong?'.
- **Fault Mode Effects Analysis (FMEA)**[11] – is used to identify potential failures in a structural or mechanical design. The process breaks down the design into appropriate levels for examination to identify the potential modes and consequence of failures and the effects this may have on the component and the systems as a whole.
- **Preliminary Hazard Analysis (PHA)**[12] – is used to identify hazards, hazardous situations and events that can cause harm for a given activity, facility or system. It is commonly used early in the development of projects, however it can be used when analysing existing systems or prioritising hazards if a more extensive method cannot be used.
- **Human Reliability Assessment (HRA)**[13] – deals with the impact of people on system performance and the influence of human errors on reliability.
- **Construction Hazard Assessment Implication Review (CHAIR)**[14] – is a tool designed specifically for safe design in construction.

2.3.1.2 Assess the risk of harm

If use in any subsequent phase of the lifecycle of the designed-product has the potential to result in harm, designers, manufacturers, constructors and/or suppliers need to analyse and evaluate the risk. Analysis utilises a number of qualitative and quantitative tools to:

> identify and evaluate any existing controls

> determine the likelihood of a harmful event occurring, and

> determine the consequences of such an event.

The purpose of risk evaluation is to assist in making decisions about the most effective way to

[8] Australian and New Zealand Standard 3931 (1998) *Risk Analysis of Technological Systems - Application Guide*, pp.21-22

[9] Australian and New Zealand Standard 3931 (1998) *Risk Analysis of Technological Systems - Application Guide*, pp.26-27

[10] Australian and New Zealand Standard 3931 (1998) *Risk Analysis of Technological Systems - Application Guide*, pp.23-24

[11] Australian and New Zealand Standard 3931 (1998) *Risk Analysis of Technological Systems - Application Guide*, pp.23

[12] Australian and New Zealand Standard 3931 (1998) *Risk Analysis of Technological Systems - Application Guide*, pp.28

[13] Australian and New Zealand Standard 3931 (1998) *Risk Analysis of Technological Systems - Application Guide*, pp.28 - 30

[14] WorkCover NSW 2001, CHAIR: Safety in Design Tool, Sydney, workcover.nsw.gov.au


control the risks, through direction or alteration of the design and to provide recommendations to the user regarding control of residual risks unable to be addressed during the design phase.

2.3.1.3 Control the risks

Hierarchy of control

The **Hierarchy of Control** model is commonly used as a problem-solving and creative-thinking tool at the control stage of the risk management process.

> **Elimination.** If you eliminate a hazard you completely remove the associated risk.

> **Substitution.** If the hazard can't be eliminated, minimise the risks by substituting a substance or a process that has less potential to cause injury.

> **Isolation.** You can make a structural change to the work environment or work process to interrupt the path between the worker and the risk.

> **Administration.** You may be able to reduce risk by upgrading training, changing rosters or other administrative actions.

> **Personal protective equipment.** When you can't reduce the risk of injury in any other way, use personal protective equipment (such as gloves or goggles) as a last resort.

The higher up the hierarchy the more effective the risk control. It is at the design stage that it is more practical to achieve elimination or substitution of the hazard. Control measures at the top of the hierarchy are preferred because they do not rely on the actions of workers to control risks, and function regardless of whether unforeseen events occur, or whether workers or others are using the equipment as intended. Such control measures are known as passive safety features and, where possible, should be designed into the product.

Unless hazards can be eliminated, there can often be an even safer design. For example:

> pop-up railings installed on fuel tankers provide a method of protection against falls, but tankers that require no top access are a safer design

> installing mesh beneath a fragile skylight will help prevent a fall to the ground, but the use of non-fragile material will be a safer design.

Designers need to check that any control put in place does not create another risk or introduce a new hazard for users.

If it is not practical to eliminate the hazard, the designer should reduce the risk to the lowest level possible and provide information on the remaining or residual risk and the measures required to control this in the workplace. All relevant information should be provided to the manufacturer, supplier and user of the product.

2.3.1.4 Monitor and review the residual risk and effectiveness of risk control measures

This step involves monitoring whether the control measures have eliminated the hazards or reduced the risks, and whether any new hazards have been introduced. On-going monitoring and review at each phase of the lifecycle ensures that data is collected for feedback into the system to enable continuous improvement. Designers and manufacturers should first confirm the

effectiveness of risk controls through testing or trials. This may include controlled prototype studies across the identified range of tasks or uses.

Persons with control of workplaces should monitor and review the risk controls communicated by the designer, as well as those identified and implemented internally. New information and more effective risk controls should be communicated to users as well as back to the designer. Feedback from users to assist designers to improve their designs could be provided through:

- post occupancy evaluations for buildings
- defect reports
- accident investigation reports
- information regarding modifications
- user difficulties, or
- deviations from intended conditions of use.

2.3.1.5 Maintain records of risk assessments

A designer should keep a record of the risks identified during the design process and the steps taken to eliminate or minimise those risks.

Furthermore, where new information becomes available and the design is modified to take this information into account, a record should be kept of this.

Designers may find that the most effective way of communicating risk to manufacturers, suppliers and users is to make the risk assessment available to them. This would not necessarily preclude the need for manufacturers, constructors, suppliers and persons with control of workplaces to conduct their own risk assessment because the people and work environment may vary significantly from one workplace to another.

2.3.2 Integrating Risk Management into the Design Process

The design process can be modelled as a sequence of phases. At each phase, it is possible to apply appropriate risk management strategies as shown in **Figure 2.** This model enhances the ability for products to be safely manufactured, constructed and used throughout their lifecycle, and disposed.

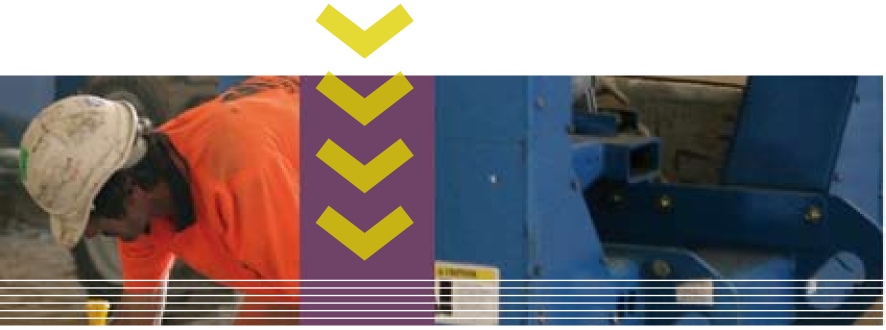
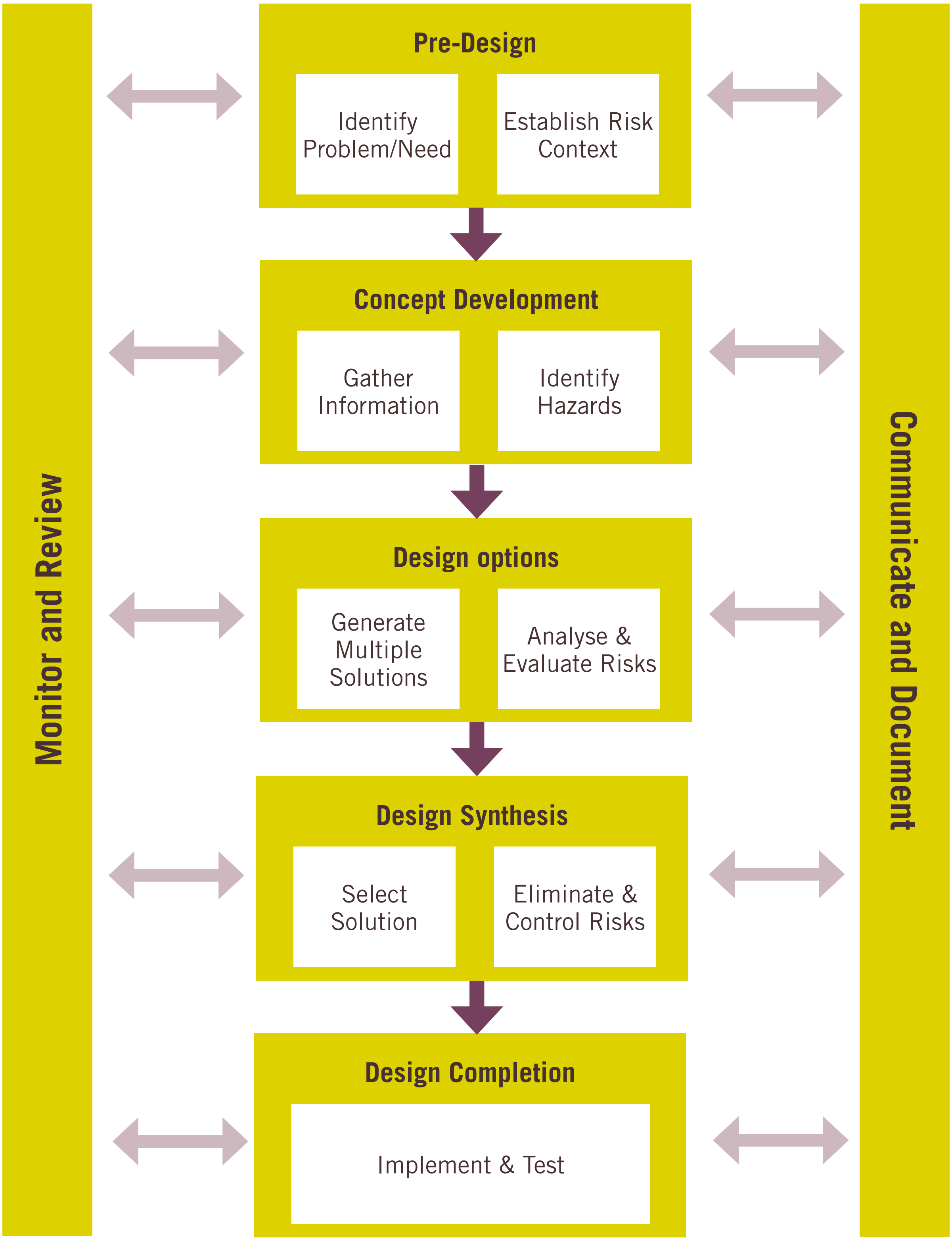


Figure 2 - A model for Safe Design



2.3.2.1 Pre-design

Establish the design context in terms of the scope and complexity of the project, as well as the business, social, regulatory, cultural, competitive, financial and political environments that may impact on the design.

- Establish the risk management context by identifying the breadth of workplace hazards that need to be considered.
- Identify the roles and responsibilities of various parties in relation to the project, and establish collaborative relationships with clients and others who can influence the design outcome.
- Decide the criteria against which risk will be evaluated. Decisions may be based on operational, technical, financial, legal, social, environmental, humanitarian or other criteria.
- Develop a safe design framework for the project, by identifying the steps in the process that need to be taken to ensure that risks are addressed throughout the lifecycle of the product.

2.3.2.2 Concept Development

- Conduct a preliminary hazard analysis. Review historical risks and failures for similar projects.
- Use a variety of hazard identification techniques and tools to gather sufficient information concerning potential risks. Consider what could happen, where it could happen and when.
- Systematically generate and document a list of hazards and events that might affect the product and consider possible causes and scenarios – why and how it could happen.

2.3.2.3 Design Options

- Identify hazards that can be adequately addressed by applying existing solutions in recognised standards (for example BCA or Australian Standards).
- Analyse the level of risk by combining the consequences and likelihood of something going wrong during the lifecycle.
- Consider both technical and human factors, including humans' ability to change behaviour to compensate for design changes. Anticipate misuse throughout the lifecycle.
- Develop a set of design options that meet the criteria for safety.

2.3.2.4 Design Synthesis

- Systematically assess the design options against the risk criteria established in the pre-design phase.
- Apply the Hierarchy of Control to try to achieve the highest level of control (see section 2.3.1.3 for more detail).
- Select the optimum solution. Balance the direct and indirect costs of implementing the design against the benefits derived.

2.3.2.5 Design Completion

Test, trial or evaluate the design solution with various users.

Finalise the design and prepare risk control plans for the lifecycle of the product.

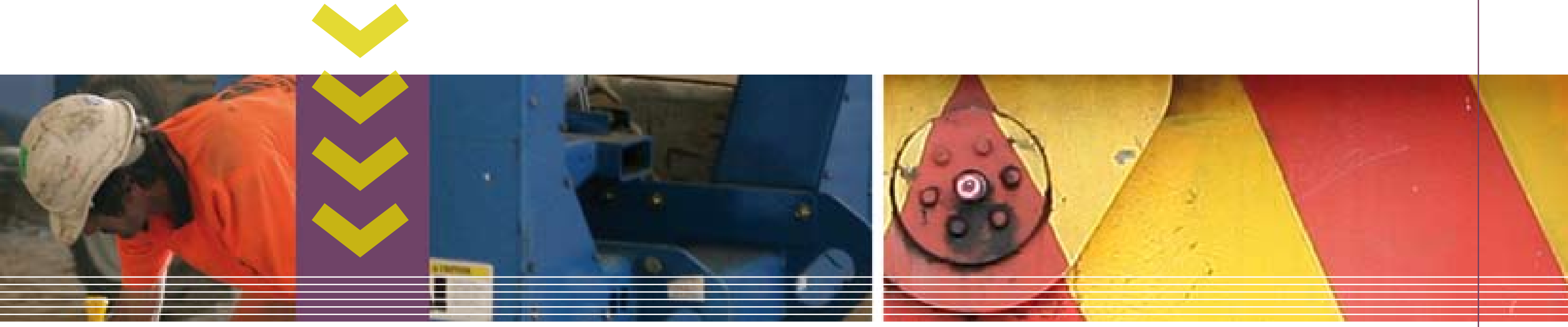
2.3.2.6 Monitor and review

Review design solutions to confirm the effectiveness of risk controls and if necessary, redesign to reduce the risks as far as reasonably practicable.

Review feedback from users and relevant new information to improve subsequent designs.

2.3.2.7 Communicate and Document

- Consult with the client and, where possible, users of the product to obtain information for each design phase.



> Document any findings or alterations to ensure that others can follow the design plans or modifications.

> Ensure that key information, concerning actions taken to address safety, is adequately recorded and transferred from the design/ planning phase and that those involved at later lifecycle phases have access to information about any residual risks that may affect their health and safety.

2.4 Knowledge and Capability for Safe Design

In addition to core design planning capabilities, the following skills and knowledge should be demonstrated or acquired by a designer or person with control over safe design:

> knowledge of OHS legislation, regulations and other regulatory requirements

> knowledge of the lifecycle

> knowledge of hazard identification, risk assessment and control methods

> knowledge of technical design standards

> the ability to source and apply relevant data on human dimensions, capacities and behaviours, and

> the ability to integrate knowledge from a range of sources and disciplines into a new solution.

Many design projects are too large and complex to be fully understood by one person. Various persons with specific skills and expertise may need to be included in the design team or consulted during the design process to fill any knowledge gaps, including persons with:

> a thorough knowledge of the product area, and

> other specialist knowledge (ergonomists, engineers, materials chemists, occupational hygienists), such as that required to carry out the risk assessment.

An example of the specification of competence for advising on safe design is the Advanced Diploma level Business Services Training Package Unit of Competency which has been developed within the vocational education and training system[15]. This unit of competency specifies the range of knowledge and skills required in the application of safe design principles to OHS risk control during a product's lifecycle. This is a generic unit that can be applied in the context of the specific industry or product being managed.

2.5 Information Transfer and Feedback

Information transfer is the process by which those who will work with the product are informed of any risks involved, risk control measures, and specific training requirements. Key information concerning action required to control risks should be recorded and transferred from the design phase to all users in later phases of the lifecycle.

All parties should similarly ensure feedback is given to designers regarding newly identified risks. **Figure 3** depicts the reciprocal transfer of information and feedback required for safe design.

It is very difficult to design information to be effective as a risk control. If the designer thinks that the only risk control option is to provide information, the designer should reconsider the design to see if the need for information can be designed out. **Figure 4** illustrates how designers can minimise the need to provide information as a control measure.

Instructions, warnings and labels should be designed to be easily seen and understood. The specific form of information needed will vary according to the type of product, but might include instructions aimed at people who are:

> involved in construction, erection, installation, commissioning or set up

> involved in transport or storage

> using, handling or otherwise working with it as end users, once it is produced

[15] The National Training Information Service provides further details at http://www.ntis.gov.au/cgibin/waxhtml/~ntis2/unit.wxh?page=80&inputRef=35159&sCalledFrom=std

> involved in ongoing cleaning, maintenance, repair or adjustment, and

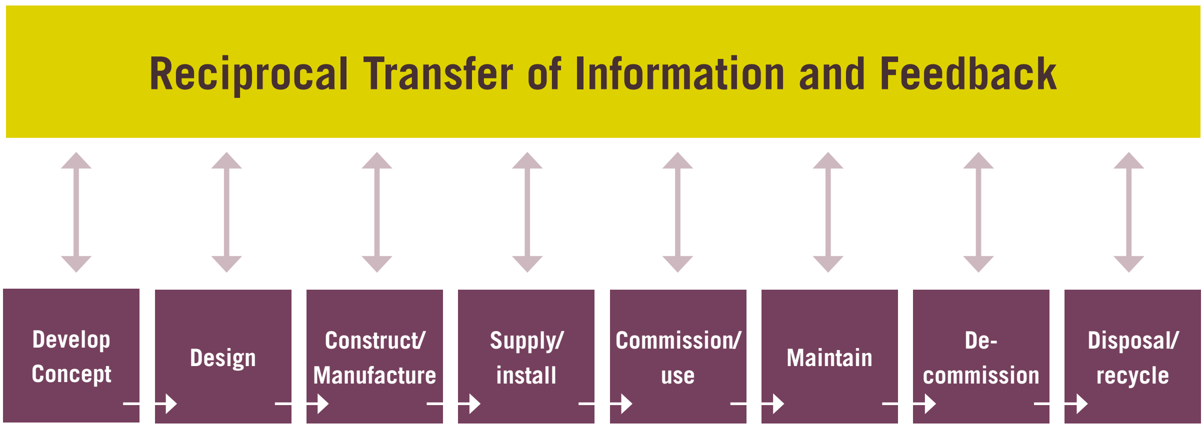
> responding to a failure, breakdown or blockage.

Different forms of information provision include product safety data sheets or manuals, labels, and health and safety files. Product safety information for hazardous substances is well developed and there are specific requirements for labels and material safety data sheets.

For plant manufacturers it is common practice to produce either warning labels or notices that are attached to plant and/or an operation manual, which may include OHS information (such as safe installation procedures, noise emissions or safe working limits). However, the scope and quality of this information varies. All of the Australian OHS laws require manufacturers, importers and suppliers of plant to provide information (and most states and territories establish the same duty on designers).

Employers and persons with control of workplaces need to translate any information provided by designers, manufacturers or suppliers into clear procedures and provide training to users.

Figure 3 - Lifecycle with Feedback



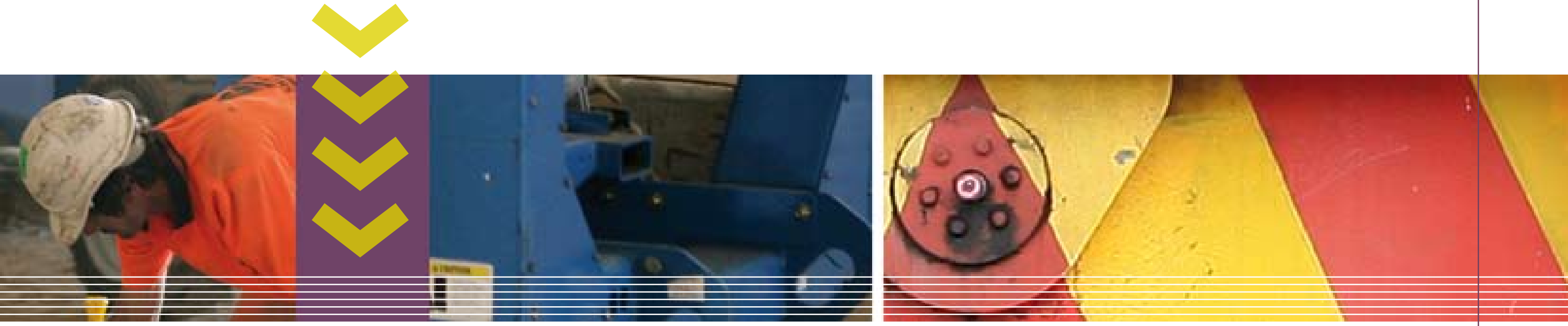
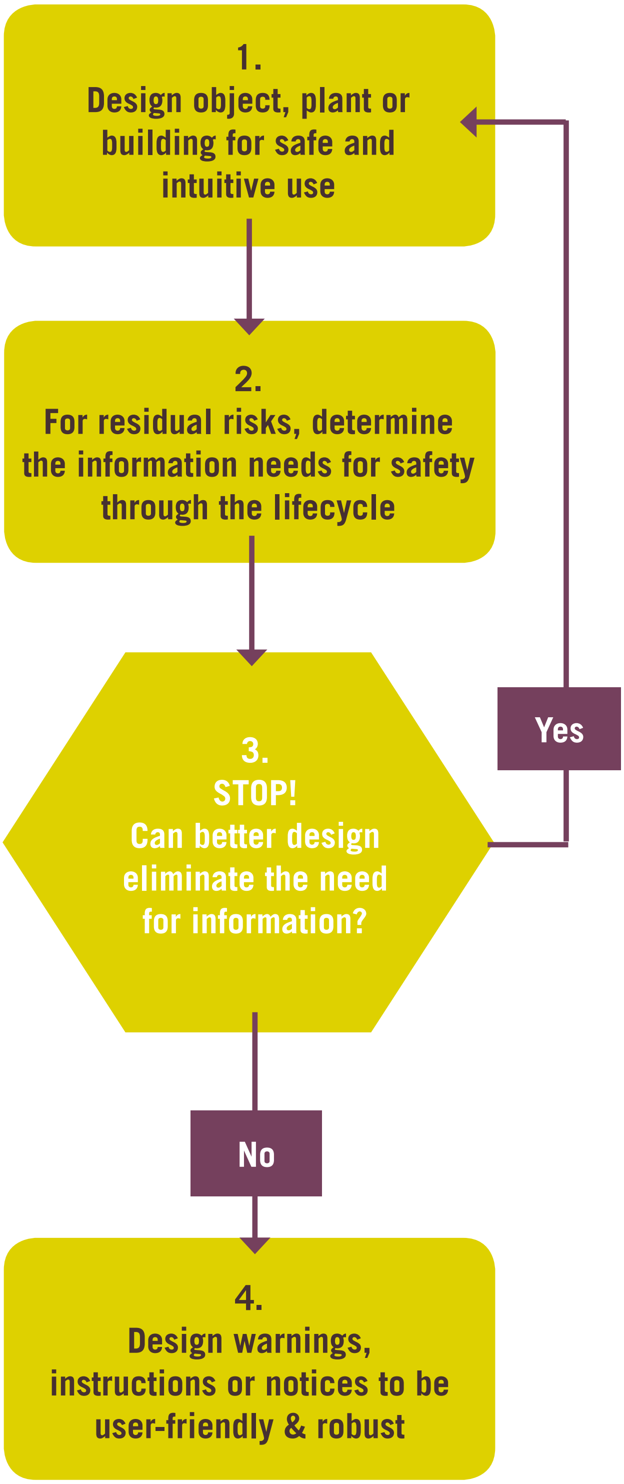


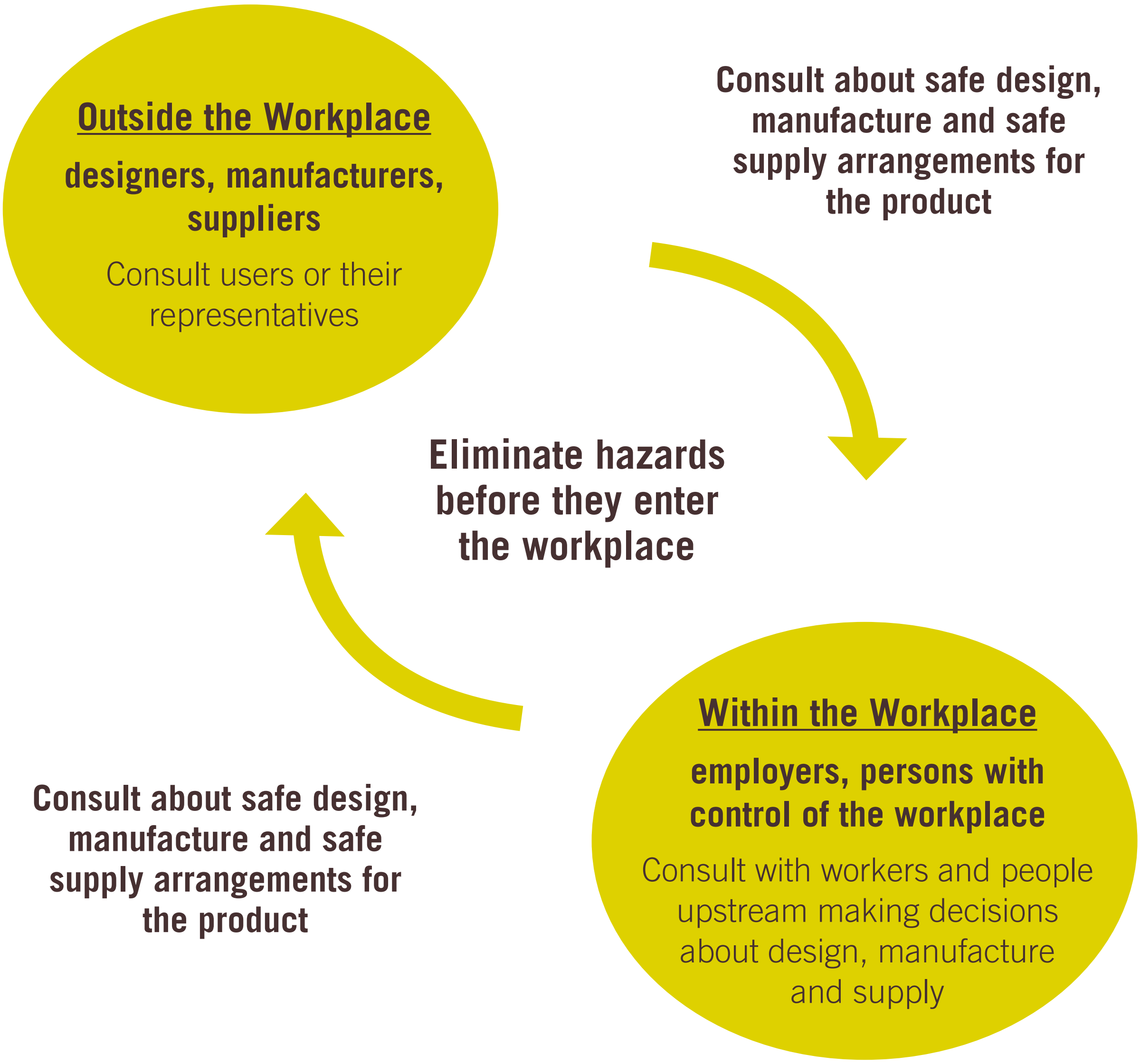
Figure 4 - Information Design Loop



2.5.1 Consultation

The OHS laws in Australia recognise the importance of employers and employees participating in health and safety issues through consultation, and therefore the process of consulting in a workplace with those potentially affected by design decisions concerning plant, workplace layout, work systems, etc. is now generally commonplace. Employers with responsibility for ensuring safe design within the workplace cannot fulfil their duties without consulting those affected. Although there are no formal mechanisms in place for consultation between designers and end users, this can be achieved as shown in **Figure 5.**

Figure 5 - Information Exchange Model



3. PRACTICAL SAFE DESIGN EXAMPLES

3.1 Positioning of Air-conditioners for Maintenance

Split system and other air-conditioning systems require maintenance access. Air-conditioning systems are sometimes located on roofs or attached to upper story walls creating fall risks for maintenance workers.

Air-conditioning systems should ideally be placed at ground level. If this is not practicable then fall protection can be provided through guard railing.

Air-conditioning system high on a wall in a commercial setting.
Photo: J.Culvenor

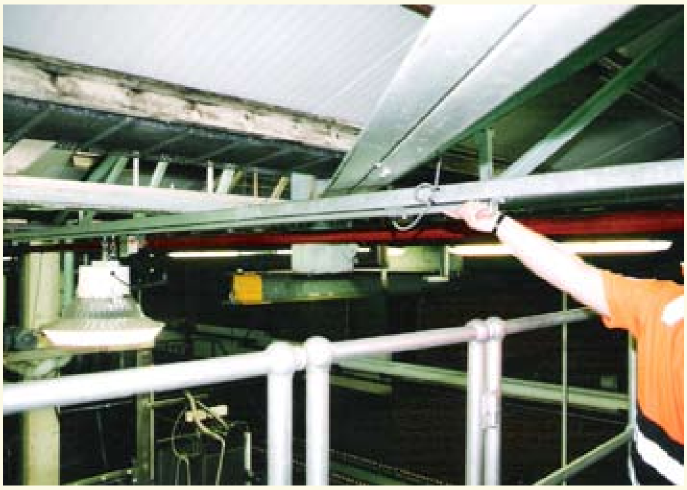
Air-conditioning systems located at ground level with good access.
Photo: J.Culvenor

The person with control over the decision of locating the system may be the architect, building owner, builder or air-conditioning installer. All of these persons need to consider the maintenance issue (as well as the installation) and ensure that accessibility can be gained safely.

The benefits of ground level location include reducing falls and awkward conditions for manual handling as well as reducing maintenance costs.

3.2 Access for Lighting Maintenance

Maintenance of a lighting system can involve difficult access and work at heights. Maintenance can therefore be hazardous and expensive. A solution can be to install lighting systems on sliding tracks.



Sliding lighting systems.
Photo: J.Culvenor, thanks to Fosters/CUB

The person with control over the decision to install this system may be the architect, engineer, building owner, electrical contractor or builder.

Maintenance personnel need to know that the lighting system can be accessed via the sliding rails and know how to operate the system. Although this may be evident such as in the photo above, notices should be placed where they can be easily seen.

The benefits of a sliding track system include minimising falls and reduced cost of maintenance work (such as cleaning and changing of bulbs and tubes) due to efficiencies achieved from using the existing walkways. The people that would benefit from this kind of installation include maintenance workers, cleaners and installing electricians.

3.3 Forward-only Vehicle Movements

Reversing vehicles within a workplace are a hazard to pedestrians. At the design stage a system of forward-only movements can be considered for mobile equipment and vehicles. The photo below illustrates a forward-only interface. Roller-doors at the exit end of the building are normally closed, making the thermal conditions more comfortable. These normally closed doors must be opened to exit, which indicates to any personnel outside and in the vicinity that a truck is about to exit. The action of the door opening can also be linked to an alarm and warning light.

Forward-only system for the movement of trucks (roller doors at the exit end of the building).
Photo: J.Culvenor

The person with control over the decision for such a safety system include the facility owner, architect and engineer.

The benefits of a forward-only system include eliminating reversing movements and minimising the possibility of collision with pedestrians and other vehicles.

3.4 Car-carrier Fall Protection

Fall hazards from the upper deck of car-carriers are a hazard that has been around for many years. Fitting railings to the trailer can significantly reduce the risk of falling.

Access to the vehicle on a car-carrier involves standing on the edge of the trailer.
Photo: J.Culvenor

Car-carrier with fall protection railings
Photo: J.Culvenor

The person with control over the decision for this change would be the plant designer and manufacturer.

Those that benefit from this solution are the truck drivers transporting cars, and possibly workers performing maintenance on the trailers. Information on the maintenance of the railing systems would need to be transferred from the manufacturer on purchase.

Accessing the vehicle on a car-carrier with the railing fitted.
Photo: J.Culvenor

Enclosed car-carrier with fall protection provided by side walls
Photo: J.Culvenor

Car-carrier where the frame extends to a sufficient height to provide a barrier against falls. The frame of many car-carriers extends only to the height of the floor of the top deck leaving the driver walking alongside vehicles with no fall protection.
Photo: J.Culvenor

3.5 Maintenance System for a Printing Press

The 'turbo' is a cleaning system within a printing press. The turbo uses a brush and applies water to the paper roller. The turbo is about 1.8m long and weighs approximately 50kg. Cleaning is required to remove paper, lint and ink contamination. This heavy and awkward item was once changed every two weeks. The interior of a press is very confined. Manually handling this heavy and awkward object is traditionally difficult and hazardous. Over many years of using similar systems, experience had shown that there was a risk of musculoskeletal injuries especially of the back, neck, shoulder, elbow and knees. Slips and trips were also a hazard. Striking and crushing of the hands were possible.

Because of the safety problems at the procurement stage in one case a supplier was required to develop a design that did not utilise a turbo, which in this instance, at the Age Print Centre, (shown at right) proved unsuccessful. However, with better 'clean in place' systems the cleaning frequency has been reduced by 90% down to once every 20 weeks. Further, the manufacturer incorporated a system for handling the turbo including a rear hatch on the presses and a 'jig' system. Using the jig enables the turbo to be slid out of the press. Once out of the press the turbo is moved with a trolley. The jig is made from aluminium parts and can be moved from press to press. The jig is not permanently attached to each press. Use of the jig is therefore not self-evident. In cases like this an indication about use of the jig system would be best placed on the turbo body or inside the press where a maintenance person would be able to see it.

Printing press interior showing limited space. (Turbos are on either side). Hatch at rear is visible.

Photo: J.Culvenor, thanks to Age Print Centre

Turbo jig attached to rear of press at the Age Print Centre. The roller bed rotates to remove the turbo from the press and then into the position shown to roll the turbo onto a trolley on the walkway.

Photo: J.Culvenor, thanks to Age Print Centre

The plant designer and manufacturer were the decision making persons in this case.

Those that benefit from this system are the maintenance workers by reducing the manual handling of the turbo which reduces the risk of injury as well as the time taken to perform the turbo change.

3.6 Roll over Protection for Tractors

Many farmers, farm workers and other people who use tractors have been killed when tractor's have rolled. Roll over protection structures (ROPS) provide protection for the operator in the event of a roll over. It should be noted that ROPS do nothing to prevent a roll over and the operator needs to remain within the boundary of the structure. Therefore, seat belts and a cabin are associated solutions.

Falling object protection structures (FOPS) are also useful on tractors when working in areas where falling objects can be a risk, such as construction, forestry, mining, etc.

Tilt-down roll over protection on a small earthmover.
Photo: J.Culvenor

Loader without roll over protection.
Photo: J.Culvenor

Cab and integrated roll over protection.
Photo: J.Culvenor

It is the tractor designer and manufacturer who determine what ROPS should be fitted and users who determine where a retrofit ROPS is being added.

Those that benefit from this safety feature are farmers and construction workers. When a ROPS is fitted, information about the need for use of seat belts to maximise roll over protection effectiveness is essential. The best location of this notice would be on the tractor. An alternative approach would be installation of ignition or motion interlocks on seatbelts or other forms of restraint.

3.7 Machine Guarding Interlocks for Plant with Run-down Time

Some plant involves significant run-down time. Interlocked gate guarding is therefore not ideal for a number of reasons:

> once the interlock is broken by the gate being opened, the machine power is cut but the machine will keep moving, and thus remain hazardous, and

> a machine can be fitted with a brake to overcome this problem, however the braking system causes a sudden stop of the machine which may be mid-cycle. The sudden braking of a machine can increase maintenance costs and the mid-cycle stop can involve delays in restarting the equipment.

The interlock 'logic' shown over page is reversed so that the gate interlock will not open while the machine contains live energy, or is 'running down' or idling. To access the guarded area it is therefore necessary to stop the machine which will continue until a cycle is complete, remove the power, then allow the machine to run down before the gate interlock is released. Once the machine has stopped the area is then safe to access. The machine cannot be re-started until the gate is closed and locked.

The intended operation is such that the system is tamper-proof. Signage at the gate points should nevertheless indicate that access can not be gained until the machine is stopped via the normal control. Hazardous access to plant, which may contain moving parts even though power is shut off, is prevented. Access mid-cycle is prevented and therefore avoids costly delays in restarting the equipment.

This solution would be implemented by an engineer.

Those that benefit from this solution include production workers, maintenance workers, cleaners, electricians and fitters.

Bottle filling machine with large momentum and run-down time – note perimeter guard is in close proximity to the machine to prevent whole body access within the hazardous space.
Photo: J.Culvenor, thanks to Fosters/CUB

This guarding on the gate consists of a uniquely coded captive key and interlock system which cannot be defeated using pens or screw-drivers.
Photo: J.Culvenor, thanks to Fosters/CUB

Physical guarding preventing access by even the tallest person, yet provides visual access to the plant.
Photo: J.Culvenor, thanks to Fosters/CUB

3.8 Load Balancing Equipment

Handling of heavy plant, such as the filling hose (shown below), involves manual handling hazards. The hose is heavy and awkward to manipulate.

Load balancers can be incorporated to support the weight of the hose.

Load balancing for a heavy liquid receiving hose
Photo: J.Culvenor, thanks to Fosters/CUB

Easy handling of a heavy hose with load balancing.
Photo: J.Culvenor, thanks to Fosters/CUB

The decision makers and persons who would be responsible for implementing this change include engineers and builders.

Those that benefit would include delivery workers and those operating the hoses. The load balancers do not change the operation of the hose, therefore no operational instructions are required.

3.9 Breathing Apparatus Fitting System for Fire Fighting

The fitting of breathing apparatus can be an awkward and hazardous procedure. For fire-fighters, the task must be carried out under time pressure and potentially difficult environmental conditions. A system for fitting the breathing apparatus to the fire-fighter was developed using an extension arm to reduce awkward lifting along with new designs for the fire fighting vehicles.

Breathing apparatus is stored in a side compartment. The breathing apparatus is fixed to an arm that can be extended out of the compartment.
Photo: R. Luke, thanks to SEM Fire & Rescue

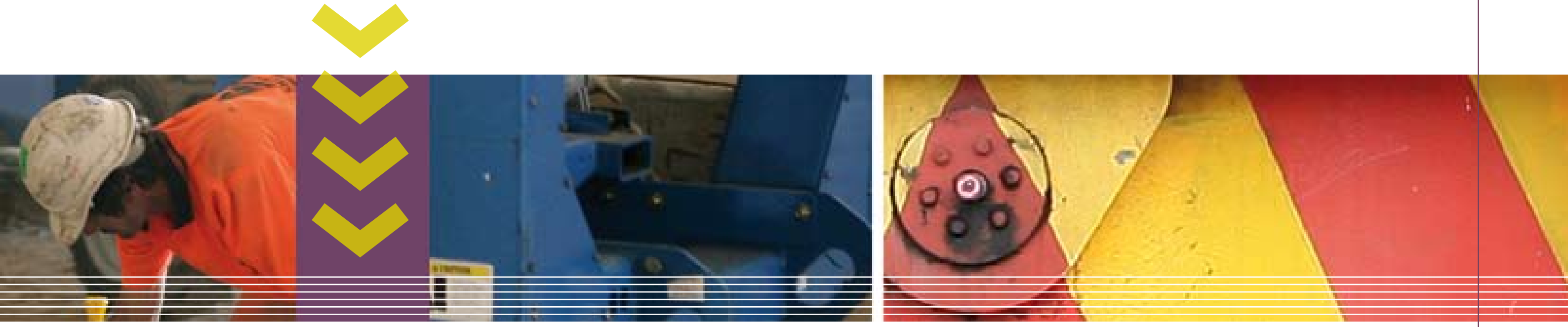
The person 'backs up' to the breathing apparatus. The fitment is made without the awkward lifting that previously occurred.
Photo: R. Luke, thanks to SEM Fire & Rescue

The persons with control over the decision to implement this system would be the relevant fire service, with the system being implemented by the plant designer and manufacturer.

Those that benefit from this system are the fire-fighters as it reduces awkward manual handling of the heavy breathing apparatus. Since the system is not self-evident, instruction and training on its use would be necessary. Instructions would be best placed inside the cover of the breathing apparatus hatch for quick reference in an emergency situation.

APPENDIX A - DEFINITIONS FOR THE PURPOSES OF THIS GUIDE

Design	the conceptual process used to bring together innovation, aesthetics and functionality to plan and create an artefact, a product, a process or a system to meet an artistic or industrial requirement of an individual or group. It includes research and development, conceptual design, general design, drawings, plans, systems, quantities, method of construction or manufacture, detailed cost and risk analysis (including analysis of OHS risks), feasibility, detailed design, technical specification, and redesign.
Ergonomics	the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance.
Hazard	any thing (including an intrinsic property of a thing) or situation with the potential to cause harm to people.
Lifecycle	all phases in the life of a product. Specific phases depend on the type of product but may include design, development, manufacture, construction, assembly, import, supply, distribution, sale, hire, lease, storage, transport, installation, erection, commissioning, use or operation, consumption, maintenance, servicing, cleaning, adjustment, inspection, repair, modification, refurbishment, renovation, recycling, resale, decommissioning, dismantling, demolition, discontinuance, disposal.
Person with control	a person who, by virtue of their position or role in the design process, can make decisions that may influence the design outcomes.
Product	the item to be designed, which might be a built environment, plant or equipment, chemical, work system or process or any other physical attribute or system associated with either the work place or the interface with people.
Residual risk	the risk that remains after the application of controls, barriers and other risk reducing methods or techniques.
Risk	the likelihood of a hazard causing harm to a person.
Risk assessment	the process of analysing the probability and consequences of injury, illness or damage arising from exposure to identified hazards.
Safe Design	the integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of injury throughout the life of the product being designed.
Supply	includes retail sale, wholesale, exchange, second hand sale, auction, lease, hire, hire-purchase and distribution, and includes any form of resupply.
Users	A user can be any person who interacts with the product throughout the lifecycle of the product.



APPENDIX B - LEGISLATIVE PROVISIONS RELATING TO DESIGNERS' DUTY OF CARE

Australian Capital Territory

Occupational Health and Safety Act 1989
Section 42 – Duties of manufacturers in relation to plant and substances

Commonwealth

Occupational Health and Safety (Commonwealth Employment) Act 1991
Section 18 – Duties of manufacturers in relation to plant and substances

New South Wales

Occupational Health and Safety Act 2000
Section 11 – Duties of designers, manufacturers and suppliers of plant and substances for use at work

Northern Territory

Work Health Act 2005
Section 30B – Duties of manufacturers, &c.

Queensland

Workplace Health and Safety Act 1995
Section 23 – Obligations for workplace health and safety
Section 32 – Obligations of designers of plant
Section 34B – Obligations of designers of structures used as workplaces

South Australia

Occupational Health, Safety and Welfare Act 1986
Section 23A – Duties of designers and owners of building
Section 24 – Duties of manufacturers etc

Tasmania

Workplace Health and Safety Act 1995
Section 14 – Duties of designers, manufacturers, importers, suppliers and installers

Victoria

Occupational Health and Safety Act 2004
Section 27 – Duties of designers of plant
Section 28 – Duties of designers of buildings or structures

Western Australia

Occupational Safety and Health Act 1984
Section 23 – Duties of manufacturers, etc.

APPENDIX C - SAFE DESIGN RESOURCES

ASCC

> *The role of design issues in work-related injuries in Australia 1997-2002* <http://www.ascc.gov.au/SafeDesign/Information_sources/SafeDesignWorkInjuries.pdf>

> *Design Issues in Work-Related Serious Injuries* <http://www.ascc.gov.au/PDF/Standards/10605DesignIssues_fa.pdf>

> *Safe Design for Engineering Students* (not available on the internet - contact the Office of the ASCC by email on safedesign@dewr.gov.au for further information)

OHS Authorities:

NSW

> *Code of Practice: Safety Aspects in the Design of Bulk Solids Containers including Silos, Field Bins and Chaser bins, 2005* <http://www.workcover.nsw.gov.au/NR/rdonlyres/756EBFFA-CC2B-4605-9DA2-915AA59482F0/0/code_safety_aspects_design_bulk_solids_containers_4734.pdf>

> *Health and Safety Guidelines for Hairdressers* <http://www.workcover.nsw.gov.au/safebusiness/Publications/guide_hs_hairdressers_123_1.pdf>

> *CHAIR (Construction Hazard Assessment Implication Review) Safety in Design Tool* <http://www.workcover.nsw.gov.au/publications/OHS/SafetyGuides/chairsafetyindesigntool.htm>

QLD

> *Code of Practice: Safe Design and Operation of Tractors, 2005* <http://www.dir.qld.gov.au/workplace/law/codes/tractors/>

VIC

> *Designing Safer Buildings and Structures* <http://www.workcover.vic.gov.au/dir090/vwa/publica.nsf/Site+Search/2F2442883CD15F7CCA2570DD001F5502>

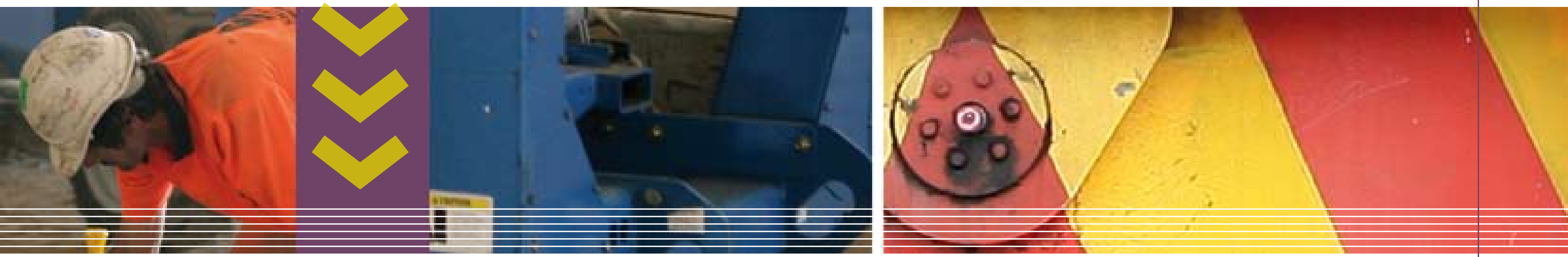
> *Designing Workplaces for Safer Handling of Patients and Residents* <http://www.workcover.vic.gov.au/dir090/vwa/publica.nsf/docsbyUNID/9C015A405548624ECA256FD30008931C?Open>

> *Safety by Design – Eliminating Manual Handling Injuries in Road Transport* <http://www.workcover.vic.gov.au/dir090/vwa/publica.nsf/docsbyUNID/CC798B9513282F07CA256FD30008930D?Open>

WA

> *Checkout workstations in retail – safe design and work practices* <http://www.safetyline.wa.gov.au/pagebin/guidwswa0085.htm>

> *A guide for designers, manufacturers, importers, suppliers and installers of plant* <http://www1.safetyline.wa.gov.au/pagebin/pg000576.pdf>



Other Resources:

Australian Building Codes Board

> Responsible for building regulatory matters and development of the Building Code of Australia (BCA)
abcb.gov.au

Standards Australia

> Multiple standards relating to design – see specific subject matter (ie Safeguarding machinery)
standards.com.au

RegNet

> National Research Centre for OHS Regulation; some funding by DEWR, located within ANU.
ohs.anu.edu.au

Health and Safety Executive, UK (HSE)

> The Health and Safety Commission is responsible for health and safety regulation in Great Britain. The Health and Safety Executive and local government are the enforcing authorities who work in support of the Commission
hse.gov.uk

Safety in Design

> benchmarked standards for knowledge and competence for designers

> industry guidance on design for the built environment
safetyindesign.org

Practice Notes prepared by industry associations:

> Building Design Professions (BDP)
bdp.asn.au

> Royal Australian Institute of Architects (RAIA)
architecture.com.au

Publications:

> Morris W, Wilson J, Koukoulaki T. *Developing a participatory approach to the design of work equipment.* Belgium. TUTB, 2004

> Health and Safety Executive. *A guide to managing health and safety in construction.* UK: HSE, 1995

> Christensen W, Manuele F, eds. *Safety Through Design.* USA. National Safety Council,1999

ascc.gov.au