CODE OF PRACTICE
SAFE DESIGN OF BUILDINGS AND STRUCTURES
2008

commission
for occupational
safety and health

Foreword

This code of practice is issued by the Commission for Occupational Safety and Health, under provisions of the *Occupational Safety and Health Act 1984* (the OSH Act). The introduction of the OSH Act enabled the establishment of the Commission. It comprises representatives of employers, unions and government, as well as experts, and has the function of developing the occupational safety and health legislation and supporting guidance material, and making recommendations to the Minister for Employment Protection for their implementation. To fulfill its functions, the Commission is empowered to establish advisory committees, hold public inquiries and publish and disseminate information.

The Commission's objective is to promote comprehensive and practical preventive strategies that improve the working environment of Western Australians. This code of practice has been developed through a tripartite consultative process and the views of employers and unions, along with those of government and experts, have been considered.

Scope and application of this code of practice

In March 2008, the Minister for Employment Protection approved this code pursuant to section 57 of the OSH Act. This code of practice applies to all workplaces in Western Australia covered by the OSH Act. It is intended to assist those involved in designing buildings or other structures to meet the requirements of the OSH Act and the Occupational Safety and Health Regulations 1996 (the OSH Regulations).

In particular, this code of practice aims to:

- explain the legal obligations applicable to a person who is in control of, or who may have influence over, the design of a building or structure; and
- provide guidelines for ways in which these obligations can be met by providing practical guidance on ways of maximising the safety of the design.

Legislative framework for occupational safety and health

The Occupational Safety and Health Act 1984

The OSH Act provides for the promotion, co-ordination, administration and enforcement of occupational safety and health in Western Australia. It applies to all workplaces with the exception of mining and petroleum.

With the objective of preventing occupational injuries and diseases, the OSH Act places certain duties on employers, employees, self-employed people, manufacturers, designers, importers and suppliers. These broad duties are supported by further legislation, commonly referred to as regulations, together with non-statutory codes of practice and guidance notes.

Occupational Safety and Health Regulations 1996

The OSH Regulations have the effect of spelling out specific requirements of the legislation. They prescribe minimum standards and have a general application, or define specific requirements related to a particular hazard or type of work. They may allow licensing or granting of approvals and certificates etc.

If there is a regulation about a risk in the OSH Regulations, it must be complied with.

Codes of practice published under the OSH Act

Codes of practice published under the OSH Act provide practical guidance on how to comply with a general duty or specific duties under the legislation. Codes of practice may contain explanatory information. However, the preventive strategies outlined do not represent the only acceptable means of achieving a certain standard.

A code of practice does not have the same legal force as a regulation and is not sufficient reason, of itself, for prosecution under the legislation, but it may be used by courts as a standard when assessing other methods or practices used.

If there is a code of practice about a risk, either:

- do what the code of practice says; or
- adopt and follow another way that gives the same level of protection against the risk.

If there is no regulation or code of practice about a risk, choose an appropriate way and take reasonable precautions and exercise proper diligence to ensure obligations are met.

Note there may be additional risks at the workplace not specifically addressed in this code of practice. The OSH Act requires identification and assessment of them and implementation of control measures to prevent or minimise risk.

Relationship between this code and the Building Code of Australia

The Building Code of Australia (BCA) is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Federal Government and state and territory governments. It contains technical provisions for the design and construction of buildings and other structures, and covers such matters as structure, fire resistance, access and egress, services and equipment, and certain aspects of health and amenity. The BCA has been given the status of building regulations by all states and territories.

The BCA has the status of a regulation and must be complied with, whereas this code of practice takes the form of practical guidance and does not have the same legal status as regulation. However, in addition to meeting the BCA requirements, under the occupational safety and health legislation consideration must be given to addressing specific hazards and risks that might arise in relation to the particular building or structure during its life cycle. For example, in addition to meeting BCA design specification requirements, there may also be manual handling considerations to be addressed for workers in the finished building who have to move equipment through the space.

Definitions

'Building or structure' – includes any erection, edifice, wall, chimney, fence, bridge, dam, reservoir, wharf, jetty or ship or other floating structure, and includes any part of any of those things.

'Practicable' – some of the general duty provisions in the OSH Act are qualified by the words 'so far as is practicable'. This applies to general duties for employers, self-employed people, people with control of workplaces, designers, manufacturers, importers, suppliers, erectors and installers. These people are expected to take measures that are practicable.

'Practicable' has a particular meaning in the OSH Act. The definition can be found in section 3(1) (with other definitions) and is explained in more detail below.

If something is practicable, it is 'reasonably practicable', taking into account:

- the severity of any injury or harm to health that may occur;
- the degree of risk (or likelihood) of that injury or harm occurring;
- how much is known about the risk of injury or harm, and the ways of reducing, eliminating or controlling the risk; and
- the availability, suitability and cost of the safeguards.

In other words, to be practicable, something must not only be capable of being done, it must also be reasonable in light of the factors mentioned above. The risk and severity of injury must be weighed up against the overall cost and feasibility of the safeguards needed to remove the risk. Only those factors listed above are relevant, and a factor cannot be ignored unless, after considering what a reasonable person at the time would have known, the factor is clearly irrelevant. Each factor is considered in light of what a reasonable person, in the position of the person who owes the duty, would have known.

Contents

1. Introduction

Safe design is based on the principle that everyone has a right to be protected from unnecessary risk of injury or harm. It is concerned with eliminating occupational safety and health hazards at the design stage or controlling risks, as early as possible, in the planning and design of buildings, structures, products, processes or systems.

As well as risk of loss of life, injury or income, poor design can result in a range of other economic costs, such as low productivity, higher maintenance, higher employment and workers' compensation expenses and reduced asset life. It is more costly to retrofit or modify existing products to achieve safety than it is to 'design out' hazards early in the process.

See Sections 23(3a), 23AA, 19 and 19A of the OSH Act. See also the foreword for explanation of 'as far as practicable'.

Designers have specific responsibilities under the safety and health legislation to, as far as practicable, eliminate or control hazards during the construction phase and use and occupation of a building or structure. Employers also have a 'duty of care' obligation to ensure that, as far as practicable, their employees are not exposed to hazards and risks related to a building or structure to be used as a workplace.

Safe design of a building or structure will always be part of a wider set of design objectives, including practicability, aesthetics, cost and functionality. These sometimes competing objectives need to be balanced in a manner that does not compromise the safety and health of those who construct, maintain or use a building or structure as a workplace. The benefits of safe design include risk control and a reduced need for retrofitting.

The opportunities to eliminate, as far as practicable, or reduce occupational safety and health hazards prior to construction commencing are considerable. Where hazards cannot be 'designed out':

- risk control measures compatible with the original design concept, and with the structural and functional requirements of the project, can often be incorporated; or alternatively
- where changes to the design are not practicable, the designer may well be in a position to advise others of the risks involved and how these might be mitigated.

Put simply, designers have a responsibility to ensure that, in the construction and use of their designs, others are not subjected to unnecessary risk.

Safe design involves consideration of processes, including human factors, organisational issues and life cycle management, not just products.

Additionally, the designer must also take into consideration how the design of the building or structure will affect, or be affected by, the design of related products or systems, where these are part of the normal use or maintenance of the building or structure.

Life cycle of a building or structure

Safe design requires an understanding of the occupational safety and health issues associated with each stage in the life of a building or other structure, starting with the initial conception, through to demolition.

The life cycle phases of a building or structure can be categorised as illustrated below.

Concept development ▶ Design ▶ Initial construction ▶ Fit out & installation ▶ Use & occupation ▶ Maintenance & repair ▶ Renovation or modification ▶ Demolition

Figure 1 – Life cycle of a building or other structure

Risk management approach

The 'safe design approach' begins in the design and planning phase with an emphasis on making choices about the design, methods of construction and materials used, based on occupational safety and health considerations. This approach involves a range of stakeholders. The safety aspects of a design can be enhanced prior to construction if a risk management approach is adopted with consultation and communication with all relevant stakeholders.

This code is presented as a starting point for undertaking the risk management process in relation to a building or structure to address relevant issues, where design elements may have occupational safety and health consequences.

The focus in this code is on how those responsible for the design phase of a building or structure might consider, in the context of a particular project, which hazards or risks are evident and whether these might be eliminated or controlled as part of the design process.

This code is directed at design professionals and those who may have influence over the design. It recognises that there are many groups or individuals who affect the design, and widely varying hazards and risks dependent on the nature of a particular building or structure.

It is suggested that the risk management approach outlined in this code is tailored to the unique demands of a particular building or structure. The definition of building or structure under the legislation includes ships and other floating structures and, while this code does not provide specific examples for these, the same principles of risk management apply.

Consultative processes

Consultation between all relevant stakeholders during the risk management process is most likely to produce workable measures that draw on the knowledge and expertise of those either performing tasks or overseeing the construction process, as well as the end users of a building or structure.

The code recognises that many parties are involved in the design and construction of a building or structure and their responsibilities often overlap. Consequently, a focus is placed on improving consultative processes, particularly between those with control, or the capacity to exercise control, over the design and the construction process. This is a means of ensuring there is no compounding effect in design decision making that increases the risks of exposure to hazards.

Some of the groups or individuals involved in the design process include:

- those who influence design decisions, such as developers, builders, owners, project managers, purchasers, clients, end users and workers;
- design professionals, such as architects, civil, services, mechanical and structural engineers, landscape architects, building designers and drafters and industrial designers;
- other groups who can influence design decisions, such as quantity surveyors, insurers, occupational safety and health professionals and human factors and ergonomics practitioners; and
- suppliers including manufacturers, importers and plant hire, constructers, installers and trades and maintenance people.

Further information on the principles is available at: www.ascc.gov.au

1.1 Principles of safe design

The Australian Safety and Compensation Council has identified the following five principles[1] (key elements) for safe design, which can be applied to the construction industry, as well as other industries.

Table 1. Principles of safe design	
Principle 1: People with control	**Safe design is everyone's responsibility** – ensuring safe design rests with parties or people having control or influence over the design of products, items or processes.
Principle 2: Product life cycle	**Safe design employs life cycle concepts** – safe design applies to every phase in the life cycle, from conception through to redevelopment and disposal, and involves eliminating hazards or minimising risks as early in the life cycle as possible.
Principle 3: Systematic risk management	**Safe design implements risk management** – through the application of hazard identification, risk assessment and risk control processes, risk management achieves safe design.
Principle 4: Safe design knowledge and capability	**Safe design requires knowledge and capability** – which should be either demonstrated or accessed by any person with control or influence over design.
Principle 5: Information transfer	**Safe design relies on communication** – effective communication and documentation of design and risk control information between all people involved in phases of the life cycle is essential for the safe design approach.

While not all these principles are grounded in law, they collectively contribute to building the knowledge, awareness and understanding required for designers to adopt a safe design approach.

1 From: Australian Safety and Compensation Council (2006). *Guidance on the principals of safe design at work.* Canberra, pp 5-6.

2. Delineation of responsibility

Principle 1: safe design is everyone's responsibility.

It will not always be possible to clearly delineate who has responsibility, in which circumstances, in relation to the elimination or reduction of hazards associated with a building or structure. However, the law imposes an obligation on those who not only control the activity but also those who have a capacity to control or influence. Such decision making leads to a shared responsibility between the parties for the control of a design.

See sections 19, 19A, 21, 21B, 22, 22A, 23 and 23AA of the OSH Act.

When considering what is or is not within a designer's control, designers should consider that:

- something being outside of a designer's understanding is different to being outside a designer's control;
- any changes to a design made without the designer's knowledge can remove the designer's control. The control of a design is limited to the elements of the design detailed or specified by the designer and not by others; and
- if a designer holds an accreditation to perform certain works, then that level of accreditation should be the level of control the designer has over the design.

Stakeholders involved in a building project should be aware of the expertise required in order to carry out the project in a manner that does not expose themselves or others to hazards throughout the life cycle of the building or structure.

Designers may not have management and control over the actual construction of a project but particular attention should be paid to:

- providing guidance on how it might be constructed safely;
- minimising hazards in the design;
- applying safe design principles to more traditional designs and processes and considering whether new or innovative approaches to design will eliminate or reduce risk and result in an intrinsically safer building or structure;
- providing information of any identified hazards arising from an unconventional design to those who will construct or use the building; and
- carrying out the above in association with those who have expertise in construction safety.

Designers are well placed to manage risk and apply safe design principles, as an integral part of the design process, to ensure safe design outcomes for end users and maintenance workers. This is to ensure that the products, systems and processes they generate are as safe as practicable for all who might interact with them.

With tilt-up and precast construction, reference should be made to the Commission's *Code of practice: Tilt-up and precast construction*, which sets out design considerations, as well as specific obligations for different parties.

Principle 4: safe design requires knowledge and capability.

3. Knowledge, skills and experience required

In the context of the safe design of buildings and structures, designers including architects and engineers need to:

- have a knowledge of workplace hazards and their harmful effects. For example, materials or techniques dictated by the design, those that might arise during the stages of the life cycle and especially those not self-evident, such as noise, heat, chemicals and radiation;
- understand common law and statutory occupational safety and health requirements, responsibilities and penalties;
- understand the risk management process, including risk assessment and typical industry practices used to control risk of injury or harm from hazards;
- understand the principles of designing to give consideration to normal human behaviour;
- be aware of how design can impact on reliability and safety, both on the environment and people; and
- be aware of sources of information relating to occupational safety and health.

4. The risk management process: The three step process

Principle 3: safe design implements risk management.

The risk management process for a design is a structured and systematic way of considering and addressing occupational safety and health issues that could arise for people during the life cycle of a building or structure.

The Occupational Safety and Health Regulations 1996 outline the risk management process. It involves a three-step process to:

- identify hazards;
- assess risks of injury or harm arising from each identified hazard; and
- control risks through implementation of control measures to eliminate or reduce them.

The risk management process should be conducted and monitored on an ongoing basis to ensure control measures are working and no new hazards have been introduced when, for example, modifications are made to a design or changes are made to the materials used or sequencing of a construction project.

Generally, buildings or structures are unique in design, location and circumstances. Consequently, mechanisms are needed to anticipate, learn and modify designs where necessary based on past experience.

Designers should seek input from builders and consult with other stakeholders who are likely to know about the risks associated with each stage of the life cycle of a building or structure.

Getting started

To carry out the risk management process for a design, initial consideration should be given to how it will be facilitated. Depending on the project, the following matters may need to be considered:

- Who should be involved – consideration should be given to holding discussions with those who may have responsibilities for safety (see Section 2) and key stakeholders either involved with or who may influence the design. This may occur in two stages. For example, firstly during the conception stage when there is the opportunity to consider all the stages of the building or structure's life cycle. Secondly, immediately prior to construction when the detailed design is known and construction, maintenance and demolition issues can be considered.
- What is needed to formally carry out the risk management process and carry out discussions with stakeholders – consideration should be given to matters listed in Section 4.1 and 4.2.
- Who will be responsible for taking action, for example gathering further information and/or finding safer alternatives.
- What knowledge, skills and experience is required – see Section 3.
- How information will be communicated to relevant people – see Section 4.5 and 4.6.

4.1 The first step: Hazard identification

The first step in the risk management process is identifying hazards through the life cycle of a building or structure. This involves identifying anything that may cause injury or harm to the health of a person during the life cycle of a building or structure as a workplace.

Category of hazards	Examples of hazards	Sources of control information to decide risk or control measures
Siting of structure	Events or incidents occurring between multiple structures, arising from poor siting or lack of separation.	Specialist risk techniques may be required. Controls will involve siting of structures. Building Code of Australia (BCA) requirements.
High consequence hazards	The storage and handling of dangerous goods or work with high energy hazards, for example temperature and pressure, and health hazards such as biological materials.	Specialist techniques are likely to be necessary to assess risks and controls. Australian Standards and safety and health legislation, compliance codes and guidance will provide information and possible control measures. Cumulative assessment of the overall risk may be necessary for these hazards. BCA requirements.
Systems of work involving the interaction of people with the structure	The systems of work including cleaning and maintenance of the building or structure that pose risks, for example inadequate pedestrian/vehicle separation, restricted access for building and plant maintenance and exposure to hazardous substances, manual tasks, occupational violence and working at height risks.	Professionals, such as engineers, occupational physicians, ergonomists, occupational hygienists and materials chemists, can provide information on controls and suitable assessment techniques.
Environment	Environmental conditions that are not part of the specific system of work, such as inadequate ventilation or lighting and amenities that do not meet workplace needs.	The requirements of standards, for example the BCA, Australian and Australian/New Zealand standards, building and other legislation are generally sufficient, if particular hazards or systems of work do not require a specific approach.
Incident mitigation	The possibility that the structure may increase consequences after an incident due to inadequate egress, siting of assembly areas and emergency services' access. Considerations when reviewing incident mitigation issues should include the situations involving all potential occupants/end users of the workplace. For example, will there be a safe interim area for people with disabilities in the event the workplace is evacuated?	The requirements of the BCA and building and other standards. Liaison with emergency services.

Source: WorkSafe Victoria (2005) *Designing safer buildings and structures* - 1st edition.

There are a number of ways to identify potential hazards that may cause injury or harm. Choosing an appropriate process or procedure for identifying them will depend on their nature and that of the building or structure as a workplace.

Hazard identification processes or procedures may, depending on the complexity or uniqueness of the project, include the following examples:

- considering whether items from the following checklist of hazards apply to the particular building or structure;
- developing a specific hazard checklist;
- using a risk assessment tool such as those listed in Appendix 3;
- examining records of past incidents for similar types of construction to facilitate a review of historical risks or failures for similar projects;
- examining data, where readily available, about the particular construction technique or use of a building or structure;
- conducting a constructability review with a special emphasis on occupational safety and health issues;
- consulting relevant standards, codes and guidance material;
- consulting with others with relevant expertise including industry associations; and
- considering any particular issues associated with the known end use of the project or foreseeable hazards that may occur during later phases of the life cycle including modification and demolition.

Identifying exceptional hazards

The designer should give consideration to any exceptional hazards or matters a competent builder or user would not be expected to be aware of.

Example

A builder would not necessarily be aware that a long steel span member was unstable until fully fixed into position or that particular props or braces are integral to the safety of a tilt panel. In such situations, the designer should take responsibility for including relevant information either in the drawings/specifications or transfer the information to the builder for appropriate design management. Take into account sources of risk and the likelihood of their occurrence, considering both technical and human factors. As outlined below for risk assessment, qualitative and quantitative techniques should be used to systematically analyse possible risks. **The tools listed in Appendix 3 may be used to do this**.

Hazard check list for designers and others involved with design

Potential hazards associated with the design of buildings and structures include but are not limited to the following examples.

Electrical safety

- Electrical installations
- Underground power cables
- Proximity to exposed cables
- Work near high voltage power lines
- Number and location of power points

Fire and emergencies

- Fire risks
- Fire detection and fire fighting
- Emergency routes and exits
- Access for and structural capacity to carry fire tenders
- Other emergency facilities

Movement of people and materials

- Safe access and egress
- Traffic route and control
- Loading bays and ramps
- Other emergency facilities

Radiation

- Exposure to ionising radiation
- Exposure to non-ionising radiation, eg electromagnetic radiation

Working environment

- Ventilation for thermal comfort and general air quality and specific ventilation requirements for the work to be performed on the premises
- Temperature
- Lighting including that of plant rooms
- Acoustic properties and noise control, eg noise isolation, insulation and damping
- Seating
- Slipperiness of floor surfaces for buildings
- Space for occupants

Plant

- Tower crane locations, loading and unloading
- Mobile crane loads on slabs
- Plant and machinery installed in a building or structure
- Materials handling plant and equipment
- Maintenance access to plant and equipment
- The guarding of plant and machinery
- Lift installations

Amenities and facilities

- Necessary access to various amenities and facilities such as storage, first aid rooms/sick rooms, rest rooms, meal and accommodation areas and drinking water

Earthworks

- Excavation, eg risks from earth collapsing or engulfment in swampland
- Exposure to underground utilities

Structural safety

- Erection of steelwork or concrete frameworks
- Temporary fragility or instability of structure
- Load bearing requirements
- Stability and integrity of structure

Manual handling

- Methods of material handling
- Accessibility of material handling
- Loading docks and storage facilities
- Access and egress paths and doorways to facilitate doorway or other mechanical aids
- Assembly and disassembly of pre-fabricated fixtures and fittings

Substances

- Exposure to hazardous substances and materials including insulation and decorative materials
- Exposure to volatile organic compounds and off gassing through the use of composite wood products or paints
- Exposure to irritant dust and fumes

Falls prevention

- Guard rails
- Footholds on or near guard railing
- Window heights and cleaning
- Anchorage points for building maintenance and cleaning
- Access to working spaces for construction, cleaning, maintenance and repairs
- Scaffolding
- Temporary work platforms
- Roofing materials and surface characteristics such as fragility, slip resistance and pitch

Specific risks

- Exposure to biological hazards
- Use of explosives
- Confined spaces
- Risk of drowning
- Over and under water work, including diving and work in caissons with compressed air supply

Noise exposure

- Exposure to noise from plant
- Exposure to noise from surrounding area
- Design of workplace layout

Note: The above listing contains examples only and is by no means complete.

4.2 The second step: Risk assessment

The second step in the risk management process is assessing the risks of injury or harm arising from the hazards identified for the particular building or structure.

This involves looking at the chance or likelihood of a hazard occurring and, if it does occur, the extent of any harm or injury, ie the consequences. It is a way of deciding which hazards need to be addressed first, ie where there is the highest risk of injury or harm.

Risk assessment is not an absolute science – it is an evaluation based on available information. Therefore, it is important those involved in a risk assessment have the necessary information, knowledge and experience of the work environment and work process.

Risk assessment methods should, where possible, be based on objective data. In assessing risk of hazards, it is important to recognise that many of them will be inter-related and they should not, therefore, be considered in isolation.

If similar tasks or processes apply for a number of projects, or the design is of a fairly routine nature, a generic risk assessment model might be appropriate. However, the designer is still responsible for ensuring that the generic assessment is valid for the project, before deciding to adopt it.

Risk assessment methods for assessing design safety may include:

- fact finding to determine existing controls, if any;
- testing design assumptions to ensure that aspects of it are not based on incorrect beliefs or anticipations on the part of the designer, as to how workers or others involved will act or react (see the above hazard checklist);
- testing of structures or components specified for use in the construction, end use and maintenance;
- consulting with key people who have the specialised knowledge and/or capacity to control or influence the design, for example the architect, client, construction manager, engineers, project managers and safety and health representatives, to identify and assess risks;
- consulting directly with other experts, for example specialist engineers or designers, manufacturers and product or systems designers who have been involved with similar constructions;
- when designing for the renovation or demolition of existing buildings, reviewing previous design documentation or information recorded about the design structure and any modifications undertaken to address safety concerns; and
- consulting professional industry or employee associations who may assist with risk assessments for the type of work and workplace.

Appendix 3 lists a number of risk assessment tools that can be used.

Example

A company managing a multi-million dollar construction project made design changes to improve safety, after conducting a risk assessment using the CHAIR (Construction Hazard Assessment Implication Review) – see **Appendix 3**. They included:

- corridors widened for safer access for movement of goods and people;
- standard doors enlarged by 25 per cent to improve access for equipment;
- lights repositioned to allow for easier/safer maintenance access;
- windows changed to 'flip over' for easy inside cleaning; and
- air conditioner moved to ground level, with the ducts remaining as planned.

4.3 The third step: Risk control

The third step is to implement control measures to eliminate or reduce the risk of a person being injured or harmed and ensure they are monitored and reviewed on an ongoing basis.

There is a general preferred order (hierarchy) of control measures, ranging from the most effective to the least effective, to eliminate or reduce the risks of injury or harm. This is outlined in the following table:

Table 2 Preferred order (hierarchy) of control measures to eliminate or reduce the risk of injury or harm

1.	**Elimination** — removing the hazard from the building or structure design by 'designing it out', eg replacing slippery onyx tiles with ceramic tiles, which have a 'rougher' finish.	**Most effective control measure**
2.	**Substitution** — substituting or replacing a hazard or hazardous design component with a less hazardous one through a process of redesign, eg replacing concrete panels with wood or steel where the specification requires completed and stabilised panels to be at an angle of 30 degrees, thereby reducing the hazard to workers from having to fix concrete panels at this angle.	
3.	**Isolation** — isolating or separating the hazard from people involved in the work or people in the general work area, eg prefabricating off site, thereby reducing workers' exposure to the fabrication process, as well as minimising installation time.	
4.	**Engineering controls** — if the hazard cannot be eliminated, substituted or isolated, an engineering control, eg a guard or barrier, is the next preferred measure and should be specified in the design notes.	
5.	**Administrative controls** — these include noting in the design, the work practices needed to reduce risks, such as providing procedures, instruction and training. Requiring construction of components off site to reduce dust levels on site is an example of an administrative control.	**Least effective control measure**

In some instances, a combination of control measures may be appropriate.

In applying the above principle of preferred order (hierarchy) of control measures, consideration should be given to the following:

- engineering controls or 'passive safety measures' rank higher in the hierarchy of control measures above administrative controls such as provision of training or information, as they do not depend on the actions of people. Therefore, passive safety measures should be designed into the construction or installation within the building or structure wherever they are needed;
- administrative controls include providing information on any remaining or residual risks and how to control them and personal protective equipment. However, control of risks using information should not be over used. The need for information and the type to be provided needs to be carefully assessed; and
- when providing instructions, warnings and labels, their design needs to be considered carefully, as words can have unintended double meanings and will not alone protect those without knowledge of the language. For example, visual warnings or labels will not assist the vision impaired, while audible warnings may not assist the hearing impaired. Warning signs or labels should comply with Australian Standard AS1319 *Safety signs for the occupational environment*.

The applicability of control measures will depend on the particular situation and the hazards and risks. Recommendations for control measures are outlined below in Section 4.4.

Holistic approach to risk management

The risk management process of identifying hazards, assessing their risks and implementing controls should be holistic. For example:

- interaction between a combination of hazards and the effect on the level of risk should be assessed; and
- a potential hazard may not necessarily require a single matching control measure. A response could be to implement a control measure that addresses a number of potential hazards.

4.4 Examples of control measures

When considering which control measures to implement:

- look specifically at identifying any exceptional risks that a competent builder might not be aware of or have the appropriate level of expertise;
- where residual risks remain, ensure these are communicated to the builder and/or other people likely to exercise control in the next stages of the life cycle of the building or structure, for example clients and maintenance contractors. **Refer to Appendix 3 for risk assessment tools**;
- take a holistic view on the interaction of hazards in the assessment of their risks and implementation of control measures; and
- assess alternative control measures for their applicability.

The control measures on the following pages are presented as examples for designers and people involved in the design of the building to consider.

4.4.1 Building elements

Potential control measures to implement in relation to building elements include:

Excavation

- Avoiding additional or different excavation depths near site boundary, for example designing lift shafts away from boundaries

Walls and tilt-up panels

- Limiting the size of tilt panels where site access is restricted
- Considering the use of pour strips to assist in stability of wall panels

Nature and pitch of roofing

- Considering any maintenance requirements and the need for access

Plastering

- Using suspending systems, pre-formed corner and bulkhead sections to reduce dust during finishing
- Changing the design to use smaller sheets, use lifters to hoist sheets and preloading floors to reduce manual handling hazards

Plumbing

- Using prefabricated risers to eliminate on site work and the need to work at heights

Beams

- Designing concrete beams so they can be erected from above, to prevent the risk of workers being crushed should the beams become dislodged during installation
- Designing beam to column connections to have support from column during the connection process by adding a bean seat, extra bolt hole or other redundant connection point that provides continual support for beams during erection

Flooring

- Considering floor treatment specifications to take into account the end use. For example, incorporating use of slip resistant surfaces in areas exposed to the weather, frequent spills or dedicated wet areas

Lighting

- Ensuring adequate lighting for intended jobs and tasks in the building

4.4.2 Building technique

Potential control measures to implement in relation to building technique include:

- relocating power lines or placing them underground before construction;
- ensuring power lines are the correct distance from the building to reduce exposure to radiation from the lines;
- consider the exposure of people to extremely low frequency radiation from internal power sources such as distribution boards, electrical wiring and lifts;
- clearly indicating on documents design loads for the different parts of the structure;
- considering different erection processes for steel structures;
- designing components to facilitate pre-fabrication off site or on the ground so they are erected in place as complete assemblies, reducing worker exposure to falls from heights or being struck by falling objects;
- considering different construction sequences; and
- considering the complexity of the design.

4.4.3 Construction process

Potential control measures to implement in relation to the construction process include:

- minimising or eliminating the need for confined/enclosed work spaces;
- considering work at heights;
- minimising the need to work at height, for example by positioning air-conditioning units and lift plant at ground level or designing to enable construction at ground level;
- designing parapets to a height that complies with guardrail requirements, eliminating the need to construct guardrails during construction;
- designing and scheduling a permanent stairway constructed at the beginning of construction to help prevent falls and other hazards associated with temporary stairs and scaffolding;
- considering the use of power tools by limiting the extent of on site fabrication; and
- considering access and egress during construction for people and vehicles.

4.4.4 Specific hazards or risks

Potential control measures to implement in relation to specific hazards or risks include:

Refer to the OSH Regulations for specific requirements for fall prevention eg edge protection.

Falls

- Considering design features that can mitigate the risk of falls, both during construction, occupation, maintenance and demolition, such as reducing the spacing of roof trusses and battens or installation of meshing to decrease the risk of internal falls

For further guidance on fall prevention see the Commission's *Code of practice: Prevention of falls*.

Electrocution

- Indicating, where practicable, the position and height of all powerlines to assist with site safety procedures
- Reorienting the building or structure to avoid overhead or underground services
- Providing adequate clearance between the building or structure and overhead power lines
- Specifying Residual Current Devices (RCDs) are to be used in all temporary power circuits during construction

Traffic

- Designing traffic areas to separate vehicles and pedestrians
- Moving the building back from the roadway to facilitate safety of delivery workers

Inhalation of fumes or dust

- Designing pre-fabricated panels with channels for electrical cables and plumbing to reduce chasing
- Selecting materials like paints or other finishes that emit low volatile organic compound emissions

Noise

- Encapsulation or isolation of noisy plant and equipment
- Procurement of plant and equipment with noise levels that complement safe noise level guidelines

Toxic gases, vapours, chemicals

- Selection of non-hazardous products or chemicals where available
- Changing coating types to be non-toxic, especially where they are to be applied in enclosed spaces, such as underground car parks, kitchens and toilets
- Selecting materials like paints or other finishes which emit low volatile organic compounds

Demolition

- Considering whether the nature of the design facilitates safe demolition at the end of the life cycle of the building or structure or in the event of fire or natural disaster. For example, designing tilt panel structures so the panels fall inward

4.4.5 End use

Potential control measures to implement in relation to end use include:

Maintenance and repair

- Allowing for access for maintenance, providing hatches, walkways or stairways
- Designing so that maintenance operations, such as windows, light bulbs and smoke detectors, can be done from ground level or from the structure. For example, inward opening windows with window cleaning bays or gangways integrated into the structural frame
- Incorporating building maintenance units for multi-storey buildings to avoid the use of rope access methods or long ladders for cleaning windows
- Designing and positioning permanent anchorage and hoisting points where maintenance needs to be done at height
- Using durable materials that do not need to be coated or treated after occupation
- Including safety rails and harness connection points
- Designing adequate access/egress. For example, considering how windows positioned high in a void area will be accessed for cleaning

Occupation and use

- Designing adequate access, eg allowing wide enough corridors in nursing homes for the movement of patients on wheelchairs and beds
- Designing interior acoustics to meet intended use requirements
- Designing spaces to accommodate or incorporate mechanical devices to reduce manual handling risks
- Considering exposure to specific hazards such as manual handling in a health facility, violence in a bank and dangerous goods storage in a warehouse
- Considering injuries due to:
  - poorly designed seating;
  - inadequate or poorly placed lighting; and
  - lack of consideration given to human behaviour including errors.

4.5 Communication and transfer of information

Principle 5: Safe design relies on communication.

Consultation with building or structure users and other stakeholders is an essential part of safe design to eliminate or reduce risks to workers and other people.

Effective communication at all stages as far as practicable, along with documentation of key information concerning hazards identified and action taken to control risks throughout the life cycle of a building or structure, not only makes users aware of any residual risks, but helps in meeting the designer's legal obligations.

See regulation 3.140 of the OSH regulations.

The Occupational Safety and Health Regulations 1996 require designers to report to the client in writing on the safety and health aspects of the design. This report must set out:

- the hazards associated with the construction work required to build the design, for example any hazardous procedures, material, practices or structural features;
- the designer's assessment of the risk of injury or harm resulting from those hazards;
- the action the designer has taken to reduce those risks, for example changes to the design or changes to construction methods; and
- any parts of the design where hazards have been identified but not resolved.

The level of detail in the report must be appropriate for the client, the nature of the hazards and the degree of risk.

Designers should provide clear, precise information suitable for people in control and users of the various phases of the building or structure. This is particularly important where the tendering arrangements have precluded any initial contact and discussion between the building designer and the construction team.

Points for designers to consider when providing information include:

- making notes on drawings, as these will be immediately available to construction workers;
- developing a register or list of significant hazards, potential risks and control measures;
- providing information on significant hazards, including:
    - hazardous substances or flammable materials included in the design;
    - heavy or awkward prefabricated elements likely to create handling risks;
    - features that create access problems;
    - temporary work required to construct or renovate the building as designed. For example, bracing of steel or concrete frame buildings;
    - features of the design essential to safe operation;
    - methods of access where normal methods of securing scaffold are not available;
    - residual risk where design change has minimised but not eliminated the risk; and
    - noise hazards from plant.

Development and use of an occupational safety and health (OSH) file could assist the designer to provide this information to others. See section 4.6.

Communication of this information between all stakeholders will minimise the likelihood of safety features deliberately incorporated into the design being eliminated at later stages of the life cycle by those engaged in subsequent work on or around the building or structure.

Responsibilities of clients

Clients commissioning design and/or construction work as part of a trade or business must, as far as practicable, ensure that information given to them on safety and health issues is provided to the main contractor, if the client is not the main contractor, and anyone who obtains the end product of the construction work. In particular, information that relates to:

See regulation 3.139 of the OSH regulations.

- identifying hazards to which a person at the construction site is likely to be exposed;
- assessing the risk of injury or harm to a person resulting from those hazards; and
- considering the means by which the risks may be reduced.

4.6 Occupational safety and health file

An OSH file is one means by which information about safety issues in relation to the design can be communicated to everyone who needs it, including those involved in the construction of a building or structure.

The file can be established at the outset, maintained and passed to subsequent clients (building owners) and form a useful record for later reference during the life of the building or structure.

If such a file is generated and maintained, it is important to specify clearly who is responsible for preparing and contributing to it. For example:

- it could be established by the principal or the principal's agent at the concept development phase; then
- transferred to the designer during the design phase; then
- updated by the main contractor during construction and fit out; and
- at the conclusion of the above phases, the principal or owner or the agent of the owner should retain the file. It should be made available to those responsible for **maintaining** the building and to any future designers and principal contractors involved in **renovation** or **demolition**.

The OSH file

The file could contain:

- design criteria;
- details of the client, designer(s), principal contractor(s) and any other people involved, for example developers;
- construction methods and materials used;
- details of services;
- plant and equipment as built and installed; and
- all drawings and operations and maintenance manuals that can provide information for future construction and subsequent maintenance work, such as cleaning, maintenance and demolition.

The following information needed by end users for maintenance, modifications and demolition is also relevant:

- general work instructions;
- existence of hazardous substances and materials;
- stressors;
- work likely to be dangerous;
- confined spaces;
- design reviews;
- hazards and limitations related to use of machinery and equipment;
- hazards created by, and within, surrounding environment including traffic; and
- any other matter judged by one of the key people, particularly the designer, to be relevant.

Appendix 1 Relevant sections of acts and regulations

Relevant sections of acts and regulations include:

The *Occupational Safety and Health Act 1984*

• Section 19	Duties of employers
• Section 19A	Breaches of section 19(1)
• Section 20	Duties of employees
• Section 20A	Breaches of section 20(1) or (3)
• Section 21	Duties of employers and self-employed persons
• Section 21A	Breaches of section 21
• Section 22	Duties of persons who have control of workplaces
• Section 22A	Breaches of section 22(1)
• Section 23	Duties of manufacturers, including people who design
• Section 23AA	Breaches of section 23
• Section 23G	Duty of employer to maintain safe premises
• Section 23H	Breaches of section 23G

The Occupational Safety and Health Regulations 1996

• Regulation 1.4	Responsibility of employers
• Regulation 1.5	Responsibility of self-employed persons
• Regulation 1.6	Responsibility of main contractors
• Regulation 1.7	Responsibility of persons having control of a workplace
• Regulation 1.8	Responsibility of persons having control of access to a workplace
• Regulation 1.16	Penalty for breaches by employers and others
• Regulation 3.1	Identification of hazards, and assessing and addressing risks, at workplaces
• Regulations 3.48-3.57	Prevention of falls at workplaces
• Regulations 6.1-6.32	Performance of high risk work

Division 12 – Construction industry – consultation on hazards and safety management etc.

• Regulation 3.139	Responsibilities of commercial clients
• Regulation 3.140	Responsibilities of designers
• Regulation 3.141	Responsibilities of main contractors
• Regulation 3.142	Occupational health and safety management plans
• Regulation 3.143	Safe work method statements

Appendix 2 Other sources of information

Legislation

The *Occupational Safety and Health Act 1984*

Occupational Safety and Health Regulations 1996

The above can be purchased from the State Law Publisher.
Refer to the internet site at www.slp.wa.gov.au or telephone (08) 9321 7688.

Codes of practice, guidance material and other documents

Australian Building Codes Board

The Building Code of Australia. Refer to the internet site at www.abcb.gov.au

Australian Safety and Compensation Council

Code of practice for the safe removal of asbestos 2nd edition [NOHSC:2002(2005)]

National standard for construction work [NOHSC:1016(2005)]

National OHS strategy 2002-2012

Guidance on the principles of safe design for work

Safe design for engineering students

Design issues in work related serious injuries

The above are available at www.ascc.gov.au

Commission for Occupational Safety and Health

Code of practice: Concrete and masonry cutting and drilling

Code of practice: Tilt-up and precast concrete construction

Code of practice: Prevention of falls at workplaces

Guidelines for the development of industry codes of practice

Standards Australia

Australian Standard AS 3610-1995 *Formwork for concrete*

Australian Standard AS 1319-1994 *Safety signs for the occupational environment*

Australian/New Zealand Standard AS/NZS 1680.1:2006 *Interior and workplace lighting – General principles and recommendations*

Australian/New Zealand Standard AS/NZS 1680.2.4:1997 *Interior lighting – Industrial tasks and processes*

Australian Standard AS 4024.1-2006 series *Safety of machinery*

Australian/New Zealand Standard AS/NZS 4360:2004 *Risk management*

Australian/New Zealand Standard AS/NZS 4576:1995 *Guidelines for scaffolding*

Australian/New Zealand Standard AS/NZS 4801:2004 *Occupational health and safety management systems – Specification with guidance for use*

Contacts for further information

The relevant employer association or union.

Chamber of Commerce and Industry Western Australia

180 Hay Street

EAST PERTH WA 6004

Tel.: (08) 9365 7415

Fax: (08) 9365 7550

Email: osh@cciwa.com

Internet site: www.cciwa.com

UnionsWA

Level 4, 79 Stirling Street

PERTH WA 6000

Tel.: (08) 9328 7877

Fax: (08) 9328 8132

Email: unionswa@tlcwa.org.au

Internet site: www.unionswa.com.au

Department of Consumer and Employment Protection

WorkSafe Division

Level 5, 1260 Hay Street

WEST PERTH WA 6005

Tel.: 1300 307 877

Fax: (08) 9321 8973

Email: safety@docep.wa.gov.au

Internet site: www.worksafe.wa.gov.au

National Relay Service: 13 36 77

Appendix 3 Risk assessment tools

CHAIR *(Construction Hazard Assessment Implication Review)* has been specifically developed for the construction industry by WorkCover New South Wales. The primary aim of CHAIR is to identify hazards and eliminate or minimise risks as early as possible in the life of a project. While it is focused on safety, the process also takes into account operational requirements, aesthetics and financial considerations, with a view to producing the safest possible design in all the circumstances.

The designer misconception tool helps designers systematically test products and processes for misconceptions about how people will act or fail to act in particular situations. It complements other tools for technical analysis and is based on the premise that many design faults are due to the fact that the designer either has an incorrect belief about how a person will act or a situation will develop, or fails to anticipate these.

Event tree analysis (ETA) is used to identify initiating events and then considers how often they might occur and possible outcomes. The initiating event may be a failure within a system or an external event. ETA starts with the initiating event and then searches forward. Event trees are well suited to analysing failsafe mechanisms in safety critical systems, for example a centralized gas heating hot water system in a building.

Fault tree analysis (FTA) is a technique used to identify and pictorially depict conditions and factors that can lead to undesirable events. Possible causes of fault modes in functional systems are identified by assessing what could go wrong. It is a technique that could be used to further analyse undesirable events identified during the CHAIR process. FTA can assist the designer or engineer to focus on causes and faults likely to have the most severe consequences and how frequently these might occur. FTA could be used in a construction setting to analyse and assess the importance of the consequences of a failure of computer driven systems within a building.

Fault mode effects analysis (FMEA) 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 consequences of failures and the effect that this may have on the component and the systems as a whole. This technique asks the question: if this part fails, in this manner, what will be the result? Further questions are then asked about:

- how each component might fail;
- the possible causes of these failures;
- the effects of these failures;
- the seriousness of these failures; and
- the means of detection of each failure mode.

FMEA typically considers and ranks severity from 1-10, minor to major, and consequences in categories I-IV, minor to catastrophic.

Preliminary hazard analysis (PHA) is used to identify hazards, hazardous situations and events that can cause harm in particular situations. It is often used early in the development of a project but can be used in other phases of the life cycle, for example prior to renovation or demolition.

Human reliability assessment (HRA) deals with the impact of people on system performance and the influence of human errors in reliability.

Constructability ('buildability') review is a review of plans and the design to check for buildability. It is an approach that links the design and construction processes. This type of review can be useful for identifying potential hazards and risks in the design of a building or structure, allowing these to be addressed at less cost than when construction commences.