



Department of **Energy, Mines,
Industry Regulation and Safety**



CODE OF PRACTICE Tower cranes







Department of Energy, Mines,
Industry Regulation and Safety



WorkSafe
Western Australia

CODE OF PRACTICE Tower cranes



WHSC
WORK HEALTH AND
SAFETY COMMISSION

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Foreword

This Code of practice on tower cranes is an approved code of practice under section 274 of the *Work Health and Safety Act 2020* (the WHS Act).

An approved code of practice provides practical guidance on how to achieve the standards of work health and safety required under the WHS Act and the Work Health and Safety (General) Regulations 2022 (the WHS General Regulations), the Work Health and Safety (Mines) Regulations 2022 (the WHS Mines Regulations) and effective ways to identify and manage risks.

For the purpose of this Code, a reference to WHS Regulations refers to both WHS Mines Regulations and WHS General Regulations. A reference to a person conducting a business or undertaking includes a reference to a mine operator.

Under the WHS legislation, the regulator means the WorkSafe Commissioner.

A code of practice can assist anyone who has a duty of care in the circumstances described in the code of practice. Following an approved code of practice will assist the duty holder to achieve compliance with the health and safety duties in the WHS Act and WHS Regulations, in relation to the subject matter of the code of practice. Like regulations, codes of practice deal with particular issues and may not cover all relevant hazards or risks. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS Act and WHS Regulations. Courts may regard a code of practice as evidence of what is known about a hazard, risk, risk assessment or risk control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code of practice relates. For further information see [*How to determine what is reasonably practicable to meet a health and safety duty: Interpretive guideline*](#).

Compliance with the WHS Act and WHS Regulations may be achieved by following another method if it provides an equivalent or higher standard of work health and safety than the code.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice.

Scope and application

This Code is intended to be read by a person conducting a business or undertaking (PCBU). It provides practical guidance to PCBUs on managing health and safety risks of working with tower cranes.

This Code may be a useful reference for other persons interested in the duties under the WHS Act and WHS Regulations.

This Code applies to all workplaces covered by the WHS Act and WHS Regulations where a tower crane is operated and where tower crane equipment is used or stored.

How to use this Code of practice

This Code includes references to the legal requirements under the WHS Act and WHS Regulations. These are included for convenience only and should not be relied on in place of the full text of the WHS Act or WHS Regulations.

The words 'must', 'requires' or 'mandatory' indicate a legal requirement exists that must be complied with. The word 'should' is used in this Code to indicate a recommended course of action, while 'may' is used to indicate an optional course of action.

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1 Introduction

1.1 What is a tower crane?

A **crane** means an appliance intended for raising or lowering a load and moving it horizontally including the supporting structure of the crane and its foundations, but does not include any of the following:

- an industrial lift truck
- earthmoving machinery
- an amusement device
- a tractor
- an industrial robot
- a conveyor
- building maintenance equipment
- a suspended scaffold
- a lift.

Tower crane means a crane that has a boom or a jib mounted on a tower structure.

The four general types of crane typically referred to as tower cranes used in Australia are hammerhead (including flat top), luffing (including hydraulic luffing jib), articulated and self-erecting.

A self-erecting tower crane is a crane that is not disassembled into a tower element and a boom or jib element in the normal course of use, and where the erecting and dismantling processes are an inherent part of the crane's function.

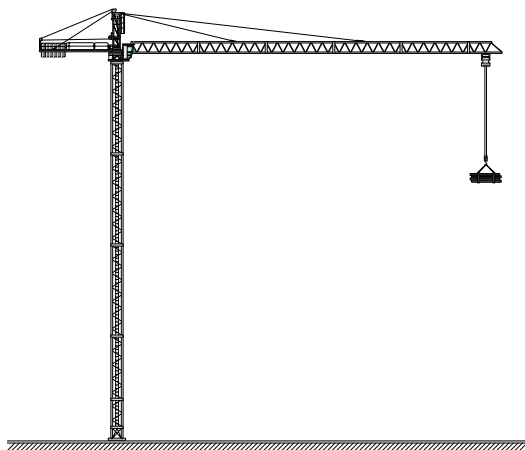


Figure 1 Hammerhead tower crane

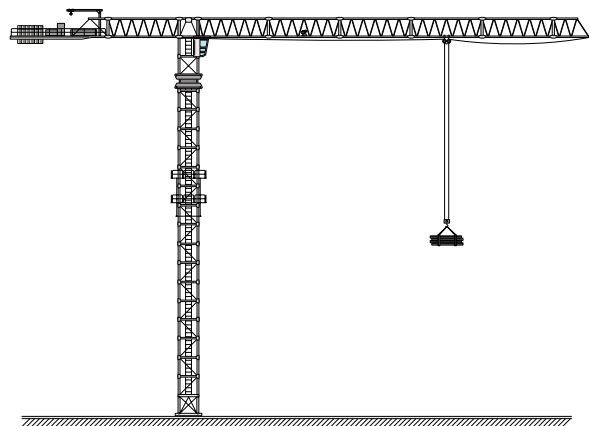


Figure 2 Flat top tower crane

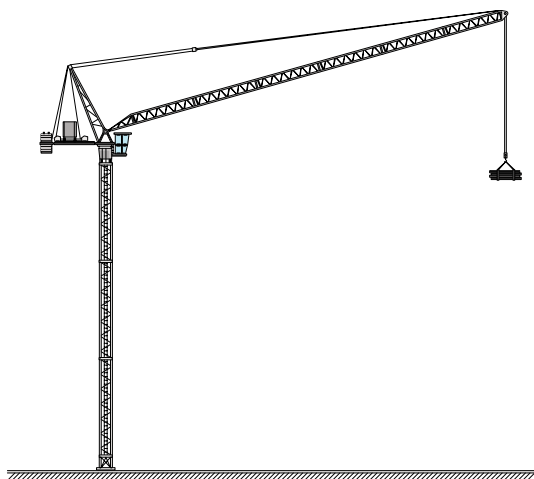


Figure 3 Luffing jib tower crane

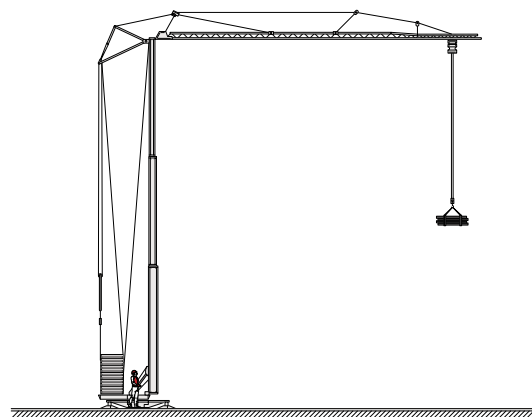


Figure 4 Self-erecting tower crane

For high risk work licensing purposes, a tower crane (if a jib crane) may be a horizontal or luffing jib type and the tower structure may be demountable or permanent. Using a tower crane requires a tower crane high risk work licence.

Using a self-erecting tower crane requires a high risk work licence to operate a self-erecting tower crane rather than a tower crane licence. A self-erecting tower crane is a tower crane that is not disassembled into a tower element and a boom or jib element in the normal course of use, and where erecting and dismantling processes are an inherent part of the crane's function.

Item	High risk work licence	Description of class of high risk work
1	Tower crane	Use of tower crane
2	Self-erecting tower crane	Use of self-erecting tower crane

1.2 Who has health and safety duties in relation to tower cranes?

There are a number of duty holders who have a role in managing the risks of tower cranes in the workplace. These include:

- persons conducting a business or undertaking (PCBUs), including mine operators
- PCBUs involving the management or control of fixtures, fittings or plant
- designers, manufacturers, importers and suppliers of plant, substances or structures
- installers
- WHS service providers
- officers
- workers and other persons at the workplace.

Workers and other persons at the workplace also have duties under the WHS Act, such as the duty to take reasonable care for their own health and safety at the workplace.

There are generally a number of people involved with a tower crane during its life cycle. For example, different people will be involved from its design through to its use and eventual disposal. Throughout this process, a person can have more than one duty, and more than one person can have the same duty at the same time.

For example, if a PCBU owns and operates a tower crane and decides to modify it themselves, they will have the duties of a designer and manufacturer as well as a person with management or control of plant at the workplace.

Person conducting a business or undertaking

WHS Act s. 19

Primary duty of care

A PCBU must eliminate risks arising from plant in the workplace, or if that is not reasonably practicable, minimise the risks so far as is reasonably practicable.

This duty includes ensuring, so far as is reasonably practicable, the:

- provision and maintenance of safe plant including cranes
- safe use, handling, storage and transport of plant.

PCBUs have a duty to consult workers about work health and safety and may also have duties to consult, cooperate and coordinate with other duty holders. Section 19(1) relates to the PCBU's duties to protect the health and safety of workers, and Section 19(2) relates to the PCBU's duties to protect the health and safety of other people (for example, members of the public who may be near a construction site).

The WHS Regulations include more specific requirements for PCBUs to manage the risks of hazardous chemicals, airborne contaminants and plant, as well as other hazards associated with the workplace.

Persons who conduct a business or undertaking involving the management or control of fixtures, fittings or plant

WHS Regulations r. 203

Management of risks to health and safety

WHS Regulations r. 204

Control of risks arising from installation or commissioning

WHS Regulations r. 205

Preventing unauthorised alterations to or interference with plant

WHS Regulations r. 206

Proper use of plant and controls

WHS Regulations r. 207

Plant not in use

WHS Regulations r. 208

Guarding

WHS Regulations r. 209

Guarding and insulation from heat and cold

WHS Regulations r. 210

Operational controls

WHS Regulations r. 211

Emergency stops

WHS Regulations r. 212

Warning devices

WHS Regulations r. 213

Maintenance and inspection of plant

The WHS Regulations include specific duties for PCBUs involving the management or control of plant, including requirements to:

- manage the health and safety risks associated with plant
- prevent unauthorised alterations to or interference with plant
- use plant only for the purpose for which it was designed unless the proposed use does not increase the risk to health or safety.

The person with management or control of a tower crane is often the crane owner but may also be the principal contractor of a construction project or another PCBU.

Designers, manufacturers, importers and suppliers of plant or structures

WHS Act s. 22

Duties of persons conducting businesses or undertakings that design plant, substances or structures

WHS Act s. 23

Duties of persons conducting business or undertakings that manufacture plant, substances or structures

WHS Act s. 24

Duties of persons conducting businesses or undertakings that import plant, substances or structures

WHS Act s. 25

Duties of persons conducting businesses or undertakings that supply plant, substances or structures

Designers, manufacturers, importers and suppliers of plant, substances or structures must ensure, so far as is reasonably practicable, the plant, substances or structure they design, manufacture, import or supply is without risks to health and safety.

This duty includes carrying out testing and analysis as well as providing specific information about the plant. To assist in meeting these duties, the WHS Regulations require:

- manufacturers to consult with designers of the plant, and
- importers and suppliers to consult with designers and manufacturers of plant.

Installers, constructors, and commissioners of plant, substances or structures

WHS Act s. 26

Duties of persons conducting businesses or undertakings that install, construct or commission plant or structures

The WHS Regulations include specific duties for PCBUs that install, construct, or commission plant or structures that are to be used, or could reasonably be expected to be used, as, or at, a workplace. This includes ensuring, so far as is reasonably practicable, that the way in which the plant or structure is installed, constructed, or commissioned ensures that the plant or structure is without risks to the health and safety of persons:

- who install or construct the plant or structure at a workplace, or
- who use the plant or structure at a workplace for a purpose for which it was installed, constructed or commissioned, or
- who carry out any reasonably foreseeable activity at a workplace in relation to the proper use, decommissioning or dismantling of the plant or demolition or disposal of the structure, or
- who are at or in the vicinity of a workplace and whose health or safety may be affected by any such work.

WHS service providers

WHS Act s. 26A

Duty of persons conducting businesses or undertakings that provide services relating to work health and safety

WHS service providers must, so far as is reasonably practicable, ensure that the WHS services are provided so that any relevant use of them at, or in relation to, plant, will not put at risk the health and safety of people who are at the workplace.

Further information on WHS service providers is available in [*Duty of persons conducting businesses or undertakings that provide services relating to work health and safety: Interpretive guideline*](#).

Officers

WHS Act s. 27

Duty of officers

Officers, for example company directors, have a duty to exercise due diligence to ensure the PCBU complies with the WHS Act and WHS Regulations. This includes taking reasonable steps to ensure the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks to health and safety.

Further information on who is an officer and their duties is available in [*The health and safety duty of an officer: Interpretive guideline*](#).

Workers

WHS Act s. 28

Duties of workers

Workers have a duty to take reasonable care for their own health and safety and to not adversely affect the health and safety of other persons. Workers must comply with reasonable instructions, as far as they are reasonably able, and cooperate with reasonable health and safety policies or procedures that have been notified to workers.

If personal protective equipment (PPE) is provided by the business or undertaking, the worker must, so far as they are reasonably able, use or wear it in accordance with the information, instruction and training provided.

Other persons at the workplace

WHS Act s. 29

Duties of other persons at the workplace

Other persons at the workplace, such as visitors, must take reasonable care for their own health and safety and must take care not to adversely affect other people's health and safety. They must comply, so far as they are reasonably able, with reasonable instructions given by the PCBU to allow that person to comply with the WHS Act.

1.3 What is involved in managing risks associated with tower cranes?

WHS Regulations Part 3.1

Managing risks to health and safety

WHS Regulations r. 203

Management of risks to health and safety

Tower crane operations may present a risk of injury to persons from:

- structural or mechanical failure and collapse
- contact or collision with other plant, structures, or people
- arcing or flashover from an energised overhead or underground electric line
- falling objects
- person falling from height
- extreme weather and related damage or collapse
- fire and related damage or collapse
- noise
- fatigue
- psychosocial hazards (e.g. high job demands, remote or isolated work, or poor physical environments).

A PCBU must manage the risks associated with tower cranes using the following systematic process:

- Identify hazards: find out what could cause harm.
- Assess risks: understand the nature of the harm that could be caused by the hazard, how serious the harm could be and the likelihood of it happening. This step may not be necessary if dealing with a known risk with known controls.
- Eliminate risks, so far as is reasonably practicable.
- Control risks: if it is not reasonably practicable to eliminate the risk, minimise the risk by implementing the most effective control measures that are reasonably practicable in the circumstances in accordance with the hierarchy of control measures, and ensure they remain effective over time.
- Review control measures to ensure they are working as planned.

[Section 2](#) of this Code provides guidance on how to manage the risks associated with tower cranes in the workplace by following the hierarchy of control measures.

Further guidance on the risk management process is in [How to manage work health and safety risks: Code of practice](#).

Psychosocial risks

A PCBU must ensure, so far as is reasonably practicable, workers and other persons are not exposed to risks to their psychological health and safety at work. A PCBU must eliminate psychosocial risks in the workplace, or if that is not reasonably practicable, minimise these risks so far as is reasonably practicable.

Further information on how to manage psychosocial hazards in the workplace can be found in [Psychosocial hazards in the workplace: Code of practice](#).

Consulting workers

WHS Act s. 47

Duty to consult workers

WHS Act s. 48

Nature of consultation

A PCBU must consult, so far as is reasonably practicable, with workers who carry out work for the business or undertaking and who are (or are likely to be) directly affected by a health and safety matter. In construction work, not all workers are engaged at the early stages of work, and consultation should be expanded as workers are engaged.

This duty to consult is based on the recognition that worker input and participation improves decision-making about health and safety matters and assists in reducing work-related injuries, diseases and illnesses.

The broad definition of a 'worker' under the WHS Act means a PCBU must consult, so far as is reasonably practicable, with contractors and subcontractors and their employees, on-hire workers, outworkers, apprentices, trainees, work experience students, volunteers and other people who are working for the PCBU and who are, or are likely to be, directly affected by a health and safety matter.

Workers are entitled to take part in consultations and to be represented in consultations by a health and safety representative who has been elected to represent their work group.

Workers usually know the hazards and risks associated with the plant they use. By drawing on the experience, knowledge and ideas of workers it is more likely hazards will be identified so that effective control measures can be implemented.

Workers should be encouraged to report hazards and health and safety problems immediately so the risks can be managed before an incident occurs.

It is important to consult workers as early as possible when planning to introduce new plant or change the way plant is used.

Consulting, cooperating and coordinating activities with other duty holders

WHS Act s. 46

Duty to consult with other duty holders

A PCBU must consult, cooperate and coordinate activities with all other persons who have a work health or safety duty in relation to the same matter, so far as is reasonably practicable.

There is often more than one business or undertaking involved in managing risks of plant in the workplace. Each may have responsibility for the same health and safety matters, either because they are involved in the same activities or share the same workplace.

In these situations, each duty holder should exchange information to find out who is doing what and work together in a cooperative and coordinated way so risks are eliminated or minimised, so far as is reasonably practicable.

If using a crane at a workplace shared with other businesses, the plant owner or manager should talk to those businesses about the risks the plant could cause them and work together in a cooperative and coordinated way to manage the risks.

Further guidance on consultation requirements is available in [Work health and safety consultation, cooperation and coordination: Code of practice](#).

1.4 Information, training, instruction and supervision

WHS Act s. 19

Primary duty of care

WHS Regulations r. 39

Provision of information, training and instruction

WHS Regulations r. 204

Control of risks arising from installation or commissioning

Using a tower crane requires a high risk work licence. For further information on high risk work licences, refer to [Section 4.2](#).

A PCBU must ensure, so far as reasonably practicable, the provision of any information, training, instruction or supervision that is necessary to protect all persons from risks to their health and safety arising from work carried out as part of the conduct of the business or undertaking. This includes refresher training. Training should be provided by a competent person. High risk work licences are issued by the regulator and require the relevant qualification issued by a registered training organisation.

Information, training or instruction provided to a worker must be suitable and adequate having regard to:

- the nature of the work carried out by the worker
- the nature of the risks associated with the work at the time the information, training and instruction is provided
- the control measures implemented.

For a tower crane, this includes seeking evidence of the person's familiarity with the specific crane design and configuration to be used and providing any additional information, training, instruction or supervision needed. This should include:

- the particular model of crane to be operated, its characteristics, functions and limitations
- the information in the crane's operating manual
- the crane's load chart, including all notes and warnings, and how to calculate or determine the crane's actual net capacity in every possible configuration
- how to safely access and exit the tower crane
- safe work method statements (SWMS) for tower crane operations involved in high risk construction work
- any site conditions that may affect crane operations, including wind conditions, the presence of energised overhead or underground electric lines, nearby structures or other cranes or mobile plant
- how to carry out inspections, shut-down, cleaning, repair and maintenance
- emergency procedures, including crane malfunctions and rescue procedures
- the correct use of guarding and other control measures
- the proper use, wearing, storage and maintenance of PPE.

Evidence should again be sought from all crane crew workers, and further information, training, instruction or supervision provided, when changes are made to the crane crew.

The PCBU must ensure, so far as is reasonably practicable, that the information, training and instruction are provided in a way that is readily understandable for the worker to whom it is provided.

A person with management or control of plant must also provide the necessary safety information to workers who are involved in installing, commissioning, testing, maintaining, or repairing plant, as well as decommissioning, dismantling, or disposing of the plant. This should include information on the types of hazards and risks the plant may pose to workers when they are carrying out these activities.

Emergency instructions relating to an item of plant should be clearly displayed on or near it.

General construction induction training

WHS Regulations r. 316

Duty to provide general construction induction training

WHS Regulations r. 317

Duty to ensure worker has been trained

A PCBU must ensure that general construction induction training is provided to a worker engaged by the person who is to carry out construction work, if the worker:

- has not successfully completed general construction induction training, or
- successfully completed general construction induction training more than 2 years previously and has not carried out construction work in the preceding 2 years.

A PCBU must not direct or allow a worker to carry out construction work unless:

- the worker has successfully completed general construction induction training, and
- if the worker completed the training more than 2 years previously, the worker has carried out construction work within the preceding 2 years.

2 The risk management process

WHS Regulations r. 34

Duty to identify hazards

WHS Regulations r. 35

Managing risks to health and safety

WHS Regulations r. 36

Hierarchy of control measures

WHS Regulations r. 37

Maintenance of control measures

WHS Regulations r. 38

Review of control measures

WHS Regulations r. 297

Management of risks to health and safety

WHS Regulations r. 299

Safe work method statement required for high risk construction work

2.1 Identifying the hazards

The first step in the risk management process is to identify all hazards associated with a tower crane in a workplace. This involves identifying situations that could potentially cause harm to people. Hazards generally arise from the following aspects of work and their interaction:

- physical work environment
- equipment, materials and substances used
- work tasks and how they are performed
- work design and management.

Hazards must be managed throughout the asset lifecycle, for example, selection of appropriate tower crane, design and manufacturing stages, site assessment and site-specific design issues, installation, use, maintenance and inspection, dismantling and storage.

Typical hazards associated with a tower crane include:

- the tower crane itself, for example, structural or mechanical failure and collapse, poor visibility for operator, significant delays to entering and exiting the tower crane
- collisions, for example, with people, buildings, other cranes and powered mobile plant
- extreme weather, for example, high winds, lightning, extreme cold or heat, and dust
- falling objects, for example, during loading and unloading, or crane erection and dismantling
- workers falling from height, for example, while accessing the crane cabin or during crane erection and dismantling.

Inspect the workplace

Hazards may be identified by looking at the workplace and how work is carried out. All the activities that may be carried out during the life of the tower crane at the workplace should be considered. These may include transport, storage, installation, commissioning, operation, inspection, testing, maintenance, repair, decommissioning, dismantling, and disposal. For each of these activities, consideration should be given to whether the tower crane could:

- cause injury due to entanglement, dropped loads, collision, falling, crushing, trapping, cutting, puncturing, shearing, abrasion or tearing
- create hazardous conditions due to harmful emissions, fluids or gas under pressure, electricity, noise, radiation, friction, vibration, fire, explosion, moisture, dust, ice, hot or cold parts, cleaning, and undisclosed asbestos-containing materials
- cause injury when an operator responds to common failure modes, for example, if operator controls are difficult to reach or require high force to operate.

Safe design and good work design

The best chance to find ways to eliminate hazards and minimise risks is during the design phase.

Safe design of buildings, structures, equipment and vehicles accounts for the hazards and risks present at all stages of the product's lifecycle. For a tower crane, this means thinking about its manufacture, storage, transportation, installation, commissioning, access, egress, use, inspection, testing, maintenance, repair, decommissioning, dismantling, and disposal.

Tower crane designers include professionals like engineers, industrial designers and designers of plant systems, for example, software and electrical systems. However, anyone who modifies plant can be a designer if the modification has not been designed by someone else. For more information, see Safe Work Australia's [Guide for safe design of plant](#).

Effective design of 'good work' considers the work tasks, work systems, the physical working environment, and the workers and others in the workplace. For more information on good work design principles, see Safe Work Australia's [Principles of good work design: A work health and safety handbook](#).

Inspect the tower crane

A person with management or control of plant at a workplace must review the relevant safety information and inspect each tower crane in the workplace and observe how it is used. Consultation with workers and their health and safety representatives can help to find out what their experience is with the tower crane they operate, inspect or maintain. The manufacturer's and the supplier's instructions for safe set-up and use of the tower crane should also be reviewed.

If the tower crane is hired or leased, the person who owns the tower crane should be consulted about potential hazards, because there is a joint duty for ensuring, so far as is reasonably practicable, that the tower crane is safe and without risk to health and safety.

Factors to consider include:

- the condition of the tower crane, for example, its age, maintenance history and how frequently the tower crane is used
- the suitability of the tower crane, for example, its intended purpose, and if it requires to be modified from its intended use
- the location of the tower crane, for example, its impact on the design and layout of the workplace, and worker accessibility without introducing the risk of slips, trips or falls
- abnormal situations, for example, potential misuse or fluctuation in operating conditions.

Review safety information

Information about hazards, risks and control measures relating to tower cranes in the workplace can be obtained from:

- manufacturers, importers or suppliers of the tower crane
- maintenance technicians or specialists, for example, competent persons
- workers
- regulators, unions and other organisations
- similar businesses or undertakings
- Australian, international or other technical standards.

Review incident records and other data

To collect information about tower crane hazards, records of workplace injuries and illness, dangerous incidents, tower crane inspection reports and maintenance logs should be checked, along with workers' compensation records and the results of investigations.

Crane owners should have systems in place to review similar and reoccurring faults, misuse, or incidents to identify root causes.

Data logging and remote monitoring systems should be implemented to better understand crane use, incidents, and load spectrum, and therefore the remaining life of structural and mechanical components.

This analysis should include considering industry trends, known incidents, service bulletins, alerts issued by manufacturers and other information sources to identify factors that may influence the service life of components.

2.2 Assessing the risks

A risk assessment involves considering what could happen if someone is exposed to a hazard and the likelihood of it happening. A risk assessment can help determine:

- how severe a risk is
- whether existing control measures are effective
- what action should be taken to control the risk
- how urgently the action needs to be taken.

Hazards have the potential to cause different types (e.g. physical or psychological) and severities of harm, ranging from minor discomfort to a serious injury or death.

Many hazards and their associated risks are well known and have well established and accepted control measures. In these situations, the second step to formally assess the risk is not required. If after identifying a hazard the risk and how to control it effectively is known, then the relevant controls can be implemented.

In some circumstances, a risk assessment will assist to:

- identify which workers are at risk of exposure
- determine what sources and processes are causing the risk
- identify if and what kind of control measures should be implemented
- check the effectiveness of existing control measures.

The nature and severity of risks will depend on various factors.

To assess the risk associated with identified tower crane hazards, the following should be considered:

What is the potential impact of the hazard?

- How severe could an injury or illness be? For example, a serious or fatal crush injury, lacerations, amputation, burns or loss of hearing.
- What is the worst possible harm the tower crane hazard could cause? For example, a crane could collapse causing harm to the operator, workers and others below.

How likely is the hazard to cause harm?

- How frequently and how long are workers exposed to the hazard?
- What conditions is the tower crane used in? For example, in a windy, muddy, dusty or corrosive environment.
- What is the condition of the tower crane? For example, is it old and missing safety features found on new tower cranes? Is it reliable or often needing emergency maintenance?
- If there are other people or items of plant in the vicinity, what effect do they have on the likelihood or consequence?
- How could the hazards interact and combine to create new, changed or higher risks? For example, psychosocial risks may increase if workers are exposed to high job demands or harassment, as well as remote or isolated work.
- Where and when is access required during the installation, operation or maintenance of a tower crane and in an emergency?
- What work practices and procedures exist for tower crane safety? For example, is isolation required to carry out maintenance?
- What kinds of information, training, instruction and supervision are provided to workers and other persons who may be near or around the tower crane?
- Does the tower crane's safety depend on the competence of its operators?
- How is work organised? For example, consider:
 - pedestrian and vehicular traffic around the tower crane
 - time spent on repetitive tasks
 - shift-work arrangements
 - production incentives that may affect health and safety.

2.3 Controlling the risks

The WHS Regulations require duty holders to work through a hierarchy of control measures when managing risks to health and safety associated with a tower crane.

Specific controls required under the WHS Regulations are discussed in [Section 3](#) and [Section 4](#).

Hierarchy of control measures

The WHS Regulations require duty holders to work through the hierarchy of control measures when managing certain risks; however, the hierarchy of control can be applied to any risk. The hierarchy ranks control measures from the highest level of protection and reliability to the lowest.

Further guidance on the risk management process and the hierarchy of control measures is in the [How to manage work health and safety risks: Code of practice](#).

Eliminating the risk

Eliminating the risk must always be the aim of risk management. Eliminating risks related to using tower cranes will generally mean not using a tower crane or similar plant. For example, designing items of a size, shape and weight so they can be delivered, handled or assembled at the location where they will be used without the need for a crane.

This may not be practical if doing so means a business cannot make an end product or deliver a service.

Minimising the risk

If eliminating the hazards and associated risks is not reasonably practicable, the risk must be minimised by using one or more of the following:

- **Substitution:** minimise the risk by substituting or replacing a hazard or hazardous work practice with something that gives rise to a lesser risk. For example, replace a crane operating cabin that has a restricted field of vision with one that has a clear field of vision or use a remote control such as a wireless or pendant control.
- **Isolation:** minimise the risk by isolating or separating the hazard or hazardous work practice from any person exposed to it. For example, use mesh fencing to separate tower crane operations from workers and other powered mobile plant.
- **Engineering controls:** engineering controls are physical control measures to minimise risk. For example:
 - hoist motion limit switch that automatically stops the hook block from contacting the boom tip
 - an automatic control system that prevents tower cranes from colliding while sharing the same air space
 - interlocked guards on machinery.

If risk remains, it must be minimised by implementing administrative controls, so far as is reasonably practicable. For example, use signs to warn others that the crane is operating, and schedule crane operations to minimise the presence of pedestrians and vehicles in the crane's area of operation.

Any remaining risk must be minimised with suitable PPE. For example, providing workers with gloves, hard hats, high visibility vests, ear plugs or muffs and eye protection.

Administrative control measures and PPE do not control the hazard at the source. They rely on human behaviour and supervision and, used on their own, tend to be the least effective in minimising risks.

The control measures applied may change the way work is carried out. In these situations workers must be consulted and a safe work procedure developed. Workers must be provided with any information, training, instruction, or supervision they need on the changes.

Combining control measures

In most cases, a combination of control measures will be needed to minimise the risk to the lowest level reasonably practicable. For example, protecting workers from falling objects when erecting a tower crane may involve using restraining systems and tethers to prevent or arrest the fall of crane components and tools, installing a catch platform to catch falling objects, and erecting barriers to separate workers from the area near the crane's base.

Chosen control measures should be checked to ensure new hazards have not been introduced. For example, hiring a forklift to control hazardous manual tasks introduces risks involving moving plant that also need to be controlled.

2.4 Maintaining and reviewing control measures

WHS Regulations r. 37

Maintenance of control measures

WHS Regulations r. 38

Review of control measures

Control measures must be maintained so they remain fit for purpose, suitable for the nature and duration of work and are installed, set up and used correctly.

The control measures put in place to protect health and safety should be regularly reviewed to make sure they are effective. If the control measure is not working effectively, it must be revised to ensure it is effective in controlling the risk.

Control measures must be reviewed and, as necessary, revised so as to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety. A control measure must be reviewed and revised:

- when the control measure does not control the risk so far as is reasonably practicable
- before a change at the workplace that is likely to give rise to a new or different health and safety risk that the measure may not effectively control
- when a new or relevant hazard or risk is identified
- when the results of consultation indicate that a review is necessary, or
- when a health and safety representative requests a review, if that person reasonably believes that:
 - any of the circumstances listed above may affect the health and safety of a member of the work group represented by the health and safety representative, or
 - the duty holder has not adequately reviewed the control measure in response to the circumstance.

Common review methods include workplace inspection, consultation, testing and analysing records and data.

Control measures can be checked by using the same methods as in the initial hazard identification step. Workers, and, where applicable, their health and safety representatives must also be consulted.

If problems are found, information from the risk management steps should be reviewed, with further decisions made about control measures.

3 Before using a tower crane

3.1 Planning the work

Planning is the first step in ensuring a tower crane is used safely. Planning includes:

- developing a scope of work
- selecting a crane
- providing a safe system of work.

Planning for tower crane operations should start as early as possible and should involve consultation with all persons engaged in the work. This may include the principal contractor, crane owner, crane supplier, electricity supply authority, designer, project manager, crane operators and crew, and other workers.

Effective planning will help identify ways to protect persons who are:

- erecting, climbing, commissioning, inspecting, and dismantling a tower crane
- directly involved in a lifting operation, such as the crane operator and dogger
- performing other work activities at the workplace
- in an area adjacent to a tower crane, including a public area or private property.

The construction project schedule should include dedicated dates and times for inspection and maintenance activities that align with the crane manufacturer's recommendations, including annual, major and routine inspection and maintenance.

3.2 Selecting a tower crane

Many injuries and illnesses occur due to a failure to select the right equipment for the job. Before purchasing, hiring, or leasing a tower crane, check it is suitable for the intended use, including the environment it will be used in and the work to be undertaken. Needs should be discussed with the tower crane supplier.

In some cases, a tower crane may not be the right tool for the job.

Information must, so far as is reasonably practicable, be passed on from the designer through the manufacturer and supplier to the end user. This information includes:

- the purpose for which plant was designed or manufactured
- the results of calculations, analysis, testing or examination
- conditions necessary for the safe use of the plant
- a design registration number.

The crane that best suits the workplace and the work should be used. This includes considering:

The workplace

- layout, including site access, space for erection and dismantling, loading areas, distance from other buildings and structures, and plant in or near the workplace
- ground conditions, including stability, slope, and adequacy to support the weight of the crane and loads
- operations of other cranes and lifting plant, including mobile cranes, concrete placing booms, and telehandlers
- traffic, including powered mobile plant, workers, and public access
- weather conditions, including wind, extreme heat or cold
- restricted airspace
- proximity of overhead electric lines and equipment.

The work

- weight and dimension of loads to be lifted
- the range of lift heights and distances
- ensure adequate consideration of issues regarding access and egress
- the type of lifting required, for example, precise placement, loads that will be suspended for lengthy periods of time
- visibility of loads throughout lifts, either from an operator cabin or using a remote control
- number and frequency of lifts
- length of time the crane will be required.

Each type of tower crane has advantages and disadvantages. The types of tower cranes commonly used on construction sites in Australia are shown in the introduction in [Section 1](#).

For further information on what to consider when selecting tower cranes, see AS 2550.4: *Cranes, hoists and winches: Safe use – Part 4: Tower cranes*.

Second-hand tower crane

A supplier of second-hand plant must ensure, so far as is reasonably practicable, that any faults that may give rise to health and safety risks are identified. The supplier must provide information in writing about the condition of the plant and any identified faults or, if the plant is supplied only for spare parts or scrap, that it is not to be used as plant.

The inspection and maintenance history of a second-hand tower crane should be requested prior to purchase, in addition to plant design and item registration details (where required). Where a tower crane has been in service prior to purchase and information on its condition and safe use is not available, a competent person (for example, a qualified mechanical engineer) should be engaged by the supplier to assess the crane and develop this information.

Where a second-hand tower crane has been imported from overseas, the importer or supplier must obtain design and item registration prior to use.

Prior to using a second-hand tower crane the PCBU must ensure the crane has undergone all required inspections, maintenance and repair as specified by the manufacturer, including required major inspections. The regulator may request evidence of inspection and maintenance as part of a design registration application for a second-hand crane.

Hiring a tower crane

Any person hiring or leasing a tower crane to others will have duties as a supplier and as a person with management or control of a tower crane in the workplace. This means that the supplier must ensure, so far as is reasonably practicable, that the crane is safe to use and maintained in accordance with the manufacturer's instructions. If such instructions are unavailable and it is not reasonably practicable to obtain them, the crane should be maintained in accordance with the instructions of a competent person. They must also provide specific information with the crane including on how to erect, inspect, use, maintain and dismantle it safely. The competent person should follow the design standards and other applicable standards to make this determination.

Tower crane owners or hiring companies should periodically contact the tower crane supplier or manufacturer for any safety alerts or product advisory bulletins applicable for their crane. Any such additional inspection or maintenance requirements form part of a manufacturer's maintenance requirements (especially for second-hand or used tower cranes).

The PCBU hiring a tower crane has duties during the time it is in their possession and have some control over the way it is used.

Before hiring a tower crane, the PCBU should ensure it is suitable for the intended use. If they do not have the knowledge or expertise regarding crane specifications, limitations and operational requirements, the supplier should be consulted and provided with all relevant information regarding the nature of the work, the workplace and the type of lift to enable the supplier to provide the appropriate crane. The PCBU should also check that the tower crane has been inspected and maintained by the owner according to the manufacturer's specifications. This may involve checking the logbook or maintenance manual. The hirer should also provide the manufacturer's information about the purpose of the crane and its proper use.

In most cases the supplier will be responsible for inspecting and maintaining the crane. However, if the crane is to be hired or leased for an extended period of time, the PCBU and the supplier may develop arrangements to ensure that the crane is adequately inspected and maintained throughout the lease. This may involve the supplier coming to the workplace to maintain the crane, or the PCBU maintaining the crane while it is at the workplace.

The arrangements made will depend on the PCBUs ability to inspect and maintain the crane in accordance with the manufacturer's specifications. If the PCBU chooses to maintain the crane during the lease, all information and records about the maintenance should be provided to the supplier at the end of the lease. More information on inspection and maintenance can be found in [Section 5](#).

3.3 Registering a tower crane

Certain plant designs and items of plant need to be registered. A tower crane or self-erecting tower crane must be design-registered before being supplied and item-registered before being used.

A person with management or control of plant in the workplace must not direct or allow a worker to use a tower crane in the workplace if it is not registered.

Design registration

WHS Regulations r. 243, r. 251, r. 252, r. 258, r. 260

Plant design to be registered

Design registration is the registering of a completed design, from which any number of individual items can be manufactured. The original designer or a person with management or control of the item of plant may apply for design registration.

A tower crane must be design registered if:

- it has not already been design registered
- the design is altered by modifying or relocating the tower crane, if these alterations may affect health and safety.

To register a plant design, the design must be verified by a design verifier who provides a statement that the design meets published technical standards or engineering principles. The design verifier should also certify that the load chart provided is the correct one for the crane.

When registering a plant design, the regulator will issue a plant design registration number. This number must be passed on to the manufacturer, importer, and supplier through to the end user. The person with management or control of the tower crane at the workplace must ensure this number is always readily accessible near the plant (for example, by permanently marking the design registration number on the plant). The regulator may impose any conditions they consider appropriate on the registration of a plant design.

Altered design registration

WHS Regulations r. 244

Altered plant designs to be registered

WHS Regulations r. 245

Recognition of designs by corresponding regulator

If a registered plant design is altered and these alterations may affect health and safety, the altered design must be registered. This is because altering a plant design may require the introduction of new risk control measures. Alterations may include:

- changes in engines, drives, brake systems, control systems, boom sections and other components where the new component is not simply a like-for-like replacement
- the addition of signage with greater wind area or mass, or in a different location, than allowed for in the crane design
- the use of tower sections other than those considered in the crane design, and the design of transition sections to accommodate this.

Relocation of a tower crane from one location to another is an alteration and an alteration to design registration must be completed, followed by the item of plant registration, prior to use.

Relocation of tower crane and alteration to design registration requirements

WHS Regulations r. 244

Altered plant designs to be registered

Relocation of a tower crane will require a design registration. This includes the supporting structures of the crane and its foundations. The tower crane base is included in the design registration of tower cranes in WA.

A competent person, such as a structural engineer, should verify that the foundations would be safe for the tower crane and its expected load. This generally requires geo-technical inspections specific to the site and a site-specific crane base designed by an engineer in accordance with engineering principles or relevant technical standards. If the tower crane has ties to the building, the adequacy of the building for tie loads must be assessed as part of the relocation of tower crane and alteration to design registration.

The size and design of tower crane bases will vary according to factors such as:

- maximum height under hook
- wind speed
- terrain type
- site specific geotechnical assessments including ground type and bearing capacity, as well as boom length and the maximum rated capacity of the crane
- vibration factors
- foundations and the building ties.

Items of plant registration

WHS Regulations r. 246

Items of plant to be registered

WHS Regulations r. 247

Recognition of plant registered by corresponding regulator

Plant item registration applies to a specific item of plant. Each item requires registration.

The purpose of registering an item of plant is to ensure it is inspected by a competent person and is safe to operate. A person is competent to inspect a tower crane if they have acquired through training, qualification, or experience the knowledge and skills to carry out the task. Relevant training and qualification may include tertiary or vocational qualifications in an engineering discipline or knowledge of the technical standards relevant to the tower crane to be inspected.

The PCBU should obtain a copy of the design registration from the supplier of the plant to ensure all registrable plant items are registered.

The design registration number and a copy of the design registration must be included with the application for item registration.

Once a tower crane is registered

The regulator will issue a registration document. The registration holder must keep this document and make it available for any inspection under the WHS Act.

The regulator may impose conditions on registering items of plant including conditions about the use and maintenance of the plant, record keeping or providing information to the regulator.

Changes to item registration

WHS Regulations r. 282

Changes to information

The regulator must be informed in writing if:

- the tower crane is altered so that it requires new risk control measures
- the tower crane is usually at a fixed location but is relocated
- the registration holder no longer has management or control of the tower crane.

For more information on plant design and item registration, see [*Managing the risks of plant in the workplace: Code of practice*](#).

3.4 Safe work method statements

WHS Regulation 299

Safe work method statement required for high risk construction work

Generally, using a tower crane is high risk construction work. This means it requires a safe work method statement (SWMS).

An SWMS is a written document that must identify the high risk construction work activities to be carried out at a workplace, the hazards and risks to health and safety arising from these activities, the measures to be implemented to control the risks and how the control measures are to be implemented, monitored and reviewed.

The primary purpose of an SWMS is to help PCBUs, supervisors and workers implement and monitor the control measures established at the workplace to ensure high risk construction work is carried out safely.

Who is responsible for preparing an SWMS?

A PCBU must prepare an SWMS, or ensure an SWMS has been prepared, before high risk construction work starts.

The person responsible for carrying out the high risk construction work is best-placed to prepare the SWMS in consultation with workers who will be directly engaged in the high risk construction work.

If more than one PCBU has the duty to ensure an SWMS is or has been prepared, they must consult and cooperate with each other to coordinate who will be responsible for preparing it.

Consultation

Workers and their health and safety representatives, if any, must be consulted when preparing an SWMS. If there are no workers engaged at the planning stage, consultation must occur with workers when the SWMS is first made available to workers, for example, during workplace-specific training or a toolbox talk. Workers and their health and safety representatives, if any, must also be consulted when an SWMS is reviewed.

3.5 Crane siting

A tower crane and its load present serious risks to the health and safety of workers and others in or near the workplace. This includes risks from crane collapse, collisions, falling objects and electrocution.

When planning where to site a tower crane, consider the location of:

- permanent or temporary building, structures, and plant
- overhead and underground electric lines
- work areas with workers and other persons at the workplace, including loading areas
- traffic, including site access and movement of mobile plant and pedestrians
- assistance, including from other workers and emergency services
- public access areas, such as footpaths, roadways and railways in the vicinity of the crane
- the vicinity of aerodromes and aircraft flight paths including emergency helicopter landing zones.

Before siting a tower crane, relevant persons engaged in the work should be consulted, including the principal contractor, crane owner, crane supplier, electricity supply authority, designer, project manager, crane operators and crew, and other workers.

Falling objects

WHS Regulations r. 54

Management of risk of falling objects

WHS Regulations r. 55

Minimising risk associated with falling objects

A PCBU at a workplace must manage risks to health and safety associated with an object falling on a person if it is reasonably likely to injure the person. Falling objects include part or all of a tower crane, objects being suspended or moved by the tower crane, or equipment and tools being used or carried while on the tower crane.

This is a risk whenever a tower crane is at a workplace, including during:

- erection and dismantling
- commissioning
- operator and crew entry and exit
- operation, including loading, unloading, suspending, and moving a load
- inspection, maintenance, and repair
- structural or mechanical failures, collapse, fires, and other emergencies.

If it is not reasonably practicable to eliminate the risk of falling objects, a safe system of work to minimise this risk must be provided and maintained. This safe system of work must provide adequate protection against the risk of falling objects, including by:

- preventing an object from falling freely, so far as is reasonably practicable, or
- if this is not reasonably practicable, by providing a system to arrest the fall of a falling object, so far as is reasonably practicable.

For example, during planning, consider if a proposed tower crane site will allow installation of barriers or restraining systems to prevent crane components or other objects falling, or safety nets or catch platforms to catch falling objects.

Consider using tool lanyards to secure tools and equipment to an anchor point, such as a column or beam. If the lanyard is attached to a person, the weight of the tool and lanyard should not impose any additional risks to the person. A lanyard should be made from material such as synthetic or natural fibre, steel rope or webbing, which will maintain the required strength and resistance to abrasion under harsh conditions. If the tool is dropped, the length of the lanyard should be no longer than necessary to prevent the tool from hitting a person below and to reduce the risk of snagging as the worker moves about. For example, a tool lanyard attached at the wrist should have a length of no longer than 300 millimetres.

Any remaining risks must be minimised, so far as is reasonably practicable, using substitution, isolation, or engineering controls. For example, when planning where to site a tower crane, consider:

- redesigning the work process to minimise the number of objects at height
- isolating the crane away from people, plant and structures, including work areas and public access areas like buildings, footpaths, roads, railways, and waterways. This includes sufficient space to protect persons if the crane drops a load, collapses, or tips over
- erecting a physical barrier to separate workers and other mobile plant from the tower crane's operating radius.

If risks remain, they must be minimised, so far as is reasonably practicable, by implementing administrative controls, such as supervising exclusion zones near the crane or scheduling crane erection, dismantling, or other operations to minimise the presence of pedestrians and vehicles near the crane. Exclusion zones should include a barrier, for example 1,800 mm high mesh fencing, erected around the base of the tower crane, and security to stop people entering this area. The size of an exclusion zone should be based on a risk assessment.

Any remaining risks must be minimised by providing suitable PPE, such as hardhats with chin straps, as well as eye protection.

A combination of controls may be needed if a single control is not enough to minimise the risks, so far as is reasonably practicable.

Crane instability can cause falling objects. Information on crane stability appears later in this section.

Dual braking system

A dual braking system should be provided with the luff function of a luffing tower crane and any other function specified by the manufacturer and relevant technical design standards.

Self-erecting tower cranes

Counterweights on self-erecting tower cranes are located at the base of the crane. People who encroach into the slewing arc of the counterweights face the risk of being hit by them.

A barrier, for example 1,800 mm high mesh fencing, should be erected around the base of self-erecting tower cranes to stop people entering this area and being hit by the crane's counterweights. The barricade should be positioned to provide enough room to avoid people being trapped between the barricade and the counterweights.

Collisions

WHS Regulations r. 219

Plant that lifts or suspends loads

A person with management or control of the tower crane must ensure, so far as is reasonably practicable, that the crane used is specifically designed to lift or suspend the load.

A person with management or control of the tower crane must manage the risks of a tower crane or its load colliding with any person or thing. They must identify hazards, assess risk if necessary, control any risks, and maintain and review controls.

The best chance to control the risks of collisions is when planning where to site a tower crane. The risk of collisions must be eliminated. If this is not reasonably practicable, the risk must be minimised using substitution, isolation, or engineering controls, so far as is reasonably practicable. For example:

- minimise the number of cranes in the workplace
- site the crane away from people, plant and structures
- erect a physical barrier to separate workers and other mobile plant from the tower crane's operating radius
- use an anti-collision system, particularly if multiple tower cranes share the same air space.

Any remaining risks must be minimised using administrative controls, so far as is reasonably practicable. This could include:

- supervising exclusion zones to prevent entry during crane operations
- scheduling crane operations to minimise the presence of pedestrians and vehicles in the crane's area of operation
- implementing a method of communication between the crane crew and other plant operators
- using a working radius indicator device to help warn the operator if the crane may be at risk of a collision
- using an audible warning device to alert others when the tower crane is moving, and
- implementing a tower crane's climbing procedure to ensure the crane remains as far above any structure or plant (e.g. jump forms) as practicable.

Any remaining risk must be minimised with suitable PPE, for example, high visibility vests.

In most cases, a combination of controls will provide the best solution to minimise the risk to the lowest level reasonably practicable.

Control measures must be maintained to ensure they are effective. They must also be reviewed and revised as necessary to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety.

When cranes share the same air space but are sited on different workplaces, the PCBU must consult, cooperate, and coordinate with all other persons who have a WHS duty in relation to these crane operations. The system of work should identify people from each workplace who will coordinate scheduling requirements and a clear way of communicating between the workplaces.

Where tower cranes are set up in or close to flight paths (e.g. near aerodromes, or due to the height of the crane), the local aerodrome operator must be contacted to ensure the requirements of the Civil Aviation Safety Authority are met. Where necessary, aircraft warning lights should be fitted to the highest part of the crane.

Working radius indicator

A radius indicator should be fitted on a tower crane. A radius indicator displays the radius of the suspended load, generally measured from the centre of the slew ring. The working radius should be displayed in metres and be accurate to +10 per cent and -3 per cent of the actual radius. Where the crane is operated by remote control and the jib is horizontal and fully visible to the operator the indicator may consist of 1 metre graduations marked on the jib with numbers written at intervals that are not excessive, for example, every five metres.

Anti-collision system

A tower crane should be installed with an anti-collision system where multiple tower cranes are used in a workplace. An anti-collision system combines crane movement tracking, including a crane's braking capacity, with motion limiting devices that stop or slow crane functions to avoid a collision between cranes or their load.

Zoning technology prevents a tower crane moving the jib or load over critical exclusion zones, such as public areas, private properties, site boundaries, roads or railways. The tower crane computer is programmed, and the system monitors the crane's operations, including load parameters and hook height, preventing entry into those exclusion zones.

A limiting device will provide more reliable and higher protection than an indicator device. While these devices may aid crane operators, they should not be solely relied upon to control the risk of collisions.

Where limiting and indicating devices are to be installed on a tower crane, the safety circuits of these devices should generally meet either:

- a reliability level of Category 4 under AS 4024: *Safety of machinery*, or
- a safety integrity level of 3 under AS 62061: *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*.

Overhead and underground electric lines

Electric lines pose significant risks, including electrocution, arcing, explosion, fire causing burns, unpredictable cable whiplash and electrifying other objects including signs, poles, trees or branches. Whether carrying voltage of 400,000V or 230V, contact with energised electric lines can be fatal. It is not necessary to touch an electric line to be electrocuted. A 'flashover' or 'arc' can electrocute a person close to a line conductor.

WHS Regulations r. 147

Risk management

WHS Regulation s r. 166

Overhead and underground electric lines

WHS Regulations r. 166A

Duty of person conducting a business or undertaking: overhead electric lines

A PCBU at a workplace must ensure, so far as is reasonably practicable, that no person, plant or thing at the workplace comes within an unsafe distance of an overhead or underground electric line. This includes a tower crane and its load.

Where overhead electrical lines are present and there is any risk of entering the exclusion zone, the principal contractor should ensure documented consultation occurs with the relevant electrical supply entity (in addition to other consultation outlined in [Section 1](#)), and all recommendations from the electrical supply entity are followed.

The distance required to avoid electrical flashover should be considered, allowing for the inadvertent movement of a person or plant, and allowing for the sag and sway of conductors.

If it is not reasonably practicable to ensure a safe distance, a risk assessment must be conducted for the proposed work, and control measures implemented that are consistent with the risk assessment and the requirements of an electricity supply authority where it is responsible for the electric line.

The following should be considered:

- Are workers or plant likely to go near electric lines? If so, how high are the electric lines and the plant and what voltage are the lines?
- Are overhead electric lines hard to see in the sky or are they hidden by trees?
- Have underground electric lines been accurately located?
- Has the relevant state or territory electricity supply authority been contacted for information about specific requirements when working near electric lines, including the qualifications required for those people working near electric lines?
- Have emergency rescue procedures been established, including calling the electricity supply authority to isolate the electricity supply before trying to rescue a person receiving an electric shock?

Danger zone

The danger zone for working around overhead electric lines vary for people, plant and materials depending on the voltage of the overhead electric line and whether the electric lines are insulated or bare.

A PCBU at, or person with management or control of, a workplace must ensure that a worker or any plant or material used or controlled by a worker does not enter the danger zone of an overhead electric line or aerial bundled conductor line.

The danger zone is anywhere that:

- is within 0.5 metres of a live insulated overhead electric line or aerial bundled conductor line of a voltage of not more than 1,000 volts
- is within 1 metre of a live uninsulated overhead electric line of a voltage of not more than 1,000 volts
- is within 3 metres of a live overhead electric line, whether insulated or not, of a voltage exceeding 1,000 volts but not more than 33,000 volts
- is within 6.0 metres of a live overhead electric line, whether insulated or not, of a voltage exceeding 33,000 volts.

The requirement to establish a danger zone does not apply if:

- the PCBU or person with management or control of the workplace has proof that the overhead electric line has been adequately insulated and effectively cordoned off, or has been otherwise made safe as necessary, to protect the safety of workers or other people, or
- the worker is authorised to carry out electrical work under the *Electricity Act 1945*.

Keeping a safe distance

To ensure a tower crane or its load does not come within an unsafe distance of an overhead electric line, such as entering the danger zone, the following should be considered:

- the maximum radius of the crane boom, including from luffing
- the size and shape of any load to be lifted
- load swing, including from wind, slewing motion or after the boom comes to rest
- electric lines swaying or sagging, usually from wind or temperature changes.

To ensure a safe distance, consideration should be given to removing the energised electric lines from the workplace or relocate the tower crane so no part of it or its load can enter the danger zone. This should be arranged with the electricity supply authority as quickly as possible as this can take some time to arrange. Where electric lines have been de-energised, confirmation should be sought from the person in control of the electric line before undertaking any work.

If this is not reasonably practicable, consider using substitution, isolation, or engineering controls, for example:

- using alternative plant which cannot reach or enter an unsafe zone
- setting up the crane away from electric lines
- erecting a physical barrier to prevent any part of the crane or load entering an unsafe distance
- using mechanical stops or an anti-collision system to limit the crane's movement.

If risks still remain, administrative controls should be used, for example:

- providing a safety observer
- installing warning signs to indicate the location of overhead electric lines
- installing tiger tails or line markers on overhead electric lines to act as a visual aid to highlight the location of the electric line (note: tiger tails do not insulate wires)
- using warning devices to warn the crane operator before the boom enters the exclusion zone.

In most cases, a combination of the control measures will provide the best solution to minimise the risk to the lowest level reasonably practicable.

Safety observer

A safety observer is a person trained and competent to observe and advise the crane operator. Safety observers should not carry out other tasks, such as dogging duties (described further below), at the time of observing crane operations. All workers on a worksite should clearly be able to identify persons carrying out duties as a safety observer. This ensures that workers do not distract safety observers while they are carrying out spotting duties.

The safety observer should:

- mark the border of the danger zone with suitable markers, for example, red warning tape easily seen by the crane operator
- stop unauthorised people entering the danger zone
- not be required to observe more than one operating crane at a time
- be able to communicate effectively with the crane operator at all times and warn them if a part of the crane or the load it is lifting is about to enter the danger zone
- be provided with specialist communication equipment where there is a barrier to communication
- be trained to perform the role
- have the authority to stop the work at any time.

To carry out crane operations in the danger zone, the operator of the crane and the safety observer require authorisation from the relevant electricity supply authority.

A tower crane may not need a safety observer when:

- the electric lines have been de-energised and steps taken to ensure they cannot be inadvertently re-energised. High voltage electric lines should also be earthed
- limiting devices have been installed to prevent any part of the crane, plant or load being moved from entering the danger zone
- any part of the crane or its load is prevented from entering the danger zone by physical barriers.

For more information, contact the state electricity supply authority.

3.6 Pre-erection inspection and testing

WHS Act s. 25

Duties of persons conducting businesses or undertakings that supply plant, substances or structures

A PCBU operating as a supplier must ensure the tower crane components supplied are without risks to health and safety of persons who:

- use the tower crane for a purpose for which it was designed or manufactured
- carry out any reasonably foreseeable activity at a workplace in relation to the tower crane's assembly or use for a purpose for which it was designed or manufactured or its proper storage, decommissioning, dismantling or disposal, or
- are at or in the vicinity of a workplace and who are exposed to the tower crane at the workplace, or whose health or safety may be affected by its use or activity.

The supplier must carry out, arrange, or ensure the carrying out of any calculations, analysis, testing or examination necessary to fulfil WHS duties, ensuring this inspection and testing is done prior to the components being delivered to the workplace and erected. See [Section 5](#) for more information on inspection and maintenance.

Information about the tower crane must be passed on to the end user, including the results of such inspection and testing. The supplier should ensure tower sections are clearly and permanently identified with their model type and serial number and match those specified on the registered tower crane design.

Once the tower crane components have been delivered to the workplace, the supplier should ensure they are inspected for damage and wear during transport.

WHS Regulations r. 204

Control of risks arising from installation or commissioning

A person with management or control of a tower crane at a workplace must ensure that the processes for the installation, construction, commissioning, decommissioning, and dismantling of a tower crane include inspections that ensure, so far as is reasonably practicable, that risks associated with these activities are monitored.

The person with management and control of the tower crane should work with the supplier to ensure the tower crane is inspected and tested before it is delivered and erected.

Pre-erection inspection and testing includes:

- non-destructive testing of welds on vital components including boom clevises, butt heel bosses and counterweight rope sheave brackets
- non-destructive testing of tower bolts
- non-destructive testing of slew ring bolts
- non-destructive testing of aluminium sheaves
- the condition of the power supply cable, where used
- the condition of motor brakes
- the condition of the slew ring gear and pinions
- air controls and associated valves
- the condition of ropes and sheaves (e.g. erection, hoisting, counterweight and trolley) and correct rope tracking
- the condition of limit switches and limiting devices
- the condition of counterweights
- the condition and fitment of machinery guarding
- brake systems, which must be dismantled and inspected for wear and damage according to:
 - dry brakes: prior to each erection or more frequently if directed by the manufacturer
 - wet brakes: prior to each erection, after 5,000 hours of crane operation or as directed by the manufacturer
- all normal service items, including items supplied by the crane manufacturer (e.g. temperature control units and adequate seating) being maintained in a serviceable condition according to the crane manufacturer's instructions
- other tests and inspections specified by the manufacturer.

The following should also be inspected:

- the crane base design and engineer's report
- crane ties and structure to support them where used
- the power supply and earthing.

More information on inspecting and maintaining a tower crane is in [Section 5](#).

3.7 Erecting, commissioning, and dismantling

WHS Regulations r. 201

Duties of persons conducting businesses or undertakings that install, construct or commission plant

WHS Regulations r. 204

Control of risks arising from installation or commissioning

WHS Regulations r. 237

Records of plant

A person with management or control of a tower crane at a workplace must ensure:

- the person who installs, assembles, constructs, commissions, decommissions, or dismantles the tower crane is competent and is provided with the available information for eliminating or minimising risks to health and safety, and
- the processes for the installation, construction, commissioning, decommissioning, and dismantling of a tower crane include inspections that ensure, so far as is reasonably practicable, that risks associated with these activities are monitored.

Records of all tests, inspections, maintenance, commissioning, decommissioning, dismantling, and alterations of the tower crane must be kept while it is used or until control of it is relinquished. More information on record keeping is in [Section 5](#).

Erecting

Erecting a tower crane involves numerous steps, including:

- assembling crane components, usually with a mobile crane
- constructing the tower, the turntable and cab
- hoisting and attaching the jib and counter jib
- installing the counterweights and cables.

Much of this is high risk work and requires the relevant high risk work crane or rigging licence. An Intermediate Rigging high risk work licence is required for tower crane erection and demolition.

WHS Regulations r. 201

Duties of persons conducting businesses or undertakings that install, construct or commission plant

WHS Regulations r. 299

Safe work method statement required for high risk construction work

Erecting a tower crane is also high risk construction work, which requires an SWMS. A PCBU that installs or constructs a tower crane must ensure it is installed or constructed having regard to:

- the information provided by the designer, manufacturer, importer or supplier of the tower crane, or
- the instructions provided by a competent person to the extent those instructions relate to health and safety.

When preparing an SWMS, the following should be considered:

- technical standards, for example, AS 1418.4: *Cranes, hoists and winches: Tower cranes*
- the crane's stability
- interaction with other plant, structures or work processes at the workplace
- the use of special tools, jigs and appliances necessary to minimise the risk of injury
- control measures for securing crane components
- environmental factors, such as wet or windy conditions
- all relevant electrical installations associated with the crane comply with AS 3000: *Electrical installations*.

Commissioning

Commissioning tower cranes involves performing necessary adjustments, tests and inspections to ensure the crane is in full working order to specified requirements before the crane is used. A person with management or control of a tower crane must not commission the tower crane unless they have established it is, so far as is reasonably practicable, without risks to the health and safety of any person.

A PCBU that commissions a tower crane must ensure it is installed, constructed or commissioned having regard to:

- the information provided by the designer, manufacturer, importer or supplier of the tower crane, or
- the instructions provided by a competent person to the extent those instructions relate to health and safety.

When commissioning a tower crane, ensure that:

- the commissioning sequence has been developed and implemented according to the risk management process
- an erection plan is developed to cover such things as the sequence of operations, and the safety procedures to be carried out during commissioning
- tests are carried out to ensure the crane will perform within design specifications (e.g. dummy runs, load tests)
- stresses which exceed design specifications are not imposed on the crane, for example, use the load specified by the manufacturer for conducting load tests.

Commissioning inspection and testing

Commissioning inspections and tests should be carried out by an independent or third-party competent person onsite once the crane has been erected and before it is put into service.

Commissioning inspections and tests should include:

- crane electricity supply, where used
- crane base weights or ballast, where used
- tower section identification and access
- tower bolts to correct tension
- climbing frame and connection
- jib connection pins and retainers
- A-frame connections and retainers
- jib and deck pendant pins and retainers, where used
- machinery guarding
- leakage in lines, tanks, valves, pumps, and other parts of air or hydraulic systems
- the condition of the ropes and sheaves (for example, erection, hoisting, trolley and counterweight) and correct rope tracking
- isolating switches
- the condition and phase of the power supply cable
- verification that the crane wiring complies with AS 3000: *Electrical installations*
- effective operation of controls including interlocks
- effective operation of indicating devices
- effective operation of travel deceleration switches
- effective operation of hoist upper and lower (where required) working limit switches
- effective operation of warning devices
- effective operation of the hoist and travel brakes when the crane is laden to the maximum rated capacity
- effective operation of the rescue-controlled descent device
- other tests and inspections specified by the crane manufacturer.

The crane owner should be notified of commissioning results and provided with appropriate documentation, including:

- any problems identified during commissioning that indicate the crane is not performing safely
- confirmation that the crane will perform the functions for which it has been commissioned.

Decommissioning and dismantling

A person with management or control of a tower crane must not decommission or dismantle it unless the work can be carried out, so far as is reasonably practicable, without risks to the health and safety of any person.

Dismantling a tower crane is high risk work and requires persons undertaking this work to hold the relevant high risk work licence. It should be decommissioned and dismantled in accordance with the manufacturer's instructions or, if not available, those of a competent person.

Dismantling a tower crane is also high risk construction work and requires an SWMS.

3.8 Crane design loads and controls

WHS Regulations r. 54

Management of risk of falling objects

WHS Regulations r. 55

Minimising risk associated with falling objects

WHS Regulations r. 206

Proper use of plant and controls

An unstable tower crane may collapse, or move unexpectedly during erection, operation, or any time until it is dismantled and removed from the workplace. Instability can cause objects to fall, including part or all of the tower crane, objects being suspended or moved by the tower crane, or equipment and tools being used or carried while on the tower crane.

Crane stability depends on a number of factors, including:

- the design of the tower crane
- the footings and foundations
- the design, number, and location of crane ties
- the stabilising moment of the crane: the crane counterweight generally provides the primary stabilising moment
- the crane has the capability to resist the forces applied by the suspended load and wind
- wind conditions: stability will vary according to the size and shape of the suspended load and crane boom.

A PCBU must manage risks to health and safety associated with an object falling on a person if it is reasonably likely to injure the person. If it is not reasonably practicable to eliminate this risk, a safe system of work must be provided and maintained to minimise it. This safe system of work must provide adequate protection against the risk of falling objects, including by:

- preventing an object from falling freely, or
- if this is not reasonably practicable, by providing a system to arrest the fall of a falling object, so far as is reasonably practicable.

Any remaining risks must be minimised, so far as is reasonably practicable, using substitution, isolation, or engineering controls, so far as is reasonably practicable. For example, when erecting a tower crane consider, on the advice of a competent person, who should consult the manufacturer as needed:

- using a different design for the tower crane base
- isolating the tower crane to protect persons from falling objects during erection and dismantling
- supporting or tying the tower crane to another structure, often the building under construction
- use of high level access bridges
- the effect of other components that may cause a force to be applied, such as a fall arrest system, on the structural stability of the tower crane.

If risks remain, these must be minimised, so far as is reasonably practicable, by implementing administrative controls, such as:

- physically inspecting tower components prior to erection
- supervising exclusion zones near the crane, or
- scheduling crane work to minimise the presence of people or plant near the crane.

Any remaining risks must be minimised by providing suitable PPE, such as hardhats and eye protection.

A combination of controls may be needed if a single control is not enough to minimise the risks, so far as is reasonably practicable.

Information on lifting or suspending loads with a tower crane is in [Section 4](#).

Footings and foundations

Generally, the base of a tower crane is structurally bolted to, or embedded in, the ground or another structure. In some situations, a tower crane can be located on a 'static' crane base that relies on the dead weight of the base for its stability.

The size and design of tower crane bases will vary according to factors such as:

- tower height
- wind speed
- terrain type
- ground type and bearing capacity
- boom length and crane lifting capacity.

A competent person, such as a structural engineer, should verify that the foundations would be safe for the tower crane and its expected load. This generally requires geotechnical inspections specific to the site and a site-specific crane base designed by an engineer in accordance with engineering principles or relevant technical standards.

Adequate precautions should be taken when it is known that the crane will be sited in the vicinity of underground services, excavations, or embankments.

Self-erecting tower crane

The use of self-erecting tower cranes is common particularly on small to mid-sized building sites as they are self-contained and do not require another crane to erect them. Self-erecting tower cranes ([Figure 4](#)) are generally made up of a horizontal boom that folds out during erection and can include a telescopic tower. The counterweight is usually at the base of the crane.

Unlike tower cranes, self-erecting tower cranes do not require fixing to a crane base. Footings and foundations for the installation of a self-erecting tower crane should be designed in accordance with engineering principles or relevant technical standards. The design should consider the results of geotechnical inspections specific to the location of the crane installation.

Crane standing

The crane standing should conform to the crane manufacturer's instructions and be capable of withstanding the forces likely to be imposed on it by the crane while in-service, out of service, and during erecting and dismantling. These forces include:

- dead weight of the crane
- dead weight of the load and any lifting attachments
- dynamic forces caused by movements of the crane, or other dynamic forces such as a fall arrest system
- wind loadings
- other loads as required by the designer of the crane standing.

When a crane is to be supported on, or tied to, a permanent or temporary structure, the design of the structure should be capable of withstanding the forces likely to be imposed on it by the crane, as well as other forces. A competent person should verify the design of the structure.

The PCBU should ensure crane ties are installed in accordance with instructions specified by the tower crane designer and manufacturer.

Self-climbing tower crane

Some tower cranes use a specialised method to increase or decrease height without the use of another crane. There are two main methods:

- internal climbing: where the tower is supported by a building and the whole tower is raised as the building rises, or
- external climbing: where the tower is extended outside a building by inserting additional sections.

There is a very high risk of crane collapse during tower crane climbing operations. The climbing frame as a whole must cope with significant static and dynamic forces involved in climbing.

A climbing tower crane has similar risks during erection as other tower cranes and similar control measures are available. One additional control to consider is ensuring the centre of gravity of the tower crane is balanced over the climbing equipment. This includes avoiding slew operations at all times during climbing operations. The 'balancing' procedure should be obtained from the designer, manufacturer, importer, or supplier, or from a competent person such as an engineer.

Counterweights

Tower crane counterweights are critical to ensuring crane stability. A counterweight too light for a load and boom configuration may cause the crane to collapse in the direction of the suspended load. A counterweight too heavy for the load and boom configuration may cause the crane to fall over backwards.

Counterweights should be secured to the tower crane in the manner specified by the crane manufacturer.

Some tower cranes are provided with moving counterweights on rails that slope downwards away from the crane. These types of tower cranes require the counterweight to be positioned at the top of the counterweight rail during the climbing process. The counterweight is kept in position by means of a latch that locks onto a lug on the bottom of the rail. To help prevent inadvertent release of the latch, a secondary means of securing the latch in place should be provided (e.g. connecting the latch lever to the machine deck with a rope or chain).

Wind and weather conditions

Winds impose extra loads on a crane and may affect the crane's stability. Wind gusts will also have a different effect on the crane than a constant wind.

An anemometer (wind gauge) should be fixed to a tower crane to provide an accurate wind speed reading. The placement of the anemometer should not be shielded from the wind and will vary according to the type of crane. For example, anemometers should be fixed on:

- the top of the A-frame on luffing tower cranes
- either the A-frame or machine deck handrail on non-luffing tower cranes.

A tower crane should only be erected, commissioned, used, or dismantled if the environmental conditions are within the designer or manufacturer's specifications. This includes storms or strong winds that make components uncontrollable when suspended. Wind load can be increased by funnelling effects between adjacent structures or by the large size of components.

Information on operational wind conditions when lifting or suspending loads is in [Section 4](#).

Signs on tower cranes

Regardless of their size, signs can impact the operation of a tower crane, particularly in windy conditions. Signs on crane booms can significantly slow down the slew speed when slewing against the wind and increase the speed when slewing with the wind. Signs may make applying the slew brake more hazardous. There is also a risk that signs that are inappropriately attached to the boom or poorly manufactured could detach during crane operations, and result in injury to persons in the vicinity of the crane.

For these reasons, signs should not be attached to tower crane booms. However, signs may be used on machine (rear) decks, but these should be certified by an engineer prior to being installed. Certification from an engineer should state that the design of the sign and its attachments are 'fit for purpose'. This includes ensuring that maintenance on the sign will not be required for as long as the crane is on site.

Flexible signs should be made of an ultraviolet resistant material that will not deteriorate over the life of the crane installation. Flexible signs should be securely attached using an appropriate tying system that will withstand potential wind loadings.

Solid signs should be attached by bolted connections. An appropriate means of locking the nuts on the bolts should be used. When workers attach solid signs they should not:

- drill holes into the crane structure
- weld joints on to the crane structure
- use strapping and cable ties.

Signs may also be attached to wind sails in certain circumstances. Wind sails may be part of a crane design to counteract wind effects on the machine deck, for example, when a short boom is fitted to a hammerhead tower crane. Attaching a sign to a wind sail may reduce the sail's flexibility and its effectiveness. It may also increase the sail's weight and the risks of harming someone if the sail collides with something or detaches and falls. Before attaching a sign to a wind sail, the PCBU should ensure a competent person, such as an engineer, verifies this will be safe for the tower crane.

Overloading

If a tower crane is overloaded, a structural or mechanical component may fail, or the crane may collapse. The safe lifting capacity of a tower crane is generally limited by:

- its structural strength when the working radius is small
- its stability when the working radius is greater.

The lifting capacities specified on a load chart should never be exceeded, except during testing of the crane by a competent person under controlled conditions.

More information on overloading when lifting or suspending loads is in [Section 4](#).

Load chart

A load chart, also called a rated capacity chart, identifies the weight of a load a tower crane can lift safely. A load chart is generally provided by the crane manufacturer. During the design registration process, the design verifier should verify that the load chart is the correct one.

Load charts must be provided in a way that is readily understandable by the operator, for example, written in English and using metric units. It should provide enough information to identify the crane configuration it applies to. The load chart must be available in the crane cabin for the crane operator to verify the crane is not being overloaded.

Load indicator

A load indicator should be installed in a tower crane to measure and display the mass of the load being lifted. This indicator assists the operator to stay within the load chart and rated capacity of the crane. The load indicator should be capable of displaying the mass of the suspended load at all times.

Rated capacity limiters

A rated capacity limiter should be installed in a tower crane to prevent overloading of the crane. If an overload is detected, a rated capacity limiter stops any crane function that will increase the overload.

Rated capacity means the maximum gross load that may be applied to the crane while in a particular working configuration. The load to be raised includes the weight of all lifting appliances that are not permanently attached to the crane. Deductions should be made in accordance with the manufacturer's instructions. The crane's load chart will also provide instruction on any deductions that may need to be made.

Rated capacity limiters should prevent:

- hoisting a load exceeding 100 per cent of the maximum rated capacity (noting 100 per cent of capacity should only be used during commissioning)
- the radius being increased if that would cause the load to exceed 100 per cent of the maximum rated capacity.

Motion limiting device

A tower crane should be installed with a motion limiting device to stop or slow the crane when it reaches the limits of the crane's designed range of motion, including:

- the highest position of the hook: hoist limiting devices.
- the lowest position of the hook when persons are lowered in a work box into a shaft
- the extreme permissible operating positions of the jib (luff limiter) where a luffing motion is part of normal working operations
- the end positions of the trolley track on the jib
- the end positions of horizontally telescoping or movable jibs
- the end position of the tracks for rail-mounted travelling tower cranes.

A limiting device will provide more reliable and higher protection than an indicator device. While these devices may aid crane operators, they should not be relied upon solely to control the risk of overloading.

Where limiting and indicating devices are to be installed on a tower crane, the safety circuits of these devices should generally meet either:

- a reliability level of Category 4 under AS 4024: *Safety of machinery*
- a safety integrity level of 3 under AS 62061: *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*.

All limiting and indicating devices such as slew limiters, anti-collision limiters, hook travel limiters etc. should be tested and calibrated as specified by the manufacturer, designer or competent person. Heat, dust, ultraviolet and other weather factors may impact the correct operation of these devices, so that they do not always work as expected, with a potential impact on the safe operation of the crane.

3.9 Falls from height and tower crane access

WHS Regulations r. 60

Managing risks to health and safety

WHS Regulations r. 78

Management of risk of fall

WHS Regulations r. 79

Specific requirements to minimise risk of fall

WHS Regulations r. 80

Emergency and rescue procedures

A PCBU at a workplace must eliminate or minimise the risk of a fall from one level to another if the fall is likely to cause injury to a worker or any other person. This includes the risk of falling during tower crane:

- erection and dismantling
- commissioning
- operator and crew entry and exit
- operation, including loading and unloading
- inspection, maintenance, and repair.

Eliminating the risk of a fall

[Section 4.7](#) discusses the use of remote control systems to operate a tower crane from a location other than the cab, which eliminates the risk of falls but has the potential to introduce other risks in the absence of suitable controls.

Managing the risk of a fall

If it is not reasonably practicable to eliminate the risk of a fall by working on the ground or on a solid construction, a safe system of work must be provided and maintained to minimise the risk. This safe system of work must provide adequate protection against the risk of fall, including by:

- providing a fall prevention device
- if this is not reasonably practicable, provide a work positioning system
- if neither of these are reasonably practicable, provide a fall arrest system, so far as is reasonably practicable.

Fall prevention

A fall prevention device is material or equipment, or a combination of both, designed to prevent a fall for temporary work at heights, which does not require any ongoing adjustment, alteration or operation by any person to ensure its integrity after initial installation. This includes secure fencing, edge protection, scaffolding, or working platforms.

Edge protection is commonly used with tower cranes. It consists of a system of rails, mesh, sheeting or other material to prevent persons from falling off a platform or other surface. The components should be designed to withstand the forces imposed on it if a person fell against it. Where possible, tower crane sections should be designed so edge protection is in place prior to erecting the tower crane.

Work positioning

A work positioning system includes any plant or structure, other than a temporary work platform, that enables a person to be positioned and safely supported at a location in such a way that a fall is prevented. This includes using an industrial rope access system or restraint technique.

Restraint technique is commonly used with tower cranes. It controls a person's movement by physically preventing the person from reaching a position where there is a risk of a fall. It consists of a harness that is connected by a lanyard to an anchorage or horizontal lifeline. It must be set up to prevent the wearer from reaching an unprotected edge (Figure 5).

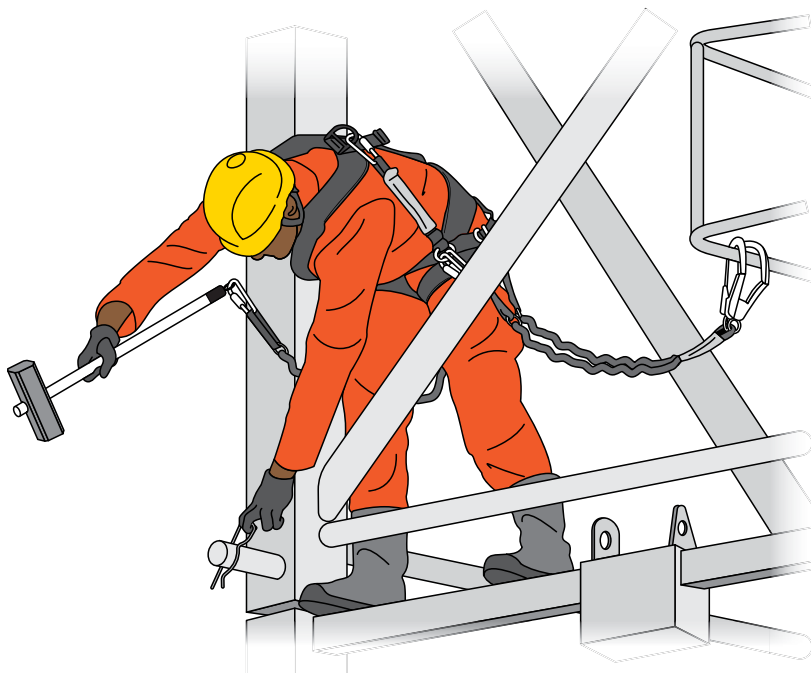


Figure 5 Fall arrest system used during tower crane assembly

Restraint technique should be installed by a competent person in accordance with the manufacturer's instructions. Restraint anchorage should be designed for a fall arrest loading.

Fall arrest

Fall arrest systems, such as catch platforms, safety nets and individual fall arrest systems (including anchorage lines or rails), are intended to safely stop a worker falling an uncontrolled distance and reduce the impact of the fall.

The system should be designed and installed so that the person travels the shortest possible distance before their fall is stopped. The equipment and anchorages should be designed, manufactured and installed to be capable of withstanding the force applied to them as a result of a person's fall. If equipment has been used to arrest a fall, it should not be used again until it has been inspected and certified by a competent person as safe.

Emergency procedures, including rescue procedures, must be established if a fall arrest system is used.

Further controls

Any remaining risks or risks introduced by using these controls must be minimised, so far as is reasonably practicable, using one or more of the following approaches:

- substitute the new or introduced hazard for something safer, e.g. use a specifically designed anchor device instead of a solid permanent structure as an anchor point
- isolate the new or introduced hazard from people, e.g. use a physical barrier to prevent people from entering an area, or install or place anchor devices away from edges
- use engineering controls, e.g. use rope protection to guard ropes from hazardous contact points such as sharp edges or abrasive or hot surfaces.

If risks remain, these must be minimised, so far as is reasonably practicable, by implementing administrative controls, e.g. supervising access to an exclusion zone, using warning signs, planning so work is not carried out for an extended time at height.

Any remaining risks must be minimised by providing suitable PPE, e.g. helmets fitted with chinstraps that have suitable impact protection.

A combination of controls may be needed to sufficiently minimise the risk of a fall.

Tower ladders

The use of continuous vertical ladders without tower crane access for accessing the total length of the tower is not recommended. However, where used, the risk of a fall must be controlled, for example, by using a fall-arrest system that does not require the person to constantly hook on and off. The system may incorporate a vertical rail or rope with a locking cam device. The risk of injury to a person falling off a ladder can be reduced by ensuring the length of lanyard between the person and the vertical rail or rope does not exceed 300 mm. Hoop guards or other ladder safety devices may also be used to reduce the risk of a fall. Where a ladder cage is used, the lowest part should be between 2 metres and 2.2 metres above the lower deck.

A-frame ladder cage

A ladder cage should be provided on the A-frame to ensure that if a person falls off the ladder, the person will be confined within the cage and fall onto the machine deck, not off the tower crane. The lowest part of the ladder cage should be between 2 metres and 2.2 metres above the lower deck. The horizontal spacing between the vertical bars on the ladder cage should not exceed 150 millimetres. Mesh infill may be used instead of vertical bars.

Guardrails on machine deck and A-frame platform

Tower cranes should be provided with perimeter edge protection that extends around the machine deck to prevent the crane operator and maintenance workers from falling. The edge protection should consist of a top rail, a mid-rail and a kickboard. *AS 5240 Cranes – Access guards and restraints provides suitable specifications.*

Access bridges

An access bridge (Figure 6) is a walkway at a higher point on the tower crane, which allows the operator to use other means of getting to the level of the bridge (such as a personnel hoist or stairway in the structure under construction), and then accessing the tower crane. This reduces the amount of ladder climbing required, which reduces the risk of slips or falls while using the ladder.

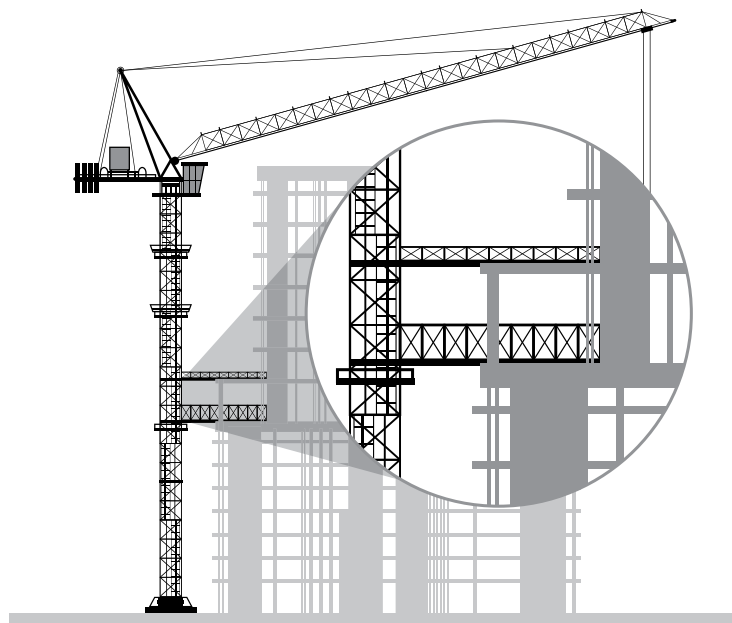


Figure 6 Access bridge from crane to building

An access bridge must be designed in consultation with the designer or manufacturer of the tower crane or with the advice of a competent person. Inclusion of an access bridge must be included in the design registration or alteration of design registration application.

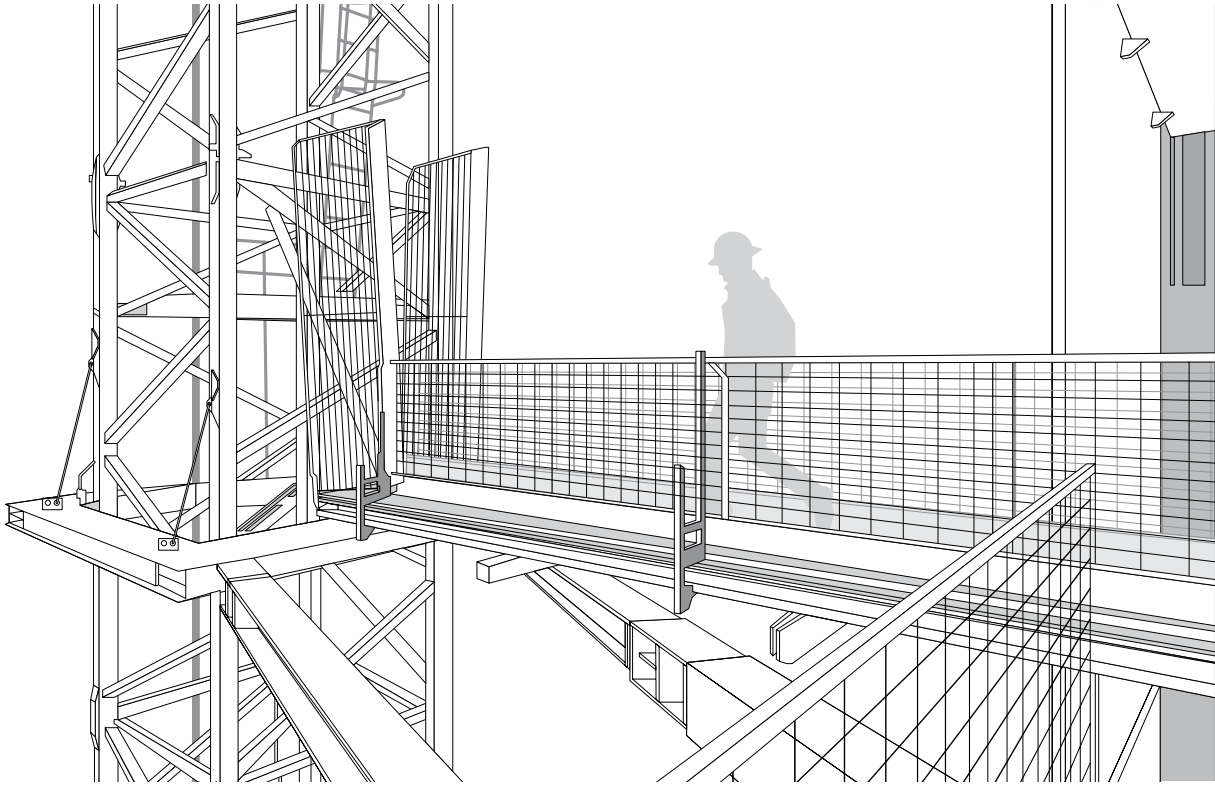


Figure 7 Access bridge located near crane ties

Typically, an access bridge is located near a point that the tower crane is tied to the structure, to minimise structural design impacts.

Use of an access bridge is a risk control that is frequently reasonably practicable and should be a consideration at the planning stage.

Saddle bag platforms

Saddle bag platforms may be needed on tower cranes with moving counterweights to provide access for riggers while erecting the crane and for people carrying out maintenance. Safe access to the saddle bag platform can be achieved by either providing a trapdoor in the machine deck or a ladder cage on the saddle bag ladder. This platform should be provided with a top rail, mid-rail and kickboard. Climbing over the machine deck guardrail and down a ladder leading onto the platform is not recommended due to the increased risk of a fall.

Cantilevered and hanging platforms

Small access platforms may be needed on tower cranes with moving counterweights to provide access for riggers while erecting the crane and for people carrying out maintenance work. Safe access to these platforms must be provided and people should not have to climb over the machine deck guardrail and down a ladder to access the platforms.

Safe access to these platforms can be achieved by either providing a trapdoor in the machine deck, or a ladder cage on the platform ladder. Platforms should be provided with perimeter edge protection.

Crane jib access

Some tower cranes require riggers and crane operators to access the jibs while erecting, inspecting and maintaining the crane. These tower cranes should be fitted with a rigger's run and static lines that extend for the complete length of the jib to allow workers to position safely along the jib. Static lines that are permanently installed in each jib section do not require testing after the jib is installed on site and can be tested on the ground prior to erection.

Double lanyards should be used to ensure continuous contact while transferring between jib section static lines. If the work positioning system will not prevent a worker from reaching an unprotected edge, the crane should be fitted with a separate anchor point to allow the worker to also be attached to a backup safety line to minimise the risk of a fall. Installation of an anchor point must be considered as part of the design of the tower crane and included in the design registration or alteration of design registration.

Some non-luffing tower cranes are fitted with trolley platforms for inspection and maintenance purposes. These platforms should remain on the crane.

Safe access

A safe means of access to and exit from the workplace must be provided, including to any area within the workplace where there is a risk of a fall from one level to another that is reasonably likely to injure a worker or any other person. This includes access to and exit from a tower crane for:

- erection and dismantling
- commissioning
- operation, including loading and unloading, and
- inspection, maintenance, and repair.

Self-erecting tower crane access

Generally, most self-erecting tower cranes do not have to be climbed while in use and maintenance can often be carried out after collapsing the crane.

Some self-erecting tower cranes are provided with ladders for maintenance access. Before a worker uses such a ladder, the work must be carried out on the ground or a solid structure, so far as is reasonably practicable. Where this is not reasonably practicable, adequate protection from a fall must be provided, including providing a fall prevention device such as an elevating work platform or a work positioning system. If neither of these is reasonably practicable, then a fall arrest system, such as catch platforms, safety nets and individual fall arrest systems must be provided.

Ladders

Long ladder climbs may increase the risk of musculoskeletal injury and fatigue, particularly where a tower crane operator has to regularly climb more than 30 metres to the operator's cabin.

Ladder landings should be provided where there is available space in the tower crane. Landings allow for rest breaks while climbing ladders. This helps minimise fatigue and the risk of injury to workers.

Where reasonably practicable, the vertical distance between landings should not exceed six metres. However, if the crane manufacturer has designed otherwise, the length of the lowest ladder in the tower should not exceed 12.5 metres and subsequent ladders should not exceed 10 metres.

The provision of rest platforms beside a vertical ladder is not an adequate control measure on its own to reduce the potential fall distance of a person. The use of fold-down type platforms is also not recommended because they can hinder rescue procedures and increase the risk of a person falling down the ladder.

Internal guardrails on tower landings will minimise the risk of a person falling internally down or off the tower. Some tower cranes are provided with an internal guardrail to tower landings to protect people from falling down the access hole. For example, either a guardrail on the internal side of the access hole or a rail that extends around the back of the access hole could be installed. Having ladders offset between landings can also reduce the risk or severity of a fall, if access hatches have been left in the 'open' position. It may be impractical to provide an internal guardrail on the top tower landing as slewing of the crane may cause the lower end of the ladder to strike and damage the internal guardrail, and entrapment of people on the top tower landing.

Personnel hoists

Most personnel hoists used on tower cranes are enclosed platforms operating on a powered pulley system that can be used to carry one or two people up or down the tower. These hoists may be mounted to the outside of the frame or within the tower frame. Where reasonably practicable, a personnel hoist should be used to access a tower crane. Historically, personnel hoists have been rarely used on tower cranes in Western Australia (WA), however in some jurisdictions they are used more regularly.

It would be practicable that when purchasing a new tower crane, consideration is given to purchasing one with an integrated personnel hoist. This may minimise the risk of musculoskeletal injuries and falls. If used with a ladder, a personnel hoist should minimise the distance a worker climbs on the ladder.

A personnel hoist requires a high risk work licence. However, if the hoist is not an integrated part of the crane design, there is a requirement to consult with the crane manufacturer. This is because it will place load on the crane, as well as affect wind loading. Where the personnel hoist is integrated as part of the original design, the hoist and tower crane will be design registered and item registered as one design and one item.

Multiple tower crane suppliers have introduced models with a personnel hoist. PCBU's investigating the purchase of a new tower crane should discuss this with suppliers to identify a model that matches their requirements.

If a tower crane has a personnel hoist, platforms are still required and would be used in an emergency. The emergency procedure would need to be adapted.

3.10 Lighting

WHS Regulations r. 40

Duty in relation to general workplace facilities

A PCBU must ensure, so far as is reasonably practicable, that lighting enables each worker to carry out work safely, persons to move around safely and safe evacuation in an emergency. Workers should be able to perform their job without having to adopt awkward postures or strain their eyes to see.

When considering the type and level of lighting needed in the workplace, the following factors should be taken into account:

- the nature of the work activity
- the nature of hazards and risks in the workplace
- the work environment
- the level of natural light including transitions or changes throughout the day
- the level of artificial lighting
- glare
- contrast
- reflections.

It is important that crane operators and crew have adequate lighting when climbing and accessing tower cranes. This could include the installation of permanent lighting in tower sections. Appropriate lighting may also be provided from other sources on the worksite, such as lighting attached to a structure in close proximity to the tower crane.

Adequate lighting after dark may also be required for outdoor paths around the workplace and car parks. This should allow workers to move about easily without risk of falling or otherwise risking injury.

Too much lighting can also result in glare or excessive reflection. Measures to ensure correct levels of lighting include:

- changing the position of existing lights
- changing the location of the work activity
- increasing or decreasing the number of lights
- changing the type of lighting used, for example from white light to blue light
- changing the diffusers or reflectors on existing lights
- using screens, visors, shields, hoods, curtains, blinds or external louvres to reduce reflections, shadows and glare.

Emergency lighting must be provided for the safe evacuation of people in the event of an emergency. Extra lighting may be needed for some types of work or at places of particular risk, for example crossing points on traffic routes.

3.11 Emergency planning and safety equipment

WHS Regulations r. 43

Duty to prepare, maintain and implement emergency plan

A PCBU must ensure that an emergency plan is prepared for the workplace. This is a written set of instructions specifically developed for the particular workplace and its specific hazards and covers a range of potential incidents. Persons at the workplace must receive information, training and instruction about implementing the emergency plan.

A reliable and effective means of communication should be established between work areas and persons involved to allow effective evacuation of danger areas.

Rescue equipment should be available and easily accessible so an injured worker can be removed quickly.

A site meeting should occur between the local fire and emergency services, principal contractor, and crane crew to discuss and document emergency rescue and fire response. This will enable local fire and emergency services to be prepared in the event they are required.

The emergency procedures in the emergency plan must clearly explain how to respond in various types of emergencies including how to evacuate people from the workplace in a controlled manner. Contact numbers for emergency services should be prominently displayed. The emergency plan should clearly document the rescue plan for the rescue and medical aid to incapacitated operators, including from the tower crane cabin and from the tower crane access systems.

A register of persons at the workplace on a particular day should be kept so in the case of any emergency everyone can be accounted for.

The emergency plan must provide for the following:

- emergency procedures, including an effective response to an emergency
- evacuation procedures
- notifying emergency service organisations at the earliest opportunity
- medical treatment and assistance
- effective communication between the person authorised to coordinate the emergency response and all people at the workplace
- testing of the emergency procedures, including the frequency of testing
- information, training and instruction to relevant workers in relation to implementing the emergency procedures.

Preparing emergency procedures

The procedures should be written clearly and be simple to understand. Emergency procedures may include:

- the personnel in charge of emergencies including personnel to respond to and oversee the evacuation of injured persons
- the warning system (for example, the alarm signal for evacuation)
- the safe assembly point
- shutting down of work including plant and electrical equipment
- information regarding hazardous chemicals located on site
- provision of firefighting and rescue equipment at appropriate locations
- procedures for assisting injured people and people whose means of escape are limited
- procedures for managing the risk of combustible materials (such as paper, card, wood, dust, timber, plastic and polystyrene) and highly flammable liquids and gases (such as solvents, liquefied petroleum gas (LPG) and oxygen)
- procedures following an evacuation, for example undertaking a headcount to determine if persons that were at the workplace have been accounted for
- procedures regarding incident investigation, counselling and debrief.

The evacuation procedures should be displayed in a prominent place, for example on a noticeboard and may also need to be incorporated into the SWMS where relevant. The emergency plan and evacuation procedures must be tested on a regular basis.

Emergency procedures could also consider having a secondary crane driver (preferably part of the crane crew) to make the crane safe or move the crane to a safe position if the primary crane driver becomes incapacitated.

Shared workplaces

In shared workplaces PCBUs must consult, cooperate and coordinate activities with all other persons who have a work health or safety duty in relation to the same matter, so far as is reasonably practicable.

In shared workplaces where there are multiple PCBUs, a master emergency plan could be prepared that all relevant duty holders use. Examples of shared workplaces include shopping centres, construction sites or office buildings.

Further guidance on emergency plans and procedures is available in Safe Work Australia's [*Emergency plans fact sheet*](#) and [*AS 3745–2010: Planning for emergencies in facilities*](#).

Fire suppression

A PCBU with management or control of a tower crane at a workplace must manage the health and safety risks associated with the tower crane, in accordance with the hierarchy of control measures. This includes the risk of fire.

There are a number of factors that can contribute to a fire on a tower crane, including:

- diesel and electric engines, which can be a source of heat, fuel, and ignition
- combustible liquids, including diesel and hydraulic fluid, in tanks or pumped through hoses
- lightning strikes, particularly in areas prone to storms.

Fire presents a significant risk to isolated workers, such as crane operators or crane crew working on the crane, as well as people near the crane if the heat causes crane components to fall or the crane to collapse.

All tower cranes should provide a pre-plumbed extinguisher system aimed at locations where combustible fluids could pool and burn. Where this is not reasonably practicable, appropriate fire extinguishers or a fire suppression system should be provided at readily accessible locations to the operator. A fire suppression system should be used if it is reasonably practicable.

Only necessary quantities of combustibles should be stored on the machine deck. These should be stored in accordance with the materials data sheet information.

A fire warning system (for example, a fire detection system or camera within the power pack with operator cabin display) should be implemented where reasonably practicable. Where a fire warning system is not fitted, the consideration and determination will need to be recorded in the crane documentation (for example, how the existing engine monitoring systems provide adequate early warning).

Fire suppression and warning systems must be maintained, inspected, and tested, and workers must be provided the information, training and supervision they need to maintain and use them in an emergency.

All fire suppression device suction and feed hoses running from the hydraulic oil tank should have fire resistant, or better grade, hydraulic hoses. The selection of replacement hoses should be made in consultation with the crane manufacturer or a specialist hydraulic hose supplier.

4 Using a tower crane

4.1 Proper use

WHS Regulations r. 39

Provision of information, training and instruction

WHS Regulations r. 206

Proper use of plant and controls

A person with management or control of a tower crane at a workplace, must take all reasonable steps to ensure that the tower crane is used only for the purpose for which it was designed, unless it has been determined that the proposed use does not increase the risk to health or safety. To determine this, the PCBU must ensure the proposed use is assessed by a competent person.

All reasonable steps must be taken to ensure that all health and safety features and warning devices (including guarding, operational controls, emergency stops and warning devices) are used in accordance with the instruction and information provided by that person.

More information on training, instruction and supervision is in [Section 1](#).

4.2 High-risk work licence

WHS Regulations r. 81

Licence required to carry out high-risk work

WHS Regulations r. 82

Exceptions

WHS Regulations r. 85

Evidence of licence – duty of PCBU

Schedule 3 to the WHS Regulations

High risk work licences and classes of high risk work

A PCBU must not direct or allow a worker to carry out high risk work for which a high risk work licence is required, unless the PCBU sees written evidence that they hold the relevant high risk work licence.

A high risk work licence is not required if the work is carried out during a training course to get the relevant high risk work licence and the work is supervised by a person licensed to perform that work. A high risk work licence is also not required if the person has, within the last 60 days, received a certification from a relevant VET course and applied for that licence.

Tower crane operation

A person must hold a high risk work licence to use a tower crane. For high risk work licensing purposes, a self-erecting tower crane is not a tower crane and requires a self erecting tower crane licence.

A high risk work licence for a tower crane is not required if the work is:

- solely for manufacturing, testing, trialling, installation, commissioning, maintenance, servicing, repair, alteration, demolition or disposal of the tower crane or self-erecting tower crane
- solely moving the tower crane or self-erecting tower crane within the workplace, including loading or unloading it from a vehicle or equipment used to move it.

In these situations, the tower crane must be operated or used without a load except when standard weight loads with predetermined fixing points are used for calibration of the crane.

If a person is setting up or dismantling a tower crane, they must hold an Intermediate high risk work licence.

Dogging work

A person performing dogging work is called a dogger or dogman and must have a dogging high risk work licence. Dogging work is work that requires judgement when:

- selecting an appropriate slinging method and lifting gear by considering load size and shape and determining load weight and centre of gravity
- inspecting lifting gear, like chains, slings, ropes, cables and hooks
- directing the crane operator in the movement of a load when the load is out of the operator's view by communicating with the operator using hand signals, whistles, or two-way radios.

To effectively perform or supervise dogging work, a dogger should not carry out other work or functions, such as operating the crane or being a safety observer when the crane is operating close to overhead electric lines.

If the tower crane operator is a licensed dogger, they may make judgements on the load and slinging methods, and select and inspect lifting equipment, but they should first turn off the crane controls and secure them to prevent unintended activation. A tower crane operator must not supervise a dogger, even if they are a licensed dogger, because they would be at the crane controls and therefore unable to provide supervision effectively.

The dogger should be positioned to safely observe the entire lifting operation they are responsible for. If a load is being controlled by more than one dogger, the different doggers should know what part of the lifting operation they are responsible for.

For more information on dogging work, see Safe Work Australia's [High risk work licensing for dogging information sheet](#).

Rigging Work

To conduct certain lifts a qualified rigger may be required.

There are three classes of rigging: basic rigging, intermediate rigging and advanced rigging. These classes are hierarchical. All riggers may undertake dogging tasks and tasks in the lower classes of rigging. For further information, refer to the WHS General Regulations Schedule 3, parts 4–7.

4.3 Crane crew

When determining the number of persons in each crane crew, the following risks should be considered:

- collision of the tower crane or load with people, other cranes and plant, or structures (including neighbouring property and temporary structures such as scaffolding)
- loads obstructing walkways, roads, and work areas
- proximity of overhead electric lines
- ability of the operator and crane crew to maintain visibility of the load
- the safety of the dogger while slinging and unslinging the load.

Additional control measures may be required during the lift process because of:

- the positioning of the proposed crane crew
- the size or complexity of the site or structure
- the proximity of collision hazards
- the lift process or procedure.

Examples of additional control measures may include:

- redesign of the proposed lift or use of different crane
- isolation of area during the lift
- anti-collision devices and systems
- cameras fitted to the crane, crane hook or structure
- use of additional crew, including a safety observer or a dogger
- flagging and insulated covers on overhead electric lines.

4.4 Communication

WHS Regulations r. 48

Remote or isolated work

A worker using a tower crane is often isolated from assistance, including rescue, medical assistance, or attendance by emergency service officers. Find information on emergency planning in [Section 3](#).

A PCBU must manage the risks to both the physical and psychological health and safety of a remote or isolated worker. If the risks cannot be eliminated, they must be minimised by providing a safe system of work. This includes providing effective communication with the isolated worker.

The type of communication system will depend on the site-specific conditions, such as the size of the workplace, noise and weather conditions. Expert advice and local knowledge may be needed to assist with the selection of an effective communication system.

A PCBU must ensure workers are provided information, training, or instruction on how to use the communication systems provided.

The use of two-way radios is common practice in the tower crane industry. Persons using radio equipment should be familiar with the manufacturer's operating instructions. A dedicated radio frequency should be selected for the duration of the crane operations to prevent interference to or from other radio equipment being used in the vicinity of the crane. Only one person, such as a dogger, should communicate with the crane operator at any one time. When more than one dogger is involved in a lift, each dogger should understand when responsibility for their part of the lifting operation should be handed over to another dogger.

All persons using radios should be aware of the risk of interference and signals from other radio equipment. Work should stop immediately if there is a loss of radio communication.

The safe use of two-way radio communication usually involves:

- the crane operator and dogger performing an operating safety check to ensure the radios are dry, handled with care and performing satisfactorily, and that a fully charged battery and spare are available
- ensuring operators are familiar with the specific procedures for using radio communication for that workplace
- adopting a constant talk method between radio users so that all involved persons are always aware of the progress of the lifting operations.

Workers should also have other forms of communication available to use alongside radios or for when radios are not available. This includes hand signals, whistles, or bell and buzzer signals. For more information, see AS 2550.1: *Cranes, hoists and winches: Safe use – General requirements*.

Mobile phones should not be used to direct tower crane operations.

Further information can be found in [*Managing the work environment and facilities: Code of practice*](#).

For information on managing the psychosocial risks see [*Psychosocial hazards in the workplace: Code of practice*](#).

4.5 Pre-start and operational checks

A pre-start visual inspection and operational test of the crane should be carried out by the crane operator at the start of each work shift. These checks should include all relevant items indicated in the manufacturer's operations manual.

A pre-start check should include a visual inspection of the condition and setup of:

- the crane, including structure, crane access, and logbooks
- counterweights, wire ropes, rope winch drums, anchorages, splices and lifting hooks
- power systems, including power supply, electrical cabinet and main isolation switch
- fluid systems, including fuel, coolant, oils, hydraulics, lubrication and any spillages
- brake mechanisms and any emergency load lowering equipment
- load radius indicator, load chart, rated capacity and manufacturer's data plate
- warning lights and devices and firefighting equipment.

An operational check involves:

- starting the crane as required by the workplace procedures and the manufacturer
- testing and where practical inspecting all limits, governors, controls, gauges, mechanisms, warning devices, indicators, switches, fixtures, brakes, locks, and pins
- checking rated capacity and radii measurements are on the load moment indicator.

The person with management or control of a tower crane must keep a record all tests and inspections while it is used or until they relinquish control of it. More information on record keeping is in [Section 5](#).

All PPE should be inspected to ensure it is functioning correctly. All safety-related problems should be recorded and rectified prior to crane use.

Inspect lifting gear

A person with management or control of lifting gear must ensure the maintenance, inspection, and if necessary, testing of lifting gear is carried out:

- in accordance with the manufacturer's recommendations, if any
- if there are no manufacturer's recommendations, in accordance with the recommendations of a competent person, or
- in relation to inspection, if it is not reasonably practicable to comply with the above, annually.

Lifting gear should be checked before and after each use and inspected regularly by a competent person, typically a dogger, to determine whether it is suitable to remain in use. It should be stored appropriately and not left on the crane hook overnight. Checks should ensure:

- the lifting gear is tagged and all relevant information listed, for example the date of the last inspection, relevant information for a chain sling includes grade of chain, rated capacity, manufacturer, chain size and relevant Australian Standard marking
- lifting hooks are provided with operable safety latches shackles are prevented from unscrewing, for example mousing or similar
- lifting eyes and inserts are compatible
- lifting slings are not damaged, for example excessive wear, damaged strands, cracks, deformation, or severe corrosion, and
- the sling is suitable for loads being lifted, including adequate capacity and protection from sharp edges.

The severity of use should also be considered, particularly for materials that are easily worn or damaged. The inspection of synthetic slings should be carried out at three-monthly intervals (see AS 1353.2: *Flat synthetic-webbing slings: Care and use* and AS 4497.2: *Round slings, Synthetic fibre: Care and use* for further information).

A PCBU must ensure, so far as reasonably practicable, the provision of any information, training, instruction or supervision that is necessary to protect all persons from risks to their health and safety arising from work carried out as part of the conduct of the business or undertaking. For example:

- seek evidence of a dogger's familiarity with specific lifting gear and how to inspect it
- provide the dogger with information and instruction about inspecting the lifting gear provided by the designer or manufacturer
- provide additional training or refresher training.

Find information on the use and inspection of chains, wire ropes and synthetic slings in:

- AS 2759: *Steel wire rope – Use, operation and maintenance*
- AS 3775.2: *Chain slings: Grade T – Care and use*
- AS 4497.2: *Round slings: Synthetic fibre – Care and use*
- AS 1353.2: *Flat synthetic-webbing slings – Care and use*
- AS 4991: *Lifting devices*.

4.6 Lifting or suspending loads

WHS Regulations r. 54

Management of risk of falling objects

WHS Regulations r. 219

Plant that lifts or suspends loads

WHS Regulations r. 220

Exception – Plant not specifically designed to lift or suspend a person

There are numerous duties related to managing the risks of using tower cranes to lift or suspend a load. Some are discussed in [Section 3](#), including managing the risks relating to:

- falling objects, particularly when lifting loads near people
- collisions, particularly loads colliding with a person or thing
- crane stability, particularly overloading.

A person with management or control of a tower crane at a workplace must also ensure, so far as is reasonably practicable, that the lifting and suspending is carried out:

- with lifting attachments that are suitable for the load being lifted, and
- within the safe working limits of the plant.

The person with management or control of a tower crane at a workplace must ensure:

- loads are lifted or suspended in a way that ensures the load remains under control during the activity, and
- no load is lifted simultaneously by more than one item of plant, unless the method of lifting ensures that the load placed on each item of plant does not exceed the design capacity of that plant.

Selection of an appropriate slinging method and lifting gear is dogging work and requires a high risk work licence. More information about dogging work is in [Section 4.2](#) of this section.

The person with management or control of a tower crane at the workplace must ensure, so far as is reasonably practicable, that the plant used is specifically designed to lift or suspend the load. This includes lifting gear. If this is not reasonably practicable, it must be ensured that the plant used does not cause a greater risk to health and safety than if specifically designed plant were used.

For example, synthetic slings should only be used for round loads as sharp edges may damage or tear this type of sling.

For lifting or suspending some materials, such as plasterboard sheets, this means using a material box, so far as is reasonably practicable.

For lifting or suspending persons, this means using scaffolding or an elevating work platform, so far as is reasonably practicable, rather than a tower crane. If this is not reasonably practicable and a tower crane is used to lift or suspend a person, the person with management or control of the tower crane at the workplace must ensure a design registered work box is used in accordance with the relevant manufacturer's specifications.

Lifting multiple loads at the same time (commonly known as high/low loads) should be avoided unless additional safety controls are in place, due to the difficulty in ensuring the dogger is not underneath the suspended loads.

Slinging techniques

Only a competent person, such as a dogger or rigger should sling loads. Loads should be slung and secured to ensure the load is balanced and stable and no part can fall. The person with management or control of a tower crane at a workplace should ensure:

- slings placed around a load are not crossed or twisted
- the point of the lift is located directly above the load's centre of gravity
- tag lines or similar control devices are used to control loads while lifted or suspended
- formwork frames are tied together, secured in a lifting frame, or lifting slings wrapped around the load
- loads of pipes, joists, timber or sheeting are strapped together and lifted in a flat position to prevent individual items slipping
- loads are supported where possible with dunnage, with the load uniformly distributed over the supporting surface
- wherever basket hitches are used, the sling is positively restrained from sliding along the load
- load factors for various slinging techniques are included in calculations to ensure slings are not overloaded.

The following table provides examples of **correct** and **incorrect** use of slinging techniques. These are provided as examples only and do not replace the need for an assessment of the correct slinging techniques by a competent person.

Table 1 Correct and incorrect slinging techniques

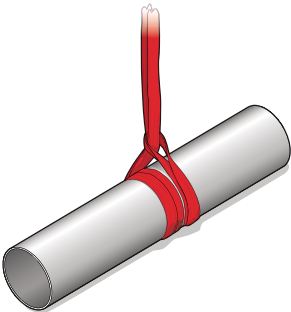

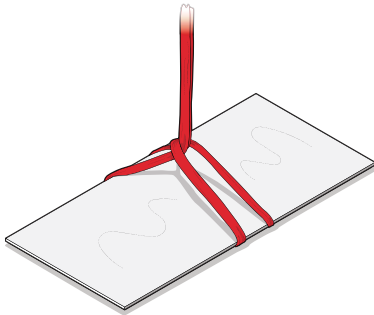

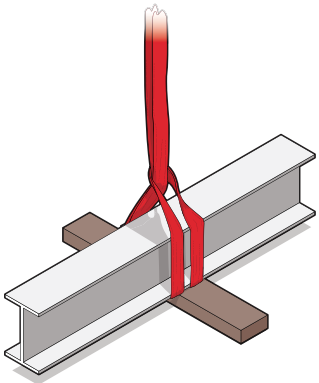







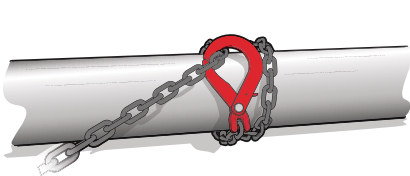



Image	Summary	Safe use	Comments
	Round webbing sling with double wrap choke around steel pipe.		Large radius so sling protection not required.
	A synthetic sling being used to lift metal sheeting.		Edges may cut this type of sling.

Image	Summary	Safe use	Comments
	A synthetic sling being used to lift an I-Beam.		Edges may cut this type of sling.
	A steel webbing sling being used to lift metal sheeting.		Edges will not damage this type of sling.
	Chain sling with double wrap choke around steel pipe.		Double wrap helps to prevent any slippage.
	Chain sling with single wrap choke around steel pipe.		Likely to slip.
	Chain sling with double wrap choke around steel pipe.		Chain bearing against latch.
	Sling hook inserted into pipe.		Likely to slip.

Material boxes

A material box is a carrying device designed to be suspended from a crane to lift materials. The material box must be suitable for the material being lifted. Material boxes should:

- be designed and certified by an engineer
- have the tare mass and working load limit (WLL) clearly marked. A distinct identification number on the box that can be cross referenced to the design drawing or certificate for the box will assist to verify this.
- have four chains, one in each corner, attached during lifting
- have enclosed sides or robust mesh, with openings less than the minimum size of materials being lifted
- have loads secured against movement
- not have materials stacked higher than the side of the material box unless they are adequately secured, but at no time should the material box become top heavy.

For loads such as plasterboard sheets, if a material box is not used then the lifting system should:

- be certified by an engineer or a person who holds an intermediate or advanced rigging licence
- specify the minimum and maximum load, for example the minimum and maximum number of plasterboard sheets
- specify the number and locations of lifting slings
- specify the capacity of lifting slings.

Work boxes

A work box is a personnel carrying device designed to be suspended from a crane to provide a working area for a person elevated by and working from the device (Figure 8). Work boxes include first aid boxes. First aid boxes should be clearly identified as first aid boxes and only used for the retrieval of injured persons.

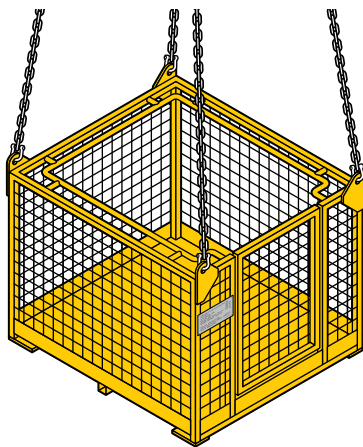


Figure 8 Work box with data plate

Work boxes should only be used to perform minor work for a short amount of time in an elevated work area. They do not provide a level of safety equivalent to properly erected scaffolding, elevating work platforms, or other specifically designed access systems. But they can provide a higher level of safety than using a fall arrest system as the primary control measure. Refer to the section below for further information on operational wind conditions.

If a tower crane is used to lift or suspend a person, the person with management or control of a tower crane at a workplace must ensure:

- the person is lifted or suspended in a work box that is securely attached to the crane
- the person remains substantially within the work box while it is lifted or suspended
- if there is a risk falling from a height, a safety harness is provided and worn by the person to prevent, so far as is reasonably practicable, injury if they fall, and
- there are procedures in place so workers can safely exit the work box if there is a failure in the crane's normal operation.

It should also be ensured that the safety harness is attached to fall-arrest anchorage points in the work box or to the main sling ring above the person's head.

The person with management or control of a tower crane at a workplace must ensure a work box is design registered. Information about design registration is in [Section 3](#).

Work boxes should:

- have the working load limit, tare mass and design registration number clearly marked, for example on a data plate
- have sides not less than 1 metre high
- have fall-arrest anchorage points
- be correctly tagged
- have lifting slings supplied with the box and attached to the lifting points by hammerlocks or moused shackles
- have a safety factor for each suspension sling of at least eight for chains and 10 for wire rope
- where provided, a door is to be inward opening only and self-closing with a latch to prevent unintentional opening
- be fitted with a handrail that runs around the inside of the box perimeter. This handrail helps to prevent injury to an occupant's hands in the event of the box contacting other obstructions.

First aid boxes (Figure 9) may be provided with outward opening doors for ease of access, but doors are to be self-closing with automatic latches.

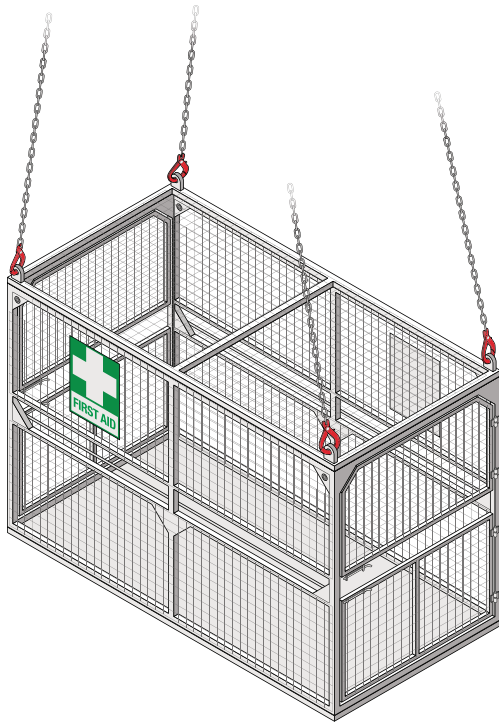


Figure 9 First aid box

When using a tower crane to lift or suspend a work box, the crane should:

- where practicable, be equipped with a secondary back-up system that will prevent the load from falling if the primary lifting device fails
- have a minimum rated capacity of at least twice the total load of the work box and its contents, at the maximum radius for the task to be performed and not less than 1000 kg
- be fitted with an upper hoist limit, anti-two block, that stops operation of the hoist, luff and telescope functions of the crane or be designed so two-blocking cannot damage part of the crane or lifting gear
- have levers and foot pedals fitted with a constant pressure system so crane motion stops immediately after the operator removes pressure from the controls.

If the crane is fitted with a free fall facility, this function should be positively locked out to prevent inadvertent activation when lifting a work box.

Where a crane has a brake acting directly on the drum, the braking efficiency of the hoisting drive train should be tested by hoisting and holding a load:

- equivalent to the line pull of the hoist winch
- not less than twice the maximum hoisted load.

If the crane will be used to lift other loads this test should be repeated before re-lifting the work box.

During operation of the crane with a work box, the line pull of the hoist winch should not exceed that used in the test.

Further information on the design and safe use of crane-lifted work boxes can be found in:

- AS 1418.17: *Cranes (including hoists and winches) – Design and construction of workboxes*
- AS 2550.1: *Cranes, hoists and winches: Safe use – General requirements*
- AS/NZS 1891 series – *Industrial fall arrest systems and devices*.

Overloading when lifting or suspending loads

Before lifting a load, the crane operator or dogger should:

- check the hoist rope hangs vertically above the load
- verify if the marked load mass is correct and not in excess of the crane's rated capacity
- verify the correct counterweight is correctly mounted and the outrigger settings, where applicable, are in accordance with the load chart being used, and
- control crane movement to stop excessive load swing that may overload the crane.

The crane operator should perform additional checks after the load has been lifted a few centimetres, including:

- ensure the dogger confirms the load remains slung securely, balanced and stable
- test the hoist brakes
- check the mass recorded on the load indicator
- recheck the load chart.

Operational wind conditions

The manufacturer's recommendations on the maximum operational wind speed for the crane should be checked. Generally, this maximum is for operating the tower crane only and ignores the load. This means that the safe maximum operating wind may be less than designer or manufacturer recommends.

When lifting or suspending loads in windy conditions, particularly loads with large surface areas, a competent person should carry out a risk assessment to determine:

- the types of loads that can be lifted under these conditions
- the control measures that need to be applied.

The principal contractor, crane owner, crane operator, and crane crew should be consulted in considering:

- load surface area
- size to weight ratio (density) (e.g. a timber wall form will be more easily affected by the wind than a concrete panel of the same frontal area)
- boom length and surface area of the boom, including any attachments
- the ability of the crane's slew motors and brakes to operate safely in high winds
- the ability of doggers to control load movement, particularly when it is being slung or unloaded
- the ability of the crane operator to see the load, particularly when the load is being slung or unloaded
- the effect of wind on crane movement (e.g. slewing against wind or luffing down against wind), which may present a risk of rope bunching on the drum and the boom dropping on rope luffing tower cranes.

Windy conditions increase the risk of crane collapse during climbing operations. Generally, this means the safe maximum wind speed for climbing operations is less than other crane operations. The manufacturer recommendations should be checked and a competent person should carry out a risk assessment to determine if climbing operations are safe to proceed and what control measures should be applied.

4.7 Remote operation

Many tower cranes may be remotely operated by either hard-wired pendant controls or wireless controls. While this feature can sometimes be an advantage, as it allows the operator to walk around the site, it has also led to incidents where the crane has collided with powerlines or other obstacles because the operator was not located in the best position to view the crane's load. For this reason, remote controls should generally not be used if the crane is fitted with a cabin, unless equivalent visibility has been provided such as by suitably located cameras.

The reliability of the circuits on the controls should be the same as that achieved by controls in a cabin. Wireless remotes should be uniquely coded to avoid corruption of signals and interference from other devices.

Remotely operated tower cranes including self-erecting tower cranes should have a dedicated operator who is available to operate the crane. A number of competent people should be available to safely complete the lifts especially where there are multiple drop-off points that are out of sight of the operator. Directing a crane operator to move a load that is out of the operator's view is dogging or rigging work. This requires a high risk work licence.

The tower crane operator should remain stationary when the load is in motion. If the tower crane operator has to move to a different location, the crane should not be operated while moving and the travel path should be free from obstacles, penetrations and other hazards.

If the tower crane operator is undertaking other tasks, the remote control should be turned off and secured to prevent unintended activation of remote functions or other people using the crane, and effective communications should be maintained between the crane operator and other personnel.

If the tower crane operator is a licensed dogger, they cannot perform dogging work while operating the tower crane. More information on dogging work is at the start of this section.

4.8 Cranes not in use

WHS Regulations r. 207

Plant not in use

A person with management or control of plant at a workplace must ensure, so far as is reasonably practicable, that when a tower crane is not in use that it is left in a state that does not create a risk to the health or safety of any person.

An unattended tower crane may collide with other things, become unstable, or be used by a person not competent to operate it. Except in an emergency due to fire or other life threatening reasons, the crane operator should never leave the crane cabin or controls without adequately securing it.

If a tower crane is to be left unattended, the person with management or control of the tower crane at the workplace should ensure:

- the manufacturer's instructions are followed or, if not available, those of a competent person
- loads are removed from the hook or lifting device
- the hook or lifting device has been secured or raised to a position where it is clear of people, plant, and other things, and will remain clear as the crane moves during weather-vaning
- the power supply and controls are isolated and locked off, including remote control equipment
- the keys removed or the starting device locked out
- adequate systems are in place to prevent unauthorised access to the tower crane or provide warning of unauthorised access, for example, 2,400 mm high boarding with anti-climb screen mesh around the base of the tower crane, a lockable hatch to restrict access to the crane cabin, and fitting of movement detectors, security camera or intruder (back to base) alerts.

If there is no risk of a tower crane boom contacting other structures or things, the crane should be left to weathervane when unattended, according to the manufacturer's instructions or, if not available, those of a competent person.

If weather-vaning is not possible, the crane's jib should be tethered in accordance with manufacturer's instructions or those of a competent person.

A warning light visible for up to 60 m should be used that confirms the crane has been placed in weathervane mode. An additional warning light should be used to verify that the jib has been stowed at the angle or radius recommended by the manufacturer's instructions or as recommended by a competent person such as the commissioning engineer.

5 Inspecting and maintaining a tower crane

WHS Regulations r. 204

Control of risks arising from installation or commissioning

WHS Regulations r. 213

Maintenance and inspection of plant

WHS Regulations r. 237

Records of plant

A person with management or control of a tower crane at a workplace must ensure that the processes for the installation, construction, commissioning, decommissioning, and dismantling of a tower crane includes inspections that ensure, so far as is reasonably practicable, that risks associated with these activities are monitored.

The person with management or control of a tower crane at a workplace must ensure the maintenance, inspection, and if necessary, testing of the tower crane is carried out by a competent person. This must be carried out:

- in accordance with the manufacturer's recommendations, if any
- if there are no manufacturer's recommendations, in accordance with the recommendations of a competent person, or
- in relation to inspection, if it is not reasonably practicable to comply with the above, annually.

Earlier sections discussed specific inspections and testing that should be undertaken:

- pre-erection inspection and testing in [Section 3](#)
- commissioning inspection and testing in [Section 3](#)
- pre-start and operational checks in [Section 4](#).

Tower crane inspection and maintenance should also include:

- routine inspection and maintenance
- annual inspection
- major inspection.

5.1 Record keeping

A person with management or control of a tower crane at a workplace must keep a record of all tests, inspections, maintenance, commissioning, decommissioning, dismantling, and alterations of the tower crane. This applies while it is being used or until control of it is relinquished.

Tower crane records include maintenance logbooks of the significant events concerning the safety and operation of the crane must be kept and readily available. Records should be kept in a suitable format and must be transferred with ownership of the crane. Entries in the maintenance logbook should:

- clearly describe the work carried out and parts replaced
- be dated
- note the name of the person carrying out the work
- be signed by the person carrying out the work.

The checks, adjustments, replacement of parts, repairs, inspections performed and irregularities or damage concerning the crane's safe use must be recorded.

Inspection records should include a statement from a competent person confirming the item of plant has been inspected and whether it is safe to operate until the next scheduled inspection. This should include a reference to the date or other indicator for that future inspection.

Inspection records should include:

- What was looked at, component specification or areas of the plant inspected.
- What was looked for, signs of wear, damage, cracking or corrosion.
- What criteria were used, rejection criteria.
- How was it looked for, and techniques used.
- What was found, test results, photographs or measurements.
- What was recommended, repairs required before continued use.
- What recommendations were actioned, recommendations acted upon and date tasks were completed.

5.2 Routine inspection and maintenance

Cranes should be routinely inspected and maintained even if they are not operated regularly, because their condition can deteriorate over time, including from corrosion or damage.

Limiting and indicating devices, such as slew limiters anti-collision limiters and hook travel limiters, should be tested and calibrated as necessary. Heat, dust, ultraviolet light, and other weather factors may impact their correct operation. Additionally, these devices may not always work as expected. This can potentially impact the safe operation of the crane.

Routine inspection can take place weekly, monthly, or quarterly and should include an inspection of:

- crane functions and the controls for speed, smoothness of operation and limits of motion
- emergency and safety switches and interlocks including limiting and indicating devices
- lubrication of moving parts
- verify accuracy of any load moment indicator (LMI) and rated capacity indicator (RCI) devices with a test lift using a certified test weight
- ensure the effective functioning and calibration of all limiting and indicating devices
- filters and fluid levels and leaks
- visual inspection and measurements as necessary of structural components and critical parts including brakes, gears, fasteners, pins, shafts, wire ropes, sheaves, locking devices and electrical contactors
- signage including warning signs and control markings
- extra items nominated in the crane manufacturer's instructions.

If replacement parts are needed as a result of the inspection, these parts should meet the original part's specification.

If a tower crane has been damaged and there are risks to health and safety, it should be immediately taken out of service and people prevented from using it. If, however, there is a need for the crane to be operated during maintenance or cleaning and this need cannot be eliminated, risk control measures must be taken to allow the crane to be operated in such a way that any risks to any person carrying out maintenance and cleaning are eliminated so far as is reasonably practicable or, if not, minimised so far as is reasonably practicable.

Annual inspection

An annual inspection may be less comprehensive than a major inspection. It should include every item specified by the crane manufacturer for annual inspection and every item included in the routine inspection and maintenance programs.

Annual inspections should include a detailed check of:

- functioning and calibration of limiting and indicating devices
- structural and wear components
- tolerances for wear limit
- evidence of corrosion
- critical areas for evidence of cracking
- relevant items in the pre-erection inspection and tests that can be safely completed while the crane is erected.

Where a tower crane owner is aware a crane will be erected when the scheduled annual inspection falls due, the owner should carry out an annual inspection during the pre erection inspection. If the tower crane is installed at a site for more than 12 months, annual inspections must be conducted on or before the due date.

As part of annual inspections, the manufacturer or supplier's safety alerts and product advisory bulletins applicable to the crane should be addressed. Additional inspection or maintenance requirements are considered part of the manufacturer's maintenance requirements.

5.3 Major inspection

WHS Regulations r. 235

Major inspection of registered mobile cranes and tower cranes

A person with management or control of a registered tower crane at a workplace must ensure that a major inspection of the tower crane is carried out:

- at the end of the design life recommended by the crane manufacturer
- if there are no manufacturer's recommendations, in accordance with the recommendations of a competent person, or
- if neither of these are not reasonably practicable, every 10 years from the date the crane was first commissioned or registered, whichever occurred first.

The person with management or control of a tower crane at a workplace must ensure that a major inspection is carried out by, or under the supervision of, a competent person.

Under the WHS Regulations, a competent person means a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task. For major inspection of tower cranes, a competent person must be eligible for professional engineer membership of Engineers Australia. The regulator can also determine a person to be a competent person, if the regulator considers that exceptional circumstances exist.

As part of major inspections, the manufacturer or supplier's safety alerts or product advisory bulletins applicable to the crane should be addressed. Any such additional inspection or maintenance requirements form part of the manufacturer's maintenance requirements.

Items requiring inspection

A major inspection means an examination of all critical components of the crane, if necessary by stripping down the crane and removing paint, grease and corrosion to allow a thorough examination of each critical component, and a check of the effective and safe operation of the crane. The competent person carrying out or supervising a major inspection should determine what is examined and how.

Where there is documented evidence that inspection and testing has been carried out on certain items, for example slew ring bolts, drive systems and braking systems, within a reasonable preceding period as determined by a competent person, the item may not have to be stripped down in the major inspection. The competent person should still inspect the safe operation of the item to certify it is operating safely and document the reasons for the decision.

Suggested inspection methods are listed below. Some of the items may not apply, for example where the item does not exist on the crane.

Slew ring

- Remove the slew ring bolts and split the slew ring.
- Measure the wear in the slew ring.
- Replace worn bearings and spacers.
- Carry out non-destructive testing and repair of bearing race.
- Measure the backlash and teeth width in the pinion drives and ring drive to ensure they are within the manufacturer's specifications.
- If the manufacturer specifies that slew ring bolts can be reused, the bolts are crack tested by non-destructive testing, or replace all bolts with new bolts.

Hydraulic motors

- Remove, strip down and inspect all hydraulic motors.
- Replace all worn valves and other components where measurement identifies wear has exceeded the manufacturer's fail criteria.
- Ensure tolerances comply with manufacturer's specifications prior to reassembly.
- Ensure motors are pressure and performance tested prior to re-entering service.

Hydraulic pumps

- Remove, strip down and inspect all hydraulic pumps.
- Replace all worn valves and other components where measurement identifies wear has exceeded the manufacturer's fail criteria.
- Ensure tolerances comply with manufacturer's specifications prior to reassembly.
- Ensure pumps are pressure and performance tested prior to re-entering service.

Valve blocks (bodies)

- Remove, strip down and inspect all valve blocks.
- Replace all worn valves and other components.
- Ensure tolerances comply with crane manufacturer's specifications prior to reassembly.
- Ensure valves are pressure and performance tested prior to re-entering service.

Hoist and luff drums

- Remove luff drums and replace drive shaft bearings as required.
- Inspect grooves on the luff drum.
- Inspect the drive pinions for wear and correct allowable backlash.
- Replace drive pinions if the tolerances are outside of the manufacturer's specifications.
- Inspect rope anchor points to ensure they are correct for rope dimensions.

Braking systems

- Remove and dismantle all brakes from the crane.
- Check pins, springs and bushes for correct tolerance.
- Replace rubber seals.
- Check pistons for correct operation.
- Ensure welds in braking systems are crack tested by non-destructive testing.
- Inspect hydraulic systems for leaks prior to reassembly on the crane.
- Inspect wear limits on brake linings.

Rope sheaves

- Remove all rope sheaves and replace bearings as necessary.
- Check sheave groove size and replace the sheave if it is outside of the manufacturer's specifications.
- Inspect sheaves for cracking, alignment and damage.
- Replace synthetic sheaves if recommended to do so by the sheave manufacturer.

Hydraulic luffing cylinder

- Remove cylinder and ram from the crane and strip the cylinder and valve blocks.
- Ensure gland nuts are crack tested and threads are checked for wear.
- Replace seals and re-chrome ram where necessary.
- Ensure the reassembled cylinder is pressure tested and checked for operation and leaks.
- Ensure welds on rod ends and caps are crack tested by non-destructive testing.

Gear boxes and drive shafts

- Remove and dismantle gear boxes, drive shafts and flexible couplings to the extent that a thorough inspection is possible.
- Replace worn and damaged bearings and gears.

Boom

- Ensure all non-destructive testing on boom components required in the pre-erection tests is carried out.
- Ensure ultrasonic chord thickness of boom is performed.
- Ensure a minimum of 10% of lacing welds on each boom section are crack tested by non-destructive testing. If any cracks are found, ensure all lacing welds on the boom section are tested.

A-frame

- Remove all pins.
- Ensure non-destructive testing is carried out on all connector welds on primary chords.
- Ensure a minimum of 10% of lacing welds are crack tested by non-destructive testing.

Pins with moving parts (e.g. boom heel pins, ram pins)

- Remove and inspect all pins with moving parts.
- Measure the diameter of the pin and bush to ensure it is within the manufacturer's tolerance. If not, the pin must be re-machined or replaced and the bush replaced.
- Inspect restraint systems (i.e. cheek plates) and grease nipples.

Static pins

- Remove and inspect all static pins.
- Repair pins if necessary.

Steel wire ropes

- Inspect all ropes for wear, including hoist, luff, pendant, trolley and counterweight ropes.
- Ensure ropes are only replaced with the type of rope specified by the crane manufacturer unless a competent person specifies otherwise.
- Inspect pins and terminations on pendant ropes.

Electrical systems

- Ensure a qualified and licensed electrician inspects switchboards, wiring, motors and other electrical components in accordance with AS 3000: *Electrical installations and other relevant standards*.
- Replace damaged or worn components.
- Ensure sign-off is provided by the electrician.

Control systems

- Ensure electrical control systems and components are inspected by a competent person.
- Replace damaged or worn components.
- Ensure sign-off is provided by the competent person.

Electric motors

- Remove and dismantle electric motors from the crane.
- Inspect brushes, bearings, switches and motor wiring for damage and wear.
- Inspect splines and shaft keyways for wear and cracks.
- Ensure sign-off is provided by the competent person.

Hook trolley (non-luffing cranes)

- Inspect hook trolley wheels for damage and wear.
- Replace hook trolley wheels if necessary.
- Ensure welds on the trolley are crack tested by non-destructive testing.

Hook assembly

- Dismantle and dimensionally inspect the hook assembly to ensure it is within the manufacturer's specifications.
- Ensure the hook is crack tested by non-destructive testing.

Actions following a major inspection

The competent person who carried out or supervised the major inspection should provide a written report with the results of the major inspection to the person with management or control of the tower crane. This includes making recommendations of what needs to be done to ensure the tower crane can be safely operated, for example, upgrading the crane to comply with relevant technical standards. The competent person should state the period by which the next major inspection is due for the tower crane.

Completion of a major inspection does not indicate that the components inspected will have a further 10-year life. It should not be assumed that the items included in the list only require inspection at 10-yearly intervals. Items will require some type of inspection and maintenance at more frequent intervals, for example, at annual and other inspection intervals, according to the manufacturer's instructions.

5.4 Non-destructive testing of tower crane components

Non-destructive testing (NDT) is the testing of materials to detect internal, surface and concealed defects, cracks, breaks or gaps using methods that do not damage or destroy the material being tested.

A person with management or control of a tower crane at a workplace must ensure any necessary testing is carried out by a competent person. This includes ensuring the person performing NDT has suitable knowledge and experience in NDT methods and is able to determine the appropriate NDT method for the component being tested.

When using magnetic particle NDT to detect cracks in metals, remove the paint from the metal surface. This is not required for Eddy current NDT.

NDT of specific tower crane components should take place according to the manufacturer's instructions and at set intervals, for example, pre-erection tests and major inspection. [Table 2](#) recommends minimum frequencies for some common NDT of particular crane components.

Table 2 Minimum frequency of NDT of particular crane components

Component tested	NDT description	NDT frequency
Boom clevises	Crack test	Pre-erection
Counterweight sheave bracket welds – moving counterweights only	Crack test	Pre-erection
Cruciform welds – luffing cranes only	Crack test	Pre-erection
Butt heel bosses – luffing cranes only	Crack test	Pre-erection
Band brake welds	Crack test	Pre-erection
Slew ring bolts – where slew ring must be split at disassembly	Crack test	Pre-erection
Tower bolts (where applicable)	Crack test minimum 10% bolts	Pre-erection
Boom lacing welds	Crack test minimum 10%	Pre-erection
Tower sections	Crack test minimum 10%	Pre-erection
Aluminium sheaves	Crack test	Pre-erection
Slew ring bolts – slew rings	Crack test bolts	5 years
Boom chord thickness	Material thickness testing	10 years
Slew ring	Crack test	10 years
Hydraulic luffing cylinder gland nut	Crack test	10 years
Hydraulic luffing cylinder and ram-rod ends and caps	Crack test	10 years
A-frame – connector welds on primary chords	Crack test	10 years
A-frame lacing welds	Crack test minimum 10%	10 years
Hook	Crack test	10 years
Welds on hook trolley	Crack test	10 years

Crack testing of booms and counterweight sheave bracket welds

Booms on non-self-erecting tower cranes are connected by pins passing through male and female clevises on the ends of each boom section. Every weld on male and female clevises on the ends of every boom section should undergo NDT before each crane erection for non self-erecting cranes. Magnetic particle testing is the usual method used for performing these tests.

Counterweight sheave bracket welds, butt heel bosses and welds in cruciform area on luffing crane booms are known to crack and should also be crack tested by NDT before each crane erection.

Crack testing of band brakes

Older designs of luffing tower cranes use band brakes. On some of these cranes, the steel band is welded to an end fitting that has a pin passing through it. These welds have been known to crack.

Crack testing of the weld between the band and the end fitting should be carried out by NDT before each time a luffing tower crane fitted with band brakes is erected, keeping in mind there may not be a weld on some brake bands.

Crack testing of slew ring bolts

The integrity of slew ring bolts is critical for making sure both the machine deck and boom remain attached to the tower. Once removed, slew ring bolts should be replaced unless the manufacturer's instructions state they can be reused. If bolts can be reused, they should be tested.

For tower cranes where the slew ring needs to be split each time the crane is moved, and for which the manufacturer allows the slew ring bolts to be re-used, all bolts should undergo NDT. Where each bolt has a unique identifier marking, the number of bolts to be tested can be reduced to 10 per cent of the total number of bolts. In such cases, bolts to be tested should be selected from the slew ring by a competent person, and different bolts should be tested prior to each erection until all bolts have been tested.

Crack testing of tower bolts or pins

Tower bolts or pins are a critical part of the crane and permit the effective transfer of load from the crane boom to the crane base. Tower bolts or pins can become damaged, and their effective life can be reduced if the bolts are either under or over-torqued. Some tower bolts are made from extremely high grade steel and can be more susceptible to cracking.

Unless the manufacturer's instructions state tower bolts can be reused, they should be replaced prior to each erection. If tower bolts can be reused, crack test a minimum of 10 per cent by NDT before each crane erection. If any cracks are detected, all bolts should be tested.

A system that makes sure all tower bolts or pins are tested over time is preferred. However, a random system of testing can also be used. The tested bolts should be identified by a method that does not damage the bolt.

Chord thickness testing

Steel lattice-type tower crane booms can be prone to internal and external corrosion affecting the thickness of the boom. The thickness of the chord wall can be reduced through abrasive blasting of the boom.

Main chord sections on tower crane booms should undergo thickness testing at intervals not exceeding 10 years. Ultrasonic thickness testing is one method of verifying the strength in the chords of the boom.

Review chord sections for structural adequacy when the thickness is shown by testing to be 90 per cent or less than 90 per cent of the original thickness.

Appendix 1 Glossary

Term	Description
Boom	A member, attached to the crane structure, from which the load is suspended and which may be luffed, telescoped or slewed.
Competent person	<p>A person who has acquired, through training, qualification or experience, the knowledge and skills to carry out the task. The definition of 'competent person' in the WHS Regulations prescribes specific requirements for some types of work such as diving and working with asbestos. A person who has acquired through training, qualification or experience the knowledge and skills to carry out the task.</p> <p>A competent person has a more specific meaning in the following circumstances:</p> <ul style="list-style-type: none"> • For design verification, the person must have the skills, qualifications, competence and experience to design the plant or verify the design. • For inspecting plant for registration purposes the person must have educational or vocational qualifications in an engineering discipline relevant to the plant being inspected, or knowledge of the technical standards relevant to the plant being inspected. • For inspecting a continuously blown inflatable device with a platform height less than nine metres, the person must have acquired through training, qualification or experience the knowledge and skills to inspect the device. • For major inspections of mobile cranes and, tower cranes, and annual inspections of amusement devices and passenger ropeways the person must: <ul style="list-style-type: none"> – have the skills, qualifications, competence and experience to inspect the plant, and be eligible for professional engineer membership of Engineers Australia, or – be determined by the regulator to be a competent person (WHS General Regulations r. 235(1B)). <p>A person is not a competent person to carry out a detailed inspection of an amusement device or passenger ropeway that includes an electrical installation unless the person is qualified, or is assisted by a person who is qualified, to inspect electrical instalments (WHS General Regulations r. 240(2)).</p>
Counterweight	A weight added to a crane or appliance in such a position to assist stability.
Crane	<p>An appliance intended for raising or lowering a load and moving it horizontally including the supporting structure of the crane and its foundations, but does not include any of the following:</p> <ol style="list-style-type: none"> an industrial lift truck earthmoving machinery an amusement device a tractor an industrial robot a conveyor building maintenance equipment a suspended scaffold a lift.

Term	Description
Design verifier	A competent person who has acquired through training, qualification or experience the knowledge and skills to design or verify the design of the plant and is eligible for professional engineer membership of Engineers Australia.
Dogging work	The application of slinging techniques, including the selection and inspection of lifting gear, to safely sling a load; or the directing of a plant operator in the movement of a load when the load is out of the operator's view.
Duty holder	Any person who owes a work health and safety duty under the WHS Act including a person conducting a business or undertaking, a designer, manufacturer, importer, supplier, installer of products or plant used at work (upstream duty holder), officer or a worker.
De-energised	In relation to a part of an electrical installation means separated from each supply of electricity to the part in such a way that the part cannot be inadvertently energised.
Hammerhead	A slewing non-luffing horizontal jib.
Health	Includes physical and psychological health.
Health and safety committee	A consultative body established under the WHS Act. The committee's functions include facilitating cooperation between workers and the person conducting a business or undertaking to ensure workers' health and safety at work, and assisting to develop work health and safety standards, rules and procedures for the workplace.
Health and safety representative	A worker who has been elected by their work group under the WHS Act to represent them on health and safety matters.
Jib	A member, attached to the crane structure, from which the load is suspended and which is not capable of being luffed while the crane is handling a load.
Load chart	A notice fitted on a crane specifying the rated capacities as supplied by the manufacturer.
Load moment system indicator	A system which indicates visually or audibly, or both, to the operator when the rated capacity is approached and reached.
Luffing	Angular movement of a crane boom or jib, in a vertical plane.
May	'May' indicates an optional course of action.
Must	'Must' indicates a legal requirement exists that must be complied with.
Officer	An officer under the WHS Act includes: <ul style="list-style-type: none"> • an officer under section 9 of the Corporations Act 2001 (Cth) • an officer of a public authority within the meaning of section 4A of the WHS Act. A partner in a partnership or an elected member of a local authority is not an officer while acting in that capacity

Term	Description
Person conducting a business or undertaking (PCBU)	<p>A PCBU is an umbrella concept which intends to capture all types of working arrangements or relationships.</p> <p>A PCBU includes a:</p> <ul style="list-style-type: none"> • company • unincorporated body or association • sole trader or self-employed person. <p>A reference in the WHS Regulations to a PCBU includes the mine operator of a mine where relevant.</p> <p>Individuals who are in a partnership that is conducting a business will individually and collectively be a PCBU.</p> <p>A volunteer association (defined under the WHS Act, see below) or elected members of a local authority will not be a PCBU.</p>
Person with management or control of plant at a workplace	A person conducting a business or undertaking to the extent that the business or undertaking involves the management or control of fixtures, fittings or plant, in whole or in part, at a workplace.
Rated capacity	The maximum gross load which may be applied to the crane or lifting attachment while in a particular working configuration and under a particular condition of use.
Regulator	Means the WorkSafe Commissioner or delegate
Rigging work	<p>Means:</p> <p>(a) the use of mechanical load shifting equipment and associated gear to move, place or secure a load using plant, equipment or members of a structure to ensure the stability of those members; or</p> <p>(b) the setting up or dismantling of cranes or hoists.</p>
Self-erecting tower crane	A crane that is not disassembled into a tower element and a boom or jib element in the normal course of use, and where erecting and dismantling processes are an inherent part of the crane's function.
Should	'Should' indicates a recommended course of action.
Tower	Part of a structure which provides elevation and support for the boom, jib mounting or platform.
Tower crane	<p>A crane that has a boom or a jib mounted on a tower structure.</p> <p>For high risk work licensing purposes, a tower crane, if a jib crane, may be a horizontal or luffing jib type and the tower structure may be demountable or permanent, but 'tower crane' does not include a self erecting tower crane</p>
Tower section	A standardised interchangeable structural component used to support a crane.
WHS Act	<i>Work Health and Safety Act 2020</i>

Term	Description
WHS services	<p>Services that relate to work health and safety. Exclusions from the definition include:</p> <ul style="list-style-type: none"> (i) services provided under the WHS Act by a WHS authority, a health and safety representative (or deputy) or a health and safety committee (ii) services provided under a corresponding WHS law by a person or body corresponding to a WHS authority, a health and safety representative (or deputy) or a health and safety committee (iii) emergency services provided by police officers, or other emergency services personnel, in situations where there is a serious risk to the health or safety of any individual (iv) services that are subject to legal professional privilege or that would be subject to legal professional privilege but for that privilege having been waived.
WHS service provider	<p>A person who conducts a business or undertaking that provides WHS services:</p> <ul style="list-style-type: none"> (i) to a person who conducts another business or undertaking (ii) that are to be used, or could reasonably be expected to be used, at, or in relation to, a workplace at which work is carried out for the other business or undertaking.
Work box	A personnel carrying device, designed to be suspended from a crane, to provide a working area for a person elevated by and working from the device.
Work group	A group of workers established to facilitate the representation of workers by one or more health and safety representatives. A work group may be all workers at a workplace but it may also be appropriate to split a workplace into multiple work groups where workers share similar work conditions or are exposed to similar risks and hazards. For example, all workers on night shift.
Work positioning system	Any plant or structure, other than a temporary work platform, that enables a person to be positioned and safely supported at a location for the duration of the relevant work being carried out.
Worker	Any person who carries out work for a person conducting a business or undertaking, including work as an employee, contractor or subcontractor (or their employee), self-employed person, outworker, apprentice or trainee, work experience student, employee of a labour hire company placed with a 'host employer' or a volunteer.
Working load limit (WLL)	See 'rated capacity'.
Workplace	Any place where work is carried out for a business or undertaking and includes any place where a worker goes, or is likely to be, while at work. This may include offices, factories, shops, construction sites, vehicles, ships, aircraft or other mobile structures on land or water.

Appendix 2 References and other information sources

Australian/New Zealand Standards

- AS 1353.2–1997: *Flat synthetic-webbing slings – Care and use*
- AS 1418.1–2021: *Cranes, hoists and winches – General requirements*
- AS 1418.4–2004: *Cranes, hoists and winches Part 4: Tower cranes*
- AS 1418.17–1996 (R2016): *Cranes (including hoists and winches) – Design and construction of workboxes*
- AS/NZS 1891.2–2001: *Industrial fall-arrest systems and devices – Horizontal lifeline and rail systems*
- AS 1891.4–2009: *Industrial fall-arrest systems and devices – Selection, use and maintenance*
- AS 2550.1–2011: *Cranes, hoists and winches: Safe use – General requirements*
- AS 2550.4–2004: *Cranes, hoists and winches: Safe use, Part 4: Tower cranes*
- AS 2550.20–2005: *Cranes, hoists and winches: Safe use – Self-erecting tower cranes*
- AS 2759–2004: *Steel wire rope – Use, operation and maintenance*
- AS 3775.2–2014: *Chain slings: Grade T and V– Care and use*
- AS/NZS 4024 (Series): *Safety of machinery*
- AS 4497.2–1997: *Round slings: Synthetic fibre – Care and use*
- AS 4991–2004: *Lifting devices*
- AS/NZS 62061–2019: *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

Other information sources

Work Health and Safety Commission

Codes of practice:

- [*How to manage work health and safety risks*](#)
- [*Work health and safety consultation, cooperation and coordination*](#)
- [*Managing the risks of plant in the workplace*](#)
- [*Construction work*](#)
- [*Psychosocial hazards in the workplace*](#)

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