

Australian Capital Territory

Work Health and Safety (Tower Crane Code of Practice) Approval 2022

Notifiable instrument NI2022–432

made under the

***Work Health and Safety Act 2011*, section 274 (Approved Codes of Practice)**

1 Name of instrument

This instrument is the *Work Health and Safety (Tower Crane Code of Practice) Approval 2022*.

2 Commencement

This instrument commences on the 14th day after its notification day.

3 Code of Practice Approval

Under section 274 of the *Work Health and Safety Act 2011* (the Act) and being satisfied that this code of practice was developed by a process described in s274 (2) of the Act, I approve the attached Tower Crane Code of Practice.

Mick Gentleman
Minister for Industrial Relations and Workplace Safety
5/9/2022



ACT
Government

Tower Crane

Code of Practice

August 2022

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Foreword

This Tower Crane Code of Practice 2022 is an approved code of practice under section 274 of the [Work Health and Safety Act 2011](#) (the WHS Act).

An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the WHS Act and the [Work Health and Safety Regulation 2011](#) (the WHS Regulation).

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, adhering to an approved code of practice would achieve compliance with the health and safety duties in the WHS Act in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks which may arise. 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 the WHS Regulation. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

Compliance with the WHS Act and the WHS Regulation may be achieved by following another method, such as a technical or an industry standard, 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 provides practical guidance to persons conducting a business or undertaking on how to comply with their health and safety duties when carrying out work with tower cranes.

How to use this code of practice

In providing guidance, 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.

This code also includes various references to provisions of the WHS Act and the WHS Regulations which set out the legal requirements. These references are not exhaustive. The words 'must', 'requires' or 'mandatory' indicate that a legal requirement exists and must be complied with.

1. Introduction

1.1 What is a tower crane?

A **crane** is an item of plant intended for raising or lowering a load and moving it horizontally and includes the supporting structure of the crane and its foundations. The three general types of crane typically referred to as 'tower cranes' used in Australia are:

- luffing
- hammerhead (including topless)
- self-erecting.

Under the WHS Regulation:

- tower crane means a crane that has a boom or jib mounted on a tower structure. 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.
- self-erecting tower crane means 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.

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

A **person conducting a business or undertaking** (PCBU) has the primary duty to ensure, so far as is reasonably practicable, that workers and other persons are not exposed to health and safety risks arising from the business or undertaking.

The duty of the person is to eliminate or minimise (so far as is reasonably practicable) health and safety risks, and ensure the:

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

The WHS Regulation includes specific duties for a person conducting a business or undertaking with management or control of plant, and plant that lifts or suspends loads.

If you own a crane you are the person with management or control of that plant. If you hire or lease a crane, you have management or control of that plant for the period you have hired it. Both you and the person you have hired or leased it from will have duties to eliminate or minimise the risks associated with the plant, so far as is reasonably practicable. For example, duties include ensuring that construction or commissioning of the crane is completed by a competent person and ensuring that maintenance, inspection and testing of the crane is carried out by a competent person.

Designers, manufacturers, suppliers and importers of plant must ensure, so far as is reasonably practicable, the plant they design, manufacture, import or supply is without risks to health and safety. This duty includes carrying out analysis, testing or an examination and providing specific information about the plant. Information must, so far as is reasonably practicable, be passed on from the designer through to the manufacturer and supplier to the end user.

Suppliers must provide a purchaser of a crane which requires plant design registration with the design registration number.

Officers, such as company directors, have a duty to exercise due diligence to ensure that the business or undertaking complies with the WHS Act and the WHS Regulation. This includes taking reasonable

steps to ensure that the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks from plant.

Workers and other people at the workplace must take reasonable care for their own health and safety, co-operate with reasonable policies, procedures and instructions and not adversely affect other people's health and safety.

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

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

- structural failure
- collapse
- contact or collision with other plant and structures
- arcing or flashover when crane boom comes close to energised electric line
- falling objects
- falling from a height – see the [Managing the Risk of Falls at Workplaces Code of Practice 2020](#)
- noise – see the [Managing Noise and Preventing Hearing Loss at Work Code of Practice 2020](#)
- fatigue.

WHS Regulation section 35

In managing risks to health and safety, a duty holder must:

- a. eliminate risk to health and safety so far as is reasonably practicable; and
- b. if it is not reasonably practicable to eliminate risks to health and safety – minimise those risks, so far as is reasonably practicable

To properly manage these health and safety risks, duty holders must use the following steps:

1. **Identify hazards.** The following can help identify potential hazards:
 - observe the workplace to identify areas where cranes operate and how they interact with vehicles, pedestrians and fixed structures like overhead electric lines
 - ask the crane operator, crane crew, and others about any problems they encounter at the workplace.
 - review inspection, test and maintenance records (e.g. log books, and incident and injury records including near misses).
2. **Assess the risk.** People who work with or near cranes are most at risk. A risk assessment can help determine what action to take and how urgently to take action.
3. **Take action to control the risk.** If it is not reasonably practicable to completely eliminate a risk, you should minimise the risk by using one or more of the following approaches:
 - substitute the hazard for something safer (e.g. 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 pendant control)
 - isolate the hazard from people (e.g. use concrete barriers to create exclusion zone to separate crane operations from workers and powered mobile plant)
 - use engineering controls (e.g. enclosing the operator with a falling objects protective structure to minimise risk of operator being hit by a falling object).

If after implementing the above control measures a risk still remains, then consider the following approaches:

- use of administrative controls (e.g. schedule crane operations to avoid/reduce the need for pedestrians and vehicles to interact with crane in area of operation)
- use of personal protective equipment (PPE) (e.g. gloves, hard hats, high visibility vests, ear plugs/muffs and eye protection).

You need to consider all possible control measures and make a decision about which are reasonably practicable for your workplace. A combination of controls may be appropriate to minimise risks.

4. **Check your control measures.** Control measures need to be regularly reviewed to make sure they are effective, taking into consideration any changes, the nature and duration of work and that the system is working as planned.

Guidance on the general risk management process is available in the [How to Manage Work Health and Safety Risks Code of Practice 2020](#).

1.3.1 CONSULTING WORKERS

Consultation involves sharing of information, giving workers a reasonable opportunity to express views and taking those views into account before making decisions on health and safety matters.

Consultation with workers and their health and safety representatives is required at each step of the risk management process. By drawing on the experience, knowledge and ideas of your workers, you are more likely to identify all hazards and choose effective control measures.

You should encourage your workers to report any hazards and health and safety problems immediately so that risks can be managed before an incident occurs, and you must consult your workers when proposing any changes to the work that may affect their health and safety.

WHS Act section 47(1)

The PCBU must, so far as is reasonably practicable, consult with workers who carry out work for the business or undertaking who are, or are likely to be, directly affected by a matter relating to work health or safety.

WHS Act section 48(2)

If the workers are represented by a health and safety representative, the consultation must involve that representative

1.3.2 CONSULTING, COOPERATING AND COORDINATING ACTIVITIES WITH OTHER DUTY HOLDERS

Sometimes you may share responsibility for a health and safety matter with other business operators who are involved in the same activities or who share the same workplace. In these situations, you must exchange information to find out who is doing what and work together in a cooperative and coordinated way so that all risks are eliminated or minimised as far as reasonably practicable.

WHS Act section 46

If more than one person has a duty in relation to the same matter, each person with the duty must, so far as is reasonably practicable, consult, cooperate and coordinate activities with all other persons who have a duty in relation to the same matter.

Further guidance on consultation is available in the [Work Health and Safety Consultation, Coordination and Cooperation Code of Practice 2018](#).

1.4 Safe work method statements

A safe work method statement (SWMS) must be prepared for high-risk construction work before the work starts.

High risk construction includes work:

- involving a risk of a person falling more than 2 metres
- carried out on a telecommunication tower
- involving demolition of an element of a structure that is load-bearing or otherwise related to the physical integrity of the structure
- involving or likely to involve the disturbance of asbestos
- involving structural alterations or repairs that require temporary support to prevent collapse
- carried out in or near a confined space
- carried out in or near –
 - a shaft or trench with an excavated depth greater than 1.5 metres, or
 - a tunnel
- involving the use of explosives
- carried out on or near pressurised gas distribution mains or piping
- carried out on or near chemical, fuel or refrigerant lines
- carried out on or near energised electrical installations or services
- carried out in an area that may have a contaminated or flammable atmosphere
- involving tilt-up or precast concrete
- carried out on, in or adjacent to a road, railway, shipping lane or other traffic corridor that is in use by traffic other than pedestrians
- carried out at a workplace in which there is movement of powered mobile plant
- carried out in an area in which there are artificial extremes of temperature
- carried out in or near water or other liquid that involves a risk of drowning
- involving diving work.

The SWMS must:

- identify the type of high risk construction work being done
- specify the health and safety hazards and risks arising from the work
- describe how the risks will be controlled
- describe how the control measures will be implemented, monitored and reviewed.

A SWMS must be developed in consultation with workers and their representatives who are carrying out the high risk work.

WHS Regulation, section 299

When carrying out high risk construction work, a PCBU must ensure that a safe work method statement is prepared or has already been prepared by another person.

1.5 Information, training, instruction and supervision

All people exposed to work health and safety risks should be provided with information about:

- work health and safety legislation
- their organisation's work health and safety policy or program
- risk management processes

- control measures in place to minimise exposure to workplace hazards
- safe work procedures
- how to use and maintain equipment
- any special safety information needs.

Adequate and appropriate training is a way of managing the risks associated with hazards. Training should be appropriate to the type of work to be performed. In some cases, formal training will be required, in others, on-the-job training may be more appropriate. The special needs of workers should be taken into account in deciding on the structure, content and delivery of training. This assessment should include literacy levels, work experience and specific skills required for a job.

Section [9](#) of this code provides specific advice on the training requirements for tower crane operations.

WHS Act, section 19(3)(f)

A PCBU must ensure, so far as is 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.

WHS Regulation, section 39(2) and (3)

A PCBU must ensure that information, training and instruction provided to a worker is 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 or instruction is provided
- the control measures implemented.

The person must ensure, so far as is reasonably practicable, that the information, training and instruction is provided in a way that is readily understandable by any person to whom it is provided.

WHS Regulation, section 317(1)

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 two years previously, the worker has carried out construction work in the preceding two years.

2. Safe design of tower cranes

The safe design of tower cranes involves using the design process to eliminate or minimise risks to health and safety throughout the lifecycle of the crane. A designer of a tower crane is a PCBU involved in preparing sketches, plans or models of tower cranes to be used, or could reasonably be expected to be used at a workplace including variations to a plan or changes to the crane. Designers can also be those who make decisions, for incorporation into a design, which may affect the health or safety of people who manufacture, use or carry out activities with the crane.

Designers should identify potential hazards and design solutions as a tower crane is manufactured, transported, installed, commissioned, used, maintained, repaired, de-commissioned, dismantled, disposed of or recycled.

WHS Act, section 22

A person (the designer) who conducts a business or undertaking that designs plant or a structure that is to be used, or could reasonably be expected to be used, as, or at, a workplace must ensure, so far as is reasonably practicable, that the plant or structure is designed to be without risks to the health and safety of persons who:

- a. use the plant or structure at a workplace for the purpose for which it was designed
- b. store the plant
- c. construct the structure
- d. carry out any reasonably foreseeable activity at a workplace in relation to the manufacture, assembly or use of the plant or structure for a purpose for which it was designed, or the proper storage, decommissioning, dismantling or disposal of the plant or structure, or
- e. are at or in the vicinity of the workplace and who are exposed to the plant or structure at the workplace or whose health or safety may be affected by one of the above uses or activities.

The designer must:

- a. carry out, or arrange the carrying out of, any calculations, analysis, testing or examination that may be necessary to ensure, so far as is reasonably practicable, that the plant or structure is designed to be without risks to the health and safety of persons
- b. give adequate information to each person who is provided with the design for give adequate information to each person who is provided with the design for the purpose of giving effect to it
- c. on request, so far as is reasonably practicable, give current relevant information to a person using the plant or structure for a purpose for which it was designed or when carrying out a reasonably foreseeable activity using the plant.

2.1 Design registration of tower cranes

Tower cranes must be designed by an engineer in accordance with acceptable engineering principles and relevant technical standards, to ensure the tower crane is without risk to health and safety.

An application for a certificate of registrable plant design must be accompanied by:

- a design verification statement

- representational drawings of the crane
- the appropriate fee.

A design verification statement must be written and signed by an eligible design verifier for the design and state that the design was produced in accordance with relevant technical standards or engineering principles.

The following people are not eligible to be a design verifier:

- a person who is involved in the production of the design
- a person who was engaged by the PCBU that produced the design at the time the design was produced.

A certificate of registrable plant design stops having effect if the design is changed in a way that requires new measures to control risk. The following is an example of a change in design **causing** the certificate to stop having effect:

a certificate of registrable plant design is in force for the design of a tower crane. The tower crane's reach is increased by fitting a longer boom than that listed in the original design registration submission. This increases the stress in the boom. The certificate stops being in force because of the change.

The following is an example of a change in design **not causing** the certificate to stop having effect:

a certificate of registrable plant design is in force for the design of the tower crane. The tower crane is fitted with a shorter boom than that listed in the original design registration submission, but the boom is of the same basic construction and material type as the original boom. The certificate does not stop being in force because of the change.

WHS Regulation, section 243

The design of specified items of plant must be registered. Schedule 5, Part 1 lists the specific items of plant requiring design registration, which includes tower cranes (including self-erecting tower cranes).

WHS Regulation, section 244

An altered design of an item of plant must be registered if the alteration may affect health or safety. However, this does not apply to tower cranes if the crane is relocated for use in a different workplace and the design for the supporting structure of foundations of the crane is altered in accordance with a site-specific design prepared for the safe operation of the crane and the design is not altered in any other way.

WHS Regulation, section 245

A design of an item of plant is not required to be registered if the design is registered under a corresponding WHS law.

2.1.1 DESIGN REGISTRATION OF TOWER CRANE BASE

A tower crane base forms part of the crane. When a new base is designed for a tower crane installation, the tower crane base must be designed by an engineer, inspected by an engineer prior to pouring of concrete, then once the crush test results indicate the required strength it is then signed off by an engineer.

An engineer and/or third party must design all tower crane bases.

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.

Detailed drawings showing the crane base along with the operating configuration of the crane form part of the design registration application. These detailed drawings are verified by an engineer.

In some situations a tower crane can be located on a 'static' crane base. A static base is the term given to a base that relies on the dead weight of the base for its stability. In other words, the base is not structurally bolted to, or embedded in, the ground or another structure.

The design for a static base should be submitted when the design registration for the tower crane is originally obtained. If this is done, there is no need to require a new design registration number every time the crane is erected on a static base. However, engineering design input for the design of the support system for the static base is still required.

2.2 Crane stability

Stability is a crucial safety issue for tower cranes. Failing to maintain stability may lead to a serious incident through mechanical or structural failure, or crane collapse. A tower crane should be designed to be stable, and without risk of overturning, falling or moving unexpectedly during erecting and dismantling, and under all operating conditions.

Tower crane stability depends on:

- the stabilising moment of the crane—the crane counterweight generally provides the primary stabilising moment
- the overturning moment applied by the suspended load and wind
- the footings and foundations designed for the specific crane installation
- the design, number and location of crane ties
- wind conditions—stability will vary according to the size and shape of the suspended load and crane boom.

2.2.1 STABILISING AND OVERTURNING MOMENTS

Load charts

Load charts, also called rated capacity charts, identify what the crane is able to lift safely. The load chart is specified for the crane by the crane manufacturer. During the design registration process, the design verifier is to site and verify that the load chart is the correct one.

Load charts must be written in English, and use metric units. Lifting operations should not take place unless the load chart is fixed in the operator's cabin in a clearly visible location. The load chart must be available for the crane operator to verify that the crane is not being overloaded.

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

Counterweights

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

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

2.2.2 FOOTINGS AND FOUNDATIONS

Footings and foundations for a tower crane installation must be designed by an engineer in accordance with engineering principles or relevant technical standards. This design must consider the results of geo-technical inspections specific to the location of the crane installation.

2.2.3 CRANE TIES

Crane ties play a critical part in ensuring the stability of a tower crane as the height of the crane increases. Crane ties must be secured to the supporting structure at set intervals in accordance with the instructions specified by the crane manufacturer and the designer of the crane installation.

The design and detail of the crane ties must be verified by an engineer taking into account the structural adequacy and any potential movement or deformation of the supporting structure.

2.2.4 WIND CONDITIONS

Operational wind speeds

Strong winds will impose additional loads on a crane and may affect the crane's stability. A maximum permissible operational wind speed of 54 km/hour (15 metres/second) has been traditionally specified for tower crane operations and applies when a crane operator is at the controls and in the process of lifting a load.

A number of tower crane installations are now being designed for a maximum operational wind speed of 72 km/hour (20 metres/second) as specified in *AS 1418.4: Cranes, hoists and winches – Tower cranes*. Although the tower crane base and crane ties may have been designed for this higher operational wind speed, crane operators should not operate the crane in wind speeds they consider to be unsafe.

A crane manufacturer will generally only specify a maximum wind speed in which to operate the crane, ignoring the type of load to be lifted. In some cases, there may not be a maximum wind speed specified for the crane itself. The effect of wind gusts will also have a different effect on the crane than a constant wind. A crane operator must base the decision to make a lift on information provided by the crane manufacturer, and prior experience as a crane operator. If the operator believes a specific crane operation is hazardous, the operator should conduct a risk assessment relevant with the specific task/s. Guidance should be sought from the crane manufacturer or a competent person regarding the conditions under which a lift can take place safely.

Ensuring stability of tower cranes

Tower cranes must be operated within their engineered design capacity. To ensure the stability of a tower crane in windy conditions, the following factors should be addressed:

- crane manufacturers should state the maximum wind speed that the crane may be operated in. However, such maximum operating wind speeds as stated by the manufacturer may in particular circumstances be excessive, especially when the crane boom and loads have large surface areas.
- an anemometer (wind gauge) is to be fixed on each tower crane, in an appropriate location, 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, or
 - either the A-frame or machine deck hand-rail on non-luffing tower cranes.
- where a non-standard lift with a suspended load or large surface area is to be undertaken in windy conditions, the competent person should provide written advice on safe lifting conditions.

Climbing operations should not proceed where wind speeds exceeds 36 km/hour (10 metres/second). However, it should be noted that this is a maximum wind speed, and performing the climbing operation is up to the discretion of the rigging crew.

Operating tower cranes in wind speeds greater than 54 km/hour

If a tower crane must be operated in wind speeds greater than 54 km/hour, a documented risk assessment must be carried out to determine:

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

The risk assessment should involve a consultative process between the principal contractor, crane owner and operator, and other members of the crane crew. Matters to be considered during this consultative process include:

- 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.

Only tower cranes that have been designed to operate in wind speeds greater than 54 km/hour may be operated under these conditions.

Using a first aid box

Please refer to Section [7.5](#) for information on wind speeds when using a first aid box.

2.3 Limiting and indicating devices

Limiting and indicating devices must be fitted to tower cranes as required by either AS 1418.4: Cranes, hoists and winches – Tower cranes or other relevant technical standards. The purpose of limiting devices is to stop a specific crane motion before the crane moves out of its limits into an unsafe situation. Indicating devices are used to visually or audibly warn the crane operator that the crane may be approaching its set limits or an unsafe situation. These devices may be used individually, or together, for specific crane motions.

2.3.1 RELIABILITY OF DEVICES

Limiting and indicating devices are intended as an aid to crane operators. The devices should not be relied upon to replace the use of the crane's load chart and operating instructions under any circumstances. Sole reliance on these devices in place of good operating practices may cause an incident.

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*.

These categories of reliability level and safety integrity level are related to the concept of 'fail-safe'.

2.3.2 RATED CAPACITY LIMITERS

A rated capacity limiter prevents overloading of the crane by stopping all relevant crane functions when an overload is detected. 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 must include 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 must be provided on all tower cranes regardless of the age of the crane. The limiter should prevent:

- hoisting a load exceeding 110 per cent of the maximum rated capacity
- the radius being increased when the load exceeds 100 per cent at the particular radius.

All tower cranes are to be fitted with load indicators and rated capacity limiters.

2.3.3 MOTION LIMITING DEVICES

Motion limiting devices are used to prevent physical damage to the crane or part of the crane due to movement of the crane or part of the crane past its designed range of motion.

Motion limiting devices must be fitted to tower cranes to prevent motion out of their service limits. These devices cause braking, including deceleration where appropriate and stopping, when the following extreme permissible positions have been reached:

- the highest position of the hook
- the lowest position of the hook when persons are lowered in a workbox 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.

2.3.4 WORKING RADIUS INDICATOR

A radius indicator must be fitted on all tower cranes. 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 one metre graduations marked on the jib with numbers written at intervals that are not excessive (e.g. every five metres).

2.3.5 DUAL BRAKING SYSTEMS

Dual braking systems must be used in accordance with the requirements of either *AS 1418.1: Cranes, hoists and winches – General requirements* or other relevant technical design standards. Dual braking systems must be provided on the luff function of all rope luffing tower cranes, and any other function specified by the crane manufacturer.

2.4 Signs on tower cranes

Signs can be placed on cranes only if it is incorporated in the Base Design. Where signs are not incorporated in the base design all signs must be installed, including wind loading and positioning as advised and certified by an engineer stating that the signs and attachments are 'fit for purpose'. The engineer is any person qualified to certify a base design for tower cranes.

It is recognized that signs, regardless of their size, can impact the effective day-to-day operation of a 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 also make applying the slew brake more hazardous. There is also a risk that signs that are inappropriately attached to the boom 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 without appropriate incorporation into the base design and/or engineer certification (whichever is applicable). However, signs may be used on machine (rear) decks, but these must be certified by an engineer prior to being installed. Certification from an engineer must 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 (UV) 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 must be used. When attaching solid signs you should not:

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

Signs may also be appropriate to be attached to wind sails in certain circumstances. Wind sails may be mandated by manufacturers in certain circumstances to counteract wind effects on the machine deck (i.e. in unusual circumstances such as when a short boom is fitted to a hammerhead tower crane). In these circumstances, wind sails assist with the operation of the crane. There are also reduced safety risks associated with the use of fabric wind sails, given their flexibility in windy conditions and reduced risk of injury if they detach. The design engineer for a tower crane installation must be aware of any requirement to attach wind sails to the boom in order to make any allowances for the size and weight of the sail. This information must be included and allowed for in any crane base drawing.

3. Planning and coordinating tower crane operations

Planning is the first step in ensuring that work is done safely. Planning for tower crane operations should start as early as possible in the development of any work or project to help eliminate many of the associated health and safety risks. In order for planning to be successful, it should involve consultation with all persons engaged in the work. Such persons include the principal contractor, crane owner, crane supplier, electricity entity, designer, and project manager.

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

- erecting, climbing, commissioning and dismantling a tower crane
- directly involved in the 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.

Some issues to be considered when planning for tower crane operations include:

- liaising with electrical entities regarding the safe supply of electricity and control measures for working around existing power supply
- consideration of proximity to overhead powerlines and appropriate control measures to prevent or minimise risks (refer to Section [4.1](#))
- determining crane requirements, including loading bays and site access, at the project design stage
- minimising the number of tower cranes on site to reduce the likelihood of collision between cranes and other plant
- ensuring that each tower crane can be installed at an acceptable distance away from other tower cranes and concrete placement booms.
- ensuring there is at least a two metre distance between the highest extremity of the building worksite to the bottom of a slung load, unless not reasonably practicable
- ensuring the tower crane boom remains an appropriate distance above the concrete placement boom
- ensuring that an emergency plan has been prepared for each workplace where the crane will operate (refer to Section 3.5)
- consideration of additional doggers or crane coordinators, depending on the size and complexity of the work.

Other matters to be considered during the planning stage are listed in *AS 2550.4: Cranes, hoists and winches – Safe use – Tower cranes*.

An acceptable distance between tower cranes and concrete placement booms will be when there are sufficient clearances to minimise the risk of contact between parts of the cranes, crane loads and booms. When cranes operate on adjacent sites and share the same air space, negotiations should be conducted between worksites to formulate systems of work to ensure sufficient clearances are maintained between the cranes.

This would also apply to situations where more than one crane operates on the same worksite sharing the same air space where there are multiple duty holders, consultation should be conducted between the duty holders. Refer to section 4 of this Code for further information about working near other plant for further information.

3.1 Selecting the crane

Matters to be considered in the selection of cranes are outlined in *AS 2550.4: Cranes, hoists and winches – Safe use – Tower cranes*.

There are basically three types of tower cranes operating in the Territory – luffing (see figure 1 below), hammerhead (see figure 2 below) and self-erecting tower cranes (see figure 13 on page [52](#)). Each type of tower crane has advantages and disadvantages, and the best crane type should be selected for the job to be undertaken.



Figure 1: Luffing tower crane



Figure 2: Hammerhead tower crane

Self-erecting tower cranes are discussed in more detail under [Section 8](#) *Additional requirements for self-erecting cranes*.

3.2 Crane crew

The number of persons in the crane crew should be determined by a risk assessment. The risk assessment should address the following risks:

- collision between cranes and other plant and coordination of multiple cranes
- loads contacting structures (including neighbouring property and temporary structures such as scaffolding) or obstructing walkways and other workers
- overhead powerlines
- ability of the crane crew to maintain visibility of the load, safely load and unload materials, and assess work areas before unloading deliveries.

If a risk assessment identifies that the crane crew cannot maintain visibility of the load at any point in time during the lift process due to one or more of the following risk factors, then additional control measures may be required during the lift process.

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

Examples of additional control measures may include (but are not limited to):

- re-design of the proposed lift or alternative crane
- isolation of area during the lift
- anti-collision devices and systems where installed should be utilized
- flagging and insulated covers on suspended powerlines
- use of a safety observer or 'spotter'
- use of an additional dogger

- cameras fitted to the crane, crane hook or structure.

In instances where additional control measures are required, any re-design of the lift process, use of additional personnel, or inclusion of new technology that has not already been identified at the start of the project should be undertaken in consultation between the principal contractor or persons in control of the workplace, the relevant PCBU and the crane crew.

The role of a dogger is outlined at section 7. A crane operator should not undertake their own dogging work (i.e. on a remote control tower crane) or supervise a trainee dogger, even if the operator is also a licensed dogger.

3.3 Crane siting

The siting of a tower crane may present a risk of injury to persons, including workers and members of the public in the vicinity of the crane from:

- the crane collapsing due to failure of the crane to withstand the forces likely to be imposed on it
- collision between the crane with other plant and structures at the workplace.

The siting of tower cranes should occur after careful consideration of the above factors and consultation with relevant persons engaged in the work, including the principal contractor, crane owner, crane supplier and project manager.

3.3.1 CRANE STANDING

The crane standing must 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
- 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. Adequate precautions should also be taken to ensure the stability of the crane, when it is known that the crane will be sited in the vicinity of underground services, excavations or embankments. A competent person should verify the design of the structure.

3.3.2 COLLISION BETWEEN THE CRANE WITH OTHER PLANT OR STRUCTURES

The siting of a tower crane must consider hazards such as:

- overhead powerlines
- nearby structures
- other cranes or concrete placement booms (including those on adjacent sites)
- the vicinity of aerodromes and aircraft flight paths.

For further information on control measures to minimise the risk of injury from collision, refer to section 4 of this code.

3.3.3 LOCATION OF ACCESS AREAS

When siting a tower crane, consider the location of:

common access areas for workers and other persons at the workplace
public access areas, such as footpaths, roadways and railways in the vicinity of the crane.

3.4 Communication

A reliable method of communication between a crane operator and other persons is essential for safe crane operation. Failure to implement a reliable method of communication between the crane operator and other persons will lead to unsafe crane operations, and may contribute to injury to persons from:

- a. dropped loads
- b. collision with other plant and structures.

Only one dogger should give visual and audible signals at any 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.

The use of radio communication 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. 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 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 aware of the progress of the lifting operations at all times
- ensuring the crane operator normally takes radio instructions from one person only, unless special circumstances exist that require specific arrangements to be in place for the use of more than two radios.
- the following recommendations are made for safe crane operations –
 - Digital radios have the problem of delayed signal transmission on site which is a major risk in crane operation, hence this type of radio is not recommended for the industry. Analogue radio is the suitable type of radio to be used for the least delay in directing crane movement.
 - The Trunked radio system is not recommended for the crane industry. When multiple cranes working on the same site, they do not need to communicate with each other or to a central control station, their locations do not change during the lifting task, the radio communication system recommended is point-to - point analogue radios with area wide license as this type of radio has the least delay in directing crane movement.

Where radio communication is not or cannot be used, other forms of communication, such as hand, whistle, bell and buzzer signals, which comply with *AS 2550.1: Cranes, hoists and winches – Safe use – General requirements* should be used.

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

3.5 Emergency plan

An emergency plan must be tested in the workplace and include emergency procedures such as effective responses and evacuation, notifying emergency services and medical treatment. Emergency procedure training must be provided to effected workers. Contact numbers for emergency services

should be easily seen or found. Workers should know what systems are in place to contact emergency services and how to use it.

Equipment should be available and easily accessible so an injured worker including the crane operator can be removed quickly. Relevant fire-fighting equipment such as fire extinguishers and if applicable fire blankets should also be in place and operational. Signs displaying evacuation locations should be placed where they are easily seen by workers and others at the workplace.

Plans should also include how these procedures will apply to people who are near the crane as well as those people who are operating the crane (e.g. procedures for evacuating the workplace).

WHS Regulation, section 43

A PCBU at a workplace must ensure that an emergency plan is prepared for the workplace that provides for emergency procedures, testing of the emergency procedures and information, training and instruction to relevant workers.

3.6 Lighting

It is important that crane operators have adequate lighting when climbing and accessing tower cranes. If tower cranes are to be accessed outside of daylight hours, appropriate artificial light sources should be used or provided. This could include the use of personal lighting on crane crew such as headlamps or 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.

WHS Regulation, section 40:

Duty in relation to general workplace facilities

A person conducting a business or undertaking at a workplace must ensure, so far as is reasonably practicable, the following:

the layout of the workplace allows, and the workplace is maintained so as to allow for persons to enter and exit and to move about without risk to health and safety, both under normal working conditions and in an emergency;

- a. work areas have space for work to be carried out without risk to health and safety;
- b. floors and other surfaces are designed, installed and maintained to allow work to be carried out without risk to health and safety;
- c. lighting enables;
- d. each worker to carry out work without risk to health and safety;
 - i. persons to move within the workplace without risk to health and safety;
 - ii. safe evacuation in an emergency;
 - iii. ventilation enables workers to carry out work without risk to health and safety;
- e. workers carrying out work in extremes of heat or cold are able to carry out work without risk to health and safety;

- f. work in relation to or near essential services does not give rise to a risk to the health and safety of persons at the workplace.

4. Minimising risk of injury from collision

Failure to maintain sufficient clearance between tower cranes and other plant and structures may result in a risk of injury from a collision between the crane or its load with other plant or structures. This may lead to:

- damage to crane components, such as the boom, which may seriously weaken them or lead to structural collapse
- injury to persons in the vicinity of the crane, including workers and members of the public.

The risk of injury from collision is higher when the regular working zone of the tower crane is next to another structure. Mobile plant may present a greater risk of injury from collision with a tower crane than a fixed structure, as its position may change.

4.1 Working near overhead electric lines (powerlines)

4.1.1 ELECTRICAL SAFETY LAWS

Information about requirements for working near overhead powerlines is provided in the following:

- [*General guide for Working in the Vicinity of Overhead and Underground Electric Lines*](#)— (Safe Work Australia) - provides practical advice on safe systems of work and exclusion zones.
- [*Electricity Safety Act 1971*](#)
- [*Utilities Act 2000*](#)
- [*Utilities \(Technical Regulation\) Act 2014*](#)

WHS Regulation, section 166:

Duty of person conducting a business or undertaking

1. A person conducting a business or undertaking 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.
2. If it is not reasonably practicable to ensure the safe distance of a person, plant or thing from an overhead or underground electric line, the person conducting the business or undertaking at the workplace must ensure that—
 - a. a risk assessment is conducted in relation to the proposed work; and
 - b. control measures implemented are consistent with—
 - i. the risk assessment; and
 - ii. if an electricity supply authority is responsible for the electric line—any requirements for the authority under the [*Electricity Safety Act 1971*](#), the [*Utilities Act 2000*](#) and the [*Utilities \(Technical Regulation\) Act 2014*](#).

4.1.2 PLANNING FOR WORK NEAR OVERHEAD POWERLINES

Contact with overhead powerlines can pose a risk of electric shock or electrocution when operating a tower crane. It can be difficult for crane operators to see powerlines and to judge distances from them.

Before setting up a tower crane near overhead powerlines, the PCBU should conduct an inspection to identify the presence of overhead powerlines that may pose a risk. Consultation regarding the risks of the work should occur with all relevant parties involved in the work. Once the risks associated with overhead powerlines have been identified and assessed, appropriate control measures must be put in place.

The most effective way to eliminate any risk of electric shock is by turning off the power. The person conducting a business or undertaking (PCBU), principal contractor (PC) or the crane owner should discuss options for de-energising or re-routing the electricity supply with the relevant electricity entity. These options are the most effective control measures and should be considered before anything else. The PCBU, PC and crane owner should also consult with each other to ensure the electricity entity has been contacted.

De-energising or re-routing powerlines should be arranged with the electricity entity as quickly as possible as this can take some time to arrange. Where overhead powerlines have been de-energised, confirmation should be sought from the person in control of the powerline before undertaking any work.

If it is not reasonably practicable to turn off the power or re-route the powerline, the most effective control measure to reduce the risk is to establish “exclusion zones” that prevent people, plant, equipment and materials from coming close enough to energised overhead powerlines for direct contact or flash-over to occur.

This could be achieved in a number of ways, such as:

- setting up the crane in a position that keeps it outside the exclusion zone (see Section [4.14.1](#) for more information on exclusion zones)
- erecting a physical barrier, made of non-conductive materials, to prevent any part of the crane or person entering an unsafe distance. This may require isolating the electricity supply while the barrier is installed
- engineering controls such as mechanical stops or constraints to prevent the crane entering the exclusion zone.
- lower order administrative controls should only be considered when other higher order control measures are not reasonably practicable, or to increase protection from a hazard. Administrative controls include:
 - warning signs to indicate the location of overhead powerlines
 - tiger tails or line markers on overhead powerlines to act as a visual aid to highlight the location of the powerline. (Note: tiger tails do not insulate wires)
 - warning devices to warn the crane operator before the boom enters the exclusion zone.

4.1.3 EXCLUSION ZONES FOR OPERATING A TOWER CRANE NEAR OVERHEAD POWERLINES

A PCBU must ensure, so far as is reasonably practicable, that any person, part of the crane or the crane’s load does not enter into the exclusion zone.

PCBUs should ensure that workers and the tower crane (and the load) stay at least 3 metres away from overhead powerlines, for voltages up to 132kV, with greater distances applying for voltages above that. These distances apply to any part of the crane including the load it is lifting.

A number of factors must be considered when implementing a system to maintain the exclusion zone, these include:

- identifying the minimum clearance distance from the closest part of the crane and its suspended load to the powerline, such as:
 - the maximum travel distance of the crane boom
 - the size and shape of any load to be lifted

- the possibility of “overshoot” of the load after the crane boom comes to rest
- allowing for sway or sag of the powerlines (sway is usually caused by wind, while sag may vary as the temperature of the line varies)
- using a safety observer (commonly known as a ‘spotter’) who observes the operation of the tower crane and advises the operator if it is likely the tower crane will enter into the exclusion zone.

The identified minimum clearance distance may need to be greater than the prescribed exclusion zone distance to ensure there is no breach of the exclusion zone (e.g. to take into account the load swinging once the crane stops moving).

Working at closer distances

If it is not reasonably practicable to maintain the exclusion zone (e.g. at least 3 metres away from overhead powerlines, for voltages up to 132kV), a risk assessment must be completed for the proposed work and consultation should occur with relevant parties including the electricity entity. Control measures must then be implemented consistent with:

- the risk assessment
- if the line is owned by an electricity entity, any requirements of the entity.

The electricity entity can advise of the voltage of the line and whether it is insulated or uninsulated. In addition, they can also verify the integrity of the insulation.

The electricity entity may implement control measures such as placing tiger tails or aerial marker flags on the powerline and provide advice on what needs to be done before work can be safely carried out at a closer distance. For example they may require:

- the powerlines to have visual markers fitted
- the crane operator to undertake specific training
- all work to be carried out under the control of a safety observer.

Unless all conditions are met, work cannot be carried out at closer distances.

In addition, persons operating a tower crane at a closer distance are required to be an authorised or instructed person under the [Electricity Safety Act 1971](#).

It is important to note that the electricity entity may also specify a greater distance than the smaller exclusion zones provided in the [Electricity Safety Act 1971](#), if they consider the risk warrants it.

Safety observers

A safety observer or ‘spotter’ is a person who is trained and competent to observe and advise the crane operator if the crane or any part of a load it is carrying is likely to come within an exclusion zone of an overhead powerline.

The safety observer zone concept is designed:

- to encourage plant such as tower cranes to be located away from the possibility of encroaching into the exclusion zone
- when that is not possible, adopt other suitable precautions to prevent encroachment.

A tower crane is not operating in a safety observer zone when:

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

Figure 3 below illustrates the safety observer zone concept. As the crane and its load is likely to enter the exclusion zone, the person in control could re-locate the crane to the right far enough to ensure that the crane or its load cannot enter the exclusion zone. If the crane cannot be moved, the entity may

require the powerline to be fitted with visual markers and require the crane to operate under the direction of a safety observer.

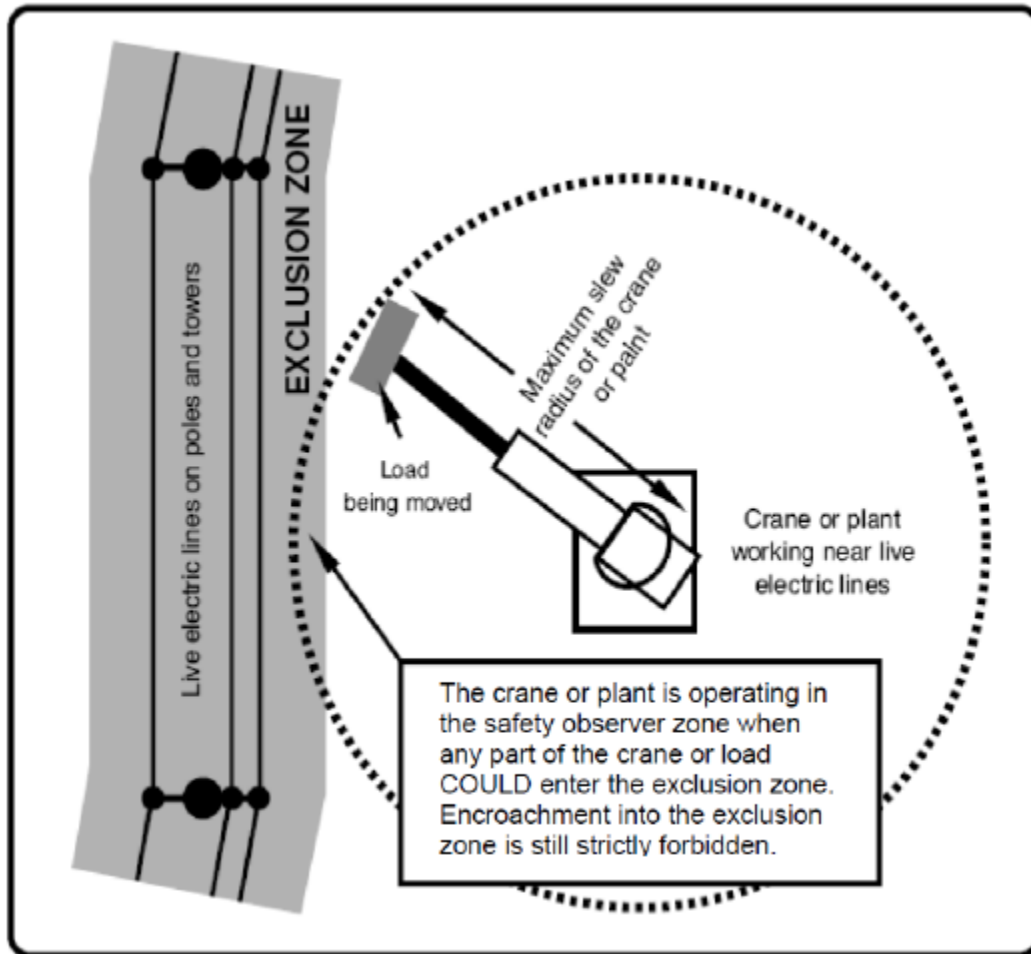


Figure 3: Safety observer zone for working near overhead powerlines

Safety observers must not carry out other tasks, such as dogging duties, at the time of observing crane operations. All workers on a worksite should be able to clearly 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.

For more information, refer to the:

[General guide for Working in the Vicinity of Overhead and Underground Electric Lines](#)– (Safe Work Australia)

[Evo Energy – Electrical Safety Rules 2016](#) – (commonly known as the Blue Book).

4.2 Working near other plant (including other cranes and concrete placement booms)

A tower crane colliding with other plant may cause injury to persons present in the vicinity of the crane from:

- dropped loads
- crane collapse
- failed crane components, such as boom sections.

A risk of injury from collision may exist where:

- a concrete placement boom is working within the tower crane's operating radius
- tower cranes located on adjacent sites are operating in the same air space.

The risk of injury from a collision between a tower crane and other plant is greater where the crane crew is not able to communicate directly with the other plant operators, or where the operators have different tasks to perform.

4.2.1 WAYS TO MINIMISE RISK OF INJURY FROM A COLLISION WITH OTHER PLANT

Where a tower crane may collide with other plant, a documented procedure, such as a SWMS, must be established early in the planning process to ensure controls are in place to minimise the risk of injury from a collision. This procedure should identify the person who is responsible for the implementation of the SWMS. All persons involved in operating tower cranes and other plant are to be aware of and trained in the procedure.

The procedure should address issues such as:

- siting cranes to minimise the need for other plant to operate within the crane's operating radius
- siting cranes and other plant with counterweights so that the counterweights cannot collide during slewing operations
- the method of communication between the crane crew and other plant operators
- scheduling of work to minimise the time the crane and other items of plant are required to work in the same area, or at the same height
- the tower crane's climbing procedure to ensure the crane remains as far above any structure or plant (e.g. jump forms) as practicable
- the frequency of regular meetings to monitor and review the effectiveness of control measures and who should attend such meetings.

All tower cranes should be fitted with an audible warning device. This will help to warn persons who may be at risk from the movement of the plant. There are a number of warning devices that can be fitted to moving plant to alert the operator and others in the workplace. More information on warning devices can be found in the [*Managing Risks of Plant in the Workplace Code of Practice 2020*](#).

Where separate tower cranes share the same air space but are sited on adjacent workplaces, the principal contractor from each workplace should negotiate and implement documented systems of work (e.g. within the construction safety plan) that includes a procedure to ensure sufficient clearances are maintained between cranes, minimising the risk of contact between parts of the cranes and crane loads. The procedure should include the name of a crane coordinator from each site that is responsible for implementation of the work system. An effective means of communication is to be provided to ensure the crane operators on the separate tower cranes can avoid collision between the cranes.

Where tower cranes are set up in flight paths (e.g. near aerodromes), the local aerodrome operator must be contacted to ensure the requirements of the Civil Aviation Safety Authority (CASA) are met (see the website at www.casa.gov.au). Where necessary, aircraft warning lights should be fitted to the highest part of the crane.

5. Erecting and dismantling tower cranes

Failure to erect or dismantle tower cranes in accordance with the crane designer's or crane manufacturer's instructions may result in injury to persons from:

- crane collapse
- falls from heights
- falling objects.

5.1 Responsibilities for persons erecting or dismantling tower cranes

The process of erecting or dismantling a tower crane must minimise the risks to health and safety.

Documented procedures such as a SWMS for the high-risk construction work of erecting or dismantling a tower crane must be prepared and consider the following:

- the crane designer's or crane manufacturer's instructions
- technical standards relevant to access and egress
- the crane's stability
- any adverse effects on 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
- the interaction of the crane with other plant
- environmental factors, such as wet or windy conditions
- all relevant electrical installations associated with the crane comply with *AS 3000: Electrical installations*.

5.2 Minimising risk of injury from crane collapse

5.2.1 ERECTING AND DISMANTLING—WAYS TO MINIMISE RISK OF INJURY FROM CRANE COLLAPSE

Tower crane components should be inspected and tested prior to being delivered to the workplace. For further information on pre-erection inspections and tests, refer to section 10.3.2 of this code.

Written instructions about erecting and dismantling activities are to be readily available on site. Tower cranes must not be erected or dismantled in conditions exceeding the crane manufacturer's specifications, or where the wind is such that components may become uncontrollable when suspended. Wind loading must be considered during all erecting and dismantling, including increased wind loads caused by funnelling effects between adjacent buildings or structures, and the wind effect on large sections.

Erecting and dismantling activities should be supervised by a competent person. Precautions must be taken to maintain the stability of the crane during erecting and dismantling in accordance with *AS 1418.4: Cranes, hoists and winches – Tower cranes* or any other relevant technical standard.

Duty holders should ensure that the crane manufacturer's instructions are followed for the assembly of components in the correct sequence, and that the correct equipment and tools are used. Crane manufacturers may require sequential installation or removal of counterjib, counterweights and boom components.

Only parts and components that meet the specifications of either the crane manufacturer or a competent person should be used when erecting a tower crane. Tower sections should be clearly and permanently identified with their model type and serial number. Tower sections of the correct model, or a model of

greater strength, must be used. The tower sections used must be the same as those specified on the engineer's crane base drawing.

When erecting a tower crane, precautions must be taken to ensure:

- only the correct type and grade of tower bolts are used when connecting tower sections
- bolts and pins used to connect tower sections are compatible with crane components, and are not defective
- tower bolts are correctly torqued to ensure normal operating conditions do not cause them to become loose or fatigued—over tightening of bolts can be as potentially dangerous as insufficient tightening
- crane ties are installed in accordance with instructions specified by the crane manufacturer and designer of the crane installation.

5.2.2 CLIMBING TOWER CRANES - WAYS TO MINIMISE RISK OF INJURY FROM CRANE COLLAPSE

The risk of serious or fatal injury from crane collapse is very high during tower crane climbing operations. The climbing frame as a whole has to cope with significant static and dynamic forces involved in climbing.

Risks from crane collapse during climbing operations can be minimised by:

- conducting climbing operations where practicable outside of normal work hours to minimise the potential for persons to be at risk
- excluding all unnecessary persons from the workplace during climbing operations
- maintaining an exclusion zone of sufficient size to contain structural failure
- prohibiting persons from entering the area directly behind the tower crane (under the counterweights) during climbing operations
- avoiding slew operations at all times during climbing operations
- conducting a physical inspection of the counterweight trolleys, including side plates, bolting and pins, safety gear, ropes and turnbuckles, prior to commencing climbing operations.

All persons involved in climbing operations must receive thorough training and instruction in the climbing procedure for the particular model and type of crane involved in the climbing sequence.

The climbing sequence must be carried out in strict accordance with the crane manufacturer's instructions. Climbing operations should not be attempted at wind speeds greater than 36 km/hour. However, this does not preclude the crane rigging crew from ceasing work at their discretion if they think safety will be compromised at a lesser wind speed. Climbing operations should not commence if either the recommended maximum wind speed or the actual wind speed is unknown.

Precautions for certain tower cranes with moving counterweights

Some tower cranes are provided with moving counterweights on rails that slope downwards away from the crane (e.g. Favco 1500 and Favco STD 1000). 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).

5.3 Minimising risk of injury from falling from a height

Persons associated with erecting and dismantling tower cranes will be exposed to the risk of falling when working at a height. These persons must be provided with an effective means of fall protection.

The PCBU must use control measures to prevent a person falling or if prevention is not practicable, to arrest a person's fall and prevent or minimise the risk of death or injury to the person. Examples of control measures to prevent a person from falling include:

- edge protection systems
- travel restraint systems
- fall-arrest harness systems.

WHS Regulation, section 291

High risk construction work includes construction work that involves a risk of a person falling more than two metres.

WHS Regulation, section 299

A PCBU that includes the carrying out of high risk construction work must, before the high risk construction work commences, ensure that a SWMS is prepared or has already been prepared by another person. A SWMS must identify the work that is high risk construction work, state hazards relating to the work and risks to health and safety, and describe measure to be implemented to control the risks and how the control measures are to be implemented, monitored and reviewed.

5.3.1 EDGE PROTECTION SYSTEMS

Edge protection provides a barrier to prevent a person falling erected along the edge of:

- a building or other structure
- an opening in a surface of a building or other structure
- a fall arresting platform, or
- the surface from which work is to be done.

Edge protection consists of a system of rails, mesh, sheeting or other material used to prevent persons from falling off a platform or other surface. Edge protection consists of components designed to withstand the forces imposed on it if a person fell against it.

Where possible, tower crane sections should be designed so that edge protection is already in place prior to the tower section being installed. However, it is generally recognised that many edge protection systems need to be installed during the actual erection phase of the tower crane. In these instances, other means of fall protection, such as workboxes and travel restraint systems, must be used.

WHS Regulation, section 78:

Management of risk of fall

- (1) A person conducting a business or undertaking at a workplace must manage, in accordance with part 3.1 (Managing risks to health and safety), risks to health and safety associated with a fall by a person from 1 level to another that is reasonably likely to cause injury to the person or any other person.
- (2) Subsection 1 includes the risk of a fall:
 - a. in or on an elevated workplace from which a person could fall; or
 - b. in the vicinity of an opening through which a person could fall; or
 - c. in the vicinity of an opening through which a person could fall; or

- d. on a surface through which a person could fall; or
- e. in any other place from which a person could fall.

(3) In this section: solid construction means an area that has:

- a. a surface that is structurally capable of supporting all persons and things that may be located or placed on it; and
- b. barriers around its perimeter and any openings to prevent a fall; and
- c. an even and readily negotiable surface and gradient; and
- b. a safe means of entry and exit.

5.3.2 TRAVEL RESTRAINT SYSTEMS

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. These systems must only be used if it is not reasonably practicable to use a fall prevention device or work positioning system or if these higher-level controls might not be fully effective in preventing a fall on their own.

Equipment used for individual fall arrest systems should be designed, manufactured, selected and used in compliance with AS/NZS 1891(set): *Industrial fall-arrest systems and devices*.

Travel restraint systems consist of a harness or belt, attached to one or more lanyards, each of which is attached to a static line or anchorage point. The system is designed to restrict the travelling range of a person wearing the harness or belt so that the person cannot get into a position where the person could fall off an edge of a surface or through a surface.

A good design practice recommends using individual horizontal lifeline systems connected within each individual boom or jib section. The use of a horizontal lifeline system that uses one rope going throughout the whole length of the boom or jib of the tower crane is permitted but should be avoided.

Travel restraint systems are preferred over those that arrest a person once the person has fallen. Static lines or anchorage points must be capable of supporting the load.

Static lines and anchorage points should comply with:

- AS 1891.2 Industrial fall-arrest systems and devices – Horizontal lifeline and rail systems and
- AS 1891.4 Industrial fall-arrest systems and devices – Selection, use and maintenance.

5.3.3 FALL-ARREST HARNESS SYSTEMS

Harness- based fall arrest systems should be installed so that the maximum distance a person would free fall before the fall arrest system takes effect is 2 metres, although a lesser free fall distance is preferable. There should be sufficient distance between the work surface and any surface below to enable the system, including the action of any shock absorber, to fully deploy.

A fall-arrest harness system is designed to arrest a person's fall and eliminate or minimise the risk of injury to the person as the fall is arrested. It consists of a fall-arrest harness that is attached to either:

- a device to absorb the energy of the falling person, attached to a lanyard that is attached to a static line or anchorage point
- a line that has a device that automatically locks the line, and absorbs the energy of the falling person, and is attached to a static line or anchorage point
- a lanyard that has a device that travels along a line or rail, automatically locks onto the line or rail, and absorbs the energy of the falling person, and is attached to a static line or anchorage point.

The use of a fall-arrest harness is not recommended as an acceptable control measure against the risk of a fall as it does not actually prevent a fall from occurring. Wherever possible and practicable, an alternative method should be selected which minimises the risk of a person falling (e.g. an edge protection system).

Should a fall-arrest harness system be used, a written procedure must describe how a person can be safely retrieved after a fall. A first aid box suitable for emergency retrieval must be readily available.

5.4 Minimising risk of injury from falling objects

WHS Regulation, section 54

A PCBU at a workplace must manage risks to health and safety associated with an object falling on a person if the falling object is reasonably likely to injure the person.

WHS Regulation, section 55

A PCBU must minimise the risk of an object falling on a person by providing adequate protection against the risk. Adequate protection includes preventing an object from falling freely, so far as is reasonably practicable, or providing a system to arrest the fall of a falling object if it is not reasonably practicable to prevent an object from falling. Examples of systems include secure barriers, providing a safe means of raising and lowering objects, and providing an exclusion zone persons are prohibited from entering.

Erecting, climbing and dismantling activities should not commence until controls are in place to prevent the risk of injury to workers and other persons from falling objects.

The following are examples of control measures that may be used to prevent or minimise the risk of being hit by falling objects during erecting, climbing and dismantling operations:

- exclusion zones
- tool lanyards
- scheduling of work
- restraining systems.

These control measures are examples only and should be implemented based on the specific items which may fall. It may be necessary to use a combination of these control measures. The requirements for selected control measures must be written into the SWMS for the work activity. All workers involved in the work activity must be made aware of these requirements.

When lifting loads, a person with management or control of a tower crane must ensure that loads are lifted in a way that ensures the load remains under control. They must also ensure that the activity is carried out with lifting attachments that are suitable for the load being lifted and within safe working limits of the crane.

5.4.1 EXCLUSION ZONES PERSONS ARE PROHIBITED FROM ENTERING

Before work starts on erecting or dismantling a tower crane, an exclusion zone must be established around the crane. The exclusion zone must be based on a risk assessment and include where practicable:

- a radius of at least 20 metres from the base of the tower crane
- a footprint relative to the size of the boom.

An exclusion zone must also be established in the area around the crane before work starts to climb a tower crane. The exclusion zone for climbing operations includes a radius of at least 12 metres where practicable from the base of the crane.

The exclusion zone for climbing operations must be in place prior to the installation of crane ties. However, as the health and safety risk associated with installing crane ties is usually lower than that associated with climbing operations, the size of the exclusion zone may be reduced where justified and evidenced by the outcome of a risk assessment.

Where practicable, the exclusion zone needs to be of sufficient size to contain any structural failure. Where public footpaths and roadways form part of the exclusion zone, permission to close off these areas must be obtained from the appropriate local authority.

Only persons immediately involved in erecting, climbing or dismantling activities may be permitted within the exclusion zone. All unauthorised persons must be excluded from the area.

These exclusion zones are distinct from the safe approach distances (exclusion zones) discussed in section [4.1](#), which apply when operating a tower crane near overhead powerlines.

5.4.2 TOOL LANYARDS

A tool lanyard is a short rope or webbing used to secure tools and equipment to an anchorage point to reduce the risk of injury from a falling object. An anchorage point may be the person using the tool, a column or beam. If the lanyard is attached to a person, the weight of the tool secured to the lanyard should not impose any additional risks to the person.

Tool lanyards allow workers to work at height while minimising the potential of dropping tools. Tools become dangerous objects if dropped from height.

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. The length of rope or webbing required to secure a tool must be considered, especially if the tool is to be used near the edge of a working platform, and other persons are working below. For example, a tool lanyard attached at the wrist should have a length no longer than 300 millimetres. This will ensure that if the tool is dropped, the lanyard would not allow the tool to hit a person working below. The length of the lanyard should also be kept to a minimum to reduce the risk of the line snagging as the worker moves about.

5.4.3 SCHEDULING OF WORK

Erecting, dismantling and climbing operations should take place at appropriate times to minimise the risk to persons, such as members of the public from falling objects. For example, consideration should be given to doing the work outside of normal working hours if the crane is next to an office building, or doing the work during normal working hours if the crane is next to a residential building.

The erection, dismantling, climbing and maintenance of cranes at a worksite should be programmed into the project's schedule of work.

5.4.4 RESTRAINING SYSTEMS FOR CRANE COMPONENTS

While erecting, dismantling and climbing activities are being carried out, control measures to restrain individual crane components (such as packers or shims) from falling should be implemented. An example of a restraint may include a short chain that is attached to both the crane component and the crane structure.

6. Commissioning Tower Cranes

WHS Regulation, section 201

A person who conducts a business or undertaking that commissions plant that is to be used, or could reasonably be expected to be used at a workplace, must ensure the plant is commissioned having regard to the information provided by the designer, manufacturer, importer or supplier of the plant, or the instructions provided by a competent person to the extent that those instructions relate to health and safety.

Failure to commission tower cranes in accordance with the crane manufacturer or supplier's specifications may lead to decreased safety and efficiency in the operation of the tower crane.

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. The person who commissions cranes should ensure that the commissioning sequence is in accordance with the design specifications and tests are carried out to check the crane will perform within design specifications.

Where directed by the regulator an independent third party **must** undertake the relevant inspections and tests prior to the commissioning of the crane. Refer to section 10.3 of this code for further information regarding independent third party inspections at the commissioning stage.

Written instructions regarding the commissioning of a tower crane should be available to all persons conducting a business or undertaking at the workplace. The commissioning of cranes must be carried out in accordance with these written instructions.

If rated capacity limiters, overload cut-outs or motion switches have been bypassed or disconnected during erection, they are to be reconnected and tested in accordance with a written procedure before the crane is put into operation.

6.1 Responsibilities of persons who commission tower cranes

A person who commissions tower cranes should ensure that:

- the crane is inspected, to determine whether it has been erected in accordance with design specifications
- commissioning methods are in accordance with specifications of the crane manufacturer or supplier
- the commissioning sequence has been developed and implemented according to risk management principles (i.e. hazards identified, risks assessed and controls implemented)
- 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)
- stresses which exceed design specifications are not imposed on the crane

- the crane owner is notified of commissioning results and provided with appropriate documentation.

The commissioner of the tower crane should provide the following information to the crane owner:

- 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.

7. Operational issues

7.1 Roles and responsibilities associated with tower crane operations

7.1.1 PERSON CONDUCTING A BUSINESS OR UNDERTAKING

WHS Act, section 19

A PCBU must ensure, so far as is reasonably practicable, the health and safety of workers engaged, or caused to be engaged by the person, and workers whose activities in carrying out work are influenced or directed by the person.

The general role and responsibilities of a person conducting a business or undertaking (PCBU) is outlined under section 1.2. The WHS Regulation also includes specific duties for PCBUs with management or control of plant, and plant that lifts or suspends loads. As a principal contractor is also a PCBU, these duties can also apply to principal contractors.

Persons who own, hire or lease tower cranes will have duties to eliminate or minimise risks associated with the crane, so far as is reasonably practicable. This includes ensuring that construction or commissioning of the crane is completed by a competent person and ensuring that maintenance, inspection and testing of the crane is carried out by a competent person.

A PCBU must also not direct a worker to carry out high risk work, such as tower crane operation, to carry out this work unless they have seen written evidence that the worker has the relevant high risk work licence.

7.1.2 THE CRANE OWNER

WHS Act, section 21

A person with management or control of plant at a workplace must ensure, so far as is reasonably practicable, that the plant is without risks to the health and safety of any person.

Prior to commissioning a tower crane, a crane owner must establish that the crane is, so far as is reasonably practicable, without risks to the health and safety of any person. They must ensure that the construction or commissioning of the crane is completed by a competent person. Crane owners may conduct a site visit and inspection to ensure that an appropriate crane is supplied for the construction work and to understand the characteristics of the job, site conditions and any hazards.

Additionally, the crane owner must take all reasonable steps to ensure that all health and safety features and warning devices of the crane are used in accordance with the relevant instructions and training.

A crane owner who employs crane operators should also ensure that operators have undergone appropriate training and obtained the relevant high risk work licence.

A crane owner must ensure that all information obtained from the manufacturer of the crane is supplied and readily available to those who need it (e.g. the crane manufacturer's operating manual should be kept on the crane, and maintenance staff should have access to all current crane maintenance manuals). The crane owner should ensure the design, load chart, maintenance records and all inspection reports of the crane are all available and signed off before deployment of the crane for use.

A crane owner must ensure that the maintenance, inspection and testing of a tower crane is carried out by a competent person. The maintenance, inspection and testing must be carried out in accordance with the manufacturer's recommendations, or if this is not reasonably practicable, the competent person's recommendations. Where the crane is stored and not used an annual inspection may not be required. However, prior to the crane being used, pre-erection and commissioning inspections should be carried out by an independent third party. Refer to Section 10.3 for further information on independent third party inspections.

The person with management or control of plant at a workplace must also ensure, so far as is reasonably practicable, that cranes that are not in use are left in a state that does not create any risks to the health and safety of other persons. This could include restricting access to ensure other persons cannot climb onto the crane. Refer to Section [7.4](#) for information on leaving a crane unattended.

7.1.3 THE CRANE OPERATOR

A tower crane operator is required to hold a high risk work licence, as specified under Schedule 3 of the WHS Regulation.

A crane operator must always exercise proper diligence and operate the crane safely. If the crane operator has reason to believe that a lift may be dangerous or unsafe, the operator must refuse to proceed until the concern has been reported, relevant risks have been managed and safe conditions have been confirmed.

Tower crane operators are required to know:

- 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
- proper inspection and maintenance procedures to be followed in accordance with the guidelines of the manufacturer and owner
- any site conditions that may affect crane operations, including the presence of overhead powerlines, nearby structures, other cranes and concrete placement booms
- basic slinging techniques.

Before and during crane operations, the crane operator must:

- check unauthorised persons are not present on the crane
- check each crane motion is safe and without risk
- complete the daily inspection checklist, including filling out the crane logbook.

7.1.4 DOGGER

A dogger is required to hold a high risk work licence for dogging work, as specified under Schedule 3 of the WHS Regulation.

The primary role of a dogger is to assist the crane operator in the safe and efficient operation of the crane. This includes the application of slinging techniques, including the selection and inspection of lifting gear, and the directing of the crane operator when a load is out of the operator's view. The use of a dogger is crucial when the crane operator's vision is obscured or when operating in high risk areas. Doggers must be positioned to safely observe the entire lifting operation that they are responsible for. However, a dogger should not be used to also perform the role of a 'spotter' when the crane is operating close to overhead powerlines.

A dogger must be in control of the load from the time it is hoisted until it is placed in position. If a load is being controlled by more than one dogger, the different doggers must know what part of the lifting operation they are responsible for.

Doggers are required to know how to:

- use the various types of ropes, slings, chains and lifting accessories
- determine the rated capacity of any rope, sling or chain to be used for lifting
- assess the weights of loads to be lifted
- safely sling loads of different weights and sizes
- direct a crane or hoist operator in the movement of a load when the load is out of the operator's view
- give appropriate directions when directing loads.

Before directing the crane operator to raise a load, the dogger must ensure:

- each lifting attachment, sling and shackle has a rated capacity, or working load limit greater than or equal to that of the load. These attachments must be suitable for safely handling the load
- the hoisting apparatus is correctly applied to the load and the crane hook
- no part of the load is loose
- the load is properly balanced
- the load is not snagged
- the load will not contact any object or constitute a hazard to any person when it is lifted.

7.2 Minimising risk of injury from lifting loads

Lifting loads may present a risk to the health and safety of persons in the vicinity of the tower crane from:

- damaged lifting gear
- crane overload
- unsecured and dropped loads (falling objects).

Some tower cranes also may be remotely operated by either hard-wired pendant controls or wireless controls. Further information on remote operation of these tower cranes, as well as self-erecting tower cranes, is provided at Section [8](#).

7.2.1 CRANE HIGH LOW LIFTS

The practice of High-Low lifts where multiple loads are slung in a vertical configuration from a crane in the one lifting operation. This practice is no longer permitted by the regulator and the crane industry must remove this practice from all lifting operations in the ACT.

Lifting operations for Tower and Mobile Cranes performing High-Low or multiple vertically loaded lifts ('Christmas tree' lifts) are deemed dangerous during lifting operations and must not be implemented to ensure consistency with legislative requirements and safety of all lifting operations in the ACT.

Australian Standards AS3775.2:2014 stipulates that dual independent loads or separately reeved loaded slings are **NOT** to be used where the loads are reeved to different heights. Refer to figure below.

The context of this rationale is that it is accepted that a single load lift cannot be eliminated or avoided (on the basis it is a necessary part of construction activity). However, a High-Low lift can be avoided (on the basis that a High-Low lift is optional rather than a necessary part of construction activity).

In summary, WorkSafe ACT considers that in order to demonstrate compliance with section 36 of the [Work Health and Safety Regulation 2011](#) a person conducting a business or undertaking PCBU) must not undertake High-Low lifts as the hierarchy of control mechanisms require the risk to be eliminated.



Figure 4: Unsafe hi-low lift



Figure 5: Unsafe multiple vertically loaded lifts (Christmas Tree Lift)

7.2.2 CONTROL MEASURES TO MAINTAIN THE INTEGRITY OF LIFTING GEAR

Guidance on the use and inspection of chains, wire ropes and synthetic slings is provided in the following publications:

- 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

- [High Risk Work Licensing for Dogging](#) Information Sheet (Safe Work Australia)

Basic items that should be checked include:

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

The manufacturer's requirements for lifting gear should be followed including using protective sleeves and corner pieces. Although the edges of a load may not appear to be sharp, a sling may become damaged when it is placed under tension.

Slings should be placed around a load so that the sling is not crossed or twisted to ensure that the load is balanced and stable. If possible, the point of the lift should be located directly above the centre of gravity of the load. This will prevent the loads from toppling or falling out during the lift.

Synthetic slings should only be used for appropriate lifts. For example, it is recommended that round (sausage) slings only be used for round loads as sharp edged loads may damage or tear this type of sling.

The following photographs provide examples of **correct** use of slinging techniques:



Figure 6: A steel webbing sling being used to lift roof sheeting – edges will not damage this type of sling



Figure 7: Chain sling with double wrap choke around steel pipe - helps to prevent any slippage



Figure 8: Round webbing sling with double wrap choke around steel pipe - large radius so sling protection not required

The following photographs provide examples of **incorrect** use of slinging techniques:



Figure 9: Unsafe use! Edges of metal sheet may cut sling



Figure 10: Unsafe use! Edges of I-Beam may cut sling



Figure 11: Chain sling with single wrap choke around steel pipe - does not prevent slippage



Figure 12: Chain sling with chain bearing against latch



Figure 13: Sling hook inserted into pipe

All lifting gear, including slings, hooks and material boxes, should be periodically inspected for damage and wear by a competent person. The period between inspections will depend on the severity of use, but should not exceed 12 months. 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). All lifting gear should be tagged to identify the date of the lifting gear's last inspection. Documented maintenance records for the lifting gear should be available on site.

7.2.3 CONTROL MEASURES TO MINIMISE RISK OF INJURY FROM CRANE OVERLOAD

A tower crane must be operated within its load chart.

Before hoisting a load, the crane operator or dogger should make sure that the hoist rope hangs vertically over the load. Care should be taken to ensure that the load does not swing once it is lifted. The crane operator should ensure the load is always under control. When handling maximum or near maximum loads, the crane operator should take the following precautions after the load has been lifted a few centimetres:

- test the hoist brakes
- check the mass recorded on the load indicator
- recheck the load chart.

Except in an emergency, the crane operator must not leave the cabin or control room while a load is suspended from the crane.

7.2.4 CONTROL MEASURES TO MINIMISE RISK OF INJURY FROM UNSECURED AND DROPPED LOADS

Extreme care must be exercised when lifting loads in the vicinity of other persons, including other workers and members of the public. All workers must be clear of the load to be lifted, especially when adjacent materials or objects can be displaced.

Where possible, handling loads over public access areas such as footpaths, roads, highways, railways, waterways and buildings must be avoided. Where this is necessary, control measures must be implemented to prevent or minimise the risk of injury from falling objects.

WHS Regulation, section 55

A PCBU must minimise the risk of an object falling on a person by providing adequate protection against the risk. Adequate protection includes preventing an object from falling freely, so far as is reasonably practicable, or providing a system to arrest the fall of a falling object if it is not reasonably practicable to prevent an object from falling. Examples of systems include secure barriers, providing a safe means of raising and lowering objects, and providing an exclusion zone persons are prohibited from entering.

WHS Regulation, section 219

The person with management or control of plant must ensure, so far as is reasonably practicable, that no loads are suspended or travel over a person unless the plant is specifically designed for that purpose. The person must also ensure that loads are lifted or suspended in a way that ensures the load remains under control during the activity.

Lifting materials

Crane-lifted loads should be slung and secured so that the load (or any part of it) cannot fall. To ensure safe lifting of loads, the following should occur:

Material boxes

- The tare mass and rated capacity should be clearly marked on all material boxes. 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.
- Material boxes should be appropriate for the material being lifted and be engineer- designed and certified.
- Four chains (one in each corner) should be attached to material boxes during lifting.
- Specifically, designed material boxes should be used to lift smaller components. Boxes should have enclosed sides or robust mesh, with openings less than the minimum size of materials being lifted.
- Material boxes should be inspected and maintained, and inspection records kept.
- Loads within material boxes should be secured against movement.
- Materials should not be 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.

General lifting

- Formwork frames should be either tied together or lifting slings should be wrapped around the load.
- Loads of joists or bearers should be strapped together before lifting.
- Timber sheeting should be strapped together and lifted in a flat position.
- Sheets of plasterboard should be lifted in a specifically designed material box. If a material box is not used, then the lifting system must:
 - o be certified by an engineer
 - o specify the minimum and maximum number of sheets
 - o specify number and locations of lifting slings
 - o specify the capacity of lifting slings.

- Tag lines should be used as required to control loads.
- All loads should be supported where possible with dunnage, with the load uniformly distributed over the supporting surface.
- Basket hitches should not be used wherever persons may be located near a lifted load, unless the sling is positively restrained from sliding along the load.
- Lifting multiple loads at the same time (commonly known as high/low loads) is *not permitted* by the regulator and the dogger is not underneath the suspended loads during rigging, slinging and attachment of loads.

Further guidance on securing loads can be found in the Safe Work Australia - General guide for cranes - Information Sheet: [High risk work licensing for vehicle loading cranes](#), and - Information Sheet: [High risk work licensing for bridge and gantry cranes](#) and [Safe access on tower cranes](#).

Failure to provide safe access for crane operators and other persons carrying out inspection and maintenance work on a tower crane will place these persons at risk of falling from a height.

7.3 Safe access on tower cranes

7.3.1 TOWER LADDERS

The type of ladder access in tower cranes is sometimes determined by available space in the tower. AS 1418.4: *Cranes, hoists and winches – Tower cranes* provides information on minimum requirements for such ladders. Landings, with changes in direction of the ladder, should be provided where there is available space in the tower. This system will minimise injury to workers, in the event of them falling off the ladder. It also allows workers to take rest breaks while climbing.

Where practicable, the vertical distance between landings should not exceed six metres. However, where the crane manufacturer has designed otherwise, the length of the lowest ladder in the tower may be up to 12.5 metres, and subsequent ladders may be up to 10 metres in accordance with AS 1418.4: *Cranes, hoists and winches – Tower cranes*.

Tower cranes with cabins—continuous vertical ladders

The use of continuous vertical ladders for accessing the total length of the tower is not recommended. However, where it is impractical to provide anything but a continuous vertical ladder, a fall-arrest system that does not require the person to constantly hook on and off must be provided. 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 millimetres. Any ladder fall-arrest system is to comply with the requirements for 'Type 1' fall-arrest devices specified in AS/NZS 1891 *Series: Industrial fall-arrest systems and devices*. Vertical ropes should be manufactured from a material that is not prone to UV degradation or corrosion (e.g. suitable grade of stainless steel).

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 the 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.

Self-erecting tower cranes without cabins

Generally, the towers on most self-erecting tower cranes do not have to be climbed by persons while in use. Instead, any maintenance required on the crane can often be carried out by collapsing the crane. However, some self-erecting tower cranes are provided with ladders on the towers for maintenance access. If a ladder is provided for maintenance activities only, the ladder can be vertical, and a permanent vertical rail or rope does not have to be provided.

However, any person climbing the ladder must be provided with a fall-arrest system. The use of work platforms, such as elevating work platforms, should be considered for performing maintenance activities.

7.3.2 INTERNAL GUARDRAIL ON TOWER LANDINGS

Internal guardrails on tower landings 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. 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.

7.3.3 GUARDRAILS ON MACHINE DECK AND A-FRAME PLATFORM

All 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 between 900 millimetres and 1100 millimetres high, a mid-rail and a toe-board at least 100 millimetres high. The guidance that should be considered for guardrail systems are contained in *AS 1418.4: Cranes, Hoists and winches – Part 4 - Tower Cranes*.

7.3.4 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.

7.3.5 CANTILEVERED AND HANGING PLATFORMS

Small access platforms may be needed on tower cranes with moving counterweights or to gain access to the slew ring. These platforms are provided to ensure access for riggers during the erection process, and for persons carrying out maintenance. Safe access is required to these platforms – workers should not be required to climb over handrails to obtain access.

Two examples of safe access to these platforms is by providing either a trapdoor in the machine deck, or a ladder cage on the platform ladder. This platform should also be provided with a top rail, mid-rail and toe-board.

7.3.6 CRANE JIB ACCESS—NON-SELF-ERECTING TYPES

Tower cranes requiring riggers and crane operators to access the jibs while erecting, inspecting and maintaining the crane should be fitted with a rigger's run and static lines that extend for the complete length of the jib. People should use the static line, and appropriate fall arrest lanyards to ensure they are attached to the crane at all times.

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

7.4 Leaving the crane unattended

WHS Regulation, section 207

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

Failure to take adequate safety precautions to secure an unattended tower crane may encourage unauthorised use of the crane by persons who are not competent to operate it.

A tower crane should not be left unattended unless the following actions have been taken:

- all loads are removed from the hook
- the hook has been raised to a position where it is safely clear of other operation
- all powered motions have been disabled
- the keys have been removed from the crane
- there are adequate systems in place to prevent unauthorised access to the tower crane base.

Where there is no risk of the tower crane boom contacting other structures, the crane should be left to weathervane when unattended in accordance with the crane manufacturer's instructions. For tower cranes with a luffing boom, the crane manufacturer's instructions should specify the correct boom angle.

Where it is necessary to restrict the movement of the boom of a tower crane, the method of tethering (i.e. securing the boom to prevent slewing) is to comply with instructions provided by the crane manufacturer. The strength of the tethering system, including its anchorages, is to be checked and certified by an engineer.

7.5 Work boxes and first aid boxes

7.5.1 FEATURES AND USE OF 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.

Crane-lifted workboxes may be used by workers to gain access to elevated work areas that are otherwise difficult to reach to perform minor work of short duration. Generally, crane-lifted workboxes do not provide a level of safety equivalent to properly erected scaffolding, elevating work platforms and other specifically designed access systems. A crane-lifted workbox can, however, provide a higher level of safety than fall-arrest harness systems.

Before workboxes are selected as a means of access, a risk assessment should be undertaken and recorded demonstrating that the use of other means of access, such as scaffolding or elevating work platforms, is impractical.

Crane-lifted workboxes should meet the following criteria:

- The work box is to be design registered.
- Correctly tagged lifting slings must be supplied with the work box and attached to lifting points by means of hammerlocks or moused shackles.
- The factor of safety for each suspension sling must be at least eight for chains and ten for wire rope.
- Have fall-arrest anchorage points.
- The rated capacity, tare mass and design registration number of the workbox must be clearly marked (e.g. on a data plate).
- If the workbox is provided with a door, this should be inward opening only, self-closing and provided with a latch to prevent accidental opening.
- The sides of the work box must be at least one metre high.
- A handrail should be provided that runs around the inside of the box perimeter. This handrail helps to prevent injury to occupants' hands in the event of the box contacting other obstructions.
- All persons in the work box must wear full body fall-arrest harnesses at all times. Harnesses must be attached to fall-arrest anchorage points in the work box or to the main sling ring above the workers' heads. Energy absorbers must be provided on the lanyards (see *AS/NZS 1891 Series: Industrial fall-arrest systems and devices* for further information).
- At least one person in the work box must hold a dogger's licence class or equivalent to ensure correct directions are communicated to and from the crane operator.

Further guidance on the design and safe use of work boxes and cranes is provided in:

- AS 1418.17: Cranes (including hoists and winches) – Design and construction of workboxes and

- AS 2550.1: Cranes, hoists and winches – Safe use – General requirements.

7.5.2 FEATURES AND USE OF FIRST AID BOXES

First aid boxes are a type of crane-lifted work box and must only be used for the retrieval of injured persons.

A crane-lifted first aid box may be required in emergency response and retrieval situations. First aid boxes should be readily accessible on the site to ensure that an effective emergency response can be initiated if they are required.

Crane-lifted first aid boxes should meet the following criteria:

- The first aid box is to be design registered.
- First aid boxes should be clearly identified and marked as first aid boxes.
- Boxes are to be provided with sides and a roof except that a horizontal gap may be provided around all sides of the box. First aid boxes must be designed in accordance with AS 1418.7 – (1996)
- A grab rail is to be provided along the sides of the box and to be recessed to minimise the risk of crush injuries.
- If the first aid box is provided with a door this may be provided with outward opening doors, but the door is to be lockable to help prevent inadvertent opening.
- Persons in the first aid box are not required to use fall arrest harnesses as the first aid box is enclosed.
- Correctly tagged lifting slings must be supplied with the first aid box and attached to lifting points by means of hammerlocks or moused shackles.
- The factor of safety for each suspension sling must be at least eight for chains and ten for wire rope.
- The rated capacity, tare mass and design registration number of the first aid box must be marked on the first aid box.
- At least one person in the first aid box must hold a dogger's licence class or equivalent to ensure correct directions are communicated to and from the crane operator.
- When using first aid boxes, emergency retrieval arrangements should be put in place before the lift so that workers can safely exit the work box in the event of crane failure.

An example of a compliant first aid box under this section can be seen below:



Figure 14- Compliant first aid box

Strong winds may affect the safe use of first aid boxes in emergency situations. It is recommended that first aid boxes not be used when wind speeds exceed 54km/hr or in adverse weather conditions such as electrical storms. The use of first aid boxes is more suitable in locations which are less susceptible to windy conditions, such as the side of a building structure which is not as exposed to high winds. First aid boxes should be lifted away from structures to avoid collision.

When wind speeds exceed 54km/hr, alternative emergency retrieval means should be used such as hoists.

7.5.3 FEATURES OF A CRANE WHEN USING WORK BOXES AND FIRST AID BOXES

When using a crane-lifted work box or a first aid box, the crane must meet the following criteria:

- Where reasonably practicable, be equipped with a secondary back-up system that will prevent the load from falling if the primary lifting device fails.
- The crane must have a minimum rated capacity of at least twice the total load of the workbox and its contents, at the maximum radius for the task to be performed and not less than 1000 kilograms.
- The crane must be fitted with an upper hoist limit that stops operation of the hoist and luff functions of the crane.
- The crane's levers and foot pedals must be fitted with a constant pressure system that stops the crane's motions when the operator removes pressure from the controls.
- The crane must not be capable of free fall.

8. Additional requirements for self-erecting tower cranes

The use of self-erecting tower cranes (see [Figure 15](#)) is increasing, particularly on small to mid-sized building sites. As the name suggests, self-erecting tower cranes can be erected on site without using a mobile crane. Self-erecting tower cranes are generally made up of a horizontal boom that folds out during erection, and can include a telescopic boom. The counterweight is provided at the base of the crane.



Figure 15- Self-erecting tower crane

Unlike most other 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 must be designed in accordance with engineering principles or relevant technical standards. The design must consider the results of geo-technical inspections specific to the location of the crane installation.

On both hammerhead and luffing tower cranes, the operator's cabin is typically located at an elevated position, close to the butt of the boom. However, self-erecting tower cranes are rarely provided with a cabin and instead are operated by remote control. 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.

8.1 Operation of self-erecting tower cranes

Self-erecting tower cranes should be operated from a designated area. At all times during the lifting operations, the crane operator should:

- remain in close proximity to the crane
- maintain good visibility of the load.

Where it is not possible for the operator to keep the load in sight, a dogger should report to the operator on the position of the load to ensure safe operation. A crane operator should not undertake their own dogging work (i.e. on a remote control tower crane) or supervise a trainee dogger, even if the operator is also a licensed dogger.

8.1.1 REMOTE OPERATION

Self-erecting tower cranes and some tower cranes may be remotely operated by either:

- hard-wired or pendant controls
- wireless controls.

The reliability of the circuits on the controls should be the same as that achieved by controls in a cabin. Wireless remotes must 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 doggers should be available to safely complete the lifts especially where there are multiple drop-off and pick-up points that are out of sight of the operator. The crane operator should follow the direction of the dogger at all times. This is particularly important when the load is out of sight of the crane operator.

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

Crane operators should not undertake their own dogging work. If the crane operator needs to undertake 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.

When the self-erecting tower crane is not in use, appropriate control measures must be in place to prevent unauthorised operation of the crane.

8.1.2 ERECTION OF BARRICADE AROUND SELF-ERECTING TOWER CRANES

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

An 1800 millimetre high barricade (e.g. mesh fence), should be erected around the base of self-erecting tower cranes to prevent people from entering this area, and being hit by the crane's counterweights. The barricade should be positioned to provide enough room to avoid entrapment between the barricade and the counterweights.

9. Training and supervision

9.1 Responsibilities for training and supervision

The duties for providing information, instruction and training are outlined in section [1](#) of this code.

Information, instruction and training for tower crane operations should cover at least:

- SWMS to be used in setting up and for safe operation of tower crane activities
- the method for inspection and maintenance of tower cranes
- knowledge of the crane manufacturer's operation and service manuals
- the correct use, care and storage of PPE
- the correct use, care and storage of tools and equipment to be used
- observance of electrical safety practice
- procedures to be adopted in the event of accident or injury.

Supervision must:

ensure only those workers who have received instruction and training are authorised to carry out that work

include sufficient monitoring of all work to ensure that agreed safe work practices are being adhered to, including the use of all safety procedures and systems and PPE.

9.2 Familiarisation training

Tower cranes can be fundamentally different in their design, mode of operation, control layout and configuration. This is particularly the case when comparing tower cranes across the three basic categories—luffing, hammerhead and self-erecting tower cranes.

Before a person is allowed to work as a crane operator, the PCBU of the person should either:

- assess the person's knowledge and understanding of safe crane operation
- seek further evidence of competence
- provide additional training, prior to allowing the person to work.

Familiarisation training provides crane operators with an opportunity to become familiar with the design, layout and operating functions of a specific tower crane. It should be provided to crane operators prior to commencing work for a new PCBU or prior to working with a crane that has been newly acquired by their PCBU. This process may require the presence of a representative from the tower crane supplier or manufacturer, particularly when the crane is new. The representative from the tower crane supplier or manufacturer should have detailed knowledge of the operational and safety features of the crane in question. The representative from the tower crane supplier or manufacturer should also be endorsed by the crane supplier or manufacturer as being competent to provide familiarisation training.

A record of familiarisation training must be made and kept by the PCBU of the crane operator. A copy of the training record is also to be given to and kept by the crane operator. Both the crane operator and the PCBU, or a representative of the PCBU, must sign the record.

The record of familiarisation training should take the format of a checklist. Crane operators must demonstrate that they understand how to safely operate the crane based on this checklist. Refer to [Appendix 3: Familiarisation training checklists](#).

PCBUs must ensure that persons who work as part of a crane crew (e.g. crane operators, doggers and riggers) receive refresher training. Refresher training may be provided by:

- the PCBU

- an independent consultant
- a third party (e.g. registered training organisation).

Refresher training should be made available to these persons on an ongoing basis. The purpose of refresher training is to ensure that crane operators, doggers and riggers maintain the competencies originally achieved in the relevant licence class for performing high risk work. It is particularly relevant for persons who have not continuously performed work in a class of high risk work.

- Refresher training should reflect issues such as:
- the application of new technology, particularly for those persons who obtained their license class while working on more basic cranes
- information in this code
- any relevant changes to work health and safety legislation and Australian Standards which may have an impact on safe crane operations
- safe crane operation.

Refresher training may include:

- conducting a training needs analysis to identify the particular training needs of individual workers
- providing theoretical information, where required
- providing practical demonstration and supervision.

9.2.1 FREQUENCY OF REFRESHER TRAINING

The interval between refresher training courses should not exceed three years. Crane operators, doggers and riggers must undergo refresher training between two and a half and three years after either being issued with their initial licence for a class of high risk work, or since attending their most recent refresher training, whichever is the shorter time frame.

9.2.2 RECORD OF REFRESHER TRAINING

Crane operators, doggers and riggers must keep a documented record of refresher training they have undertaken. This record must be kept in a logbook.

The record should consist of the following information:

- the person's name, address and signature
- the person's relevant classes of high risk work and licence numbers
- the name and signature of the person conducting the training
- the dates and times of the training
- details of the training, including where appropriate, the type of equipment used or operated and the outcomes achieved.

Each training record must be verified and signed by the PCBU, or a representative of the PCBU. The PCBU must also keep a copy of the training record.

10. Inspecting, testing, maintaining and repairing tower cranes

Failure to carry out appropriately planned inspections, tests and preventative maintenance programs may lead to decreased safety and efficiency in the operation of the tower crane.

Inspection and appropriate testing must be carried out at sufficiently frequent intervals to ensure:

- the parts of the crane subject to deterioration through corrosion, damage, wear and abrasion are replaced before they become unserviceable
- the crane is maintained in a safe and serviceable condition.

The inspection and testing regime for tower cranes consists of the following:

- pre-erection inspection and tests
- commissioning inspection and tests
- pre-operational inspection
- routine inspection and maintenance
- annual inspection (when tower cranes in place for 12 months or longer)
- major inspection.

10.1 'Competent person' for inspecting tower cranes

The WHS Act includes duties for persons conducting a business or undertaking, owners and suppliers of plant. A duty holder who owns a crane may engage a competent person to inspect the crane to determine whether the condition of the crane poses a risk to safety.

The definition of a 'competent person' is provided in [Appendix 1: Dictionary](#). A competent person can be:

- the owner of the crane
- a person employed by the owner of the crane (i.e. where the owner is also a PCBU), or
- an independent consultant or third party.

10.1.1 INSPECTING SPECIFIC PARTS OF A CRANE

A competent person who has been engaged to inspect a specific part of a crane should have suitable experience and knowledge in the inspection of that part of the crane. This person may not necessarily need experience in inspecting the complete crane.

For example:

- A competent person inspecting welding on a crane should have suitable knowledge and experience in the inspection and testing of welds, including knowledge of non-destructive testing methods, and *AS/NZS 1554: Structural steel welding*.
- A competent person inspecting hydraulic systems and circuitry on the crane should have suitable knowledge and experience in the inspection and testing of hydraulic systems.
- The inspection of electrical systems on the crane should be completed by persons who have knowledge and experience in electrical systems, including the ability to read circuit diagrams and understand relevant technical standards. Any electrical work where the voltage of the electrical system is greater than 50 volts alternating current or 115 volts direct current must be done by a qualified and licensed electrical worker.
- A competent person carrying out non-destructive testing on tower crane components should have suitable knowledge and experience in non-destructive testing methods. This person must be accredited by the National Association of Testing Authorities (NATA).

In these instances, the competent person would make a statement that the particular part of the crane (e.g. the welding, hydraulic system or electrical system) complies with the relevant technical standards. It would not be appropriate for this person to state that the complete crane complies with a relevant technical standard or is in a safe condition.

10.1.2 INSPECTING A COMPLETE CRANE

A competent person who has been engaged to inspect the complete crane should have suitable knowledge of and experience in the inspection of cranes. This person should be able to make a judgement about the maximum allowable amount of wear and deformation in mechanical and structural components, and the associated pass/fail criteria.

The person should also be able to demonstrate experience in the inspection of the specific crane type.

The decisions of the competent person should be based on information contained in the manufacturer's instructions, relevant technical standards, sound engineering principles or a combination of all these.

For major inspections, a competent person means someone who:

- complies with both of the following
 - has acquired through training, qualification or experience, the knowledge and skills to carry out a major inspection of the crane;
 - is registered under a law that provides for the registration of professional engineers; or
- is determined by the regulator to be a competent person.

In forming their opinion, competent persons may use the advice of other competent persons involved in the crane inspection who are not engineers.

10.1.3 ALTERING A CRANE

Where an alteration has been made to the design of a crane, the competent person must be an engineer with suitable knowledge and experience. It is likely that the competent person will need to perform engineering calculations on the crane design to determine that it complies with relevant technical standards.

10.2 Requirements for non-destructive testing

Non-destructive testing (NDT) is the testing of materials to detect internal, surface and concealed defects or discontinuities, using methods that do not damage or destroy the material under test. NDT of specific tower crane components must take place at set intervals (e.g. pre- erection tests and major inspection). [Table 1](#) specifies the minimum frequency of NDT for particular crane components.

All NDT must be carried out by a competent person who has been accredited by the NATA. The results of NDT must be available at the workplace where the crane is erected.

When using NDT for the detection of cracks in metals, this does not necessarily require the removal of paint.

Component tested	NDT description	NDT frequency
Band brake welds (where applicable)	Crack test	Pre-erection
Slew ring bolts (where slew ring has to be split at disassembly)	Comply with crane manufacturer's instructions (may require 100 % bolts). Otherwise crack test minimum 10 % bolts*	Pre-erection
Tower bolts	Crack test minimum 10 % bolts*	Pre-erection
Aluminium sheaves	Crack test	Pre-erection
Slew ring bolts (all slew rings)	Crack test all bolts	5 years
Boom chord thickness	Material thickness testing	10 years
Slew ring	Crack test	10 years
Boom lacing welds	Crack test minimum 10%	10 years
A-frame (all 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

Table 1- Frequency of NDT testing for specific tower crane components

*Note: where any defective bolts are located, all of the remaining bolts are to be crack tested.

10.2.1 CRACK TESTING OF SLEW RING BOLTS

The integrity of slew ring bolts is critical for ensuring both the machine deck and boom remain attached to the tower. Slew ring bolts may become damaged, and their effective life reduced if bolts are either under or over-torqued.

For tower cranes where the slew ring must be split each time the crane is moved (e.g. Favco 1500), 10 per cent of slew ring bolts must undergo NDT. Bolts to be tested are to be selected from the slew ring by a competent person. If any cracks are detected, all bolts must be tested.

All slew ring bolts on tower cranes, including self-erecting tower cranes, must undergo NDT at least every five years. The preferred system of testing is to completely remove the bolts from the slew ring and examine them by magnetic particle testing.

10.2.2 CRACK TESTING OF TOWER BOLTS

Tower bolts are a critical part of the crane, and permit the effective transfer of load from the crane boom to the crane base. Tower bolts may become damaged from job to job. Their effective life may also be reduced if the bolts are either under or over-torqued. While all tower bolts are high tensile bolts, some are made from extremely high grade steel and may be more susceptible to cracking.

A minimum of 10 per cent of tower bolts must be crack tested by NDT prior to each crane erection. If any cracks are found, all tower bolts must be crack tested.

A system that ensures all tower bolts are tested over time is preferred, however a random system of testing may also be used. A crane owner may decide to test more than 10% of bolts where

deemed necessary (e.g. due to a history of cracking). The tested bolts should be identified by a method that does not damage the bolt.

10.2.3 CHORD THICKNESS TESTING

Lattice-type tower crane booms are constructed from steel. The components of these may be prone to internal and external corrosion affecting the thickness of the boom. The thickness of the chord wall may also be reduced through abrasive blasting of the boom.

All main chord sections on tower crane booms should undergo thickness testing at intervals not exceeding ten years. Ultrasonic thickness testing is one method of verifying whether there is adequate strength in the chords of the boom.

Chord sections must be reviewed 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.

10.3 Independent third party inspections of tower cranes at commissioning

An independent third party should where practicable, and when directed by the regulator, carry out inspections and tests of tower cranes prior to commissioning and before the crane has been put into service.

10.3.1 DEFINITION OF INDEPENDENT THIRD PARTY

An independent third party is a person who:

has acquired through training, qualification or experience the knowledge and skills to carry out the task ideally the competent person is not associated with the ongoing general repair and maintenance of a particular crane (whether directly or indirectly or through an associated company, including companies who hire or lease a crane).

10.3.2 PRE-ERECTION INSPECTIONS AND TESTS

Tower crane components should be inspected and tested prior to being delivered to the workplace. It is advisable for an independent third party to undertake these inspections and tests. This will ensure any faults identified with the crane can be fixed and resolved before the crane has been erected.

These inspections and tests should include the following:

- NDT of tower bolts
- NDT of slew ring bolts
- NDT 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 the following criteria:
 - 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 specified by the manufacturer.

Once the tower crane components have been delivered to the workplace, they should be inspected for any possible damage and wear during transport.

Inspections should also be made of:

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

A pre-erection inspection and test report should be developed which satisfies the requirements of this code and relevant Australian Standards. It should also reflect the specific type and model of crane and reference all relevant design drawings and test certificates.

10.3.3 COMMISSIONING INSPECTIONS AND TESTS

Commissioning inspections and tests should be carried out by an independent third party once a crane has been erected but before it is put into service. Once the performance of the crane has been satisfactorily verified by the commissioning inspections and tests, the crane may be placed into service. A commissioning inspection should occur each time a crane is erected regardless of when an annual inspection of that particular crane has taken place.

Commissioning inspections and tests should include:

- crane electricity supply where used
- crane base weights or ballast where used
- tower section identification and access
- ensuring tower bolts are correctly torqued (i.e. by checking documentation)
- 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 confirmation of no significant accumulation of oil, grease, litter or other combustibles in the machine deck and cabin
- the condition of the ropes and sheaves (e.g. 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/NZS 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
- verification of installation and wiring of electric signs (builder's logos)

- effective operation of slew brake to allow for weathervaning
- other tests specified by the crane manufacturer.

A commissioning report should be developed which satisfies the requirements of this code and relevant Australian Standards. It should reflect the specific type and model of crane, and reference all relevant design drawings and test certificates.

10.4 Pre-operational inspection

The crane operator before the commencement of each work shift must carry out a visual inspection and function test of the crane. This should include inspection and testing of the following:

- all relevant items indicated in the operations manual
- operating and emergency controls
- brakes
- safety switches and interlocks, including limiting and indicating devices
- visual inspection of the structure
- wire ropes to ensure they are on the drum and correctly reeved on the sheave
- wire ropes for obvious damage.

The results of the inspection must be entered into a logbook and kept with the crane.

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

10.5 Routine inspection and maintenance

A program of routine inspection and maintenance should be carried out by a competent person in accordance with the crane manufacturer's instructions. It should include a visual inspection of those relevant items that can be safely done while the crane is erected.

Routine inspection and maintenance should include the following:

- all functions and their controls for speed, smoothness of operation and limits of motion
- all emergency and safety switches and interlocks, including limiting and indicating devices
- lubrication of all moving parts and inspection of filter elements and fluid levels
- visual inspection and measurements as necessary of structural members and other critical components such as brakes, gears, fasteners, pins, shafts, wire ropes, sheaves, locking devices and electrical contactors
- signage, including warning signs and control markings
- wear on wheels and rails
- additional items nominated in the crane manufacturer's instructions.

All replacement parts and components must be identical or equivalent to the original parts or components. A written report must be provided upon completion of the inspection.

10.6 Annual inspections (when tower cranes in place for 12 months or longer)

Where a crane is erected and has been in place for 12 months or longer, an annual inspection should be carried out by a competent person.

The on-site annual inspection should include all items specified by the crane manufacturer for annual inspections, as well as relevant items included in the routine inspection and maintenance programs.

Annual inspections include:

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

A written report must be provided upon completion of the inspection.

[Appendix 4: Example - Annual crane safety certificate](#) may be used as evidence that the crane has received an annual safety inspection by a competent person.

10.7 Major inspection of tower crane

WHS Regulation, section 235

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

- a. at the end of the design life recommended by the manufacturer for the crane; or
- b. if there are no manufacturer's recommendations—in accordance with the recommendations of a competent person; or
- c. if it is not reasonably practicable to comply with paragraph (a) or (b)—every 10 years from the date that the crane was first commissioned or first registered, whichever occurred first.

A major inspection carried out under an equivalent provision of a corresponding WHS law is taken to be a major inspection.

A major inspection means an examination of all critical components of the crane. It may be necessary to strip down the crane and remove paint, grease and corrosion to allow a thorough examination of each critical component. A major inspection also means checking the effective and safe operation of the crane.

The parameters of the major inspection should be considerably more comprehensive than the annual inspection, due to the amount and severity of operation that a tower crane will be exposed to after longer periods of time. Even if the crane has not been exposed to regular operation, the crane may have deteriorated due to the way it has been stored or the environment in which it has operated in (e.g. dirty or corrosive environments). The major inspection must be certified by an engineer who has experience, training and qualification in the inspection of tower cranes. The engineer may use the advice of other competent persons when preparing the inspection report.

[Appendix 5: Example - Crane safety certificate – major inspection](#) may be used for by an engineer to document as evidence that the crane has received its major inspection.

A major inspection involves the examination (usually stripping down unless otherwise determined by an engineer) of all working components of the crane. All covers and cladding must be removed where necessary to enable the major inspection to be carried out. A major inspection requires particular attention to be given to the following:

- structural, mechanical, electrical, instrumentation, control and operational anomalies
- non-destructive testing examination to an appropriate standard
- controls and emergency stop
- braking systems
- manufacturer's safety upgrades
- adequacy of safety instructions and manuals
- the capacity and viability of upgrading the crane to the requirements of the latest relevant technical standard.

10.7.1 KEY INSPECTION ITEMS FOR A MAJOR INSPECTION

The following items, where appropriate, must be included in a major inspection for tower cranes:

- slew ring
- hydraulic motors
- hydraulic pumps
- valve blocks (bodies)
- hoist and luff drums
- braking systems
- rope sheaves
- hydraulic luffing cylinder
- gear boxes and drive shafts
- boom
- A-frame
- pins with moving parts (e.g. boom heel pins, ram pins)
- static pins
- steel wire ropes
- electrical systems
- control systems
- electric motors
- alignment of the drive shaft between the motor and gear box (where applicable)
- hook trolley (non-luffing cranes)
- hook assembly.

Note that this list only specifies some of the generic items requiring inspection. Some of the items may not be applicable to some types of tower cranes because the feature will not exist on the crane. The full list of items to be inspected must be determined by the competent person.

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 as required and based upon the hours of work and use.

All items will require some type of inspection and maintenance at more frequent intervals (i.e. at annual and other inspection intervals) in accordance with the crane manufacturer's instructions. Section 10.2.1 also requires slew ring bolts to be crack tested by NDT, or replaced by new bolts, every five years.

Where there is documented evidence that the appropriate inspecting and testing has been carried out on a certain item within a reasonable preceding period (as determined by a competent person), this item does not have to be stripped down in the major inspection. However, the competent person must still inspect the

safe operation of the item to certify that it is operating safely. This requirement applies to the following items:

- slew ring
- hydraulic motors
- hydraulic pumps
- valve blocks
- hoist and luff drums
- pins with moving parts.

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 NDT 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.
- Ensure all slew ring bolts are crack tested by NDT, or replaced with new bolts.

Hydraulic motors

- Remove, strip down and inspect all hydraulic motors.
- Replace all worn valves and other components.
- 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.
- 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 NDT.
- 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 NDT.

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.
- Align the drive shafts.

Boom

- Ensure all NDT 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 per cent of lacing welds on each boom section are crack tested by NDT. If any cracks are found, ensure all lacing welds on the boom section are tested.

A-frame

- Remove all pins.
- Ensure NDT is carried out on all connector welds on primary chords.
- Ensure a minimum of 10 per cent of lacing welds are crack tested by NDT.

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 remachined 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, to ensure they do not exceed the discard criteria specified in *AS 2759: Steel wire rope – Use, operation and maintenance*. If the competent person considers that the rope will require replacing within the next

three months, replace the rope with one that passes the inspection criteria of *AS 2759: Steel wire rope – Use, operation and maintenance*.

- Ensure ropes are only replaced with the type of rope specified by the crane manufacturer unless a professional engineer specifies otherwise.
- Inspect pins and terminations on pendant ropes.

Electrical systems (hazardous voltage)

- Ensure a qualified and licensed electrician inspects switchboards, wiring, motors and other electrical components in accordance with the applicable parts of *AS 60204.1: Safety of machinery – Electrical equipment of machines – General requirements* and *AS 3000: Electrical installations*.
- Replace damaged or worn components.
- Ensure sign-off is provided by the electrician.

Control systems (non-hazardous voltage)

- 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 NDT.

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 NDT.

10.7.2 ACTION FOLLOWING A MAJOR INSPECTION

Following a major inspection, the crane must be upgraded to comply with:

- the current version of *AS 1418.4: Cranes, hoists and winches – Tower cranes* or other relevant technical standards, or
- the recommendations of the competent person who has assessed the crane and determined what needs to be done to provide a level of safety equivalent to that which would be achieved by *AS 1418.4: Cranes, hoists and winches – Tower cranes* or other relevant technical standards.

A written report detailing the result of the major inspection must be provided to the crane owner. Records of inspections and maintenance

A crane service record, such as a maintenance logbook, of the significant events concerning the safety and operation of the crane must be kept and readily available. The records must be easily understood, and written in plain English. Records may be kept in any suitable format, and must be transferred with ownership of the crane. All entries in the maintenance logbook are to:

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

Documentation stating that the crane has been inspected by a competent person, and is in a safe and satisfactory condition, should be readily available.

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

In addition, all complete routine, annual inspection and major inspection reports must be maintained and made available for examination as required.

10.8 Tower crane maintenance

A tower crane preventative maintenance program should be established based on the working environment and the frequency and severity of use of the crane. The following items should form part of an effective maintenance program:

- replacement parts and components should be identical or equivalent to the original equipment parts and components
- a specific rectification program should be carried out where past experience has shown particular problems with a crane
- all safety-related malfunctions and problems should be corrected before the crane is returned to service.

The owner of the tower crane must ensure that:

- the necessary facilities and systems of work are provided and maintained so as to minimise the risks to health and safety of persons maintaining, inspecting, repairing or cleaning the crane
- inspections, maintenance and cleaning are carried out having regard to procedures recommended by the crane designer and manufacturer, or the relevant Australian Standard, or as developed by a competent person
- repair, inspection and, where necessary, testing is carried out by a competent person
- all safety features and warning devices of the crane are maintained and tested
- when the crane has been damaged to the extent that its function or condition is impaired, resulting in increased risk to health or safety, a competent person assesses the damage and advises the owner of:
 - the nature of the damage
 - whether the crane is able to be repaired, and if so, what repairs must be carried out to minimise risks to health and safety
 - repairs to the crane are carried out so as to retain the crane within its design limits
- annual maintenance, repair and inspection records are kept for the crane.

10.9 Tower crane repair

All worn or damaged parts of a crane that constitute a hazard, impair the operation of the crane, or may constitute a hazard before the next routine inspection, are to be repaired or replaced. All repaired or new parts must comply with the crane manufacturer's recommendations or specifications. Where these are not available, the repaired or new parts must comply with the recommendations of a competent person, taking into account the design requirements of *AS 1418.4: Cranes, hoists and winches – Tower cranes* or any other relevant technical standard.

10.10 Second-hand imported tower cranes

The importance of the maintenance history of second-hand imported tower crane from overseas cannot be underestimated. Before a second-hand imported tower crane can be operated for the first time, the owner of the crane should ensure the crane is subject to inspection by an independent third party (refer to Section 10.3), or a major inspection if the crane is at least 10 years old or there is no documented evidence that shows the crane's history of use or maintenance records. In addition, where the safety of the crane cannot be verified by documentation, it should be subject to a major inspection overseen by an engineer.

Appendix 1: Dictionary

‘Anemometer’ means an instrument for measuring wind speed.

‘Common plant’ means plant provided by the principal contractor for use by any person at the workplace for a purpose other than discharging a work health and safety duty. For example, tower cranes may be provided for the use of all persons at the workplace as common plant.

‘Competent person’

For the purpose of conducting major inspections under Section [10.7](#): means a person who either—

has the skills, qualifications, competence and experience to inspect the plant; and is registered under a law that provides for the registration of professional engineers; or

is determined by the regulator to be a competent person. For all other references in the code:

means a person who—

has acquired through training, qualification or experience the knowledge and skills to carry out the task.

‘Dedicated radio frequency’ means a specific radio frequency that has been provided by the Spectrum Management Agency.

‘Design verification statement’ means a statement that—

is written and signed by a person who is eligible to be a design verifier for the design

states that the design was produced in accordance with published technical standards or engineering principles specified in the statement

includes—

the name, business address and qualifications (if applicable) of the design verifier; and

if applicable, the name and business address of the organisation for which the design verifier works.

‘Design verifier’ for a design of plant, means a person who has the skills, qualifications, competence and experience to design the plant or verify the design.

‘Engineer’, in relation to the performance of a task means a person who—

is a registered professional engineer

is competent to perform the task.

A person must not carry out professional engineering services in the Australian Capital Territory unless they are a registered professional engineer.

‘Engineering principles’ means principles stated or outlined in an engineering, mathematical or scientific text, relevant to safe plant design, commonly used in professional engineering practice.

‘Fail-safe’ means that when partial or total failure of plant occurs, the plant fails in a manner which leaves the plant in a safe condition and which does not introduce any additional condition which is unsafe.

‘Independent third party’, for the purpose of conducting pre-erection inspections and tests under Section 10.3.2 and conducting commissioning inspections and tests under Section 10.3.3, is a person who:

has acquired through training, qualification or experience the knowledge and skills to carry out the task

is not associated with the ongoing general repair and maintenance of a particular crane (whether directly or indirectly or through an associated company, including companies who hire or lease a crane).

‘Load chart’ means a notice supplied by the crane manufacturer that is fitted on a crane and specifying the rated capacities as supplied by the manufacturer.

‘Reliability level’ means a category of reliability covered in *AS 4024: Safety of machinery*, and is a measure of the ability of the safety-related control circuit to provide a safety mechanism (e.g. electronic cut-off of power) even if the safety circuit itself is damaged. For example, a category 4 safety-related control

circuit must either bring the crane motion to a safe condition after the occurrence of the first fault or, in the event of additional foreseeable faults, must not cause the designed safety function of the control circuit to be lost.

‘Representational drawing’ means a general arrangement drawing showing leading dimensions and material specifications.

‘Safety integrity level’ (SIL) means a safety integrity level covered in *AS 61508: Functional safety of electrical/electronic/programmable electronic safety-related systems*, and is used where a control circuit employs programmable electronics. For example, a SIL 3 microprocessor-based system will provide an equivalent level of reliability to Category 4 under *AS 4024: Safety of machinery*, however due to the complexity of the circuits involved in programmable electronics, the SIL is determined based on the probability of component failure, software errors and external influences rather than foreseeable fault conditions.

‘Stabilising moment’ is the moment that tends to keep the crane upright. Overturning moment is the moment that tends to tip the crane over. When the overturning moment exceeds the stabilising moment, the crane will overturn. ‘Moment’ is the engineering calculation of force multiplied by the perpendicular distance between the force and the turning point.

‘Technical standard’ for a design of plant, means a standard published by either:

- a. Standards Australia
- b. another organisation that publishes standard(s) about the design of plant.

Examples of paragraph (c):

- American National Standards Institute.
- American Society of Mechanical Engineers.
- Canadian Standards Association.
- International Standards Organisation.
- Europäische Norm (European Standard).

Appendix 2: Relevant technical standards

Technical Standard	Title
i. AS 1353.2	ii. Flat synthetic-webbing slings – Care and use
iii. AS1418.1	iv. Crane, hoists and winches – General requirements
v. AS 1418.4	vi. Cranes, hoists and winches – Tower cranes
vii. AS 1418.17	viii. Cranes (including hoists and winches) – Design and construction of workboxes
ix. AS/NZS 1554 (Series)	x. Structural steel welding
xi. AS 1657	xii. Fixed platforms, walkways, stairways and ladders – Design, construction and installation
xiii. AS/NZS 1891 (Series)	xiv. Industrial fall-arrest systems and devices
xv. AS 2550.1	xvi. Cranes, hoists and winches – Safe use – General requirements
xvii. AS 2550.4	xviii. Cranes, hoists and winches – Safe use – Tower cranes
xix. AS 2550.20	xx. Cranes, hoists and winches – Safe use – Self-erecting tower cranes
xxi. AS 2759	xxii. Steel wire rope – Use, operation and maintenance
xxiii. AS/NZS 3000	xxiv. Electrical installations (Australian/New Zealand Wiring Rules)
xxv. AS 3775.2	xxvi. Chain slings for lifting purposes – Grade T(80) and V(100) – Care and use
xxvii. AS/NZS 4024 (Series)	xxviii. Safety of machinery
xxix. AS 4497.2	xxx. Round slings – Synthetic fibre – Care and use
xxxi. AS 4991	xxxii. Lifting devices
xxxiii. AS 60204.1	xxxiv. Safety of machinery – Electrical equipment of machines – General requirements
xxxv. AS 62061	xxxvi. Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems xxxvii.

Appendix 3: Familiarisation training checklists

Electric tower crane

Crane make and model used for training: _____

The operator demonstrated the ability to correctly perform and operate the following on the first or on the second (or follow up) occasion:

xxxviii.	xxxix. st	xl. nd	xli.	xlii. st	xliii. nd
xliv. Seat adjustment	xlv.	xlvi.	xlvi. Hoist limiter	xlvi.	xlvi.
l. Control identification (levers and switches) and operation	li.	lii.	liii. Slew lock pin	liv.	lv.
lvi. Warning devices (including horn)	lvii.	lviii.	lix. Anti-collision device operation (where fitted)	lx.	lxi.
lxii. Slew lock	lxiii.	lxiv.	lxv. Maximum wind speed	lxvi.	lxvii.
lxviii.	lxix.	lxx.	lxxi. Electricity isolating switch	lxxii.	lxxiii.
lxxiv. Load charts	lxxv.	lxxvi.	lxxvii.	lxxviii.	lxxix.
lxxx. Load chart (capacity at radius)	lxxxi.	lxxxii.	lxxxiii. Safety inspection: <ul style="list-style-type: none"> ropes rams wire rope wear of pads/sheaves boom grease points fluid leaks fluid levels brakes cabin visibility lights tower bolts slew ring bolts fall-arrest harness and lanyard boom pins and retainers 	lxxxiv.	lxxxv.
lxxxvi. Load chart (variations for different boom lengths)	lxxxvii.	lxxxviii.		lxxxix.	
xc. Load chart (variations for different rope falls)	xcii.	xciv.		xcv.	xcvi.
xcvii. Rated capacity limiter	xcviii.	xcix.		c.	ci.
cii. Rated capacity limiter – features	ciii.	civ.		cv.	cvi.
cvii. Rated capacity limiter – set up and operation	cviii.	cix.		cx.	cxii.
cxii. Rated capacity limiter – relationship to load chart	cxiii.	cxiv.		cxv.	cxvi.
cxvii. Rated capacity limiter – override procedures	cxviii.	cxix.		cxx.	cxxi.
cxxii. Rated capacity limiter – digital display	cxxiii.	cxxiv.		cxxv.	cxxvi.
cxxvii. Slew function	cxxviii.	cxxix.		cxxx.	cxxxii.
cxxxii. Luff function (where applicable)	cxxxiii.	cxxxiv.		cxxxv.	cxxxvi.
cxxxvii. Trolley function (where applicable)	cxxxviii.	cxxxix.	cxl.	cxli.	cxlii.
cxliii. Hoist function	cxliv.	cxlv.	cxli. Platform and tower edge protection	cxlii.	cxliii.
cxlix. Slew brake	cl.	cli.	clii. Cable drum and cable guide	cliii.	cliv.
clv. Slewing ring ball races	clvi.	clvii.	clviii. Hoist, travel and trolley brakes	clix.	clx.
clxi. Slipping unit	clxii.	clxiii.	clxiv. Fluid couplings	clxv.	clxvi.
clxvii. Wheel bogies	clxviii.	clxix.	clxx. Fire control procedures and equipment	clxxi.	clxxii.

Worker statement:

- I have received instruction in the operation, maintenance, inspection and safe use of this crane.
- I understand its safety features and how to carry out pre-operation, daily routine and logbook checks.
- I understand the manufacturer's instructions and guidelines for the safe operation and driving of this crane.
- I confirm I am able to safely operate this crane and I agree to comply with safety instructions.
- In the event of being unsure of a task, I will request further training or instruction before performing the task.

Worker name: _____

Worker signature:_____

Date: _____

PCBU representative name: _____

Signature:_____

Date: _____

Diesel hydraulic tower crane

Crane make and model used for training: _____

The operator demonstrated the ability to correctly perform and operate the following on the first or on the second (or follow up) occasion:

clxxiii.	clxxiv. st	clxxv. nd	clxxvi.	clxxv. st	clxxvi. nd
clxxix. Seat adjustment	clxxx.	clxxxi.	clxxxii. Re-fuelling procedure	clxxxii.	clxxxiv.
clxxxv. Gauge and indicator function	clxxxv.	clxxxv.	clxxxviii. Anti-collision device operation (where fitted)	clxxxix.	cxc.
cxc. Control identification (levers and switches) and operation	cxcii.	cxciii.	cxciv. Grease applications for ropes, pinions, slew rings and sheaves	cxcv.	cxcvi.
cxcvii. Warning devices (including horn)	cxcv.	cxcix.	cc. Engine/gearbox/hydraulic tank levels and site gauges	cci.	ccii.
cciii. Slew lock	cciv.	ccv.	ccvi. Isolator switches locations and functions	ccvii.	ccviii.
ccix. Free slew procedure	ccx.	ccxi.	ccxii. Weather vane radius (based on engineer design drawings and other possible plant)	ccxii.	ccxiv.
ccxv. Load charts	ccxvi.	ccxvii.	ccxviii.		
ccxix. Load chart (capacity at radius)	ccxx.	ccxxi.	ccxxii. Safety inspection:	ccxx.	ccxxii.
ccxxv. Load chart (variations for different boom lengths)			<ul style="list-style-type: none"> ropes rams wire rope wear pads/rollers boom grease points fluid leaks fluid levels brakes cabin visibility lights tower bolts slew ring bolts boom pins and retainers 		
ccxxvi. Load chart (variations for different rope falls)					
ccxxvii. Rated capacity limiter					
ccxxviii. Rated capacity limiter – features					
ccxxix. Rated capacity limiter – set up and operation					
ccxxx. Rated capacity limiter – relationship to load chart					
ccxxxi. Rated capacity limiter – override procedures					
ccxxxii. Rated capacity limiter – digital display					
ccxxxiii. Slew function	ccxxx.	ccxxx.	ccxxxvi. Maximum wind speed	ccxxx.	ccxxx.
ccxxxix. Luff function	ccxl.	ccxli.	ccxlii. Anti-cavitation switch, operations and functions	ccxlii.	ccxlii.
ccxliv. Luff brake	ccxli.	ccxlii.	ccxliii. Platform and tower edge protection	ccxlii.	ccxlii.
ccli. Hoist function	ccli.	ccli.	ccliv. Fire control procedures and equipment	ccli.	ccli.
cclvii. Slew brake	cclvii.	cclvii.	cclx. Hoist/luff decal and ultimate limit functions (radius and height they are set at)	cclx.	cclxii.
cclxiii. Operation and control of slew brake controls, luffing lever controls, hoisting lever and winch clutches	cclxi.	cclxi.	cclxvi. Cabin control panel annunciator functions and warning signals	cclxi.	cclxi.
cclxix. Hoist limiter	cclxx.	cclxxi.	cclxxii. Sludge tank taps and functions	cclxxi.	cclxxiv.

Worker statement:

- I have received instruction in the operation, maintenance, inspection and safe use of this crane.
- I understand its safety features and how to carry out pre-operation, daily routine and logbook checks.
- I understand the manufacturer's instructions and guidelines for the safe operation and driving of this crane.
- I confirm I am able to safely operate this crane and I agree to comply with safety instructions.

In the event of being unsure of a task, I will request further training or instruction before performing the task.

Worker name: _____

Worker signature: _____ **Date:** _____

PCBU representative name: _____

Signature: _____ **Date:** _____

Appendix 4: Example - Annual crane safety certificate

Certificate no.: _____

Crane type: _____ **Crane manufacturer:** _____

Crane serial no.: _____ **Design registration no.:** _____

WHSQ plant registration no.: _____ **Manufacture date:** _____

Owner's name: _____

Address: _____

Inspection date: _____

Name of competent person: _____

Address of competent person: _____

Telephone number: _____

Qualifications of competent person (e.g. professional engineering qualification, membership of professional organisation, crane industry experience, other tertiary qualifications, trade qualifications):

Inspector identification number: _____

Competent person statement:

I hereby certify that the crane, serial number: _____, has received its annual safety inspection in accordance with the instructions of the crane designer and manufacturer, and with relevant Australian Standards, and is safe to use.

Competent person signature: _____ **Date:** _____

Comments: _____

Appendix 5: Example - Crane safety certificate – major inspection

Certificate no.: _____

Crane type: _____ **Crane manufacturer:** _____

Crane serial no.: _____ **Design registration no.:** _____

WHSQ plant registration no.: _____ **Manufacture date:** _____

Owner's name: _____

Address: _____

Inspection date: _____

Name of competent person: _____

Address of competent person: _____

Telephone number: _____

Professional Engineer RPEQ number: _____

Competent person statement:

I hereby certify that the crane, serial number: _____, has received its major safety inspection in accordance with the instructions of the crane designer and manufacturer, and is safe to use. This inspection includes mechanical, structural and electrical items of the crane.

Competent person signature: _____ **Date:** _____

Comments: _____