Department of Justice and Attorney-General

Workplace Health and Safety Queensland

Tower crane

Code of Practice 2006

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This Queensland code of practice was preserved as a code of practice under section 284 of the *Work Health and Safety Act 2011*.

This code was varied by the Minister for Education and Industrial Relations on 27 November 2011 and published in the Queensland Government Gazette on 2 December 2011.

This preserved code commences on 1 January 2012.

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Contents

1. Introduction

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

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

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the 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 Act and 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 Act and 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.

How is the code organised
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 Act and Regulation 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.

Who has duties?
A **person conducting a business or undertaking** has the primary duty under the Act to ensure, as far as reasonably practicable, that workers and other persons are not exposed to health and safety risks arising from the business or undertaking.

Officers, such as company directors, have a duty to exercise due diligence to ensure that the business or undertaking complies with the Act and Regulation. This includes taking reasonable steps to ensure that the business or undertaking has and uses appropriate resources and processes to provide and maintain a safe work environment.

Workers have a duty to take reasonable care for their own health and safety and that they do not adversely affect the health and safety of other persons. Workers must comply with any reasonable instruction and cooperate with any reasonable policy or procedure relating to health and safety at the workplace.

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.

The Act requires that you consult, so far as is reasonably practicable, with workers who carry out work for you who are (or are likely to be) directly affected by a work health and safety matter.

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

You must consult your workers when proposing any changes to the work that may affect their health and safety.

Consulting, cooperating and coordinating activities with other duty holders
The Act requires that you consult, cooperate and coordinate activities with all other persons who have a work health or safety duty in relation to the same matter, so far as is reasonably practicable.

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 should 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.

Further guidance on consultation is available in the *Work Health and Safety Consultation, Coordination and Cooperation Code of Practice*.

This code provides practical advice about how to manage the risk of injury, illness or death to persons from:
(a) operating
(b) working with
(c) working near
(d) erecting
(e) climbing
(f) commissioning
(g) dismantling
(h) inspecting
(i) testing
(j) maintaining
(k) repairing
(l) being in an area adjacent to a tower crane, including a public area.

1.1 Legislation

In order to understand the relevant workplace health and safety requirements for tower cranes, a person must consider and understand the:
(a) *Work Health and Safety Act 2011*
(b) *Work Health and Safety Regulation 2011*
(c) *Electrical Safety Act 2002,* and

(d) *Electrical Safety Regulation 2002*.

1.2 Australian Standards

An Australian Standard is a published document which sets out specifications and a procedure designed to ensure that a material, product, method or service is fit for its purpose and consistently performs in the way it was intended.

Australian Standards provide useful information which will assist a person to better understand this code and may assist in discharging a duty a person may have for health and safety. References in this code to relevant Australian Standards were correct at the time of publication.

A list of relevant Australian Standards is provided at Appendix 2.

Further information on Australian Standards is available at www.standards.com.au.

2. Managing health and safety

As part of any program for managing health and safety, the following must be undertaken:
(a) risk management
(b) consultation
(c) training.

2.1 Risk management

Further guidance on risk management is available in the *How to Manage Work Health and Safety Risks Code of Practice*.

2.2 Consultation

Further guidance on consultation is available in the *Work Health and Safety Consultation, Coordination and Cooperation Code of Practice*.

2.3 Training

All people exposed to workplace health and safety risks should be provided with information about:
(a) workplace health and safety legislation
(b) their organisation's workplace health and safety policy or program
(c) workplace health and safety risk management processes
(d) which control measures are in place to minimise exposure to risks associated with workplace hazards
(e) correct use of controls and how to ensure they are kept in working order
(f) any known residual risk
(g) safe work procedures
(h) how to use and maintain equipment
(i) any special safety information needs.

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.

Adequate and appropriate training is a way of managing the risks associated with hazards. This can be done by:
(a) determining who needs to be trained
(b) determining what training is required
(c) determining how training will be delivered
(d) ensuring that the training is provided
(e) evaluating the training
(f) keeping training records.

The amount of training will be determined by:
(a) the nature of the workplace hazards
(b) the degree of risk associated with these hazards
(c) the complexity of work, such as operating procedures and equipment
(d) other controls being implemented
(e) the qualifications and experience of the worker.

2.3.1 Types of training

There are different types of workplace health and safety training that have different purposes, including:
(a) Induction training—for workers when commencing employment or when new to the job. This training is general and may involve a workplace tour, information about conditions of employment, administration, organisational structure, emergency procedures and workplace amenities.
(b) Supervisor and management training—provided to help ensure that the supervision and management of the health and safety issues are appropriately carried out in the workplace.
(c) Specific job training and familiarisation training—providing information about the risks associated with the job.
(d) Specific hazard training—providing information about the risks associated with a particular hazard.
(e) Ongoing training or refresher training—provided periodically to ensure that work continues to be performed safely.
(f) Emergency procedures training—provided to ensure workers know what to do in the event of an emergency, including identifying persons with specific emergency roles and responsibilities, and
(g) First aid training—provided to ensure appropriate procedures are followed for administering first aid.

Section 13 of this code provides advice on the training requirements for tower crane operations.

3. The design of structures

The *Work Health and Safety Act 2011* provides that a designer of a structure has a duty to ensure the design of the structure does not affect the workplace health and safety of persons when the structure has been constructed and is being used for the purpose for which it was designed.

Examples of persons to whom duties are owed:

- Persons who work in the structure after it has been constructed.
- Persons who maintain or repair the structure or any fixtures, fittings or plant in, or forming part of the structure.

3.1 Matters to be considered when designing a structure

When designing a structure, the designer should consider matters such as:
(a) the method of construction for the structure
(b) the way tower cranes are to be used during the construction of the structure.

Specific matters to be considered in relation to the use of tower cranes when designing a structure include ensuring that:
(a) the design of the structure is within the working radius of available cranes
(b) the design of the structure allows for an adequate number of crane ties to be installed.

4. Design and plant registration of tower cranes

4.1 Design registration of tower cranes

Tower cranes must be designed 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) a design verification statement
(b) representational drawings of the crane
(c) the appropriate fee.

A person must not make a design verification statement for any part of a design of plant that the person was involved in designing.

A certificate of registrable plant design stops having effect if the design is changed in a way that requires new measures to control risk.

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.

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.

4.2 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 also be design registered. All tower crane bases must

be designed by an engineer.

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.

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 have been submitted when the design registration for the tower crane was originally obtained. If this was 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.

5. Risks associated with tower crane operations

Tower crane operations may present a risk of injury to persons from:
(a) structural failure
(b) crane collapse
(c) contact or collision with other plant and structures
(d) falling objects, and
(e) falling from a height.

Structural failure may include the failure of any crane component, such as the boom, jib, hydraulic rams or wire rope. Crane overloading is a major cause of structural failure. Structural failure may occur without warning.

A tower crane may **collapse** if it becomes unstable through overloading. A collapse may be influenced by a number of factors, including:
(a) the incorrect use of counterweights
(b) crane tower bolts being incorrectly torqued
(c) the incorrect installation of crane ties
(d) poor design of the tower crane base.

Contact or collision with other plant and structures may occur where sufficient clearances are not maintained between the tower crane and other plant and structures, such as other cranes, concrete pumping booms, buildings and overhead powerlines.

Falling objects may result from erecting and dismantling activities, and the way loads are secured during lifting operations. Falling objects present a risk of injury to workers and members of the public.

Persons may be at risk of **falling from a height** when undertaking activities associated with erecting and dismantling of tower cranes.

6. Safe design of tower cranes

6.1 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:
(a) the stabilising moment of the crane—the crane counterweight generally provides the primary stabilising moment
(b) the overturning moment applied by the suspended load and wind
(c) the footings and foundations designed for the specific crane installation
(d) the design, number and location of crane ties
(e) wind conditions—stability will vary according to the size and shape of the suspended load and crane boom.

6.1.1 Stabilising and overturning moments

Load charts
Load charts, also called rated capacity charts, identify what the crane is able to lift safely.

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.

6.1.2 Footings and foundations

Footings and foundations for a tower crane installation must be designed 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.

6.1.3 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.

6.1.4 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 in Queensland, 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 may choose not to operate the crane. 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:

(a) The crane manufacturer 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.
(b) An anemometer (wind gauge) should 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:
    (i) the top of the A-frame on luffing tower cranes, or
    (ii) either the A-frame or machine deck hand-rail on non-luffing tower cranes.
(c) 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 speed 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:

(a) the types of loads that can be lifted under these conditions
(b) 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:

(a) load surface area
(b) 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)
(c) boom length and surface area of the boom, including any attachments
(d) the ability of the crane's slew motors and brakes to operate safely in high winds
(e) the ability of doggers to control load movement, particularly when it is being slung or unloaded
(f) the ability of the crane operator to see the load, particularly when the load is being slung or unloaded
(g) 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.

6.2 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.

6.2.1 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 accident.

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

(a) a reliability level of Category 4 under *AS 4024: Safety of machinery*, or
(b) a safety integrity level (SIL) of 3 under *AS 61508: Functional safety of electrical/electronic/programmable electronic safety-related systems*.

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

6.2.2 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. The crane's load chart will provide guidance 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:
(a) hoisting a load exceeding 110% of the maximum rated capacity
(b) the radius being increased when the load exceeds 100% at the particular radius.

If the tower crane is designed and manufactured with a load indicator, the load indicator should be maintained in a serviceable condition. Where a self-erecting tower crane is not fitted with a load indicator, the crane owner should ensure that a system is in place to regularly test the reliability and accuracy of the rated capacity limiter.

6.2.3 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:
(a) the highest position of the hook
(b) the lowest position of the hook when persons are lowered in a workbox into a shaft
(c) the extreme permissible operating positions of the jib (luff limiter) where a luffing motion is part of normal working operations
(d) the end positions of the trolley track on the jib
(e) the end positions of horizontally telescoping or movable jibs
(f) the end position of the tracks for rail-mounted travelling tower cranes.

6.2.4 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% and -3% 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).

6.2.5 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.

6.3 Signage on tower cranes

The attachment of signage on tower crane booms is **not** recommended.

Any signage attached to a tower crane boom, regardless of the sign's size, will affect the operation of the crane in windy conditions. Signs that are inappropriately attached to the boom may detach during crane operations, and result in injury to persons in the vicinity of the crane.

The design engineer for a tower crane installation must be aware of any requirement to attach signage to the boom in order to make allowance for the size and weight of the signage. This

information must be included and allowed for in any crane base drawing. Signs should not be attached to the tower crane boom unless consideration has been given to the potential wind loading of the sign, and the resulting impact on the design of the crane base, tower sections and crane ties.

Certification must be obtained from an engineer that the design of the sign and its attachments to the crane 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 a UV resistant material that will not deteriorate over the life of the crane installation. Flexible signs should be securely attached to the crane boom using an appropriate tying system that will withstand potential wind loadings.

Solid signs should be attached to the boom by bolted connections that clamp around the outside of the chords or lacings of the boom. An appropriate means of locking the nuts on the bolts must be used.

When attaching solid signs:
(a) holes should not be drilled into the boom
(b) joints should not be welded on to the boom
(c) strapping should not be used
(d) cable ties should not be used.

7. 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:
(a) erecting, climbing, commissioning and dismantling a tower crane
(b) directly involved in the lifting operation, such as the crane operator and dogger
(c) performing other work activities at the workplace
(d) in an area adjacent to a tower crane, including a public area.

Some issues to be considered when planning for tower crane operations include:
(a) liaising with electrical entities regarding the safe supply of electricity and control measures for working around existing power supply
(b) determining crane requirements, including loading bays and site access, at the project design stage
(c) minimising the number of tower cranes on site to reduce the likelihood of collision between cranes and other plant
(d) ensuring that each tower crane can be installed at an acceptable distance away from other tower cranes and concrete placement booms
(e) ensuring the crane machine deck remains at a safe distance above the building, and
(f) ensuring the tower crane boom remains an appropriate distance above the concrete

placement boom.

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

7.1 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 Queensland – luffing (see figure 1), hammerhead (see figure 2) and self-erector types. 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

7.2 Crane crew

The number of persons in the crane crew should be determined by a risk assessment and be appropriate to ensure the safe operation of the tower crane at the workplace, especially in relation to minimising the risk of collision between cranes and other plant, and loads contacting other structures, overhead powerlines and workers.

The risk assessment should consider the size and complexity of the work to be undertaken when determining the number of operators and doggers to work together in a crew. The risk assessment should also consider the need for the appointment of a crane coordinator.

7.3 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:

(a) the crane overturning due to failure of the crane to withstand the forces likely to be imposed on it
(b) 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.

7.3.1 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:
(a) dead weight of the crane
(b) dead weight of the load and any lifting attachments
(c) dynamic forces caused by movements of the crane
(d) wind loadings
(e) 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.

7.3.2 Collision between the crane with other plant or structures

The siting of a tower crane must consider hazards such as:
(a) overhead powerlines
(b) nearby structures
(c) other cranes or concrete placement booms (including those on adjacent sites)
(d) the vicinity of aerodromes and aircraft flight paths.

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.

For further information on control measures to minimise the risk of injury from collision, refer to section 8 of this code.

7.3.3 Location of access areas

When siting a tower crane, consider the location of:
(a) common access areas for workers and other persons at the workplace
(b) public access areas, such as footpaths, roadways and railways in the vicinity of the crane.

7.4 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 now 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:
(a) 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
(b) ensuring operators are familiar with the specific procedures for using radio communication for that workplace
(c) 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
(d) 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.

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.

8. 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. Outcomes from the collision may include:
(a) damage to crane components, such as the boom, which may seriously weaken them, leading to structural collapse
(b) 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.

8.1 Working near overhead powerlines

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

8.1.1 Electrical legislation and guidance

Information and guidance about working near exposed live electrical parts are provided in the following publications:
(a) Electrical Safety Act 2002—outlines general electrical safety duties,
(b) Electrical Safety Regulation 2002—states the allowable working distance for working near a live part, and
(c) *Code of Practice - Working Near Exposed Live Parts*—gives practical advice on safe systems of work and exclusion zones (published by the Electrical Safety Office).

8.1.2 Planning for work near overhead powerlines

Before setting up a tower crane in the vicinity of overhead powerlines, consultation regarding the work and the related risks should occur between the principal contractor and the tower crane operator.

There are two options for working near overhead powerlines:
(a) have the powerlines de-energised, or
(b) stay outside the exclusion zones.

If powerlines are to be de-energised, arrangements should be made with the person in control of the line as early as possible when planning the work. The de-energising process can take some time and depending on the circumstances, may delay work. Where powerlines have been de-energised, confirmation should be sought from the person in control of the powerline.

8.1.3 Exclusion zones

An exclusion zone is the prescribed safety envelope around a live electrical part. Under the *Electrical Safety Regulation 2002*, a person must not operate a crane where any part of the crane or the crane's load could enter the exclusion zone. The distances for the various situations where an exclusion zone is required are specified in the *Electrical Safety Regulation 2002*. Exclusion zones vary according to the voltage, the type of overhead powerlines and whether the person is untrained, trained or authorised.

A number of factors must be considered when implementing systems to maintain the exclusion zone around overhead powerlines. These include:
(a) identifying the minimum clearance distance from the closest part of the crane or its suspended load to the powerline
(b) allowing for sway and sag of the overhead powerlines
(c) ensuring all persons operating plant and vehicles stay outside the exclusion zone at all times
(d) ensuring a 'spotter' is used when the crane or plant can enter into the exclusion zone.

Sway of overhead powerlines is usually caused by wind, while sag may vary as the temperature of the line varies.

A 'spotter' is a safety observer who has undergone specific training and is competent for the sole task of observing and warning the crane operator against the crane's encroachment into the exclusion zone. The spotter must not carry out other tasks, such as dogging duties.

8.1.4 Devices to minimise risk of injury from contact with overhead powerlines

There are a number of devices available that either assist in preventing contact with overhead powerlines or reduce the degree of risk in the event of contact. These include tiger tails and limiting or warning devices.

The use of **tiger tails** on overhead powerlines acts as a visual aid to highlight the location of the powerline. Only low voltage lines (under 1000 volts) can be continuously covered with tiger tails, which leaves the higher voltage lines on power poles (usually at least 11 000 volts) exposed. Tiger tails **do not** insulate wires.

Limiting or warning devices may be used to prevent the crane boom or load from entering the exclusion zone, or to warn the crane operator before the boom enters the exclusion zone. If a limiting device is used, the system must be designed to 'fail-safe', or should generally meet a reliability level of Category 4 under *AS 4024: Safety of machinery* or a SIL of 3 under *AS 61508: Functional safety of electrical/electronic/programmable electronic safety-related systems* (see section 6.2 of this code).

Regardless of whether safety devices are being used, the exclusion zone must not be encroached.

For more detailed information, refer to the *Electrical Safety Regulation 2002* and the *Code of Practice - Working Near Exposed Live Parts.*

8.2 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:
(a) dropped loads
(b) crane collapse
(c) failed crane components, such as boom sections.

A risk of injury from collision may exist where:
(a) a concrete placement boom is working within the tower crane's operating radius
(b) 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.

8.2.1 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 safe work method statement, 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 safe work method statement. All persons involved in operating tower cranes and other plant are to be trained in the procedure.

The procedure should address the following issues:
(a) siting cranes to minimise the need for other plant to operate within the crane's operating radius
(b) siting cranes and other plant with counterweights so that the counterweights cannot collide during slewing operations
(c) the method of communication between the crane crew and other plant operators
(d) 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
(e) the tower crane's climbing procedure to ensure the crane remains as far above any structure or plant (e.g. jump forms) as practicable
(f) the frequency of regular meetings to monitor and review the effectiveness of control measures and who should attend such meetings.

Where 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) to ensure sufficient clearances are maintained between cranes, minimising the risk of collision. This system should identify persons from each workplace who have this responsibility. A clear method of communication must be implemented between the workplaces.

9. 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:
(a) crane collapse
(b) falls from heights
(c) falling objects.

9.1 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.

A safe work method statement for the high risk construction work of erecting or dismantling a tower crane must be prepared and consider the following:
(a) the crane designer's or crane manufacturer's instructions
(b) technical standards relevant to access and egress
(c) the crane's stability
(d) any adverse effects on other plant, structures or work processes at the workplace
(e) the use of special tools, jigs and appliances necessary to minimise the risk of injury
(f) control measures for securing crane components
(g) the interaction of the crane with other plant
(h) environmental factors, such as wet or windy conditions
(i) all relevant electrical installations associated with the crane comply with *AS 3000: Electrical installations*.

9.2 Minimising risk of injury from crane collapse

9.2.1 Erecting and dismantling—ways to minimise risk of injury from crane collapse

Tower crane components must be inspected and tested prior to being delivered to the workplace. For further information on pre-erection inspections and tests, refer to section 14.3 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:
(a) only the correct type and grade of tower bolts are used when connecting tower sections
(b) bolts and pins used to connect tower sections are compatible with crane components, and are not defective
(c) 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
(d) crane ties are installed in accordance with instructions specified by the crane manufacturer and designer of the crane installation.

9.2.2 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.

The risk of injury from crane collapse during climbing operations can be minimised by:
(a) conducting climbing operations where practicable outside of normal work hours to minimise the potential for persons to be at risk
(b) excluding all unnecessary persons from the workplace during climbing operations
(c) maintaining an exclusion zone of sufficient size to contain structural failure
(d) prohibiting persons from entering the area directly behind the tower crane (under the counterweights) during climbing operations
(e) avoiding slew operations at all times during climbing operations
(f) 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 must 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 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).

9.3 Minimising risk of injury from falling from a height

Undertaking an activity where a person could fall at least two metres is high risk construction work and requires the preparation of a safe work method statement.

The *Work Health and Safety Regulation 2011* describes the control measures that must be implemented where there is a risk a person could fall from one level to another and the fall could cause an injury.

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.

Control measures to prevent the risk of death or injury from falls when working at a height include:
(a) edge protection systems
(b) travel restraint systems
(c) fall-arrest harness systems.

More than one control measure may be required.

9.3.1 Edge protection systems

Edge protection means a barrier to prevent a person falling from or through:
(a) a building or other structure
(b) an opening in a surface of a building or other structure
(c) a fall arresting platform
(d) 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.

9.3.2 Travel restraint systems

Travel restraint systems do not allow a person to get into a falling situation. These systems tether a person to an anchorage point to restrain the person from reaching an unprotected edge. Travel restraint systems are preferred over those that arrest a person once the person has fallen. Anchorage points must be capable of supporting the load.

9.3.3 Fall-arrest harness systems

A fall-arrest harness system is designed to arrest a person's fall. It consists of a fall-arrest harness that is connected to a lanyard assembly. The lanyard is also attached to a fall-arrest static line or an anchorage point where there is a risk of free fall.

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.

9.4 Minimising risk of injury from falling objects

The *Work Health and Safety Regulation 2011* describes control measures that must be implemented to protect persons from falling objects.

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:
(a) exclusion zones
(b) tool lanyards
(c) mesh screens
(d) scheduling of work
(e) 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 construction safety plan for the work activity. All workers involved in the work activity must be made aware of these requirements.

9.4.1 Exclusion zones

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) a radius of at least 20 metres from the base of the tower crane
(b) 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.

9.4.2 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. A tool lanyard should be attached to an anchorage point. 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.

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 mm. 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.

9.4.3 Mesh screens

Mesh screens are engineered designed steel mesh frames that fit around the climbing frame, and under crane ties, during climbing operations. The gaps in the mesh must be of an appropriate dimension to prevent objects, such as bolts and shims, falling through.

9.4.4 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.

9.4.5 Restraining systems for crane components

While erecting, dismantling and climbi activities are being carried out, control measures to restrain individual crane components (such as packers or shims, nuts, bolts and washers) 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.

10. Commissioning tower cranes

Failure to commission tower cranes in accordance with the crane manufacturer's 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. For further information on commissioning inspections and testing, refer to section 14.4 of this code.

Written instructions regarding the commissioning of a tower crane should be available to all PCBUs 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.

10.1 Responsibilities of persons who commission tower cranes

A person who commissions tower cranes should ensure that:

(a) the process of commissioning the crane is without risk to health and safety
(b) as a result of commissioning, the crane can be transferred to active service without risk to health and safety when it is used properly, and for the purpose for which it was designed and manufactured
(c) the crane is inspected, to determine whether it has been erected in accordance with design specifications
(d) commissioning methods are in accordance with specifications of the crane manufacturer or supplier
(e) the commissioning sequence has been developed and implemented according to risk management principles (i.e. hazards identified, risks assessed and controls implemented)
(f) an erection plan is developed to cover such things as the sequence of operations, and the safety procedures to be carried out during commissioning
(g) tests are carried out to ensure the crane will perform within design specifications (e.g. dummy runs)
(h) stresses which exceed design specifications are not imposed on the crane
(i) the crane owner is notified of commissioning results and provided with appropriate documentation.

The following information should be provided by the commissioner of the tower crane to the crane owner:

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

11. Operational issues

11.1 Roles and responsibilities associated with tower crane operations

11.1.1 The principal contractor

A principal contractor has a duty to ensure the overall coordination of the lifting operations on an ongoing basis. This includes ensuring systems are in place that facilitate communication between all PCBUs and workers at the workplace for overlapping areas of work.

For tower cranes, the principal contractor is responsible for:

(a) ensuring safe and suitable equipment has been provided to meet the requirements of the job
(b) ensuring all persons involved in the maintenance, repair, transport and assembly of the tower crane are trained and experienced
(c) ensuring PCBUs employ workers with the appropriate licence class to perform a class of high risk work
(d) defining roles and responsibilities for all persons involved with the crane operation
(e) ensuring a maintenance and inspection program is in place while the crane is provided as common plant.

11.1.2 The crane owner

A crane owner must ensure that only persons with the appropriate tower crane licence class operate the tower crane. Additionally, the crane owner who employs crane operators should also ensure that operators have undergone familiarisation and refresher training as required under this code.

A crane owner must ensure that the crane manuals for operation, servicing and maintenance are readily available to those who need them (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).

Prior to supplying a tower crane, a crane owner should obtain a clear understanding of the characteristics of the job, site conditions, restrictions and hazards. This may involve conducting a site visit and inspection to ensure that an appropriate crane is supplied for the construction work.

A crane owner should ensure that the crane supplied is fit for purpose and suitable for application in its intended use. This includes items supplied with the crane by the crane manufacturer (e.g. temperature control units and adequate seating) being provided and maintained in a serviceable condition according to the crane manufacturer's instructions.

11.1.3 The crane operator

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.

If the load is obstructed from the dogger's view at any time during the lifting operation, the

operator may need to assume control of the load until the load comes back into view of the dogger.

Tower crane operators are required to know:
(a) the particular model of crane to be operated, its characteristics, functions and limitations
(b) the information in the crane's operating manual
(c) 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
(d) proper inspection and maintenance procedures to be followed in accordance with the guidelines of the manufacturer and owner
(e) any site conditions that may affect crane operations, including the presence of overhead powerlines, nearby structures, other cranes and concrete placement booms
(f) basic slinging techniques.

Before and during crane operations, the crane operator must:
(a) check unauthorised persons are not present on the crane
(b) check each crane motion is safe and without risk
(c) complete the daily inspection checklist, including filling out the crane logbook.

11.1.4 Dogger

The primary role of a dogger is to assist the crane operator in the safe and efficient operation of the crane. This includes safe slinging of the load and providing clear directions to the crane operator. 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:
(a) use the various types of ropes, slings, chains and lifting accessories
(b) determine the safe working loads (SWL) of any rope, sling or chain to be used for lifting
(c) assess the weights of loads to be lifted
(d) safely sling loads of different weights and sizes
(e) direct a crane or hoist operator in the movement of a load when the load is out of the operator's view
(f) give appropriate directions when directing loads.

Before directing the crane operator to raise a load, the dogger must ensure:
(a) each lifting attachment, sling and shackle has an SWL, or working load limit greater than or equal to that of the load. These attachments must be suitable for safely handling the load
(b) the hoisting apparatus is correctly applied to the load and the crane hook
(c) no part of the load is loose
(d) the load is properly balanced
(e) the load is not snagged
(f) the load will not contact any object or constitute a hazard to any person when it is lifted.

11.1 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:
(a) damaged lifting gear
(b) crane overload
(c) unsecured and dropped loads (falling objects).

11.2.1 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:
(a) *AS 2759: Steel wire rope – Use, operation and maintenance*
(b) *AS 3775.2: Chain slings – Grade T – Care and use*
(c) *AS 4497.2: Round slings – Synthetic fibre – Care and use*
(d) *AS 1353.2: Flat synthetic-webbing slings – Care and use*
(e) *AS 4991: Lifting devices*
(f) *A Guide for Doggers* (published by Workplace Health and Safety Queensland).

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

Where synthetic slings are used, protective sleeves and corner pieces should be used for all loads. Although the edges of the load may not appear to be sharp, the sling may become damaged when it is placed under tension.

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.

11.2.2 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:

(a) test the hoist brakes
(b) check the mass recorded on the load indicator
(c) 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.

11.2.3 Control measures to minimise risk of injury from unsecured and dropped loads

The *Work Health and Safety Regulation 2011* describes control measures that must be implemented to protect persons from falling objects.

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.

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**
  (a) The tare mass and SWL should be clearly marked on all material boxes.
  (b) Material boxes should be appropriate for the material being lifted, and be engineer-designed and certified.
  (c) Four chains (one in each corner) should be attached to material boxes during lifting.
  (d) 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.
  (e) Material boxes should be inspected and maintained, and inspection records kept.
  (f) Loads within material boxes should be secured against movement.
  (g) 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**
  (a) Formwork frames should be either tied together or lifting slings should be wrapped around the load.
  (b) Loads of joists or bearers should be strapped together before lifting.
  (c) Timber sheeting should be strapped together and lifted in a flat position.
  (d) Sheets of plasterboard should be lifted in a specifically designed material box. If a material box is not used, then the lifting system must:
    (i) be certified by an engineer
    (ii) specify the minimum and maximum number of sheets
    (iii) specify number and locations of lifting slings
    (iv) specify the capacity of lifting slings.
  (e) Tag lines should be used as required to control loads.
  (f) All loads should be supported where possible with dunnage, with the load uniformly distributed over the supporting surface.

(g) 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.

Further guidance on securing loads can be found in the Workplace Health and Safety Queensland publication – *Guide for Doggers*.

11.2 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.

11.2.1 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 mm. 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.

11.2.2 Internal guardrail on tower landings

Internal guardrails on tower landings minimises the risk of a person falling internally down the tower. Both Favco and Liebherr tower cranes should be provided with an internal guardrail to tower landings.

For Favco tower cranes, either a guardrail on the internal side of the access hole, or a rail that extends around the back of the access hole should be provided. It is impractical to provide an internal guardrail on the top tower landing, as slewing of the crane may cause:
(a) the lower end of the ladder to strike and damage the internal guardrail
(b) entrapment of any persons on the top tower landing.

For Liebherr tower cranes, a short section of guardrail located on the internal side of the landing should be provided. There should be adequate room for a person to climb off the ladder and onto the platform.

11.2.3 Guardrails on machine deck and A-frame platform

Both Favco and Liebherr 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 mm and 1100 mm high, a mid-rail and a kickboard at least 100 mm high. The guardrail should comply with *AS 1657: Fixed platforms, walkways, stairways and ladders – Design, construction and installation*.

11.2.4 A-frame ladder cage issues

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 m and 2.2 m above the lower deck. The horizontal spacing between the vertical bars on the ladder cage should not exceed 150 mm. Mesh infill may be used instead of vertical bars.

11.2.5 Saddle bag platforms—Favco tower cranes

Saddle bag platforms are provided on Favco tower cranes with moving counterweights to provide access for riggers during the erection process, and for persons carrying out maintenance. Climbing over the machine deck guardrail and down a ladder leading onto the platform is not recommended to ensure persons do not fall off the tower crane when accessing the saddle bag platform.

Safe access to the saddle bag platform can be achieved by either providing a trapdoor in the machine deck, or a ladder cage on the saddle bag ladder. This platform should also be provided with a top rail, mid-rail and kickboard.

11.2.6 Crane jib—non-self-erecting types

Both Liebherr and Favco tower cranes require riggers and crane operators to access the jibs during erection, inspection and maintenance. All tower cranes should be fitted with a rigger's run and static lines that extend for the complete length of the jib. When persons use the static line, two lanyards, or a lanyard with a 'pigtail' at one end, should be used to ensure the person is attached to the crane at all times.

Liebherr tower cranes should also be fitted with trolley platforms.

11.3 Leaving the crane unattended

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:
(a) all loads are removed from the hook
(b) the hook has been raised to a position where it is safely clear of other operation
(c) all powered motions have been disabled
(d) the keys have been removed from the crane.

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.

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) must be determined by an engineer.

11.4 Workboxes and first aid boxes

Crane-lifted workboxes should 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.

First aid boxes must only be used for the retrieval of injured persons.

11.4.1 Features of a crane when using workboxes and first aid boxes

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

(a) The crane must have a minimum SWL of 1000 kg at the maximum radius for the task to be performed.
(b) The crane must have a minimum SWL of at least twice the total load of the workbox and its contents, at the maximum radius for the task to be performed.
(c) The crane must be fitted with an upper hoist limit (anti-two block) that stops operation of the hoist, luff and telescope functions of the crane, or be designed so that two-blocking cannot damage any part of the crane or lifting gear.
(d) 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.
(e) If the crane is fitted with a free fall facility, the free fall function must be locked out with a keyed lock out.

11.4.2 Features of workboxes and first aid boxes

Crane-lifted workboxes and first aid boxes must meet the following criteria:

(a) Correctly tagged lifting slings must be supplied with the workbox and first aid box and attached to lifting points by means of hammerlocks or moused shackles.
(b) The factor of safety for each suspension sling must be at least eight for chains and ten for wire rope.
(c) The SWL, tare mass and design registration number of the workbox or first aid box must be marked on the workbox or first aid box.
(d) 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. However, first aid boxes may be provided with outward opening doors.
(e) The sides of the workbox or first aid box must be at least one metre high.
(f) First aid boxes must be clearly identified as first aid boxes.

11.4.3 Safety of persons in crane-lifted workboxes

The following must occur to ensure the safety of persons in a crane-lifted workbox:

(a) All persons in the workbox must wear full body fall-arrest harnesses at all times. Harnesses must be attached to fall-arrest anchorage points in the workbox **or** to the main sling ring above the workers' heads. Energy absorbers must be provided on the lanyards (see *AS 1891 Series: Industrial fall-arrest systems and devices* for further information).
(b) At least one person in the workbox 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 workboxes 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*.

11.5 Fatigue

Fatigue is mental or physical exhaustion that stops a person from being able to function normally. Although fatigue is mainly caused by a lack of sleep, a person may also become fatigued through prolonged periods of physical or mental effort, without enough time to rest and recover. The level of fatigue varies, and depends on the following:

(a) workload
(b) length of the shift
(c) previous hours and days worked
(d) time of day or night worked.

Fatigue has an adverse effect on every aspect of human performance. High levels of fatigue can cause reduced performance and productivity at work, and increase the risk of accidents and injuries occurring. Fatigue can affect the ability to think clearly, which is vital when making safety-related decisions and judgements. Persons working in a fatigued state may place themselves and others at risk. The most common effects associated with fatigue are:

(a) desire to sleep
(b) lack of concentration
(c) impaired recollection of timing and events
(d) irritability
(e) poor judgement
(f) reduced capacity for interpersonal communication
(g) reduced hand-eye coordination
(h) reduced visual perception

(i) reduced vigilance
(j) slower reaction times.

11.5.1 Managing fatigue

Fatigue within the workplace should be managed by using a risk management approach.

Managing fatigue is a shared responsibility between PCBUs and their workers, as it involves factors both inside and outside of work. Workers are required to ensure that they make appropriate use of their rest periods, and are fit for duty on rostered shifts.

Methods that may be used to manage fatigue in tower crane operations include:
(a) rotating the tower crane operator or other individual members of the crew suffering the effects of fatigue (e.g. when involved in erecting, dismantling and climbing operations in addition to routine hours of operation and outside of normal working hours)
(b) ensuring crew members have adequate rest and meal breaks.

11.6 Noise

A person's hearing can become temporarily or permanently impaired if the person's unprotected ear is exposed to excessive noise.

The *Work Health and Safety Regulation 2011* defines excessive noise and describes what must be done to prevent the risk to a person from exposure to excessive noise at work.

Persons must be protected from the risk of noise-induced hearing loss during their work.

Activities, such as the erection or dismantling of tower cranes, and in particular, the use of an impact wrench, create noise which can damage hearing immediately. This type of noise is particularly damaging to hearing because of its high impulsive noise levels. Other loud noise, such as that created by the operation of a crane's diesel engine without sound proofing, will gradually damage a person's hearing after repeated exposures.

Engineering controls, such as enclosing the engine in a sound proof cabinet, should be applied to manage exposure to the noise created by the operation of a tower crane's diesel engine.

11.7 Ergonomic seating

The design of seating in tower cranes should take account of the extensive periods of time the crane operator spends in the seat. Seating should be comfortable, have adequate back support and be height adjustable.

11.8 Working in heat

Heat stress may occur when heat is absorbed from the environment faster than the body can get rid of it. One way to reduce heat stress on workers is to minimise the heat in the workplace. Temperature control units supplied with the crane should be maintained and kept in a serviceable condition according to the crane manufacturer's instructions.

For further information on managing heat stress, refer to the Workplace Health and Safety Queensland information at www.worksafe.qld.gov.au

12. Additional requirements for self-erecting tower cranes

The use of self-erecting tower cranes (see figure 3) is increasing in Queensland, 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 3 – Self-erecting tower crane

Unlike most other tower cranes, self-erecting tower cranes do not require fixing to a crane base. 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.

12.1 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:
(a) remain in close proximity to the crane
(b) 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.

12.1.1 Remote operation

Self-erecting tower cranes may be operated by either:
(a) hard-wired or pendant controls, or
(b) cableless controls.

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

When the self-erecting tower crane is not in use, appropriate control measures must be in

place to prevent unauthorised operation of the crane.

12.1.2 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 mm 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.

13. Training and supervision

13.1 Responsibilities for training and supervision

The duties for providing information, instruction and training are outlined in section 2.3 of this code.

Information, instruction and training for tower crane operations should cover at least:
(a) safe work method statements to be used in setting up and for safe operation of tower crane activities
(b) the method for inspection and maintenance of tower cranes
(c) knowledge of the crane manufacturer's operation and service manuals
(d) the correct use, care and storage of personal protective equipment
(e) the correct use, care and storage of tools and equipment to be used
(f) observance of electrical safety practice
(g) procedures to be adopted in the event of accident or injury.

Supervision must:
(a) ensure only those workers who have received instruction and training are authorised to carry out that work
(b) 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 personal protective equipment.

13.2 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:
(a) assess the person's knowledge and understanding of safe crane operation
(b) seek further evidence of competence, or
(c) 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. The record must be signed by both the crane operator and the PCBU, or a representative of the PCBU.

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 for a list of some items that can be included in a familiarisation training checklist.

13.3 Refresher training

PCBUs must ensure that persons who work as part of a crane crew (crane operators, doggers and riggers) receive refresher training. Refresher training may be provided by the PCBU, an independent consultant or 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:
(a) the application of new technology, particularly for those persons who obtained their licence class while working on more basic cranes
(b) information in this code
(c) any relevant changes to workplace health and safety legislation and Australian Standards which may have an impact on safe crane operations
(d) safe crane operation.

Refresher training may include:
(a) conducting a training needs analysis to identify the particular training needs of individual workers
(b) providing theoretical information, where required
(c) providing practical demonstration and supervision.

13.3.1 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.

13.3.2 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:
(a) the person's name, address and signature
(b) the person's relevant classes of high risk work and licence numbers
(c) the name and signature of the person conducting the training
(d) the dates and times of the training
(e) 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.

14. Inspecting, testing, maintaining and repairing tower cranes

Failure to carry out appropriate 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:
(a) the parts of the crane subject to deterioration through corrosion, damage, wear and abrasion are replaced before they become unserviceable
(b) the crane is maintained in a safe and serviceable condition.

The inspection and testing regime for tower cranes consists of the following:
(a) pre-erection inspection and tests
(b) commissioning inspection and tests
(c) pre-operational inspection
(d) routine inspection and maintenance
(e) annual inspection
(f) 10-year major inspection.

14.1 'Competent person' for inspecting tower cranes

The *Work Health and Safety Act 2011* 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.

A competent person can be:
(a) the owner of the crane
(b) a person employed by the owner of the crane (i.e. where the owner is also a PCBU), or
(c) an independent consultant or third party.

14.1.1 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) 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*.

(b) 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.

(c) A competent person inspecting electrical systems on the crane should have suitable knowledge and experience in electrical systems, including the ability to read circuit diagrams and understand relevant technical standards. This person must be a qualified and licensed electrician where the voltage of the electrical system is greater than 50 volts alternating current or 115 volts direct current, and

(d) 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.

14.1.2 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. Although this person would not necessarily need to be an engineer for inspections other than the 10-year major inspection, it is advisable that the person have a qualification in a mechanically associated trade. 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.

Where a 10-year major inspection is to be carried out, the competent person certifying the inspection must be an engineer. In forming their opinion, engineers may use the advice of other competent persons involved in the crane inspection who are not engineers.

14.1.3 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.

14.2 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 which 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, the paint must be removed from the metal surface.

Component tested	NDT description	NDT frequency
Boom clevises	Crack test	Pre-erection
Counterweight sheave bracket welds - moving counterweights only	Crack test	Pre-erection
Cruciform welds (luffing cranes only)	Crack test	Pre-erection
Butt heal bosses (luffing cranes only)	Crack test	Pre-erection
Band brake welds	Crack test	Pre-erection
Slew ring bolts (where slew ring has to be split at disassembly)	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
Hydraulic luffing cylinder gland nut	Crack test	10 years
Hydraulic luffing cylinder and ram (rod ends and caps)	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

14.2.1 Crack testing of booms and counterweight sheave bracket welds

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

In addition to carrying out crack testing of connection clevises, luffing crane booms have a history of cracking in the following areas:
(a) counterweight sheave bracket welds
(b) welds in cruciform area
(c) butt heal bosses.

These areas should also be crack tested by NDT prior to each crane erection.

14.2.2 Crack testing of band brakes

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

All Favco tower cranes fitted with band brakes must have the weld between the band and the end fitting crack tested by NDT prior to each erection. Note that there may not be a weld on some brake bands.

14.2.3 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% 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.

14.2.4 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% 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.

14.2.5 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% or less than 90% of the original thickness.

14.3 Pre-erection inspections and tests (on ground inspection)

Tower crane components must be inspected and tested by a competent person prior to being delivered to the workplace.

Where a tower crane owner is aware a crane will be erected when the scheduled annual inspection is due (refer to section 14.7 of this code), then the owner may consider carrying out an annual inspection during the pre-erection inspection.

These inspections and tests must include the following:

(a) NDT of welds on vital components, such as boom clevises, butt heal bosses, counterweight rope sheave brackets
(b) NDT of tower crane bolts
(c) NDT of slew ring bolts
(d) NDT of aluminium sheaves
(e) the condition of the power supply cable where used
(f) the condition of motor brakes
(g) the condition of the slew ring gear and pinions
(h) air controls and associated valves
(i) the condition of ropes and sheaves (e.g. erection, hoisting, counterweight and trolley) and correct rope tracking
(j) the condition of limit switches and limiting devices
(k) the condition of counterweights
(l) the condition and fitment of machinery guarding
(m) brake systems, which must be dismantled and inspected for wear and damage according to the following criteria:
    (i) dry brakes—prior to each erection or more frequently if directed by the manufacturer
    (ii) wet brakes—prior to each erection, after 5 000 hours of crane operation or as directed by the manufacturer

(n) 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
(o) other tests specified by the manufacturer.

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

Inspections must also be made of:

(a) the crane base design and engineer's report
(b) crane ties and structure to support them where used
(c) the power supply and earthing.

Crane owners should develop their own pre-erection inspection and test report that 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.

14.4 Commissioning inspections and tests

Commissioning inspections and tests must be carried out by a competent person once the crane has been erected and 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.

Commissioning inspections and tests must include:
(a) crane electricity supply where used
(b) crane base weights or ballast where used
(c) tower section identification and access
(d) tower bolts to correct tension
(e) climbing frame and connection
(f) jib connection pins and retainers
(g) A-frame connections and retainers
(h) jib and deck pendant pins and retainers where used
(i) machinery guarding
(j) leakage in lines, tanks, valves, pumps, and other parts of air or hydraulic systems
(k) the condition of the ropes and sheaves (e.g. erection, hoisting, trolley and counterweight) and correct rope tracking
(l) isolating switches
(m) the condition and phase of the power supply cable
(n) verification that the crane wiring complies with *AS/NZS 3000: Electrical installations*
(o) effective operation of controls including interlocks
(p) effective operation of indicating devices
(q) effective operation of travel deceleration switches
(r) effective operation of hoist upper and lower (where required) working limit switches
(s) effective operation of warning devices
(t) effective operation of the hoist and travel brakes when the crane is laden to the maximum rated capacity
(u) effective operation of the rescue controlled descent device
(v) other tests specified by the crane manufacturer.

14.4.1 Commissioning report

Crane owners should develop their own commissioning report that 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.

14.5 Pre-operational inspection

A visual inspection and functional test of the crane must be carried out by the crane operator before the commencement of each work shift. This should include inspection and testing of the following:
(a) all relevant items indicated in the operations manual
(b) operating and emergency controls
(c) brakes
(d) safety switches and interlocks, including limiting and indicating devices
(e) visual inspection of the structure
(f) wire ropes to ensure they are on the drum and correctly reeved on the sheave
(g) wire ropes for obvious damage.

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

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

14.6 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:
(a) all functions and their controls for speed, smoothness of operation and limits of motion
(b) all emergency and safety switches and interlocks, including limiting and indicating devices
(c) lubrication of all moving parts and inspection of filter elements and fluid levels
(d) 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
(e) signage, including warning signs and control markings
(f) wear on wheels and rails
(g) 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.

14.7 Annual inspections

An annual inspection by a competent person is required as part of registration requirements of the crane.

Where a tower crane owner is aware a crane will be erected when the scheduled annual inspection falls due, the owner may consider carrying out an annual inspection prior to crane erection or during the pre-erection inspection (refer to section 14.3 of this code).

An annual inspection should include all items specified by the crane manufacturer for annual inspection, as well as relevant items included in the routine inspection and maintenance programs.

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

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

An example of an Annual crane safety certificate is provided in Appendix 4. This document may be used as evidence that the crane has received an annual safety inspection by a competent person.

14.8 10-year major inspection

Tower cranes must undergo a major inspection every 10 years. Under this code, the 10-year major inspection must include inspection of the structure as well as mechanical components. A separate inspection of the structure may not be required at 25 years.

The parameters of the 10-year major inspection should be considerably more comprehensive than the yearly inspection, due to the amount and severity of operation that a tower crane will be exposed to after 10 years. Even if the crane has not been exposed to regular operation during the 10-year period, 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 10-year major inspection must be certified by an engineer who has experience in the inspection of tower cranes. The engineer may use the advice of other competent persons when preparing the inspection report.

An example of a Crane safety certificate for a 10-year major inspection is provided in Appendix 5. This document may be used as evidence that the crane has received its 10-year major inspection by an engineer.

A 10-year 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 10-year major inspection requires particular attention to be given to the following:

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

14.8.1 Key inspection items for a 10-year major inspection

The following items, where appropriate, must be included in a 10-year major inspection for tower cranes:

(a) slew ring
(b) hydraulic motors
(c) hydraulic pumps
(d) valve blocks (bodies)
(e) hoist and luff drums
(f) braking systems
(g) rope sheaves
(h) hydraulic luffing cylinder
(i) gear boxes and drive shafts
(j) boom
(k) A-frame
(l) pins with moving parts (e.g. boom heel pins, ram pins)
(m) static pins
(n) steel wire ropes
(o) electrical systems

(p) control systems
(q) electric motors
(r) hook trolley (non-luffing cranes)
(s) 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.

It must not be assumed that the items included in the list only require inspection at 10-yearly intervals. 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 14.2.3 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 the preceding two years, this item does not have to be stripped down in the 10-year 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:
(a) slew ring
(b) hydraulic motors
(c) hydraulic pumps
(d) valve blocks
(e) hoist and luff drums
(f) pins with moving parts.

Slew Ring
(a) Remove the slew ring bolts and split the slew ring.
(b) Measure the wear in the slew ring.
(c) Replace worn bearings and spacers.
(d) Carry out NDT and repair of bearing race.
(e) Measure the backlash and teeth width in the pinion drives and ring drive to ensure they are within the manufacturer's specifications.
(f) Ensure all slew ring bolts are crack tested by NDT, or replaced with new bolts.

Hydraulic motors
(a) Remove, strip down and inspect all hydraulic motors.
(b) Replace all worn valves and other components.
(c) Ensure tolerances comply with manufacturer's specifications prior to reassembly.
(d) Ensure motors are pressure and performance tested prior to re-entering service.

Hydraulic pumps
(a) Remove, strip down and inspect all hydraulic pumps.
(b) Replace all worn valves and other components.
(c) Ensure tolerances comply with manufacturer's specifications prior to reassembly.
(d) Ensure pumps are pressure and performance tested prior to re-entering service.

Valve blocks (bodies)

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

Hoist and luff drums

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

Braking systems

(a) Remove and dismantle all brakes from the crane.
(b) Check pins, springs and bushes for correct tolerance.
(c) Replace rubber seals.
(d) Check pistons for correct operation.
(e) Ensure welds in braking systems are crack tested by NDT.
(f) Inspect hydraulic systems for leaks prior to reassembly on the crane.
(g) Inspect wear limits on brake linings.

Rope sheaves

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

Hydraulic luffing cylinder

(a) Remove cylinder and ram from the crane and strip the cylinder and valve blocks.
(b) Ensure gland nuts are crack tested and threads are checked for wear.
(c) Replace seals and re-chrome ram where necessary.
(d) Ensure the reassembled cylinder is pressure tested and checked for operation and leaks.
(e) Ensure welds on rod ends and caps are crack tested by NDT.

Gear boxes and drive shafts

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

Boom

(a) Ensure all NDT on boom components required in the pre-erection tests is carried out.
(b) Ensure ultrasonic chord thickness of boom is performed.
(c) Ensure a minimum of 10% 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

(a) Remove all pins.
(b) Ensure NDT is carried out on all connector welds on primary chords.

(c) Ensure a minimum of 10% of lacing welds are crack tested by NDT.

Pins with moving parts (e.g. boom heel pins, ram pins)
(a) Remove and inspect all pins with moving parts.
(b) 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.
(c) Inspect restraint systems (i.e. cheek plates) and grease nipples.

Static pins
(a) Remove and inspect all static pins.
(b) Repair pins if necessary.

Steel wire ropes
(a) 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*.
(b) Ensure ropes are only replaced with the type of rope specified by the crane manufacturer unless a professional engineer specifies otherwise.
(c) Inspect pins and terminations on pendant ropes.

Electrical systems (hazardous voltage)
(a) 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 machines – Electrical equipment of machines – General requirements* and *AS 3000: Electrical installations*.
(b) Replace damaged or worn components.
(c) Ensure sign-off is provided by the electrician.

Control systems (non-hazardous voltage)
(a) Ensure electrical control systems and components are inspected by a competent person.
(b) Replace damaged or worn components.
(c) Ensure sign-off is provided by the competent person.

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

Hook trolley (non-luffing cranes)
(a) Inspect hook trolley wheels for damage and wear.
(b) Replace hook trolley wheels if necessary.
(c) Ensure welds on the trolley are crack tested by NDT.

Hook assembly
(a) Dismantle and dimensionally inspect the hook assembly to ensure it is within the manufacturer's specifications.
(b) Ensure the hook is crack tested by NDT.

14.8.2 Action following a 10-year major inspection

Following a 10-year major inspection, the crane must be upgraded to comply with:

(a) the current version of *AS 1418.4: Cranes, hoists and winches – Tower cranes* or other relevant technical standards, or

(b) 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 10-year major inspection must be provided to the crane owner.

14.9 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:

(a) clearly describe the work undertaken and parts replaced

(b) be dated

(c) note the name of the person carrying out the work

(d) 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 10 year major inspection reports must be maintained and made available for examination as required.

14.10 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:

(a) replacement parts and components should be identical or equivalent to the original equipment parts and components

(b) a specific rectification program should be carried out where past experience has shown particular problems with a crane

(c) 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:

(a) 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

(b) 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
(c) repair, inspection and, where necessary, testing is carried out by a competent person
(d) all safety features and warning devices of the crane are maintained and tested
(e) 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:
    (i) the nature of the damage
    (ii) whether the crane is able to be repaired, and if so, what repairs must be carried out to minimise risks to health and safety
(f) repairs to the crane are carried out so as to retain the crane within its design limits
(g) annual maintenance, repair and inspection records are kept for the crane.

14.11 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.

14.12 Second-hand imported tower cranes

The importance of the maintenance history of second-hand imported tower cranes from overseas cannot be underestimated. Before a second-hand imported tower crane can be operated for the first time, the owner of the crane must ensure the crane is subject to an annual inspection, or a 10-year major inspection if the crane is at least 10 years old.

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 workplace 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' means a person who—
(a) either—
  (i) has the skills, qualifications, competence and experience to inspect the plant; and
  (ii) is registered under a law that provides for the registration of professional engineers; or
(b) is determined by the regulator to be a competent person.

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

'Design verification statement' means a statement that—
(a) is written and signed by a person who is eligible to be a design verifier for the design; and
(b) states that the design was produced in accordance with published technical standards or engineering principles specified in the statement; and
(c) includes—
  (i) the name, business address and qualifications (if applicable) of the design verifier; and
  (ii) 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 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—
(a) is a registered professional engineer under the *Professional Engineers Act 2002*, and
(b) is competent to perform the task.

'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.

'Load chart' means a notice fitted on a crane or hoist 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:
(a) the chief executive
(b) Standards Australia, or
(c) 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.
- Europaische Norm (European Standard).

Appendix 2: Relevant technical standards

Technical Standard	Title
AS 1353.2	Flat synthetic-webbing slings – Care and use
AS1418.1	Crane, hoists and winches – General requirements
AS 1418.4	Cranes, hoists and winches – Tower cranes
AS 1418.17	Cranes (including hoists and winches) – Design and construction of workboxes
AS/NZS 1554 (Series)	Structural steel welding
AS 1657	Fixed platforms, walkways, stairways and ladders – Design, construction and installation
AS 1891 (Series)	Industrial fall-arrest systems and devices
AS 2550.1	Cranes, hoists and winches – Safe use – General requirements
AS 2550.4	Cranes, hoists and winches – Safe use – Tower cranes
AS 2550.20	Cranes, hoists and winches – Safe use – Self-erecting tower cranes
AS 2759	Steel wire rope – Use, operation and maintenance
AS/NZS 3000	Electrical installations (Australian/New Zealand Wiring Rules)
AS 3775.2	Chain slings – Grade T – Care and use
AS 4024 (Series)	Safety of machinery
AS 4497.2	Round slings – Synthetic fibre – Care and use
AS 4991	Lifting devices
AS 60204.1	Safety of machines – Electrical equipment of machines – General requirements
AS 61508 (Series)	Functional safety of electrical/electronic/programmable electronic safety-related systems

Appendix 3: Items for inclusion in a familiarisation training checklist

Items that should be considered for inclusion in a familiarisation training checklist for tower crane operators include:

(a) person's name
(b) date of training
(c) type and model of crane
(d) location of crane
(e) location of operator manual
(f) location of pre-start logbook checklist
(g) location of load chart
(h) location of engine oil indicator
(i) location of hydraulic oil level indicator
(j) location of fuel level gauge
(k) operation and location of computer set switch
(l) operation and location of
    (i) slew brake controls
    (ii) luffing lever controls
    (iii) hoisting lever
    (iv) winch clutches
    (v) winch pawls
    (vi) foot and hand throttle
    (vii) seat adjustment
    (viii) isolating switch
    (ix) ignition switch
    (x) battery charge gauge
    (xi) engine oil pressure gauge
    (xii) work light switches
    (xiii) tachometer
    (xiv) computer switch
    (xv) computer settings.

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 (tick one box)**:**

- ☐ Professional engineering qualification, membership of professional organisation and crane industry experience
- ☐ Professional engineering qualification and crane industry experience
- ☐ Other tertiary qualification and crane industry experience
- ☐ Trade qualification and crane industry experience
- ☐ Other (state): _____

_____

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 the *Tower Crane Code of Practice*, and is safe to use.

Competent person signature: _____ Date: _____

Comments:_____

Appendix 5: Example - Crane safety certificate – 10-year 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: _____

Qualifications of competent person* (tick one box)**:**

☐ Professional engineering qualification, membership of professional organisation and crane industry experience

☐ Professional engineering qualification and crane industry experience

_____

Competent person statement:
I hereby certify that the crane, serial number: _____, has received its 10-year major safety inspection in accordance with the instructions of the crane designer and manufacturer and the *Tower Crane Code of Practice*, and is safe to use. This inspection includes mechanical, structural and electrical items of the crane.

Competent person signature: _____ Date: _____

Comments:_____