

Mobile crane

Code of Practice 2006

PN11180

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1. Introduction

The purpose of this code of practice is to give practical advice about how to manage risks associated with mobile cranes, vehicle-loading cranes and other mobile plant used as a mobile crane to raise or lower a freely suspended load.

For the purpose of this code:

A **mobile crane** means a machine that:

- (a) is used primarily for raising or lowering a freely suspended load;
- (b) is capable of travelling over a supporting surface without the need for fixed runways (including railway tracks); and
- (c) relies only on gravity for stability, with no vertical restraining connection between itself and the supporting surface, and no horizontal restraining connection (other than frictional forces at supporting-surface level) that may act as an aid to stability.

A **vehicle-loading crane** means a crane mounted on a vehicle or trailer to load and unload that vehicle or trailer, and which may be used for other lifting purposes within its rated capacity in accordance with the crane manufacturer's instructions.

Other mobile plant means a machine that is primarily used for activities other than raising or lowering a freely suspended load, and includes a backhoe, excavator, front-end loader and telescopic handler.

This code of practice 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) dismantling
- (g) inspecting
- (h) testing
- (i) maintaining
- (j) repairing
- (k) being in an area adjacent to a mobile crane, including a public area.

This *Mobile crane Code of Practice 2006* is an approved code of practice under section 274 of the *Work Health and Safety Act 2011* (the WHS Act).

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

From 1 July 2018, duty holders will be required to comply with either an approved code of practice under the WHS Act or follow another method, such as a technical or industry standard, if it provides an equivalent or higher standard of work health and safety to the standard required in the code.

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 WHS Act, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks which may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS Act and WHS Regulation. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice. This may include issuing an improvement notice for failure to comply with a code of practice where equivalent or higher standards of work health and safety have not been demonstrated.

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 WHS Act and WHS 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 WHS 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 WHS Act and WHS 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 WHS 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 WHS 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 in the *Work health and safety consultation, co-operation and co-ordination Code of Practice*.

1.1 Legislation

In order to understand the relevant workplace health and safety requirements for mobile cranes, a person must consider and understand the:

- (a) *Work Health and Safety Act 2011* (WHS Act)
- (b) *Work Health and Safety Regulation 2011* (WHS Regulation)
- (c) *Electrical Safety Act 2002* (ES Act)
- (d) *Electrical Safety Regulation 2013* (ES Regulation).

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 in Appendix 2.

Further information on Australian Standards is available at www.standards.org.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, co-operation and co-ordination 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, and
- (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
- 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, and
- (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, and
- (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 has different purposes, including:

- (a) induction training—provided to workers when commencing employment or when new to the job. This training is general and may involve a workplace tour, and 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 or 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 people with specific emergency roles and responsibilities, and
- (g) first aid training—provided to ensure appropriate procedures are followed for administering first aid.

Section 18 of this code provides further information on the training requirements for mobile crane operations.

3. Mobile cranes and construction work

When a mobile crane is used for construction work, there may be a number of activities associated with this work that is high risk construction work. These activities include:

- (a) tilt-up and precast construction work
- (b) the movement of the mobile crane at the workplace
- (c) work on a telecommunications tower
- (d) work in, over or adjacent to water, where there is a risk of drowning, and
- (e) work on, or adjacent to, a road or railway.

The WHS Regulation requires the preparation of a safe work method statement for high risk construction work.

A PCBU must prepare a safe work method statement for high risk construction work before starting that work.

4. Design and plant registration of mobile cranes

4.1 Registration of mobile crane design

Mobile cranes must be designed in accordance with acceptable engineering principles and relevant technical standards, to ensure the mobile crane is without risk to health and safety.

An application for registration of the design of an item of plant must be accompanied by:

- (a) a statement signed by the designer of the item of plant stating:
 - the designer has complied with their obligations under section 22 of the WHS Act
 - the published technical standards and engineering principles used in the design
- (b) a design verification statement
- (c) representational drawings of the crane
- (d) the relevant 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** a certificate to stop having effect:*

A certificate of registrable plant design is in force for the design of a mobile crane. The number of counterweights on the mobile crane is increased so that the rated capacity of the crane can be increased. This increases the stress in the crane and may increase the likelihood of the crane overturning. The certificate stops being in force because of the change.

*An example of a change in design **not causing** a certificate to stop having effect:*

A certificate of registrable plant design is in force for the design of a mobile crane. The mobile crane's hoist rope is replaced with a steel wire rope of a different construction (e.g. number of strands) than that listed in the original design registration submission, and the crane manufacturer

specifies that the new type of rope may be used. The certificate does not stop being in force because of the change.

5. Risks associated with mobile crane operations

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

- (a) structural failure
- (b) crane overturning
- (c) contact or collision with other plant and structures, and
- (d) falling objects.

Structural failure may include the failure of any crane component, such as the boom, jib, hydraulic rams or wire rope. A mobile crane may suffer structural failure if the crane has been overloaded in the structural area of its load chart. Structural failure may occur without warning.

A mobile crane is likely to **overturn** if the crane has been overloaded in the stability area of its load chart. This may be influenced by a number of factors including:

- (a) poor ground conditions such as unstable ground
- (b) failure to use or fully extend outriggers or stabilisers
- (c) failure to level the crane
- (d) rapid slewing, and
- (e) high wind conditions.

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

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

6. Limiting and indicating devices

Limiting and indicating devices must be fitted to mobile cranes as required by the version of *AS 1418.5: Cranes, hoists and winches – Mobile cranes* under which they have been design registered to, unless otherwise required by this code. 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.

6.1 Reliability of devices

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

Where limiting and indicating devices are to be installed on a mobile 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 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 load that may be attached and handled by the crane, and may not include the weight of the hook block, falls of rope, slings and rigging hardware. 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 mobile cranes manufactured since 2002 with a maximum safe working load of more than three tonnes. The limiter should prevent:

- (a) hoisting of a load, within the tolerance of 100 to 110 per cent of the maximum rated capacity, and
- (b) the radius being increased when the load exceeds 100 to 110 per cent at the particular radius.

6.3 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 a mobile crane to prevent motion out of its 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 (this is generally known as 'anti-two block')
- (b) the extreme permissible operating positions of the jib (luff limiter), and
- (c) the end positions of horizontally telescoping or movable jibs.

6.4 Working radius indicator

A radius indicator displays the radius of the suspended load generally measured from the centre of the slew ring, or centre of the front axle for pick-and-carry cranes. A radius indicator should be fitted on all mobile cranes that were originally designed with this feature.

6.5 Load indicators

Load indicators should be fitted to all mobile cranes with a maximum rated capacity of more than three tonnes. Load indicators measure and display the mass of the load being lifted. This indicator assists the crane operator to stay within the load chart and safe working limit of the crane. The load indicator should be capable of displaying the mass of the suspended load at all times.

6.6 Free fall lock-out

When a mobile crane is fitted with a free fall facility, the free fall function is to be locked out with a keyed lock-out.

7. Ergonomic issues

7.1 Safe means of access

Mobile cranes should be fitted with safe means of access that allow the crane operator to safely access the crane cabin and other frequently accessed areas of the crane. Safe access includes the provision of:

- ladders
- footholds
- steps
- grab rails.

Access provisions provided by the crane manufacturer should not be removed or modified unless a qualified person (e.g. an ergonomist) specifies otherwise. Where there is a risk of slips, trips and falls, it may be necessary to modify the walking surfaces with an anti-slip product (e.g. treads, paint).

7.2 Seating

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

7.3 Windows and windscreens

Clear vision must be provided in the operator's cabin at all times. Access must be provided to enable windows and windscreens to be regularly cleaned. Cracked glass in windows and windscreens must be replaced.

8. Crane documentation and markings

8.1 Load charts

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

Load charts must:

- include the information specified in *AS 1418.5: Cranes, hoists and winches – Mobile cranes*
- be written in English
- use metric units.

Where the crane has one main load chart, this should be fixed in the operator's cabin in a clearly visible location. Where the crane has numerous load charts (e.g. for different boom and fly jib configurations), the charts should be kept in a book, folder or envelope in the operator's cabin. Lifting should not take place unless the load charts are in the crane cabin. Although the crane's load moment system may appear to be operating correctly, the load charts must be available to verify that the crane is not being overloaded.

The lifting capacity of a crane is limited by:

- (a) **structural strength** when the working radius is small
- (b) **stability** when the working radius is greater.

The load charts on most cranes have a bold line or shaded area dividing the chart into two segments. The divided segments shows the crane operator which capacities are limited by structural strength, and which are limited by stability.

Ratings above the line are based on structural strength, while the ratings below the line are based on the stability of the crane. If a crane is overloaded in the structural area of the load chart, a structural or mechanical component of the crane may fail. However, if the crane is overloaded in the stability area of the load chart, the crane may overturn.

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.

On some mobile cranes, there may be numerous load charts for differing boom and counterweight configurations. The load charts may be complex and include numerous conditions that must be complied with to ensure the crane can safely lift a load. Two important factors that are often overlooked when reading load charts are:

- (a) The need to subtract the mass of the hook block and lifting slings from the capacity of the crane at the particular radius, unless otherwise noted on the load chart. For example, if the load chart states the crane can lift 20 tonnes at a given radius, but the hook and lifting gear have a combined mass of one tonne, the load to be lifted cannot be greater than 19 tonnes. This issue becomes critical for heavier hook blocks and lifting gear (e.g. spreader beams).
- (b) The need to subtract the mass of the fly jib from the capacity of the main hook when lifting from the main hook on the main boom with a fly jib attached to the boom head, unless this is allowed for and noted on the load chart. Capacities of the main boom are generally based on the fly jib being removed. If this issue is ignored, the likelihood of the crane overturning can be very high.

8.2 Crane operator's manual

The crane operator's manual is to be supplied with the mobile crane. The manual must be:

- written in English
- kept on the crane at all times.

8.3 Crane markings

A mobile crane and its lifting components must be marked permanently and legibly in accordance with the requirements specified in *AS 1418.5 – Cranes, hoists and winches – Mobile cranes*. The markings must be in English, with values in SI units.

All operator controls must be suitably marked to indicate their function and operation. The markings on the controls must be either in English or international code. The crane's computer is to be compatible with these requirements.

9. Planning and coordinating mobile crane operations

Planning is the first step in ensuring that work is done safely. The planning for mobile crane operations should start as early as possible to help eliminate many of the associated health and safety risks. In order for this to be successful, it should involve consultation with everyone engaged in the work. These people may include the principal contractor or crane hirer, crane supplier, electricity entity, engineer, PCBU and crane operator.

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

- (a) erecting and dismantling mobile cranes
- (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 mobile crane, including a public area.

Some of the issues to be considered when planning for mobile crane operations include:

- (a) determining crane requirements appropriate for the work to be undertaken

- (b) ensuring there is adequate workplace access
- (c) identifying the most appropriate location to site the mobile crane in relation to other buildings, structures and plant at the workplace
- (d) liaising with electricity entities regarding control measures for working around overhead powerlines
- (e) ensuring that the ground conditions are adequate to support the mobile crane
- (f) ensuring that the appropriate number of people is available to support safe mobile crane operations.

Other matters to be considered during the planning stage are listed in *AS 2550.5: Cranes, hoists and winches – Safe use – Mobile cranes*.

9.1 Selecting the crane

Matters to be considered in the selection of mobile cranes are outlined in *AS 2550.5: Cranes, hoists and winches – Safe use – Mobile cranes*.

Select the type and number of mobile cranes to suit the particular needs of a workplace. If crane characteristics do not match job requirements, then unsafe conditions are created before any work is done.

When selecting a mobile crane for a job, the size and characteristics of the crane should be assessed against the following criteria:

- (a) the weights, dimensions and lift radii of the heaviest and largest loads to be lifted
- (b) the maximum lift height and radius, and the weight of the loads to be handled at these points
- (c) the number and frequency of lifts to be made
- (d) how long the crane will be required at the workplace
- (e) the type of lifting to be done (e.g. precise placement of loads)
- (f) the type of carrier required—this depends on ground conditions and machine capacity in its various operating quadrants
- (g) whether loads are to be walked or carried
- (h) whether loads are to be suspended for lengthy periods of time
- (i) the workplace conditions, including the ground on which the crane is to be set up, access roads and ramps it will travel on, space for erection, and any obstacles that may impede access or operation.

There are basically four types of mobile cranes operating in Queensland—hydraulic slewing cranes (see figure 1), lattice boom cranes (including crawler cranes), hydraulic pick-and-carry cranes and vehicle-loading cranes. Each of the basic mobile crane types has advantages and disadvantages, and the best crane type should be selected for the job to be undertaken.



Figure 1 – Hydraulic slewing mobile crane

9.2 Crane crew

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

The risk assessment should consider the size and complexity of the lifts to be performed when determining the number of operators and doggers to work together in a crew.

Where the person responsible for slinging a load is required to exercise judgement in relation to the suitability and condition of lifting gear and the method of attaching the sling (including sling accessories) to the load or crane, then this person must hold a dogger's licence or be training to be dogger and be supervised by a licensed dogger.

9.3 Crane siting

The siting of a mobile 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 mobile cranes should occur after careful consideration of the above factors.

9.3.1 Collision between the crane and other plant or structures

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

- (a) overhead powerlines and other services
- (b) nearby structures
- (c) other cranes or high obstructions, including those on adjacent workplaces (e.g. concrete placement booms)
- (d) other mobile equipment moving within the crane working area, and
- (e) the vicinity of aerodromes and aircraft flight paths for 'high' cranes.

Mobile cranes should be positioned so that the risk of injury from collision with other plant is minimised. This issue is particularly important where mobile cranes are set up on public roads. In this situation, the traffic control procedures of the road controlling authority must be complied with.

Another way to minimise the risk of injury from collision with other mobile plant and vehicles is to increase the visibility of mobile cranes. One way to increase the visibility of a crane is to permanently mark the crane's outriggers and stabilisers with high visibility hazard striping (i.e. 'zebra striping' – see figure 2). The outrigger beams or hydraulic cylinders should be marked with the hazard striping. The striping should:

- (a) be at an angle 30-60 degrees to the horizontal
- (b) be 40-150mm wide
- (c) consist of two contrasting colours, one of which is red, yellow or white.

Note: If there is inadequate room on the stabilisers of vehicle-loading cranes, the dimensions of the hazard striping may be decreased.



Figure 2 – Hazard striping on a mobile crane

Where mobile 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 avoid the risk of injury from collision, refer to section 12 of this code.

9.4 Communication

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

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

An effective means of communication is particularly important where:

- (a) the crane operator cannot see the load
- (b) the crane operator cannot see the load's landing area
- (c) the crane operator cannot see the path of travel of the load or the crane
- (d) the crane operator is not in a position to make an accurate judgement of distance
- (e) it is possible for the crane to come into contact with overhead powerlines.

People 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. Everyone using the radios should be aware of the risk of interference and signals from other radio equipment. Work must 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 performing satisfactorily, and 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 people 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 signals and bell, buzzer and whistle signals should be used. These forms of communication should comply with *AS 2550.1: Cranes, hoists and winches – Safe use – General requirements*.

Mobile phones should not be used for directing mobile crane operations.

9.5 Documented lifting procedures

Documented lifting procedures can greatly assist with the safe operation of mobile cranes, as they help to define responsibilities and approach the crane lift in a logical, systematic way. As stated in section 3, safe work method statements must be prepared for a range of high risk construction work associated with cranes. Some PCBUs also require the preparation of documented lifting procedures prior to any crane lift.

Comprehensive documented lifting procedures are required in the following situations:

- (a) tilt-up panel jobs
- (b) multiple crane lifts, where more than one crane is used to lift a load at any one time
- (c) lifting of workboxes with persons in the boxes
- (d) installation of bridge beams during bridge installation work
- (e) working near live overhead powerlines
- (f) lifting large pressure vessels or tanks
- (g) the use of mobile cranes on barges
- (h) erection of tower cranes
- (i) heavy lifts where the load is 50 tonnes or more.

Documented lifting procedures for the lift types mentioned above should include the following:

- (a) maximum load radius to be used for the cranes
- (b) where spotter duties are required (e.g. for preventing collision or contact with powerlines), what the duty is and who is responsible for performing the duty
- (c) position of the load to be lifted and the final position to which it is to be lifted, where practicable (a diagram that shows a plan view of the site may assist)
- (d) maximum wind speed where the load has a large surface area
- (e) verification of the maximum allowable ground bearing pressure (this must be carried out for heavy lifts—see section 10.2.4)
- (f) allowance for any factors that may require de-rating of the crane (e.g. for multiple crane lifts, additional radius caused by tilting of tilt-up panels)
- (g) rigging requirements of the job.

However, where the crane lift is being carried out in connection with high risk construction work, the documented lifting procedure may also include the information required for a safe work method statement.

10. Crane stability

Stability is one of the most important safety issues relating to mobile cranes. Failure to maintain stability is one of the key factors associated with serious crane incidents. The main issues relating to crane stability are:

- (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, the part of the crane boom that is outside the tipping point of the crane, and the wind
- (c) the ground conditions and means of supporting the outrigger pads or the crane tyres
- (d) the slope of the ground—both side slope and slope in direction of crane travel (this particularly applies to pick-and-carry cranes)
- (e) wind conditions—this will vary depending on the size and shape of the suspended load and crane boom.

To ensure the crane does not overturn, the above factors must be addressed.

10.1 Stabilising and overturning moments

10.1.1 Stability function of load charts

The stability factors specified by *AS 1418.5: Cranes, hoists and winches – Mobile cranes* allow for variables such as:

- (a) dynamic factors caused by the crane motion and the load (e.g. for boom movement, application of brakes, swaying of the load)
- (b) wind effects on the load and boom.

AS 1418.5: Cranes, hoists and winches – Mobile cranes requires that the stability factor of mobile cranes be based on 75 per cent of tipping for stationary mode, and 66.6 per cent for pick-and-carry mode. All mobile cranes should comply with this design requirement and the stability factor should be written on all load charts for the crane. Where second-hand cranes are imported from overseas, the crane should be stability tested to demonstrate it complies with the stability requirements of *AS 1418.5: Cranes, hoists and winches – Mobile cranes*.

When the load chart is based on 75 per cent of tipping, the maximum capacity in the stability range of the load chart will be 75 per cent of the suspended load that will cause the crane to overturn. In other words, the actual overturning load will be 33.3 per cent greater than the load being lifted. Therefore, if a crane's maximum capacity at a given radius in the stability range of the load chart is 10 tonnes, a 13.3 tonne load will cause the crane to overturn. However, it is also possible for a crane to overturn with smaller loads when operating in windy conditions or on sloping ground, or if the crane is not operated smoothly.

10.1.2 Counterweights

The crane counterweight is critical in ensuring crane stability. A counterweight that is too light for a load and boom configuration will cause the crane to overturn in the direction of the suspended load. Additionally, a crane can fall over backwards due to the effect of the counterweight in situations when:

- (a) the counterweight is too heavy for the boom configuration
- (b) the crane is travelling up a slope with the boom luffed up
- (c) inadequate timbers are placed under the outrigger pads below the counterweight when the crane is positioned on soft ground
- (d) outriggers are not extended or lowered into position.

On the majority of smaller mobile cranes, the counterweight is fixed and cannot be easily removed. However, on an increasing number of larger cranes, some of the counterweights are designed to be removed for road travel, or when smaller boom and lifting configurations are required. In this situation, it is particularly important to attach the correct type and number of counterweights to the crane for the particular lift to be undertaken.

Counterweights must be secured to the crane in the manner specified by the crane manufacturer. Where counterweights are removable, each counterweight must be clearly and permanently identified with the crane manufacturer's name or trademark and the mass of the counterweight (preferably in tonnes).

Where the crane is fitted with a rated capacity limiter, the data input into the computer must be correct for the counterweight configuration on the crane, and related to that shown on the appropriate load chart. This also applies to the boom configuration being used on the crane. In some unusual circumstances, additional counterweights are attached to the crane to increase its capacity. If this is done, an engineer is to check the complete crane design and certify that the amended design complies with *AS 1418.5: Cranes, hoists and winches – Mobile cranes*.

10.2 Ground conditions and crane support

Ground conditions can vary dramatically from one workplace to another, and even within the one workplace. Failure to address poor ground conditions to ensure crane stability may cause the crane to overturn resulting in serious injury to the crane operator and other people in the vicinity of the crane.

10.2.1 Ground factors

Factors that will affect the ability of the ground to provide adequate support include the following:

- (a) the presence of water, including when it is mixed with the soil as mud, and where it is present under the surface (e.g. underground springs or streams)
- (b) the type of ground (e.g. clay, sand, rock or a mixture of these)
- (c) backfilled ground that was previously an excavation or trench
- (d) cavities or penetrations in the ground that have been covered but still exist
- (e) continued operation of the crane in one location.

When a mobile crane is being set up, the crane operator can only make a decision based on the surface of the ground. Generally, rock provides the most stable supporting surface for a mobile crane. However, although rock may be present on the surface, it may not extend far below the surface. One way to establish how far rock may extend below the surface is to examine nearby excavations or trenches at the workplace. Rock that extends far below the surface provides a good indication of the ground's integrity. However, this will only provide a reasonable indication of the ground's strength when the excavation is not too far from the crane. Additional risks must be managed when outriggers are positioned too close to an excavation. See section 10.2.2 of this code for further information.

Care also needs to be taken with ground that has a 'crust' on its surface. The surface of this type of ground is usually firmer than the ground underneath. The firm surface may give the perception that the ground is more stable than it actually is. If the ground is punctured by an outrigger, or the end of a crawler track, the softer ground will be exposed, which may cause the crane to overturn.

Where a mobile crane is continuously operated in one location, the ground underneath the outriggers will compact. Additional care needs to be taken to ensure that the crane has not compacted the ground to the extent that the minimum overturning moment of the crane is reduced (i.e. the crane is more likely to overturn).

10.2.2 Crane proximity to excavations and trenches

When cranes are set up close to excavations or trenches, there may be an increased risk of the sides of the excavation or trench wall collapsing, causing the crane to overturn. This risk increases with softer ground, and the presence of groundwater. Additionally, the risk of collapse is greater for vertical cuts in the excavation wall in comparison to walls that have been battered back at an angle. The presence of 'slippery back', where there is a naturally occurring slip plane such as a fracture in the ground, can also increase the risk of excavation or trench collapse.

Generally, the following principles should be applied when setting up mobile cranes near excavations:

- (a) Where the ground is compact and non-friable (i.e. not crumbling), the distance of any part of the crane support timbers from the excavation should be at least equal to the depth of the excavation (1H:1V rule).

For example, for a three metre deep trench in compact ground, the outrigger timbers or pads should be a horizontal distance of at least three metres away from the closest edge of the trench wall.

- (b) Where the ground is loose or backfilled (i.e. crumbling), the distance of any part of the crane support timbers from the excavation should be at least twice the depth of the excavation (2H:1V rule).

For example, for a three metre deep trench in backfilled ground, the outrigger timbers or pads should be a horizontal distance of at least six metres away from the closest face of the trench wall.

10.2.3 Timbers, pads and bog mats

A variety of materials can be used to distribute the mass of the mobile crane, and the suspended load to the ground. Lengths of timber (timbers) with rectangular cross sections (see figure 3) are the most common form. However, timber and plastic pads are also provided for some cranes. For heavier lifts, bog mats (see figure 4), usually consisting of steel plate, are often used under mobile cranes. Timbers and pads are usually provided under outrigger feet, while bog mats may be used under the tracks of crawler cranes or where larger lifts are carried out.



Figure 3 - Crane outrigger foot on timbers



Figure 4 - Crane outrigger foot on bog mat

Crawler cranes will generally apply considerably less point load to the ground than a crane on outriggers with no timbers. This is because of the large area of tracks in contact with the ground, in comparison with the smaller contact area of the outriggers, on cranes of similar capacity. However, for heavy lifts, and where the ground has poor bearing capacity, bog mats or other supporting materials may be required.

Timbers, pads and bog mats should be of dimensions and materials as specified by the crane manufacturer. If the manufacturer has not provided this information, a competent person should specify the minimum size of the material to be used.

Generally, the following principles should be applied to timbers, pads, steel plates and bog mats:

- (a) Timbers should have a minimum width of 200mm and minimum thickness of 75mm.
- (b) Timbers should be laid together so that the width of the timber pad is wider than the outrigger foot with no gaps between timbers.
- (c) Pads should have a minimum thickness of 75mm.
- (d) The dimensions of steel plates and bog mats should be determined by a competent person, based on the type of mobile crane.

10.2.4 Performing heavy lifts

The likelihood of a mobile crane overturning is greater when the crane is used to lift heavy loads. It is extremely important to ensure the ground has adequate bearing capacity to support the crane when performing the following lifts:

- (a) bridge beams
- (b) tilt-up panels
- (c) other heavy lifts where the load is 50 tonnes or more.

The bearing capacity of the ground is usually estimated by the crane operator when lifting smaller loads. However, certification of the ground bearing capacity must be obtained from a geo-technical engineer before performing a heavy lift (see section 10.2.6 for further information).

The crane owner should compare the ground bearing capacity with the maximum pressure the crane will apply to the ground for the lift. The maximum pressure applied by a crane is a function of the crane mass, crane configuration (i.e. boom length and centre of gravity) and the mass of load on the hook. The ground bearing capacity must be greater than the maximum pressure applied by the crane to the ground to ensure adequate crane support. If not, then appropriate control measures, such as the use of bog mats, must be in place to increase the ground bearing capacity before the lift is performed.

10.2.5 Cranes on outriggers (or stabilisers)

The use of outriggers on mobile cranes helps to provide greater stability to the crane when lifting loads. Irrespective of the ground conditions, timbers or other means of distributing the load should always be placed under the outriggers.

Outriggers should be set according to the manufacturer's operating instructions for the specific type of mobile crane. The outriggers should also be used to help level the crane.

Many cranes are not designed for lifting with partially extended outriggers. If one or more outriggers are not fully extended, the crane may become unstable during lifting operations. In some instances, it may not be possible to fully extend all outriggers. Only cranes that have the manufacturer's approval to lift with partially extended outriggers should be used this way. If a lift is to be undertaken with partially extended outriggers, the correct outrigger configuration, according to the appropriate load chart, must be used.

10.2.6 Calculating pressure applied by outriggers

A number of crane manufacturers provide information on the maximum ground pressure that is applied when the crane is at maximum capacity, in the stability range of the load chart.

Different ground types will have different ground bearing capacities. Generally, harder ground, such as rock, is capable of withstanding higher ground pressures than softer ground, such as dry sand. Where the ground consists of a combination of ground types, the poorer ground type should be used for determining the maximum ground pressure that can be applied to the ground when the crane is set up on outriggers. Table 1 identifies the maximum permissible ground pressure according to the ground type.

Table 1: Maximum permissible ground pressures for various ground conditions

Ground type	Maximum permissible ground pressure, P_{MAX} (Tonnes per m^2)
Hard rock	200
Shale rock and sandstone	80
Compacted gravel (with up to 20% sand)	40
Asphalt	20
Compacted sand	20
Stiff clay (dry)	20
Soft clay (dry)	10
Loose sand	10
Wet clay	Less than 10

The greatest force applied by any outrigger to the ground will be:

- (a) at the point of tipping, just as the crane is about to overturn
- or
- (b) when the crane boom is located directly above an outrigger foot.

If a crane is designed in accordance with AS 1418.5: *Cranes, hoists and winches – Mobile cranes*, the crane will overturn within the stability part of the load chart when the maximum safe working load (SWL) is multiplied by a factor of 1.33. In reality, a crane will not approach this condition,

provided the operator does not overload the crane. However, a reasonable approximation for maximum ground pressure applied by the outriggers is detailed below.

Pressure (tonnes per m²) applied by outrigger feet

$$P_{out} = \frac{0.65 \times (\text{total crane mass} + \text{lifted load})}{\text{(individual outrigger area)}}$$

$$P_{out} = \frac{0.65 \times (C_M + L)}{\text{area}}$$

When the maximum permissible ground pressure is known, the minimum area required under the outrigger feet can be calculated as follows:

Minimum area required under outrigger foot

$$\text{area} = \frac{0.65 \times (\text{total crane mass} + \text{lifted load})}{\text{maximum permissible ground pressure}}$$

$$\text{area} = \frac{0.65 \times (C_M + L)}{P_{MAX}}$$

To find the length and width dimensions for the outrigger timbers, find the square root of the area ($\sqrt{\text{area}}$).

The following examples demonstrate the practical application of the above formulae.

Worked example 1

A mobile crane with a total mass of 40 tonnes is lifting a 20-tonne load—20 tonnes is the maximum the crane can lift in the stability range of the load chart. Each of the four outrigger feet on the crane are provided with timbers that are 0.8 m long by 0.8m wide. Calculate the maximum ground pressure that will be applied to the ground when lifting directly above an outrigger foot.

*Lifted load (L) = 20 tonnes
Total crane mass (C_M) = 40 tonnes*

*Timber area in contact with the ground = 0.8 m x 0.8 m
= 0.64 m²*

Pressure applied by outrigger feet

$$P_{out} = \frac{0.65 \times (C_M + L)}{\text{area}}$$

$$P_{out} = \frac{0.65 \times (40 \text{ tonnes} + 20 \text{ tonnes})}{0.64 \text{ m}^2}$$

$$P_{out} = \frac{39 \text{ tonnes}}{0.64 \text{ m}^2}$$

$$P_{out} = 60.9 \text{ tonnes per m}^2$$

Worked example 2

A mobile crane is to be set up on its outriggers on compacted gravel. The crane has a total mass of 25 tonnes and is to lift a 10-tonne load—10 tonnes is the maximum the crane can lift in the stability range of the load chart. The lift plan

requires the load to be slewed above each outrigger foot. Calculate the minimum required area of the timbers to be placed under each outrigger when lifting directly above an outrigger foot.

Lifted load (L) = 10 tonnes

Total crane mass (C_M) = 25 tonnes

Maximum **permissible** ground pressure (P_{MAX}) for compacted gravel = 40 tonnes per m^2

$$\text{area} = \frac{0.65 \times (C_M + L)}{P_{MAX}}$$

$$\text{area} = \frac{0.65 \times (25 \text{ tonnes} + 10 \text{ tonnes})}{40 \text{ tonnes per } m^2}$$

$$\text{area} = \frac{22.75 \text{ tonnes}}{40 \text{ tonnes per } m^2}$$

$$\text{area} = 0.569m^2$$

Dimensions of outrigger timbers:

$$\sqrt{0.569m^2} = 0.754m$$

Therefore, length x width of timbers required = 755mm x 755mm.

10.2.7 Crawler cranes

The ground pressure applied by crawler cranes is different to that applied by a crane on outriggers. It is sometimes assumed that the ground pressure will be the same at any place where the track is in contact with the ground. However, in practice this is rarely the case.

When the crawler crane is being used with a suspended load, the ground pressure will be greater towards the front of the crane. If there is no load suspended on the crane, the ground pressure will be greater towards the rear of the crane.

The distribution of ground pressure applied by a crawler crane will vary according to the working radius, load mass and counterweight mass.

10.3 Sloping ground—pick-and-carry cranes

Many crane roll overs occur when pick-and-carry cranes travel with a load along a side slope. This may also occur to telescopic handlers and other mobile plant when travelling with a suspended load. Working on a slope has the effect of either increasing or decreasing the working radius of the crane, which may in turn affect the stability of the crane, and cause the crane to overturn either forwards, backwards or sideways.

Where the centre of gravity of the mobile crane is high above the ground, a minimal ground slope can be a major factor in causing the crane to overturn. This particularly applies when:

- the boom has a high luff angle
- the boom is telescoped out
- the centre of gravity of the suspended load is high.

A side slope of only two or three degrees can have a drastic effect on the stability of the crane. Soft ground, pneumatic tyres and suspension movement will also tend to increase the side angle of the crane and make the risk of overturning greater.

Most manufacturers of pick-and-carry mobile cranes specify the cranes are to be operated on firm level ground. *AS 1418.5: Cranes, hoists and winches – Mobile cranes* does not require that mobile cranes be tested on gradients unless the crane is rated to operate on a gradient exceeding 1 degree (0.57 degrees).

In practice, it can be very difficult to ensure the supporting surface for a pick-and-carry crane does not exceed a side gradient of 1 degree. This is particularly the case at a workplace where construction work is being performed where the ground condition and slope may be constantly changing. A pothole in the ground will have the same effect as a gradient if the crane's wheel enters the hole.

Where possible, avoid working or travelling on sloping ground. If working or travelling on a slope is unavoidable, consider carrying the load on the uphill side of the crane, regardless of the direction of travel. Travel on a slope should be up or down the slope, not across the slope. Reference should be made to side de-rating charts prior to carrying out this work.

10.4 Wind conditions

Strong winds impose additional loads on a crane and affect the crane's stability. A maximum permissible wind speed of 10 m/second (36 km/hour) is specified for mobile crane operation by some crane manufacturers. Crane configurations designed for wind speeds other than 10 m/second should have the design wind speed marked on the rated capacity chart.

Where wind speeds exceed the maximum figure stated by the crane manufacturer for a specific mobile crane, crane operations should cease, and the crane be placed out of service. Crane operators should recognise that dependent on the boom length, the wind speed may be greater at the height of the load compared to the wind speed at the height of the crane's cabin.

A crane manufacturer will generally only specify a maximum wind speed 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. Wind speed may be much greater above the ground level than next to the operator's cabin. Also, the effect of wind gusts will have a different effect on the crane than a constant wind. Given these variables, crane operators must base their decision to make a lift on information provided by the crane manufacturer and their experience as a crane operator. If the operator believes it is unsafe to lift the load, written certification should be obtained from the crane manufacturer or an engineer prior to lifting taking place.

Mobile cranes must be operated within their engineered design capacity. To ensure the stability of a mobile 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. Generally, the safe operation of a crane becomes difficult to ensure when the wind speed exceeds 36 km/hour, irrespective of the size of the load. However, in many situations, this speed may be excessive, particularly where the load and boom have large surface areas.
- (b) Where the crane is lifting close to its rated capacity, the wind will have a greater effect on the crane stability and the potential application of a side load on the crane's boom.
- (c) Where the lift is a non-standard lift, with a suspended load or large surface area to be undertaken in windy conditions, a competent person should provide written advice on safe lifting conditions.
- (d) Consider attaching wind gauges to mobile cranes or providing another reliable method of measuring wind speed (e.g. handheld wind gauge). Where wind gauges are to be attached to the crane, they should be mounted at the top of the main boom, and calibrated at predetermined intervals, to ensure they provide accurate readings. Guidance on this issue should be obtained from the crane manufacturer or supplier. The provision of wind gauges on mobile cranes is strongly recommended where the maximum rated capacity of the crane is 100 tonnes or greater.

10.5 Roles and responsibilities regarding crane stability

While the crane operator is primarily responsible for crane stability to ensure a crane will not overturn, other persons who are also responsible for the stability of a crane include:

- (a) the crane manufacturer and supplier
- (b) the principal contractor or PCBU
- (c) the crane owner (PCBU)
- (d) doggers.

Refer to section 13.1 of this code for information on the roles and responsibilities associated with safety issues other than crane stability.

10.5.1 The crane operator

Crane operators must have a comprehensive knowledge of the operating capabilities of the crane, and be competent to carry out the lifting operation to ensure the crane does not overturn. The operator should have the final say about whether a lift should proceed and must be satisfied that:

- (a) the crane is adequately supported on the ground and the crane is level to within the tolerance specified by the crane manufacturer
- (b) materials placed under the outrigger feet or crawler tracks, to help ensure the crane does not overturn, are set up to comply with the crane manufacturer's specifications, or the crane owner's specifications if the former do not exist (see section 10.2.6)
- (c) the suspended load will remain within the rated capacity of the load chart
- (d) the functions of the crane are operating properly, including all crane motions, brakes, load moment systems and indicators, and
- (e) the wind is not excessive for the load being lifted, particularly for loads with a large surface area, and when the load is high above the ground.

Crane operators should also regularly inspect the ground to ensure that continuous operation of the crane has not compressed the ground to the extent that further operation of the crane will be unsafe.

An operator should not operate a pick-and-carry crane on gradients exceeding those specified by the manufacturer. Operators should not be expected to calculate how much to de-rate the capacity of the crane where the crane manufacturer does not provide written guidance on this issue.

Operators of mobile cranes must exercise proper diligence and ensure that the crane is operated in accordance with the crane manufacturer's instructions.

10.5.2 The crane manufacturer and supplier

The crane manufacturer must ensure that the crane complies with the strength and stability requirements of the design standard to which the crane has been manufactured. The crane manufacturer should be able to demonstrate that the stability of the crane is based on *AS 1418.5: Cranes, hoists and winches – Mobile cranes* and the stability factor is to be marked on the load chart (i.e. based on 75 per cent of tipping for stationary mode and 66.6 per cent for pick-and-carry mode).

The crane supplier must ensure that the information about the crane's stability factor is provided to the crane user.

Cranes on outriggers

Manufacturers of cranes made since 2000 should provide documented information on the maximum load and pressure applied by the outrigger foot to the ground for the different boom configurations supplied with the crane. The crane manufacturer should also ensure that instructions are provided that clearly show the operator the area and type of timbers or pads to be placed under the outrigger feet. Where these specifications will not ensure adequate crane support on soft ground with a bearing capacity less than 10 tonnes per m², the crane manufacturer or

supplier must clearly state the minimum required ground bearing capacity. This information should be placed in the operator's cabin.

Pick-and-carry cranes (including crawler cranes)

Side slope—manufacturers and suppliers of pick-and-carry mobile cranes (see figure 5) should provide clear information on the maximum side slope the crane may be safely operated on. For example, specifying the maximum allowable side gradient will provide more specific information to the operator compared to the term 'firm level ground', which may be open to some interpretation (e.g. tolerance).



Figure 5 – Pick-and-carry mobile cranes (non-slewing hydraulic cranes)

A pick-and-carry crane can not consistently remain within an operational slope of less than one degree at a workplace where construction work is being performed. It is recommended that crane manufacturers and suppliers provide details on the amount of de-rating that must be applied on side slopes with a gradient of up to five degrees.

Ground pressure—crane manufacturers and suppliers of pick-and-carry cranes should provide documented information on the maximum pressure applied by the crane's tyres or tracks to the supporting surface.

10.5.3 A principal contractor or PCBU

A principal contractor or PCBU should supply to the crane crew all information on the location of trenches, backfilled excavations and covered penetrations at the workplace. In some situations, it will not be obvious that the ground will support the crane by simply looking at the ground surface. Where documentation is available to the principal contractor or the PCBU on ground bearing capacity, this information must be made available to the crane operator.

However, the principal contractor or PCBU must obtain documented information about the ground bearing pressure from a geo-technical engineer when a mobile crane is required to perform the following lifts:

- (a) bridge beams
- (b) tilt-up panels
- (c) other heavy lifts where the load is 50 tonnes or more.

A principal contractor or PCBU must provide this information to the crane owner to ensure the crane owner can verify that the mobile crane will have adequate support to carry out the heavy lift.

A principal contractor or PCBU must not attempt to unduly influence a crane crew to perform a lift that the crane operator considers to be unsafe.

10.5.4 The crane owner (PCBU)

The crane owner should ensure that the timbers or pads supplied with the crane will adequately support the crane. The crane owner may need to seek the advice of a competent person when selecting appropriate materials to support the outrigger feet.

Where the timbers or pads supplied by the crane owner will not ensure adequate crane support on soft ground with a bearing capacity of less than 10 tonnes per m², the crane owner is to clearly state the minimum ground bearing capacity. This information should be placed in the operator's cabin.

The crane owner must be given information about the ground bearing capacity from the principal contractor or PCBU before a mobile crane can be supplied to perform the following lifts:

- (a) bridge beams
- (b) tilt-up panels
- (c) other heavy lifts where the load is 50 tonnes or more.

Once this information is obtained, the crane owner can ensure that adequate control measures are available to ensure the crane has adequate support to carry out the heavy lift.

10.5.5 The dogger

The dogger is responsible for safely slinging the load and providing accurate directions to the crane operator on load movement to ensure crane stability. This includes:

- (a) communicating the weight of the load to the crane operator, where this is known, to help ensure the SWL of the crane is not exceeded
- (b) calculating the SWL of the ropes, slings, chains and other lifting accessories to be used in the lift
- (c) taking adequate precautions when directing a pick-and-carry crane across rough surfaces and checking the area for other hazards
- (d) providing the crane operator with clear and accurate directions.

11. Minimising risk of injury from collision

Failure to maintain sufficient clearance between a mobile crane and other plant and structures may result in a collision between the crane, or its load, with other plant or structures. The possible outcomes from this collision include:

- (a) damage to crane components, such as the boom, which may seriously weaken the component, leading to structural collapse
- (b) injury to persons in the vicinity of the crane, including workers and members of the public.

11.1 Working near overhead powerlines

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

11.1.1 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 2013*—states the allowable working distance for working near a live part
- (c) *Working near overhead and underground electric lines Code of Practice* which gives practical advice on safe systems of work and exclusion zones, and the *Managing electrical risks in the workplace Code of Practice* (published by the Electrical Safety Office).

11.1.2 Planning for work near overhead powerlines

Before setting up a mobile crane in the vicinity of overhead powerlines, consultation regarding the work and the related risks should occur between the PCBU and the mobile 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.

11.1.3 Exclusion zones

An exclusion zone is the prescribed safety envelope around a live electrical part. Under the ES Regulation, 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 ES Regulation. 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, and
- (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.

11.1.4 Devices to minimise the risk 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 powerlines acts as a visual aid to highlight the location of the overhead 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 7.1 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 ES Regulation and the *Working near overhead and underground electric lines Code of Practice*.

11.2 Working near other plant and structures

A collision between a mobile crane and other plant (e.g. other cranes and mobile plant) and structures (e.g. buildings) may cause injury to persons present in the vicinity of the crane from:

- (a) dropped loads
- (b) overturning cranes
- (c) broken crane components, such as boom sections.

Where two or more cranes or other mobile plant work within a workplace, or share the same airspace, a documented procedure, such as a safe work method statement for construction work, must be established to ensure sufficient clearances are maintained between the cranes, their loads and the mobile plant.

When cranes operate in adjacent areas, they may share the same airspace. Systems of work should be negotiated between the persons in control from each work area to ensure sufficient clearances are maintained between the cranes. Each work area should nominate a person who has a responsibility to implement a correctly documented system to minimise the risk of injury from a collision.

12. Erecting and dismantling mobile cranes

Failure to erect or dismantle mobile cranes in accordance with the crane designer's or crane manufacturer's instructions may result in injury to persons from crane collapse or falling objects.

12.1 Responsibilities for persons erecting and dismantling mobile cranes

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

A PCBU should ensure there is a documented work procedure that follows the crane manufacturer's specifications for the erecting and dismantling process. Following the information outlined in the work procedure should ensure that:

- (a) the crane is erected or dismantled in accordance with the crane designer's or manufacturer's instructions
- (b) access to and egress from the crane complies with relevant technical standards
- (c) the crane is stable during erecting and dismantling
- (d) the proposed method for erecting or dismantling the crane will not adversely affect other plant and structures
- (e) approved special tools, jigs and appliances necessary to minimise any risk of injury during erecting and dismantling are used
- (f) the interaction of the crane with other plant is considered
- (g) environmental factors, such as wet or windy conditions, are considered; and
- (h) workers are provided with suitable fall protection when working at a height.

12.2 Minimising risk of injury during erecting and dismantling processes

12.2.1 Crane collapse

Written instructions for erecting and dismantling a mobile crane should be available with the crane. All erecting and dismantling activities should be supervised by a competent person. Only parts and components that meet the specifications of either the crane manufacturer or a competent person should be used when erecting a mobile crane. The crane components should be assembled in the correct sequence, using appropriate tools and equipment according to the prescribed assembly procedures.

When changing boom sections on lattice boom cranes (see figure 6), the crane operator should take special care to prevent the collapse of the boom. Adequate support should be provided under each section before removing the joint pins or bolts. When joint pins or bolts are replaced, they should be provided with properly fitted split pins or a locking device.



Figure 6 – Lattice boom crawler crane

Where required, the crane manufacturer's required counterweight is to be attached to the crane at the appropriate location before the boom or jib is fitted or removed. Crane manufacturers may require sequential installation or removal of the fly jib, counterweights and boom components.

12.2.2 Falling objects

Erecting and dismantling activities are likely to produce falling objects. To minimise the risk of persons being hit by falling objects during these activities, control measures based on a risk assessment should be implemented. For example:

- (a) Erect and maintain effective barricades at an appropriate distance around the mobile crane. Only persons who are directly involved in erecting and dismantling activities are to be allowed inside this area.
- (b) Schedule the erecting and dismantling of the crane to occur when the movement of other persons and mobile plant at the workplace is at a minimum.

13. Operational issues

13.1 Roles and responsibilities associated with mobile crane operations

All persons involved in mobile crane operations must have a clear understanding of their responsibilities. Such persons must understand their role and responsibility for the safety of each lift. Refer to section 10.5 of this code for specific information on the roles and responsibilities associated with crane stability.

13.1.1 Crane owner

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

A crane owner should ensure that the crane manufacturer's operating manual is kept on the crane, and maintain all of the other crane manufacturer's manuals and instructions. Instruction and training based on the manuals and instructions should be provided to all persons involved in mobile crane operations. Crane maintenance manuals should also be made available to all maintenance staff.

A crane owner or a competent person nominated by the crane owner, other than the crane operator, should perform a workplace visit and inspection to ensure that an appropriate crane is supplied to perform the following types of work:

- (a) tilt-up panel jobs
- (b) multiple crane lifts, where more than one crane is used to lift a load at any one time
- (c) lifting of workboxes with persons in the boxes
- (d) installation of bridge beams during bridge installation work
- (e) lifting large pressure vessels
- (f) erection of tower cranes
- (g) heavy lifts where the load is 50 tonnes or more.

However, if the crane owner is familiar with the workplace from previous visits, the crane owner may decide not to perform another visit.

A crane owner's responsibilities also include:

- (a) defining roles and responsibilities for all persons involved with the crane operation
- (b) ensuring a thorough equipment maintenance and inspection program is in place
- (c) ensuring equipment is maintained and inspected in accordance with the crane manufacturer's requirements and the requirements of this code and other relevant technical standards
- (d) not allowing a person in charge of and/or operating a crane, excluding operator of vehicle loading crane with capacity of 10 metre tonnes or more, to also undertake their own dogging work or supervise a trainee dogger, even if the operator is also a licensed dogger.

13.1.2 Principal contractor

A principal contractor has a duty to ensure the overall coordination of the lifting operations at a workplace where construction work is being performed. This includes ensuring systems are in place to facilitate communication between all PCBUs and workers at the workplace, for overlapping work areas.

A principal contractor's responsibilities also include:

- (a) ensuring the workplace is adequately prepared for the incoming mobile crane
- (b) consulting with the crane operator once the crane arrives at the workplace
- (c) ensuring all persons have been provided with site-specific induction where required, before they start work at the workplace
- (d) sighting general induction evidence for all PCBUs and workers before they start construction work at the workplace
- (e) ensuring crane operators and doggers hold the appropriate licence to perform a class of high risk work.

A principal contractor must not attempt to unduly influence a crane crew to perform a lift that the crane operator considers to be unsafe.

13.1.3 Crane operator

The primary role of the crane operator is to perform the function of the crane operation in a safe manner. The 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.

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 workplace conditions that may affect crane operation, including the presence of overhead powerlines, nearby structures, cranes and concrete placement booms
- (f) basic slinging techniques.

Before and during crane operation, the crane operator must:

- (a) check no unauthorised persons are present on the crane
- (b) inspect the area, including the ground condition
- (c) monitor the ground condition during repetitive crane lifts in one location
- (d) check each motion to be performed is safe and without risk
- (e) complete the daily inspection checklist, including filling out the crane logbook.

The crane operator, excluding operator of vehicle loading crane with capacity of 10 metre tonnes or more, must not:

- (a) supervise and/or direct a trainee dogger
or
- (a) leave the crane operator controls unless in an emergency or after the following actions have been taken:
 - removed all loads and lifting slings from the hook or dedicated lifting device
 - raised the crane hook to a position where it is clear of other operations namely loads and slings
 - disabled all powered crane motions.

This requirement applies regardless of whether the mobile crane operator holds the appropriate licence to perform high risk work as a dogger or rigger.

13.1.4 Dogger

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

A dogger should be in control of the load from the time it is slung until it is securely placed in its final position and slings are removed. 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.

A qualified dogger is required to know how to:

- (a) use the various types of ropes, slings, chains and accessories
- (b) determine the SWLs of any rope, sling, or chain to be used for lifting
- (c) assess the weight of loads to be lifted
- (d) sling loads of different weights and sizes safely

- (e) direct a crane or hoist operator in the movement of a load (this is particularly important when the load is out of the operator's view)
- (f) give appropriate hand and whistle signals used for directing loads.

Before signalling the crane operator to raise a load, the dogger should ensure:

- (a) Each lifting attachment, sling and shackle has a safe working load, 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, when it is lifted, will not contact any object or constitute a hazard to any person.

13.2 Minimising risk of injury from lifting loads

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

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

13.2.1 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 guidance*
- (b) *AS 3775.2: Chain slings – Grade T – Care and use*
- (c) *AS 2321: Short-link chain for lifting purposes*
- (d) *AS 4497: Round slings – Synthetic fibre*
- (e) *AS 1353.2: Flat synthetic-webbing slings – Care and use*
- (f) *AS 4991: Lifting devices*

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 used as terminal fittings 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 or 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: Round slings – Synthetic fibre* 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 at the workplace.

13.2.2 Control measures to minimise risk of injury from crane overload

A mobile crane must not be subjected to a manner of loading or a greater load than is marked on

the load chart. Where the load mass is cause for concern, the dogger should verify if the stamped load mass is correct.

Before starting to hoist 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 swinging of the load is avoided when the lift is taken. The crane operator should ensure the load is always under control when lowering loads, or when the load is suspended. 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 weight recorded on the load weight indicator
- (c) recheck the load chart.

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

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

The *Work Health and Safety Regulation 2011* describes the 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.

Where possible, handling loads over public access areas, such as footpaths, roads, highways, railways, waterways and buildings, should be avoided. If lifting over these areas cannot be avoided, appropriate control measures (e.g. exclusion zones, suitably designed gantries) must be in place to prevent or minimise exposure to the risk of being hit by falling objects during the lifting operation.

Lifting materials

Crane-lifted loads should be slung and secured so that the load (or any part of it) cannot fall. To ensure the 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 may 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 the 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.

Exclusion zones

Exclusion zones should be established around mobile cranes and adjoining areas to prevent persons from entering the area. The size of the exclusion zone should be based on a written risk assessment.

Where the exclusion zone requires closure of a public footpath or roadway, approval must be obtained from the relevant authority, and persons should be safely directed to an alternative footpath. Lane closures and other operations that require the erection of barricades and signs should comply with the requirements of Department of Transport and Main Roads, local government authorities and any relevant building or local Acts.

13.3 Multiple crane lifts

Lifting a load with two or more cranes requires greater attention to planning and supervision, because the effects of the relative motion between the cranes may create additional loadings on the cranes, the load and the lifting gear in place.

13.3.1 Safety measures for multiple crane lifts

Where possible, avoid hoisting a load with more than one crane. However, where it is necessary to lift a load using more than one crane, the following steps should be taken:

- (a) A person licensed to work as an intermediate rigger should be in overall control of the lift.
- (b) Make an accurate assessment of:
 - (i) the share of the load which is to be carried by each crane
 - (ii) how the load sharing is to be proportioned
 - (iii) how the proportioning is to be maintained.
- (c) Make sure the instructions to each crane operator and other persons involved are clear, and rehearse the operation wherever possible.
- (d) Use cranes of equal capacity and similar characteristics, where practicable.
- (e) Make sure that both cranes are aligned in the same direction when using non-slewing type cranes in the pick-and-carry mode.
- (f) Use luffing up in preference to luffing down.

Dual lifts are not to be undertaken unless all cranes are fitted with a load indicator. Section 6.5 of this code requires load indicators to be fitted to all mobile cranes with a maximum rated capacity of more than three tonnes.

13.3.2 Calculated share of the load

Where multiple hoisting operations are carried out, the following minimum capacity requirements for each crane will apply:

- (a) for two cranes—20 per cent greater than the calculated share of the load
- (b) for three cranes—33 per cent greater than the calculated share of the load
- (c) for four or more cranes—50 per cent greater than the calculated share of the load.

If it is not possible to comply with the minimum capacity requirements stated above, then an engineer must check and certify the lifting procedure. The lifting procedure must be documented.

13.3.3 Principles for multiple crane lifting

The following factors are to be considered when planning for multiple crane lifts:

- (a) mass of the load
- (b) position of the centre of gravity
- (c) mass of the lifting gear
- (d) safe working capacity of the lifting gear
- (e) synchronisation of crane motions.

Mass of the load

Ensure the total mass of the load and its distribution is either known or calculated. Where the information is taken from a technical drawing, ensure allowances are made for manufacturing tolerances.

Position of the centre of gravity

Due to the variable effect of manufacturing tolerances and rolling margins, the position of the centre of gravity may not be accurately known. Accordingly, the proportion of the load being carried by each crane may therefore be uncertain.

Mass of the lifting gear

Ensure the mass of the lifting gear and its distribution are accurately known and included as part of the calculated load on the cranes. Where heavy or awkwardly shaped loads are handled, the deduction from the safe working loads of the cranes to allow for the weight of the lifting gear may be quite significant.

Safe working capacity of the lifting gear

Ensure the distribution of the forces within the lifting gear which will arise during the lifting operation is established. The lifting gear should have a safe working capacity margin in excess of that needed for its proportioned load. Determine whether special lifting gear is required to suit the maximum variation in distribution and direction of applied loads and forces which may occur during multiple lifting.

Synchronisation of crane motions

Minimise the variation in the direction and magnitude of forces acting on the cranes by synchronising the cranes' motions. Where possible, ensure cranes of equal capacity and similar operating characteristics are used. However, in practice, there will always be some variation due to differences in response to the activation of the motion controller and the setting and efficiency of the braking system.

As it is unlikely that the motions of the cranes will be accurately synchronised, ensure that an assessment of the effect of variation in plumb of the hoist ropes, which may arise from inequalities of speed, and the means for keeping such inequalities to a minimum, is made. To allow for these inequalities, the lifting operation should be performed at low speeds with extreme care to ensure the hoist ropes are kept as close as possible to vertical.

The rated capacity of a crane is calculated on the assumption that the load will be raised and lowered in a vertical plane. The crane boom has limited strength in the lateral plane.

13.4 Leaving the crane unattended

Failure to take adequate safety precautions to secure an unattended mobile crane for a period of time may encourage unauthorised use of the crane by persons who are not competent crane operators.

13.4.1 Ways to secure an unattended crane

A mobile 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 operations

- (c) all powered motions have been disabled, and
- (d) the keys have been removed from the crane.

When leaving a mobile crane unattended for a longer period of time, ensure the crane's boom is folded up and retracted as far as possible.

13.5 Mobile cranes and road travel

Failure to follow proper precautions before and during road travel may increase the risk of injury to the crane operator and other persons, such as pedestrians and other drivers.

13.5.1 Preparation for road travel

The crane manufacturer's instructions must be followed when preparing a mobile crane for road travel.

Precautions for road travel include:

- (a) securing outriggers (both hydraulic and manual) with a locking device specified by the crane manufacturer, and stowing them in a travelling position to ensure that there is no lateral movement
- (b) storing loose components in appropriate storage areas in accordance with the crane manufacturer's instructions or any other relevant published guidelines for the safe carriage of loads on road vehicles (e.g. *Load Restraint Guide* (2018) ISBN 978-0-6480157-5-8)
- (c) disengaging all drives to hydraulic pumps, booms and outriggers, and putting the controls in the OFF position
- (d) restraining the boom in accordance with the crane manufacturer's instructions to ensure there is no unintended movement of the boom.

13.5.2 Licensing requirements

Operators of mobile cranes are required under the *Transport Operations (Road Use Management) Act 1995* to hold the appropriate class of heavy vehicle driver licence before driving the crane on a road. This means that a person who has been granted a high risk work licence to operate a mobile crane must **also** hold the appropriate heavy vehicle class of driver licence to drive that mobile crane on a road to or from a workplace. Crane operators must meet the licensing requirements before being issued with the appropriate class of licence.

Queensland's driver licensing system reflects the National Driver Licence Scheme for licence classifications. It allows for a graduated driver licence classification system based on the gross vehicle mass (GVM) of each type of vehicle. Refer to Appendix 3 for a description of the driver licence classes appropriate for mobile cranes.

13.6 Workboxes and first aid boxes

Crane-lifted workboxes are used in industry for 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. However, the use of crane-lifted workboxes is considered to provide a higher level of safety than fall-arrest systems when used as the primary control measure.

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.

13.6.1 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 is to have a minimum SWL of 1000kg at the maximum radius for the task to be performed.
- (b) The crane is to 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 is to 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 are to 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 is to be locked out with a keyed lock-out.

13.6.2 Features of workboxes and first aid boxes

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

- (a) Correctly tagged lifting slings are to be supplied with the workbox and first aid box and attached to the 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 10 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.

13.6.3 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*.

13.7 Fatigue

Fatigue is mental or physical exhaustion that stops a person from functioning 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
- (e) driving time required to get to a job.

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 incidents 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.

13.7.1 Managing fatigue

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 days, and are fit for duty on rostered shifts.

13.8 Additional precautions when using mobile cranes

13.8.1 Precautions with lattice boom cranes

On lattice boom cranes, the top of the extended boom should not be lowered to a point below the horizontal line that passes through its base pivot pin. If the boom tips below this plane, the angle of pull of the boom luffing ropes could cause the boom to buckle before the boom begins to lift.

Lattice boom cranes should not be moved uphill with an unloaded boom in the near vertical position, or operated:

- (a) with the boom at an angle less than that shown on the load chart; or
- (b) with the boom hard against the boom backstop to avoid serious damage to the structural members of the boom. Regard the boom backstop as a safety device only.

13.8.2 Precautions with hydraulic boom cranes

When extending the boom on hydraulically operated cranes, ensure that the boom sections are extended or retracted in accordance with the manufacturer's recommendations. Boom sections have failed through being extended contrary to recommendations.

The crane should not be operated with the boom at an angle less than that shown in the load chart.

13.8.3 Precautions with pick-and-carry cranes

When moving a load in the pick-and-carry mode, the dogger should remain in sight of the crane operator, and not walk in the path of the crane. When travelling and manoeuvring with a load, the crane operator should ensure that:

- (a) The slew brake is applied at all times other than when the slew motion is being used.
- (b) Precautions are taken on uneven road surfaces when loaded or unloaded, as an undulation in the road surface may move the crane into an unstable zone.
- (c) The slewing brake or lock is applied when travelling with a load.
- (d) The crane is not moved uphill with an unloaded boom in the near vertical position.

Always travel slowly to prevent excessive swinging of the load. The load should be carried as close to the ground as possible, and should not lift higher until it is almost in position.

Where possible, avoid travelling the mobile crane across slopes or over potholes, depressions, soft ground, road chambers or shoulders, rail tracks, dunnage wood or any objects, as these could destabilise the crane or load.

14. Requirements for mobile cranes used in other circumstances

14.1 Vessel-mounted cranes

14.1.1 Characteristics of vessel-mounted cranes

Vessel-mounted cranes include cranes that may be operated on a barge, pontoon or vessel. The combined mass is to be considered as a vessel-mounted crane. The vessel should be anchored during crane operation. If this is not possible, then the vessel should be anchored to a craft alongside it.

When positioning the crane on a barge, pontoon or vessel in either loaded or unloaded conditions, the following should be considered:

- (a) effect on freeboard (i.e. distance between the vessel's deck and the water)
- (b) strength of the vessel to support the crane structure
- (c) installation of stops to prevent the crane driving off the vessel's side, and
- (d) method of securing the crane when working outside of smooth water limits.

A competent person must determine the list (i.e. deck tilt) and freeboard allowable with the rated capacity and test load conditions of the crane. The competent person must be experienced in crane design and stability of waterborne vessels. The vessel and crane combination is to be certified by a marine surveyor in accordance with Department of Transport and Main Roads requirements.

As a general guide, the maximum list of the vessel under rated capacity conditions should not exceed ± 5 degrees, with one half of the freeboard remaining. Confirmation should be obtained from the crane manufacturer on the de-rating of the crane from land-based ratings when on the barge, pontoon or vessel. Note that generally, the manufacturer's rated capacities for cranes mounted on vessels are frequently not greater than 70 per cent of the land-based rated capacity.

Where the crane can move along the deck of the vessel, lifting should only take place when the crane is secured to the deck (e.g. by chains of adequate strength).

14.1.2 Testing before use

The crane and vessel combination should be inspected after erection and before the application of any loads to ensure:

- (a) All ties, anchorages and ballast are in place and correctly secured.
- (b) The crane configuration is in accordance with the crane manufacturer's or a competent person's specifications.
- (c) The crane configuration is free from any defects that would preclude the vessel-mounted crane from handling the test load safely.

The crane should undergo testing of its stability, functions and brakes as outlined in *AS 2550.1: Cranes, hoists and winches – Safe use – General requirements*. After these tests have been completed, a competent person must complete a full assessment to ensure the vessel and crane combination has withstood the test loadings without structural damage, and the mechanisms function free of any defect that will affect the safety of the crane.

14.2 Mobile cranes on suspended slabs

Mobile cranes are sometimes lifted onto a suspended floor or other elevated parts of a building for either construction or demolition activities. It should be noted that suspended floors are not originally intended to support mobile plant and there may be a risk of the floor or structure collapsing. This is particularly the case for heavier mobile cranes. Prior to lifting the crane onto the elevated area, written documentation is to be provided that demonstrates the design floor loading of the building is not being exceeded. Where the floor requires strengthening (e.g. by propping), an engineer is to provide written instructions that detail the dimensions, locations and other specifications of the propping to be used.

If the crane can only be used in particular areas of the building, due to inadequate strength in other areas, access to such areas is to be prevented by the use of barricades or other types of barriers.

14.3 Use of mobile cranes for demolition

Not all mobile cranes are sufficiently robust to withstand the stresses of demolition ball work. The use of mobile cranes for demolition ball work should be restricted to cranes designed for arduous duty, such as convertible dragline excavators. Hydraulic boom cranes should not be used for this type of work, as overstressing of the sliding points can occur.

All cranes used for demolition ball work must be fitted with a suitable falling object protective structure (FOPS), to protect the operator from falling objects.

Precautions are to be taken to ensure the hoist rope is prevented from leaving the boom point sheave. This may include fitting heavy duty rope guards to the sheave to control the slack rope condition that may occur as the ball falls. Damage is likely where the demolition ball is attached to the hoist rope. Hoist ropes should not be fixed directly to the demolition ball. A length of chain should be used to join the hoist rope to the demolition ball. The chain should be at least 16 mm, and at least two metres in length.

A crane that has been used for demolition ball work must be thoroughly inspected and verified by a competent person to be in a satisfactory condition before it is used for general lifting. The results of the inspection must be noted in the crane's service logbook.

14.4 Use of mobile cranes for tree lopping

It is recommended that mobile cranes not be used for tree lopping. Tree lopping is the activity of removing or pruning a tree by the systematic removal of the tree limbs, foliage and trunk. During tree lopping, the tree is connected to the crane hook prior to cutting and the theory is that the crane will be able to assist to lower the tree parts in a controlled manner in designated areas. Cranes have been used for tree lopping, particularly where parts of the tree are above buildings and other structures. There have been a relatively large number of serious mobile crane incidents associated with this activity.

Tree lopping with cranes is considered to be of very high risk due to the likelihood of the crane overturning or structural failure of the boom. During the activity, it is difficult to determine both the mass of the part of the tree being cut and the direction in which the timber will fall. In addition, it is extremely difficult to eliminate shock loading that will be applied to the crane. These issues will either cause the load radius to increase or apply a side loading to the boom. Safe crane operation requires that only vertical loads be applied to the hoist rope and the loads be applied gradually. This requirement is generally stated in crane manufacturer's instructions.

Mobile cranes should not be used for tree lopping unless the following can be ensured:

- (a) the crane operator does not perform the role of a dogger
- (b) a dogger is present during all lifting activities
- (c) the arborist, crane operator and dogger consult with each other
- (d) side loading will not be applied to the crane boom
- (e) any loading to the crane is well within the crane's safe working load
- (f) the crane will not be shock-loaded
- (g) wind will not adversely affect the safe use of the crane
- (h) only vertical loads will be applied to the hoist rope and crane hook
- (i) at completion of the saw cut, the radius of the load will not increase.

If the above can be ensured, and there is no other practicable alternative, a mobile crane may be used for this activity in very limited situations. However, the work procedure must be documented and hazard control measures listed in the procedure. The tree arborist and crane operator are to participate in, and be satisfied with, the documented procedure.

15. Use of other mobile plant as a mobile crane

Other mobile plant may be used as a mobile crane to lift or lower freely suspended loads (i.e. the load is not pinned to the boom or on tines, but is hanging from the boom by means of a chain or rope). Other mobile plant that is sometimes used in this way includes backhoes, front-end loaders, excavators and telescopic handlers (also known as 'load-alls' and 'tool carriers').

It is important to note that when other mobile plant is used as a mobile crane, the level of safety provided by the lifting set-up should be at least equal to that when a mobile crane is used.

15.1 Rated capacity of other mobile plant

The rated capacity of other mobile plant is the maximum mass that may be handled at the maximum lift point radius, or reach, for each lift point, without the strength and stability requirements being exceeded. When determining the allowable load to be lifted, the mass of any attachments, such as buckets or quick-hitch, must be deducted, unless the rated capacity chart allows otherwise.

To ensure the stability of the mobile plant, the rated capacity of the plant must not be greater than:

- (a) 75 per cent of tipping load in the stationary mode
- (b) 66 per cent of tipping load in the pick-and-carry mode; or
- (c) 50 per cent of tipping for articulated wheel loaders and tool carriers.

15.2 Load chart

The load chart for the mobile plant should identify each lift point location, and the corresponding rated capacity for each position. The appropriate load chart should be fixed inside the operator's cab and show the following information:

- (a) manufacturer's name and model
- (b) boom and dipper arm identification and length, particularly where different boom configurations may be used
- (c) track width, where this is variable
- (d) deductions for attachments, such as bucket or quick-hitch devices, so that the net allowable load to be lifted can be determined, and
- (e) one of the following:
 - (i) the rated load at the least stable position; or
 - (ii) where variable load rating is provided for, means to clearly determine the load position in accordance with the rated capacity chart.

15.3 Lifting points on earthmoving plant

Lifting attachments on earthmoving plant are sometimes supplied by the plant manufacturer. If this is not the case, the attachments should be designed by an engineer. Lifting attachments often consist of a welded assembly that fits onto the end of the dipper arm when the bucket is removed. All lifting points on earthmoving plant must form a closed eye, to which a load rated shackle may be attached. Figures 7 and 8 provide an example of a lifting attachment with a closed eye.



Figure 7 and Figure 8 - Lifting attachment with a closed eye on excavator

A static strength test at 200 per cent of the rated capacity of each lift point must be carried out. The lift points should not show any permanent deformation after testing. The test may be performed with the component dismantled from the machine. This should be done if application of the test load could result in damage to the earthmoving plant.

Hooks should not be used on the dipper arm or other attachments of earthmoving plant, because the load may become unintentionally disengaged as the arm rotates. This can even occur when the hook is fitted with a latch, because the latch may be damaged (e.g. with a mobile crane, the hook hangs vertical, with an excavator, the lifting point rotates).

When lifting lugs are welded to attachments or other parts of the earthmoving plant, the material specifications for the two different components are to be compatible for welding, and the appropriate welding procedures must be followed.

The attachment of lifting lugs to buckets is strongly discouraged for the following reasons:

- (a) Application of the lifted load to the outside of the bucket can load the pins and linkages in a way other than the designer intended.
- (b) It is easier for the operator to unintentionally overload the plant by not allowing for the dead weight of the bucket or because the bucket has earth stuck to the inside.
- (c) The lifting chain or sling can be damaged when a bucket is fitted because it may pass over the front edge of the bucket.
- (d) Lifting lugs on buckets may be damaged when the bucket is used for digging activities.

15.4 Quick-hitches

A quick-hitch is a latching device that enables attachments on earthmoving plant to be rapidly connected to the dipper arm of the plant. While the device saves time and effort, a number of fatalities have occurred in Australia when excavator attachments have fallen off the quick-hitch due to loss of hydraulic pressure.

Locking pins are generally used on quick-hitches to ensure the attachment is correctly engaged and remains locked in position on the dipper arm. Quick-hitches should comply with the safety system specifications included in *AS 4772 Earthmoving machinery – Quickhitches for excavators and backhoe loaders*. If the quick-hitch does not comply with AS 4772, it is to be fitted with a manual locking pin.

Where the quick-hitch supplier claims a quick-hitch complies with AS 4772, a certification document stating this should be provided by the supplier upon request.

15.5 Burst protection and rated lifting capacities

Burst protection is to be fitted on all earthmoving plant used as a crane, where the rated capacity exceeds 1 tonne. The burst protection is to be fitted to both the boom and dipper arm of the plant. Burst protection is to comply with the performance requirements of *ISO 8643: Earthmoving machinery – Hydraulic excavator and backhoe loader boom-lowering control device – Requirements and tests*.

The following additional conditions are to be applied:

- (a) The maximum rated capacity is to be in accordance with the manufacturer's specifications for the plant. Plant must not be de-rated to avoid fitting burst protection.
- (b) **Single rated capacity:** Where the decision is made to rate the lifting capacity of the plant at its maximum lifting radius, this becomes the rated capacity¹ and is to be marked on the boom or dipper arm. The rated capacity must then be strictly observed at all times, irrespective of the radius of the load. Information should be available on site to confirm that the rated capacity marked on the unit is the same as that specified by the manufacturer.
- (c) **Variable rated capacities:** Where the plant has variable lifting capacities, the manufacturer's rated capacity chart (i.e. load chart) is to be fixed to the inside of the operator's cabin. For plant

with variable rated capacity, the lifting capacity at minimum radius is to be used to decide whether burst protection is required.

- (d) Where practicable the burst protection device should not be provided with the ability for the operator to switch the device off (in case the operator forgets to switch the burst protection on when the plant is operated as a crane).
- (e) Where the rated capacity of the plant is 1 tonne or less, and the decision is made not to fit burst protection, the plant must not be used to lift loads near workers.

Earthmoving plant owners should seek advice on fitting of burst protection from original plant manufacturers, to help avoid fitting faulty or unsafe systems.

Note: safe working load abbreviated to 'SWL' can also be used to indicate the rated capacity.

15.6 Competency of operators

All operators of mobile plant must receive training in the use of the particular equipment they are required to operate. When the mobile plant is used as a mobile crane, the operator of the mobile plant may require additional training and competencies. In some circumstances, the operator of the mobile plant may also need to hold the appropriate mobile crane licence class.

Since 1996, the 'LE' type national excavator certificate for excavator operators includes basic competencies for earthmoving equipment used as a mobile crane. Where an excavator operator holds an older type of earthmoving equipment certificate, the operator should also hold a slewing mobile crane licence class.

16. Vehicle-loading cranes

16.1 General use

Vehicle-loading cranes (see figure 9) are intended to be mounted on a broad range of vehicles including tray trucks and prime movers. When originally introduced, vehicle-loading cranes were used for loading the truck on which they were mounted. However, with the introduction of larger capacity vehicle-loading cranes, these types of cranes are also used for traditional crane operations where either:

- (a) the load is lifted from the vehicle tray to an elevated area at a workplace (e.g. lifting packs of timber from the vehicle directly to a building floor)
or
- (b) the load is lifted both to and from locations, remote from the vehicle on which the crane is mounted.

While vehicle-loading cranes may be used for the applications stated above, the level of safety provided by the lifting setup should not be less than when a mobile crane is used.



Figure 9 – Vehicle-loading crane

16.2 Crane and vehicle suitability

Vehicle-loading cranes must only be mounted on vehicle types and models specified by the crane manufacturer. Failure to comply with this could lead to structural failure of the crane or vehicle, or make the crane combination unstable. Where second-hand vehicle-loading cranes are imported from overseas and introduced into Queensland, the crane and vehicle combination is to be provided with a compliance plate that has been attached by an authorised person in compliance with Department of Transport and Main Roads requirements.

The method of mounting the crane to the vehicle must be in accordance with the crane manufacturer's specifications or the recommendations of a competent person. Any adverse effects to both the vehicle and crane are to be taken into consideration. Welding the crane to the vehicle chassis is generally unacceptable because it can damage the chassis, and also lead to fatigue failure of the connection.

16.3 Design of controls on vehicle-loading cranes

Controls on vehicle-loading cranes must be of the constant pressure (deadman) type, and permanently marked with clearly visible symbols in accordance with *AS 1418.11: Cranes, hoists and winches – Vehicle-loading cranes*.

The position and layout of controls on vehicle-loading cranes should be designed so that the risk of the operator being crushed against the controls by inadvertent operation of the crane is minimised. If administrative controls are provided to prevent injury, a high level of training must be provided for operators on this issue.

An emergency stopping device should be provided at every control station on the vehicle-loading crane. The emergency stopping device should:

- (a) remove the energy supply to the crane, and bring the crane to a complete stop when activated
- (b) be readily visible and coloured red
- (c) be arranged for easy access, and located so that the operator will not be exposed to other hazards when activating the device
- (d) lock in the 'stop' position when activated.

16.4 Rated capacity limiters

Rated capacity limiters should be provided on all vehicle loading cranes with:

- (a) a maximum rated capacity of one tonne or greater; or
- (b) a gross lifting moment of 40 kNm (kilonewton metres) or greater.

The purpose of the rated capacity limiter is to prevent movements that may increase load moment in excess of the rated capacity, and to also prevent an increase of the load radius or permissible stresses in the structure.

Where smaller vehicle-loading cranes are not fitted with a rated capacity limiter, relief valves and fittings should be used to provide overload protection.

16.5 Rated capacity indicators

All vehicle-loading cranes manufactured after 2003 must be fitted with a rated capacity indicator. The rated capacity indicator must warn the crane operator when the load exceeds 90 per cent of the rated capacity. The rated capacity indicator must give a separate warning to the operator and persons in the vicinity of the crane if the rated capacity is being exceeded.

The warning for approach to rated capacity must be clearly distinguishable from the warning for exceeding the rated capacity by all persons while the crane is being operated. Both warnings must be continuous.

16.6 Operational issues for vehicle-loading cranes

The vehicle-loading crane must be operated in accordance with the operator's instruction manual provided by the crane manufacturer. Additionally, the following points must be complied with:

- (a) Operators must be trained in the specific operation of the particular vehicle-loading crane.
- (b) Operators of vehicle-loading cranes with a maximum load moment capacity of 10 metre-tonnes or more must hold the appropriate licence class (CV) to operate a vehicle-loading crane.
- (c) If the load is out of the operator's view at any stage during the lifting process, the movement of the load must be directed by a qualified dogger or rigger.
- (d) The crane may only be used with all stabilisers extended in accordance with the crane manufacturer's instructions. Where multiple positions can be used on stabiliser legs, the legs must be set up in compliance with the manufacturer's load chart.
- (e) The crane must only be used so that it is level in accordance with the crane manufacturer's specifications (usually not exceeding one degree or less).
- (f) Timbers or other pads specified by the crane manufacturer are to be provided under the stabiliser feet.
- (g) Hooks must be provided with spring-loaded safety latches, and must be adequately maintained.
- (h) Where it is possible to apply a side load to the crane hook, the hook must be provided with an appropriate swivel.
- (i) The crane must never be used in pick-and-carry mode.
- (j) Where vehicle loading cranes are used to lift persons the unit should comply with *AS 1418.10 – Cranes, hoists and winches – Part 10: Mobile Elevating Work Platforms*.
- (k) Where provided, spring lock-outs on the vehicle are to be activated during crane operation.
- (l) The crane must only be used with a load suspended vertically from the hook. The crane is not to be used to drag a load across a supporting surface.
- (m) The stabiliser legs should be clearly marked with 'zebra striping' to improve visibility. Section 9.3.1 of this code provides further information on the dimensions of the zebra striping.

17. Training

17.1 Responsibilities for training

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

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

- (a) documented work procedures to be used in the setting up and safe operation of mobile crane activities
- (b) method for inspection and maintenance of mobile cranes
- (c) knowledge of the crane manufacturer's operation and service manuals
- (d) correct use, care and storage of personal protective equipment
- (e) correct use, care and storage of tools and equipment to be used
- (f) observance of electrical safety practices
- (g) procedures to be adopted in the event of incident or injury.

PCBUs should ensure that management systems are in place to:

- (a) ensure only those workers who have received training and instruction are authorised to carry out that work, and
- (b) sufficiently monitor 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.

17.2 Familiarisation training

Mobile cranes can be fundamentally different in their design, mode of operation, control layout and configuration. 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 the person's 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 mobile crane. This should be provided to crane operators prior to commencing work for a new PCBU or operating a crane that has been newly acquired by their PCBU. This process may require the presence of a representative from the mobile crane supplier or manufacturer, particularly when the crane is new. The representative from the mobile crane supplier or manufacturer should have detailed knowledge of the operational and safety features of the crane in question. The representative from the mobile crane supplier or manufacturer should also be endorsed by the crane supplier or manufacturer as being competent to provide the familiarisation training.

A record of the 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 the familiarisation training should take the format of a checklist. Crane operators must demonstrate that they understand how to undertake safe crane operations based on this checklist. Sample checklists for familiarisation training are provided in Appendix 4 of this code.

17.3 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 or an independent consultant or third party (e.g. registered training authority).

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.

The person providing the refresher training should be endorsed by the crane company as competent to provide this training.

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.

17.3.1 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.

17.3.2 Record of refresher training

Crane operators, doggers and riggers must keep a documented record of refresher training they have undertaken.

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.

18. Inspecting, testing, maintenance and repair of mobile cranes

Failure to carry out appropriate planned inspections and preventative maintenance programs may lead to structural or mechanical failure and collapse of the mobile crane.

Inspecting and appropriate testing should be carried out frequently to ensure the:

- (a) Parts of the crane subject to deterioration through corrosion, damage, wear or abrasion are replaced before they become unserviceable.
- (b) Crane is maintained in a safe and serviceable condition (e.g. all windows and windscreens must be regularly cleaned and cracked windows and windscreens must be replaced to ensure vision is not obscured).

Inspecting and testing of mobile cranes should also include:

- (a) pre-operational inspection
- (b) routine inspection and maintenance
- (c) annual inspections
- (d) 10-year major inspections.

18.1 'Competent person' for inspecting mobile 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)
- (c) an independent consultant or third party.

18.1.1 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. This should include 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.
- (d) A competent person carrying out non-destructive testing on mobile 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 verify that the welding, hydraulic system or electrical system complies with the relevant technical standards. It would not be appropriate for this person to verify that the complete crane complies with a relevant technical standard or is in a safe condition.

18.1.2 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 crane 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.

18.1.3 Crane alterations

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.

18.2 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 mobile crane components is to take place at set intervals (e.g. 10-year major inspection).

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

When using NDT for the detection of cracks in metals, the paint must be removed from the metal surface.

18.3 Pre-operational inspection

The crane operator should carry out a visual inspection and functional test before the commencement of each work shift, including inspecting and testing 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.

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

All personal protective equipment should also be inspected to ensure it is functioning correctly. All safety-related problems must be corrected before the crane is used, and recorded at an appropriate time.

18.4 Routine inspection and maintenance

Routine inspection and maintenance should be carried out in accordance with the crane manufacturer's instructions. These inspections may include a program of weekly, monthly and quarterly inspections, and should include:

- (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
- (d) inspection of filter elements and fluid levels
- (e) 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
- (f) signage, including warning signs and control markings
- (g) wear on wheels
- (h) additional items nominated in the crane manufacturer's instructions.

All replacement parts should be identical or equivalent to the original parts or components. A written report should be supplied upon completion of the inspection.

18.5 Annual inspections

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

Annual inspections include:

- (a) the effective functioning and calibration of all limiting and indicating devices
- (b) detailed visual inspection and tolerance checking of all structural and wear components
- (c) checking of tolerances for wear limit
- (d) a detailed check for corrosion
- (e) a detailed examination of critical areas for evidence of cracking.

An example of an Annual Crane Safety Certificate is provided in Appendix 5. This document may be used as evidence that the crane has received an annual safety inspection by a competent person.

18.6 10-year major inspection

AS 2550.1: Cranes, hoists and winches – Safe use – General requirements specifies that cranes are to be subjected to a major inspection at the end of their design life or, where this is unknown, after 25 years for the structure and 10 years for the mechanical components. The 10 and 25-year periods are based on design parameters in *AS 1418.1: Cranes, hoists and winches – General*

requirements. While it is acknowledged that mechanical components may undergo greater wear and fatigue rates, this may not always be the case and structural items on cranes are generally easier to inspect. For this reason, this code does not state that a separate major inspection must be undertaken at 25-year intervals. Instead, the competent person is encouraged to inspect structural items during the 10-year major inspection.

AS 2550.1: Cranes hoists and winches – Safe use – General requirements indicates that the 10-year major inspection is intended to assess the crane's suitability for continued operation. 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 mobile 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 it has been operated in (e.g. dirty or corrosive environments). The 10-year major inspection is to be certified by an engineer who has experience in the inspection of mobile 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 6. This document may be used as evidence that the crane has received its 10-year major inspection by an engineer.

AS 2550.1: Cranes hoists and winches – Safe use – General requirements does not provide specific detail on the parts of the crane to be examined; this is left to the responsibility of the crane manufacturer, or where this information is not available, the competent person. The extent of inspection performed during the 10-year inspection will largely depend on this information. However, a number of key items are to form part of the major inspection.

Prior to listing the key inspection items, the following is to be noted:

- (a) Where the crane manufacturer specifies instructions for the 10-year major inspection, these instructions are to be followed and take precedence over the list below.
- (b) The list only specifies some of the generic items requiring inspection. The actual list of items inspected will be considerably larger and will be based on the requirements of the crane manufacturer, or if these do not exist, the instructions of a competent person.
- (c) Completion of a 10-year major inspection does not indicate that the components inspected will have an additional life of 10 years.
- (d) 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.

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. In some cases the two year period may be extended based on the opinion of the competent person. However, the reasons justifying this decision are to be documented. This requirement applies to slew ring bolts, drive systems and braking systems.

18.6.1 Key items requiring inspection

The key items which are to form part of the 10-year major inspection are detailed below.

Slew ring

The amount of clearance in the slew ring is to be quantitatively measured and compared to the maximum clearance specified by the crane manufacturer. The clearance should be measured at a minimum of four locations around the slew ring. If the clearance exceeds that specified by the manufacturer, the slew ring should be split. Where the slew ring is split, all components must be examined and replaced where they are damaged or worn. The backlash and teeth width in both the pinion drives and ring drive are to be measured and are to be within the crane manufacturer's specification.

Slew ring bolts

One of the following alternatives should be followed:

- (a) Remove all bolts and replace with new bolts of the type specified by the manufacturer, installed in accordance with the crane manufacturer's instructions (i.e. torque and tightening sequence).
- (b) Re-torque slew ring bolts to the crane manufacturer's specifications. Where any bolts fail, all bolts are to be removed and non-destructively tested and reinstalled, or replaced with new bolts. **Note:** this alternative may only be selected where the crane manufacturer states that the procedure is an acceptable method of testing integrity of the slew ring bolts.
- (c) Remove all bolts and non-destructively test for cracking or other imperfections. Reinstall undamaged bolts in accordance with the crane manufacturer's instructions (i.e. torque and tightening sequence). **Note:** this alternative may only be selected where the crane manufacturer states that the procedure is an acceptable method of testing integrity of the slew ring bolts.
- (d) Remove a percentage of slew bolts in accordance with the crane manufacturer's instructions. Non-destructively test removed bolts. If any damage is found, all bolts are to be removed and non-destructively tested or replaced with new bolts. **Note:** this alternative may only be selected where the crane manufacturer states that the procedure is an acceptable method of testing integrity of the slew ring bolts.

Hook rollers

Non-destructively test hook roller mounts for cracking or other imperfections. Measure diameter of rollers and replace if under tolerance. Check rollers to ensure they are able to rotate freely and that there is no uneven wear.

Drive systems (including hydraulic motors, gearboxes and drive shafts)

Where catastrophic failure of the drive system can result in the load or boom dropping in an uncontrolled manner, carry out the following:

- (a) Remove and strip down all parts of the drive system. Ensure all components are within manufacturer's tolerance. Replace worn components including valves, shafts and bearings.
- (b) Non-destructively test parts of the drive system that may be prone to cracking. Particular attention must be given to components, the failure of which will have a catastrophic effect. Since significant fatigue damage can occur in the microstructure of these components without evidence in non-destructive testing, the competent person must consider the replacement of such components.
- (c) Hydraulic motors and valves are to be pressure and performance tested prior to reentering service.

Where catastrophic failure of the drive system will not result in the load or boom dropping in an uncontrolled manner, carry out the following:

- (a) inspect the drive system for vibration, fluid leakage and correct operation, and
- (b) where damage or malfunction can be observed, remove and repair or replace defective part.

Braking systems

- (a) Hoist and luff brakes are to be removed from the crane and dismantled. Pins, springs, valves and bearings are to be checked for correct tolerance. Rubber seals are to be replaced and pistons checked for correct operation.
- (b) Any welds in braking systems, including band brake weld terminations, are to be crack tested by NDT. Non-destructively test parts of the braking system that may be prone to cracking. Particular attention must be given to components that will have a catastrophic effect if they fail.
- (c) Since significant fatigue damage can occur in the microstructure of these components without evidence in non-destructive testing, the competent person must consider the replacement of such components.
- (d) Hydraulic systems are to be checked for leaks prior to reattachment to the crane.
- (e) Brake linings are to be checked for wear limits.
- (f) After reinstallation brakes are to be adjusted and actuated a number of times to ensure correct operation.

Hydraulic cylinders (all cylinders, including outrigger cylinders)

- (a) Hydraulic cylinders are to be checked for external leakage and creep. Where leakage is observed, or creep exceeds manufacturer's specifications, hydraulic cylinders are to be removed and stripped down.
- (b) Seals are to be replaced and rams rechromed where necessary.
- (c) NDT crack test welds on rod ends and caps.
- (d) Reassembled cylinders are to be pressure tested and checked for operation and leaks.

Booms (hydraulic cranes)

On all hydraulic booms:

- (a) Perform creep test on telescopic function with boom extended and raised to maximum amount permitted on load chart. Where creep exceeds the crane manufacturer's specifications and this is caused by leakage in telescoping cylinder, disassemble boom and remove hydraulic cylinder for repair or replacement.
- (b) Check boom straightness in both planes to manufacturer's specifications. Where boom deflection exceeds manufacturer's tolerances, remove and dismantle boom and repair or replace.
- (c) Check wear pad clearance and replace worn wear pads.
- (d) Check boom condition for corrosion and damage. Non-destructively test accessible welds on both boom sections and slew ring upper.
- (e) Where pin type locks are used (i.e. instead of rope or chain type extensions), the effective operation of the locking mechanism is to be inspected. **Note:** in some cases, manufacturers of these boom types may require disassembly of the boom at pre-determined intervals.

There are additional requirements where the boom has internal boom extension wire ropes or chains, or where boom extension is activated by screw drive:

- (a) Remove and disassemble boom. Inspect wire ropes to *AS 2759: Steel wire rope – Use application and maintenance*, and chains to manufacturer's tolerance. Replace worn ropes and chains.
- (b) Inspect wire rope and chain anchorages and non-destructively test welds on anchorages.
- (c) Where screw drives are used, measure all screw threads and non-destructively test any welds on assembly.

Booms (lattice boom cranes)

- (a) Boom NDT for cracks:
 - (i) all welds connecting male and female clevises (on the ends of every boom section)
 - (ii) welds on boom butt section
 - (iii) welds on boom head, and
 - (iv) minimum of 10 per cent of lacing welds (all welds if cracks are found).
- (b) Chord thickness testing (ultrasonics)—all chords on boom sections.
- (c) Thickness testing of plate used on butt section (i.e. near water drain holes).
- (d) Check boom for straightness, damage and corrosion.

Rated capacity limiters and load indicators

Rated capacity limiters and load indicators are to be checked and calibrated for correct operation. The accuracy of these systems is to be within the tolerance specified by the crane manufacturer or *AS 1418.5: Cranes, hoists and winches – Mobile cranes*. A calibration certificate is to be completed by the competent person testing the equipment. However, it should be noted that rated capacity limiters and load indicators are to be calibrated at much more frequent intervals than at the 10-year major inspection.

Steel wire ropes

All hoist, luff, pendant, trolley and counterweight ropes must be inspected for wear to ensure they do not exceed the discard criteria specified in *AS 2759: Steel wire rope – Use application and maintenance*. If the competent person considers that the rope will require replacing within the next three months, the rope should be replaced with one that passes the inspection criteria of *AS 2759: Steel wire rope – Use, application and maintenance*. Ropes must only be replaced with the type of rope specified by the crane manufacturer unless a professional engineer specifies otherwise.

The pins and terminations on pendant ropes must also be inspected.

Rope sheaves

All rope sheaves must be removed and inspected for cracking, alignment and damage. The sheave groove size must be checked and the sheave replaced if it is outside of the manufacturer's specification. Bearings must be replaced if necessary. Synthetic sheaves should be replaced if recommended to do so by the sheave manufacturer.

18.7 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 should be kept and readily available. The records should be easily understood, and written in plain English. Records may be kept in any suitable format, and should 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, and
- (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 crane's safe use, should be recorded.

Additionally, all complete routine, annual and 10-year major inspection reports should be maintained and made available for examination as required.

A mobile crane preventative maintenance program should be established based on the working environment and the frequency and severity of use of the mobile 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 mobile 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; and
 - (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.

18.8 Mobile crane repair

All worn or damaged parts of a crane that constitute a hazard or impair the operation of the crane, or may constitute a hazard before the next routine inspection, should be repaired or replaced. All repaired or new parts must comply with the crane manufacturer's instructions. Where these are not available, the repaired or new parts must comply with the recommendations of a competent person, taking into account the requirements of this code and appropriate Australian Standards or any other relevant technical standard.

18.9 Second-hand imported (overseas) mobile cranes

The importance of the maintenance history of second-hand imported mobile cranes from overseas cannot be underestimated. Before a second-hand imported mobile 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.

'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 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.

'Geo-technical engineer' means an engineer who holds an engineering qualification relevant to geo-technology.

'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.

'Side de-ration chart' means a load chart that reduces the allowable lifting capacity of a crane in

relation to the degree of side slope that the crane is to travel on with a suspended load. These charts must be read in conjunction with the crane's normal load chart.

'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
or
- (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*
- *Europäische Norm (European Standard)*.

'Two-blocking' means contact of the hook block with any part of the boom head or sheaves.

'Workbox' means a personnel-carrying device, designed to be suspended from a crane, to provide a working area for persons conveyed by and working from the box.

Appendix 2: Referenced technical standards

Technical standard	Title
AS 1353.2	Flat synthetic-webbing slings – Care and use
AS 1418.1	Cranes, hoists and winches – General requirements
AS 1418.5	Cranes, hoists and winches – Mobile cranes
AS 1418.8	Cranes, hoists and winches – Special purpose appliances
AS 1418.10	Cranes, hoists and winches – Mobile Elevating Work Platforms
AS 1418.11	Cranes, hoists and winches – Vehicle-loading 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 2550.5	Cranes, hoists and winches – Safe use – Mobile cranes
AS 2550.11	Cranes, hoists and winches – Safe use – Vehicle-loading 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	Round slings – Synthetic fibre
AS 4991	Lifting devices
AS 61508 (Series)	Functional safety of electrical/electronic/programmable electronic safety-related systems

Appendix 3: Queensland driver licence classes

Queensland driver licence classes are listed in the Transport Operations (Road Use Management—Driver Licensing) Regulation 2010

Vehicle description	Licence class
<p>A motor vehicle (with or without a trailer), other than a motorcycle, that:</p> <ul style="list-style-type: none"> • has a maximum weight of 4.5 tonne (t) gross vehicle mass (GVM) • is built or fitted to carry no more than 12 adults, including the driver. <p>A moped—fitted with an electric motor or an internal combustion engine (with a maximum capacity of 50mL) with a maximum manufacturer's top rated speed of 50km/h that is not a bicycle.</p> <p>A specially constructed vehicle with or without a trailer</p>	Class C
<p>A class C vehicle.</p> <p>A bus or truck (including a prime mover or a mobile crane) not more than 8t GVM.</p> <p>Note: You may also tow a trailer with a maximum weight of 9t GVM.</p>	Class LR
<p>A class LR vehicle.</p> <p>A bus or truck (including a prime mover or a mobile crane) over 8t GVM with a maximum of 2 axles.</p> <p>Note: You may also tow a trailer with a maximum weight of 9t GVM.</p>	Class MR
<p>A class MR vehicle.</p> <p>A bus or truck (including a prime mover or a mobile crane) over 8t GVM with more than 2 axles.</p> <p>Note: You may also tow a trailer with maximum weight of 9t GVM.</p> <p>An articulated bus (a bus that can bend in the middle).</p>	Class HR
<p>A class HR vehicle.</p> <p>A truck (including a prime mover or mobile crane) over 8t GVM with a trailer of more than 9t GVM.</p>	Class HC
<p>A class HC vehicle.</p> <p>A B-double (prime mover towing 2 semitrailers, with 1 semitrailer supported at the front and connected to the other semitrailer).</p> <p>A road train (motor vehicle, other than a B-double, towing 2 or more trailers).</p>	Class MC

Table A3.1: Class of licence required to drive mobile cranes on a road.

Vehicle description	Licence class
Mobile crane of not more than 8 tonnes GVM, with or without a trailer of not more than 9 tonnes GVM	Class LR
Mobile crane over 8 tonnes GVM with a maximum of two axles, with or without a trailer of not more than 9 tonnes GVM	Class MR
Mobile crane over 8 tonnes GVM with more than two axles, with or without a trailer of not more than 9 tonnes GVM	Class HR
Mobile cranes over 8 tonnes GVM with more than two axles, with a trailer (no GVM restriction)	Class HC
All mobile cranes, with or without trailers.	Class MC

Appendix 4: Familiarisation training checklists

Hydraulic slewing crane

Crane model training performed on: _____

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

	1st	2nd		1st	2nd
Seat adjustment			Ground inspection		
Gauge and indicator function			Crane levelling (for crane set-up)		
Control identification (levers and switches)			Outrigger extension/retraction		
Warning devices (including horn)			Outrigger feet support (timber placement)		
Park brake			Outrigger lock pins		
Load chart (capacity at radius)			Maximum wind speed		
Load chart (deductions from capacity)					
Load chart - 360° ratings			Fly jib (rigging and de-rigging)		
Load chart - fly jibs					
Load chart - outrigger extension/on rubber			Safety inspection: - ropes - rams - wear pads - boom - grease points - fluid leaks - fluid levels - brakes - cabin visibility - tyre pressure - lights		
Winch line pull					
Rope full configurations					
Load moment system features					
LMS - set up and operation					
LMS - relationship to load chart					
LMS - override procedures					
Slew function					
Luff function					
Telescoping function					
Boom extension sequence					
Hoist function			Crane preparation for road travel		
Slew brake					
Slew lock pin					
Anti-two block					

Worker statement

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

Worker name: _____

Date: _____

Worker signature: _____

PCBU representative name: _____

Signature: _____

Date: _____

Familiarisation training checklist – Non-slewing hydraulic (pick-and-carry) crane

Crane model training performed on: _____

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

	1st	2nd		1st	2nd
Seat adjustment			Safety inspection: - ropes - rams - wear pads - boom - grease points - fluid leaks - fluid levels - brakes - cabin visibility - tyre pressure - lights		
Gauge and indicator function					
Control identification (levers and switches)					
Warning devices (including horn)					
Load chart (capacity at radius)					
Measure radius					
Load chart (deductions from capacity)					
Load chart (fly jib)					
Load chart (articulated capacities)					
Load chart (effect moveable counterweight)					
Side alteration load chart					
Winch line pull					
Rope full configurations			Crane preparation for road travel		
Load moment system features			Emergency steering		
LMS - set up and operation			Park brake		
LMS - relationship to load chart			Holding brake		
LMS - over ride procedures					
Load indicator (where LMS not fitted)					
Articulate function					
Luff function					
Telescoping function					
Hoist function					
Anti-two block (where fitted)					
Manual boom extension procedure					
Ground inspection					
Fly jib (rigging and de-rigging)					
Spreader bar use (where provided)					

Worker statement

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

Worker name: _____

Date: _____

Worker signature: _____

PCBU representative name: _____

Signature: _____

Date: _____

Familiarisation training checklist – Pin jib crane

Crane model training performed on: _____

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

	1st	2nd		1st	2nd
Seat adjustment			Load chart (capacity at radius)		
Gauge and indicator function			Load chart (deductions from capacity)		
Control identification (levers and switches)			Load chart - 360° ratings		
Warning devices (including horn)			Load chart - fly jibs		
Crane set-up (where applicable)			Winch line pull		
Track attachment			Rope full configurations		
Counterweight attachment					
Boom assembly			Safety inspection: - ropes - boom - sheaves - grease points - drive systems - fluid leaks - fluid levels - brakes - cabin visibility - tracks/tyres - lights		
Boom rigging					
Limit set-up					
A-frame erection					
Fly jib (rigging and de-rigging)					
Load moment system features					
LMS - set up and operation					
LMS - relationship to load chart					
LMS - override procedures					
Load indicator (where LMS not fitted)					
Slew function					
Luff function					
Luff limit					
Hoist function					
Hoist brake					
Slew brake					
Slew lock pin					
Anti-two block					
Driving crane with load (speed, load and boom position)					
Ground inspection					
Crane levelling					

Worker statement

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

Worker name: _____

Date: _____

Worker signature: _____

PCBU representative name: _____

Signature: _____

Date: _____

Appendix 5: Example of 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 Mobile Crane Code of Practice, and is safe to use.

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

Comments: _____

Appendix 6: Example of 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 Mobile 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: _____