GUIDE TO TOWER CRANES

This Guide provides information on siting, erecting and using tower cranes and self-erecting tower cranes in the workplace and supports the General guide for cranes.

This Guide forms part of a series of guides and information sheets for cranes that includes information on:

- mobile cranes
- inspecting and maintaining cranes
- bridge and gantry cranes
- vehicle loading cranes
- vessel-mounted cranes
- crane-lifted workboxes
- using other powered mobile plant as a crane, and
- quick-hitches for earth moving machinery.

What are tower cranes?

The three general types of crane typically referred to as tower cranes used in Australia are:

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

In the Work Health and Safety (WHS) Regulations:

- **Tower crane** means a boom crane or a jib crane mounted on a tower structure.
  - For high risk work licensing purposes, a tower crane, if a jib crane, may be a horizontal or luffing jib type and the tower structure may be demountable or permanent, but 'tower crane' does not include a self-erecting tower crane.
- **Self-erecting tower crane** means a crane that is not disassembled into a tower element and a boom or jib element in the normal course of use, and where erecting and dismantling processes are an inherent part of the crane's function.

High risk work licensing

A person who operates a tower crane or a self-erecting tower crane must hold the relevant high risk work licence to operate the crane. More information on high risk work licensing requirements is in the General guide for cranes.

Crane siting

When siting a tower crane or self-erecting tower crane, consider the working radius of the crane relative to:

- other permanent or temporary plant and structures
- common access areas for workers and other people at the workplace, and
- public access areas including footpaths, roadways and railways.

The size and design of a tower crane base should consider the manufacturer's instructions and factors including tower height, tie spacing, wind speed, terrain type, ground type and bearing capacity, boom length and crane lifting capacity.

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A documented procedure should be prepared to minimise the risk of injury from a collision. This procedure should address:

- siting cranes to minimise the need for other plant to operate within the crane's operating radius
- siting cranes and other plant that have counterweights so the counterweights cannot collide with other counterweights, plant, structures or people during slewing operations
- the method of communication between the crane crew and other plant operators
- scheduling of work to minimise the time the crane and other items of plant are required to work in the same area or at the same height, and
- the tower crane's climbing procedure means the crane stays as far above any structure or plant e.g. jump forms—as necessary to prevent collision.

Where cranes share the same air space but are sited on adjacent workplaces, the principal contractor from each workplace must consult and co-operate with the others to maintain clearances between cranes to minimise the risk of collision. The system of work should identify people from each workplace who have this responsibility, scheduling requirements for crane operations and a clear way of communicating between the workplaces.

Erecting a tower crane

Erection of tower cranes is high risk construction work. Failure to erect or dismantle tower cranes according to the crane designer's or manufacturer's instructions may result in injury to people and property damage from:

- crane collapse
- falls from heights, and
- falling objects.

A Safe Work Method Statement for high risk construction work must be prepared to erect a tower crane and should consider:

- the crane designer's or manufacturer's instructions
- crane stability
- the adverse effects on other plant, structures or work processes
- use of special tools, jigs and appliances necessary to minimise the risk of injury
- control measures for securing crane components
- environmental factors including wet or windy conditions, and
- relevant electrical installations associated with the crane complying with AS/NZS 3000:2007: *Electrical installations*.

Tower crane components must be inspected and tested before being delivered to the workplace. For further information see the Guide to inspecting and maintaining cranes.

Erecting and dismantling activities should be supervised by a competent person and carried out according to the manufacturer's instructions or those prepared by a competent person, for example an engineer.

Written instructions on erecting and dismantling activities should be readily available on site. Tower sections should be clearly and permanently identified with their model type and serial number. It is important for the tower sections to be the same as those specified on the engineer's crane base drawing or the crane will not be safe to use. Crane manufacturers may require the counterjib, counterweights and boom components to be installed or removed sequentially.

It is important not to erect or dismantle a tower crane unless the environmental conditions are within the crane manufacturer's specifications or where the wind does not make components uncontrollable when suspended.

Only parts that meet the specifications of the crane manufacturer or a competent person should be used when erecting a tower crane.

Precautions should be taken to make sure:

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

Footings and foundations

It is important the footings and foundations for a tower crane installation are designed according to engineering principles or relevant technical standards so they are, so far as is reasonably practicable, without risks to health and safety. This design should take into account the results of geo-technical inspections specific to the location of the crane installation. The installed footings and foundation should be certified by a competent person, for example an engineer, before tower crane installation begins.

Crane ties

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

Counterweights

Tower crane counterweights are critical in ensuring crane stability. Counterweights should be secured to the crane in the manner specified by the crane manufacturer.

A counterweight too light for a load and boom configuration may cause the crane to overturn in the direction of the suspended load. A counterweight too heavy for the load and boom configuration may cause the crane to fall over backwards.

Self-climbing tower cranes

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

The risk of injury from crane collapse during climbing operations can be minimised by:

- scheduling climbing operations to minimise the potential risk to people
- excluding unnecessary people from the workplace during climbing operations
- maintaining an exclusion zone of a size to contain structural failure
- excluding people from entering the area directly behind the tower crane under the counterweights during climbing operations
- avoiding slew operations during climbing operations, and
- conducting a physical inspection of the counterweight trolleys including side plates, bolting and pins, safety gear, ropes and turnbuckles before starting climbing operations.

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

The climbing sequence should be carried out according to the crane manufacturer's instructions. Climbing operations should not be attempted at wind speeds greater than 36 km/hour. However this does not prevent the crane rigging crew from stopping work if they think it unsafe when the wind speed is lower. Climbing operations should not start if either the recommended maximum wind speed or the actual wind speed is unknown.

Rated capacity limiters

When an overload is detected a rated capacity limiter prevents further overloading of the crane by stopping any crane functions that will increase the overload. Rated capacity means the maximum load that may be attached and handled by the crane in its current configuration but it may not include the weight of the hook block, falls of rope, slings and rigging hardware. The load to be raised includes 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 should be made.

Rated capacity limiters should be provided on tower cranes regardless of the age of the crane. The limiter should prevent hoisting a load:

- exceeding 100 per cent capacity (noting 100 per cent of the maximum rated capacity is only used during commissioning), and
- when the load exceeds 100 per cent of the specified radius.

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

Working radius indicator

A radius indicator should be fitted on tower cranes. A radius indicator displays the radius of the suspended load generally measured from the centre of the slew ring. The working radius should be displayed in metres and be accurate to +10 per cent and -3 per cent of the actual radius. Where the crane is operated by remote control and the jib is horizontal and fully visible to the operator the indicator may consist of 1 metre graduations marked on the jib with numbers written at intervals that are not excessive for example every 5 metres.

Dual braking systems

Dual braking systems should be provided on the luff function of rope luffing tower cranes and other functions specified by the crane manufacturer and used according to relevant technical design standards.

Commissioning

Commissioning tower cranes and self-erecting cranes involves performing necessary inspections, tests and adjustments to verify the crane meets specified requirements and is safe to operate before the crane is used. Commissioning should be carried out by a competent person once the crane has been erected and before it is put into service.

Test weights or load cells should be used to verify the correct calibration of both the maximum load capacity and the load moment with each installation when commissioning tower cranes.

Written instructions about commissioning a tower crane should be available to relevant people at the workplace. It is important for a crane to be commissioned according to these written instructions.

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

For further information see the Guide to inspecting and maintaining cranes.

Load charts

Load charts, also called rated capacity charts, identify what the crane is able to lift safely. The load chart should be available for the crane operator to verify the crane is not being overloaded.

It is important tower cranes are operated within their rated capacity.

Wind conditions

Wind conditions can impact on crane operation and the crane's rated capacity. Crane load charts include information on allowable wind speeds.

Strong winds impose extra loads on a crane and may affect the crane's stability. A maximum permissible operational wind speed will be included in the tower crane design but this may not apply for operational purposes—for example when a crane operator is at the controls and in the process of lifting a load.

Tower crane installations may be designed for a maximum operational wind speed, for example 72 km/hour— or 20 metres/second—as set out in relevant technical standards. Although the tower crane base and crane ties may have been designed for this higher operational wind speed, crane operators should not operate the crane in wind speeds that exceed the manufacturer's specifications or when they consider it unsafe.

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

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

Wind gusts will also have a different effect on the crane than a constant wind. A crane operator should base the decision to make a lift on information provided by the crane manufacturer and prior experience as a crane operator.

If the operator believes a specific crane operation is hazardous the operator may choose not to operate the crane. Information should be sought from the crane manufacturer or a competent person about the conditions under which a lift can safely take place.

Operating tower cranes

For a tower crane a documented risk assessment should be carried out in relation to wind conditions to determine:

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

The risk assessment should be conducted by a competent person and involve a consultative process between the principal contractor, crane owner and operator, and other crane crew members. Matters to be considered include the:

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

Only operate tower cranes in wind speeds for which they are designed.

Tower crane access

Ladders

Where ladders are used, the type of ladder access may be determined by available space in the tower. Landings between ladder sections, with changes in direction of the ladder, should be provided where there is available space in the tower. This system will minimise fatigue by allowing for rest breaks and reduce the risk of injury to workers, for example in the event of them falling off the ladder.

The vertical distance between landings should not exceed 6 metres. The crane manufacturer may design longer tower sections meaning the length of the ladder closest to the ground in the tower may be up to 12.5 metres and subsequent ladders may be up to 10 metres.

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

Internal guardrail on tower landings

Internal guardrails on tower landings will minimise the risk of a person falling internally down or off the tower. Some tower cranes are provided with an internal guardrail to tower landings to protect people from falling down the access hole. For example, either a guardrail on the internal side of the access hole or a rail that extends around the back of the access hole could be installed. It may be impractical to provide an internal guardrail on the top tower landing as slewing of the crane may cause the lower end of the ladder to strike and damage the internal guardrail, and entrapment of people on the top tower landing.

A-frame ladder cages

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

Guardrails on machine deck and A-frame platform

Tower cranes should be provided with perimeter edge protection that extends around the machine deck to prevent the crane operator and maintenance workers from falling. The edge protection should consist of a top rail, a mid-rail and a kickboard.

Saddle bag platforms

Saddle bag platforms may be needed on tower cranes with moving counterweights to provide access for riggers while erecting the crane and for people carrying out maintenance.

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

Climbing over the machine deck guardrail and down a ladder leading onto the platform is not recommended.

Crane jib access—non-self-erecting types

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

Signs on tower cranes

Attaching signs on tower crane structures is not recommended as the signs will affect the operation of the crane in windy conditions. Signs not securely attached to the structure may detach during crane operations and result in injury to people near the crane.

Signs should not be attached to the tower crane structure unless the potential wind loading of the sign and the resulting impact on the design of the crane base, tower sections, crane ties and rated capacity has been considered.

Manufacturer and designer confirmation should be obtained to verify the design of the sign and its attachments to the crane are 'fit for purpose'. This includes ensuring maintenance on the sign will not be needed for as long as the crane is on site.

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

Solid signs should be attached to the crane structure by bolted connections that clamp around the outside of the chords or lacings of the structure.

When attaching solid signs you should not:

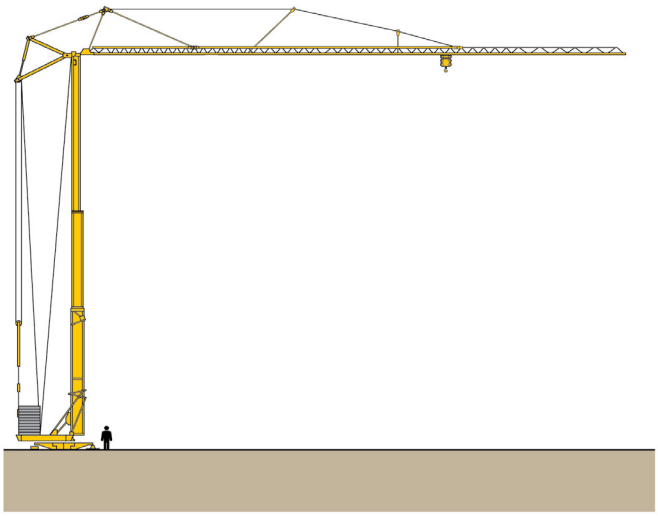
- drill holes into the crane structure
- weld joints on to the crane structure, and
- use strapping and cable ties.

Self-erecting tower cranes

The use of self-erecting tower cranes is common particularly on small to mid-sized building sites as they are self-contained and do not require another crane to erect them. Self-erecting tower cranes (see Figure 1) are generally made up of a horizontal boom that folds out during erection and can include a telescopic tower. The counterweight is usually at the base of the crane.

Unlike tower cranes, self-erecting tower cranes do not require fixing to a crane base. Self-erecting tower cranes usually do not have a cabin and instead are operated by remote control. While this feature is an advantage as it allows the operator to move around the crane operating area, it has also led to incidents where the crane has collided with overhead electric lines or other obstacles.

FIGURE 1 Self-erecting tower crane



Operating self-erecting tower cranes

Self-erecting tower cranes should be operated from a designated area. During the lifting operations the crane operator should remain in close proximity to the crane and maintain clear visibility of the load.

Where it is not possible for the operator to keep sight of the load a dogger should report the position of the load to the operator to ensure safe operation.

Remote operation

Self-erecting tower cranes and some tower cranes may be remotely operated by either hard-wired pendant controls or wireless controls.

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

Remotely operated tower cranes including self-erecting tower cranes should have a dedicated operator who is available to operate the crane. A number of competent people should be available to safely complete the lifts especially where there are multiple drop-off points that are out of sight of the operator. A dogger should direct the crane operator whenever the load is out of sight of the operator.

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

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

Erecting a barricade around self-erecting tower cranes

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

An 1800 mm high barricade, for example mesh fencing should be erected around the base of self-erecting tower cranes to stop people entering this area and being hit by the crane's counterweights. The barricade should be positioned to provide enough room to avoid people being trapped between the barricade and the counterweights.

Self-erecting tower crane maintenance access

The towers on most self-erecting tower cranes do not have to be climbed by people while in use. Instead, maintenance needed on the crane can often be carried out by folding the crane but some self-erecting tower cranes are provided with ladders on the towers for maintenance access. If a vertical maintenance ladder is provided a permanent vertical rail or rope does not have to be provided. A person climbing the ladder must be provided with a fall-arrest system. Using work platforms, including elevating work platforms, should be considered for carrying out maintenance activities.

Inspection, testing and maintenance

An inspection and maintenance program should be implemented for tower cranes and self-erecting tower cranes including daily, routine, annual and major inspections.

For further information see the Guide to inspecting and maintaining cranes.

Further information

The following technical standards provide further information on tower cranes:

- *AS 2550.1-2011: Cranes, hoists and winches—Safe use Part 1: General requirements*
- *AS 2550.4-2004: Cranes, hoists and winches—Safe use Part 4: Tower cranes*
- *AS 2550.20-2005: Cranes, hoists and winches—Safe use Part 20: Self-erecting tower cranes*