safe work australia

**DRAFT**

# CRANES

# Code of Practice

***This DRAFT Code has been approved by Safe Work Australia Members and is ready for approval by the Select Council on Workplace Relations (Ministerial Council). This Code will become a model WHS Code of Practice under the Inter- Governmental Agreement for Regulatory and Operational reform in OHS when it is approved by the Ministerial Council.***

## TABLE OF CONTENTS

## FOREWORD

This Code of Practice on managing risks associated with cranes is an approved code of practice under section 274 the Work Health and Safety Act (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 Regulations (the WHS Regulations).

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, for 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 Regulations. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

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

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

This Code of Practice has been developed by Safe Work Australia as a model code of practice under the Council of Australian Governments' *Inter-Governmental Agreement for Regulatory and Operational Reform in Occupational Health and Safety* for adoption by the Commonwealth, state and territory governments.

A draft of this Code of Practice was released for public consultation on 8 June 2012 and was endorsed by the Select Council on Workplace Relations on [*to be completed*].

## SCOPE AND APPLICATION

This Code provides practical guidance to persons conducting a business or undertaking who have management or control of cranes in the workplace, as well as people who install, commission and maintain cranes. It provides practical guidance on how to manage health and safety risks associated with cranes in the workplace, from installing, commissioning and using through to decommissioning and dismantling, and includes information about specific control measures required under the WHS Regulations for cranes.

This Code should be read with the Codes of Practice for *Managing Risks of Plant in the Workplace* and *Safe Design, Manufacture, Import and Supply of Plant*.

**How to use this code of practice**

In providing guidance, the word 'should' is used in this Code to indicate a recommended course of action, while 'may' is used to indicate an optional course of action.

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

# 1. INTRODUCTION

## 1.1 What is a crane?

A **crane** is an item of plant intended for raising or lowering a load and moving it horizontally including the supporting structure of the crane and its foundations.

The plant designs and items of some types of cranes, including mobile cranes and tower cranes, must be registered under the WHS Regulations.

A range of multi-purpose powered mobile plant, including multi-purpose tool carriers and telescopic handlers, may be classed as cranes or in some operating configurations. These types of plant require the relevant plant design and item registration.

General information on specific types of cranes is provided in Chapter 6 and the Appendices.

Other key terms used in this Code are defined in Appendix A.

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

A **person conducting a business or undertaking** has the primary duty to ensure, so far as is reasonably practicable, workers and other people are not exposed to health and safety risks arising from the business or undertaking. This duty includes ensuring, so far as is reasonably practicable the:

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

A **person conducting a business or undertaking with management or control of a crane** has some specific obligations relating to powered mobile plant and plant that lifts or suspends loads.

If you own a crane, you are the person with management or control of the crane. If you hire or lease a crane, you have management or control of that crane for the period that you have hired it. Both you and the person you have hired or leased it from have duties to eliminate or minimise the risks associated with the plant, so far as is reasonably practicable.

**Designers, manufacturers, suppliers, importers and installers** of plant they design, manufacture, import or supply is without risks to health and safety. This duty includes carrying out testing and analysis as well as providing specific information about the plant or structure.

Designers, manufacturers, importers and suppliers also have duties to provide information about the crane to enable other duty holders to meet the responsibilities they have in managing the risks associated with the crane. Information must be passed on from the designer through to the manufacturer and supplier to the end user.

Further guidance is available in the *Code of Practice: Safe Design, Manufacture, Import and Supply of Plant.*

**Officers,** such as company directors, have a duty to exercise due diligence to ensure the business or undertaking complies with the WHS Act and Regulations. This includes taking reasonable steps to ensure the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks arising from using cranes in the workplace.

**Workers** have a duty to take reasonable care for their own health and safety and to not adversely affect other people's health and safety. Workers must co-operate with reasonable policies or procedures relating to health and safety at the workplace and comply, so far as they are reasonably able, with reasonable instructions. Workers who operate certain types of cranes must have a relevant high risk work licence.

**Other persons at the workplace**, like visitors, must take reasonable care for their own health and safety and must take reasonable care not to adversely affect other people's health and

safety. They must comply, so far as they are reasonably able, with reasonable instructions given by the person conducting the business or undertaking to allow that person to comply with the WHS Act.

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

**R.203:** A person with management or control of plant at a workplace must manage risks to health and safety associated with the plant.

**R.32-38:** To manage risk, a person conducting a business or undertaking must:

- identify reasonably foreseeable hazards that could give rise to risks to health and safety
- eliminate risks to health and safety so far as is reasonably practicable
- if it is not reasonably practicable to eliminate risks to health and safety—minimise those risks so far as is reasonably practicable by implementing risk control measures according to the hierarchy of control in regulation 36
- ensure the control measure is, and is maintained so that it remains, effective, and
- review and as necessary revise control measures implemented to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety.

Chapter 2 of this Code provides guidance on how to manage the risks associated with cranes following a systematic process which involves:

- identify hazards – find out what could cause harm
- assess risks if necessary – understand the nature of the harm that could be caused by the hazard, how serious the harm could be and the likelihood of it happening
- control risks – implement the most effective control measures that are reasonably practicable in the circumstances
- review control measures to ensure they are working as planned.

Guidance on managing the risks of plant is available in the *Code of Practice: Managing Risks of Plant in the Workplace*.

**Consulting your workers**

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

**S.47:** The person conducting a business or undertaking must, so far as is reasonably practicable, consult with workers who carry out work for the business or undertaking who are, or are likely to be, directly affected by a matter relating to work health or safety.

**S.48:** If the workers are represented by a health and safety representative, the consultation must involve that representative.

It is important to consult your workers as early as possible when planning to introduce new plant or make any changes that may affect their health and safety.

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

It is important to consult your workers as early as possible when planning to introduce new plant, including cranes or make any changes that may affect their health and safety.

### Consultation, co-operation and co-ordination of activities with other duty holders

**S.46:** If more than one person has a duty in relation to the same matter under this Act, each person with the duty must, so far as is reasonably practicable, consult, co-operate and co-ordinate activities with all other persons who have a duty in relation to the same matter.

There may be other businesses who share the workplace where the crane is used or who are involved in supplying, installing, testing and maintaining the crane. They will each have health and safety duties to the extent of their ability to influence and control aspects of crane safety. It is important these duty holders consult each other on the risks associated with using the crane and work together in a co-operative and co-ordinated way to control the risks, for example controlling traffic movements in or near the work area in which a mobile crane is operating.

Further guidance on consultation requirements is available in the *Code of Practice: Work Health and Safety Consultation, Co-operation and Co-ordination*.

## 2. THE RISK MANAGEMENT PROCESS

There are a range of hazards and risks associated with using a crane. A risk management process that identifies the hazards and controls the risks will help ensure the crane is safe to use.

### 2.1 Identifying the hazards

The first step to managing the risks is to identify the hazards associated with the crane and its use. Hazards could arise from the:

- crane, e.g. structural condition, electrical and hydraulic systems, mechanical power sources, moving parts, load-carrying capacity and operator protection
- setup location, e.g. for a mobile crane, the environment including rough, muddy, sloping or uneven ground and the size of the area in which it will operate
- crane operation, e.g. the load the crane will lift, other work occurring in the same area
- crane dismantling, e.g. working at height for tower cranes.

**Table 1** Examples of specific hazards that may be associated with crane

| Hazard | Example of how it may occur |
|---|---|
| **Structural failure** | A crane component, including the boom, jib, hydraulic rams or wire rope could suffer structural failure without warning. For example, a crane may fail structurally if it is overloaded in the structural area of its load chart or the failure could be from gradual deterioration due to a lack of maintenance. |
| **Crane overturning** | For example, this could occur when a crane is overloaded in the stability area of its load chart or inadequate setup. This may be influenced by:<br>o poor ground conditions, e.g. unstable ground, inconsistent compaction or unknown underground services<br>o failure to use or fully extend outriggers or stabilisers<br>o failure to use appropriate outrigger pads<br>o failure to level the crane or operating the crane beyond its gradient limits<br>o failure to operate crane within manufacturers load charts or guidelines<br>o insufficient counterweights are used for the selected load chart<br>o load limiting devices not functioning<br>o rapid slewing<br>o high wind conditions. |
| **Crane collapse** | A tower crane may collapse if it becomes unstable from overloading or poor installation. This may be influenced by:<br>o the incorrect use of counterweights<br>o crane tower bolts being incorrectly torqued<br>o the incorrect installation of crane ties<br>o poor design of the tower crane base. |
| **Contact or collision with people, other plant and structures** | Where there is insufficient clearance between a mobile crane and pedestrian traffic routes or other plant and structures, including other cranes, concrete pumping booms, buildings and overhead electric lines. |
| **Falling objects** | Ojects falling during erecting and dismantling activities and the way loads are secured during lifting operations may create a risk to |

| | |
|---|---|
| | workers and other people. |
| **People falling from height** | When working at height including:<br>o carrying out activities associated with erecting dismantling of cranes, undertaking maintenance checks or accessing tower crane cabins<br>o using a work box to lift and position workers. |

When identifying hazards you should think about all the activities that may be carried out during the life of the crane at your workplace, including installing, commissioning, operating, inspecting, maintaining, repairing, transporting, storing and dismantling.

**How to identify hazards**

Information gathered from a range of sources can help identify hazards. This may include:

- consulting with crane designers, manufacturers, suppliers, importers, maintenance technicians or engineers and operators
- operational manuals and other information provided with the crane
- a visual inspection of the crane and associated environmental and operational conditions in which the crane is intended to be installed, erected and used
- the ergonomic and safety needs of crane operators
- inspection, testing and maintenance information
- analysis of injuries and near misses.

If you have hired or leased a crane, you should consult the person conducting the business or undertaking who supplies the crane, for example the crane owner, about potential hazards because you both have responsibility for ensuring that the crane is without risk to health and safety.

## 2.2 Assessing the risks

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

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

Many hazards and their associated risks are well known and have well established and accepted control measures. In these situations, the second step to formally assess the risk is unnecessary. If, after identifying a hazard, you already know the risk and how to control it effectively, you may simply implement the controls.

Factors that may impact on the risk associated with the hazards you have identified include:

- the condition of the crane, e.g. its age, maintenance history and how often it is used
- the suitability and stability of the crane
- the location of the crane, e.g. its impact on the design and layout of the workplace, environmental conditions, and entries and exits
- operator competency
- unusual situations, e.g. misuse or variation in operating conditions.

## 2.3 Controlling the risks

Some control measures are more effective than others. Control measures can be ranked from the highest level of protection and reliability to the lowest. This ranking is known as the *hierarchy of control*.

### Eliminating the risk

This means removing the hazard or hazardous work practice from the workplace. This is the most effective control measure and must always be considered before anything else. For example, designing items so they are of a size, shape and weight that can be delivered to, handled or assembled at the location where they will be used without the need for a crane.

If elimination of the risk is not reasonably practicable, you must consider using substitution, isolation or engineering controls, or a combination of these control measures, to minimise the risk.

### Minimising the risk

*Substitution*

Minimise the risk by substituting or replacing a hazard or hazardous work practice with a safer one. For example, replace a crane operating cabin that has a restricted field of vision with one that has a clear field of vision.

*Isolation*

Minimise the risk by isolating or separating the hazard or hazardous work practice from people, either by distance or physical barrier. For example, use concrete barriers to create an exclusion zone to separate mobile plant from crane operations and workers.

*Engineering controls*

Engineering controls are physical control measures to minimise risk. For example, enclosing the operator with a falling objects protective structure (FOPS) to minimise the risk of being hit by a falling object.

If a risk then remains, the duty holder must minimise the remaining risk, so far as is reasonably practicable, by implementing:

*Administrative controls*

Administrative controls should only be considered when other higher order control measures are not reasonably practicable, or to increase protection from the hazard. These are work methods or procedures that are designed to minimise the exposure to a hazard, for example crane cleaning or maintenance procedures could:

- require that all controllers are placed in the "off" position and the main switches are open and locked, or
- controls are physically locked out and tagged to prevent unintentional start-up.

Any remaining risk must be minimised, as far as is reasonably practicable, by ensuring the provision and use of:

*Personal protective equipment*

Personal protective equipment (PPE) is the lowest order control measure in the hierarchy of controls. PPE should also only be considered when other higher order control measures are not reasonably practicable or to increase protection from the hazard. Examples of PPE include workers gloves, hard hats, high visibility vests, and hearing and eye protection.

Administrative control measures and PPE rely on human behaviour and supervision and used on their own tend to be least effective in minimising risks.

### Combining control measures

In most cases, a combination of control measures will provide the best solution to minimise the risk to the lowest level reasonably practicable. For example, control measures to minimise the risk of people working in the same area from being hit by a crane or its load could include combining the following:

- separating workers in a work area from the crane operation using physical barriers (isolation)
- installing motion limiting devices to stop the crane or part of the crane moving outside of its operating designated area (engineering)
- developing and implementing a traffic management plan for controlling traffic (administrative)
- requiring all workers to wear high visibility reflective clothing or vests (PPE).

## 2.4 Maintaining and reviewing control measures

**R.37:** A person conducting a business or undertaking must ensure control measures are maintained so that they remain effective, including by ensuring that the control measures are and remain:

- fit for purpose
- suitable for the nature and duration of the work, and
- installed, set up and used correctly.

**R.38:** A duty holder must review and as necessary revise control measures implemented to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety.

The control measures that are implemented must be reviewed and, as necessary, revised, including when there is a change at the workplace, to make sure they work as planned and that no new hazards have been introduced by the control measures. Controls can be checked by using the same methods as in the initial hazard identification. Common methods include inspecting the workplace, consulting workers and others, testing and analysing records. When deciding how often to carry out a review, you should consider:

- the level of risk—more complex plant may need more frequent review
- the type of crane involved—there may be particular stages in the life of the crane where a more frequent review is needed.

## 3. BEFORE USING A CRANE

### 3.1 Planning the work

**R.219:** The person with management or control of plant at a workplace must ensure, so far as is reasonably practicable, that the plant used is specifically designed to lift or suspend the load. If it is not reasonably practicable to use plant that is specifically designed to lift or suspend the load, the person must ensure that:

- the plant does not cause a greater risk to health and safety than if specifically designed plant were used, and
- if the plant is lifting or suspending persons, the use of the plant complies with regulation 220.

The person must ensure that the lifting and suspending is carried out:

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

Planning is the first step in ensuring that lifting of a load is done safely. Planning includes:

- developing an initial scope of work
- selecting and getting a crane
- planning, programming, scheduling and organising the work
- managing the work.

Planning for crane operations must, so far as is reasonably practicable, involve consultation, co-operation and co-ordination with all people involved in the work. This may include the principal contractor, crane hirer, crane manufacturer, supplier, installer, electricity supply authority, designer such as an engineer, contractors, crane operator and crane crew.

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

- installing, erecting, climbing and dismantling cranes
- directly involved in the lifting operation, including the crane operator, dogger and rigger
- carrying out other activities at the workplace
- in an area near the crane, including a public area.

Some issues to consider when planning for crane operations include:

- determining scope of work and the appropriate crane for the work to be carried out
- ensuring the ground conditions and supporting structures are adequate to support the weight of the crane and loads while conducting the planned lifts
- ensuring the crane operator holds the relevant licence and is competent to operate the crane or cranes
- weather conditions, e.g. the likelihood of high winds or thunderstorms
- identifying the best location for the crane to carry out the planned lifts, e.g. where are buildings, other structures and plant at the workplace
- ensuring there is adequate room for the crane, equipment, people and other mobile plant and vehicles to enter and exit the workplace safely
- liaising with electricity supply authorities about control measures for working near overhead electric lines
- ensuring there are enough people supporting safe crane operations.

### 3.2 Selecting a crane

The type and number of cranes should be chosen to suit the needs of the workplace and the work to be carried out. Hazards can be introduced if crane characteristics do not match the work needs and work environment.

When selecting a crane, the size and characteristics of the crane should be assessed including:

- workplace conditions, including the ground on which the crane is to be set up, wind conditions, access roads and ramps it will travel on, space to erect it and any obstacles that may limit access or its operation
- weights and dimensions of loads to be lifted and the locations of the loads relative to the crane
- range of lift heights and radii from the crane and the weight of the loads to be handled at these points
- how often and how many lifts will be made
- length of time the crane is needed at the workplace to carry out the work
- type of lifting to be done, e.g. precise placement of loads
- type of carrier needed—this depends on ground conditions and machine capacity in its various operating quadrants
- if loads are to be walked or carried
- if loads may be suspended for a long time.

Discuss your needs with the supplier who must provide you with the following information when they supply a crane:

- the purpose for which the crane was designed or manufactured
- the results of any calculations, analysis, testing or examination
- any conditions necessary for the safe use of the crane.

If you buy a crane which requires design registration, the supplier must provide you with the plant design registration number.

**Second-hand cranes**

**R.198:** A supplier of plant must:

- take all reasonable steps to obtain the information required to be provided by the manufacturer under section 23(4)(a) and (c) of the Act and these Regulations, and
- when the plant is supplied, ensure the person to whom the plant is supplied is given the information obtained by the supplier.

**R.199:** A supplier of second-hand plant must ensure, so far as is reasonably practicable, that any faults in the plant are identified.

Before plant is supplied, the supplier of second-hand plant must ensure that the person to whom the plant is supplied is given written notice of:

- the condition of the plant
- any faults identified, and
- if appropriate, that the plant should not be used until the faults are rectified.

**R.8:** A supply of a thing does not include the supply of a thing by a person who does not control the supply and has no authority to make decisions about the supply, for example an auctioneer without possession of the thing or a real estate agent acting in their capacity as a real estate agent.

A person conducting a business or undertaking that imports, supplies or sells second hand plant has obligations to the person buying or receiving the plant, including for a crane.

The inspection and maintenance history of second-hand crane should be requested before buying the crane. Where the crane has been in service before sale and information on its condition and how to use it safely is not available a competent person, for example a qualified engineer, should be engaged by the supplier to assess the crane and develop this information.

A second hand crane, especially one obtained from overseas, may not have undergone the major inspections required by Regulation 235 and may require a major inspection before being placed into service.

Where a second-hand crane that requires plant registration is imported from overseas, the importer or supplier must have the design and item registered before it can be supplied for use.

For further information see section 25 of the WHS Act, regulations 198, 199 and 200 of the WHS Regulations and the *Code of Practice: Safe Design, Manufacture, Import and Supply of Plant.*

## 3.3 Hiring a crane

When you hire a crane you and the person you have hired it from both have duties for health and safety. During the time the crane is in your possession or operating at your workplace you will have some control over the way the crane is used.

Anyone hiring or leasing a crane to others has duties as both a supplier of the crane and as a person with management or control of the crane at the workplace. They must ensure, so far as is reasonably practicable, that the crane is safe to use and properly maintained and provide specific information with the crane including on how to operate it safely.

Before you hire the crane you should check the crane is suitable your needs. If you do not have the knowledge or expertise about crane specifications, limitations and operational requirements, you should consult the crane supplier and provide all relevant information about the nature of the work, the workplace and the type of lift to enable the supplier to provide a suitable crane.

Most crane hire is a ‘wet hire’ where there person who owns the crane supplies the crane and the crane operator and crew. In these situations the hirer should be provided with the necessary information to allow them to provide a suitable crane, appropriately licensed crew, access the site, set up the crane, conduct the lifts, and leave the site safely.

If you are hiring a crane as a ‘dry’ hire and will be using your own crane operator and crew you should also check the crane has been inspected and maintained by the owner according to the manufacturer’s specifications. This may involve checking the log book or maintenance manual. You should also ensure the supplier gives you the manufacturer’s information about the purpose of the crane, its proper use and if a high risk work licence is required to operate the crane, information about which class or classes of licence the crane operator must hold.

In most cases the supplier is responsible for inspecting and maintaining the crane. If the crane is hired for an extended period of time, you and the supplier may develop arrangements for the crane to be inspected and maintained throughout the lease. This may involve the supplier coming to your workplace to maintain the crane, or you maintaining the crane while it is at your workplace.

The arrangements you make will depend on your ability to inspect and maintain the crane in accordance with the manufacturer’s specifications and WHS regulations. If you choose to maintain the crane yourself during the lease, you should provide all information and records about the maintenance to the supplier at the end of the lease.

## 3.4 Registering a crane

Certain plant designs and items of plant must be registered under Schedule 5 to the WHS Regulations before they are used in the workplace. Cranes that are registrable plant must be design registered before they are supplied and, where necessary, item registered before they are used.

A table showing the types of plant that require registration is included at Appendix C.

Further information on registering plant is available in the:

- *Code of Practice: Managing Risks of Plant in the Workplace*, and
- *Code of Practice: Safe Design, Manufacture, Import and Supply of Plant*.

**Design Registration**

Design registration process includes registering a complete design from which a number of individual items can be manufactured. The person applying for design registration may be the original designer or the person with management or control of the crane. A crane design must be registered when:

- the design has not already been registered, or
- you significantly alter the crane design by modifying the crane.

When a design is registered, the regulator issues a crane design registration number. This number must be provided by the supplier to the person with management or control of the crane at a workplace when they supply the crane.

The person with management or control of the crane must keep the design registration number in a readily accessible location near the crane at all times.

Design registration does not need to be renewed as it remains valid as long as the design remains unaltered.

**Changes to design registration**

**R.244:** If the design of an item of plant specified in Part 1 of Schedule 5 that is registered under Part 5.3 is altered and the alteration may affect health or safety, the altered design must be registered.

**R.282:** The regulator must be notified in writing, within 14 days, if the item of registrable plant is:

- the name of the registration holder changes
- altered to an extent or in a way that requires the plant to be subject to new control measures
- the item of plant is usually fixed and is relocated, or
- the registration holder no longer has management or control of the plant.

A number of issues may result in a plant design being changed, for example due to a change in technology. If the alteration could affect health and safety the altered design must be registered.

Where an alteration has been made to the design of a crane, the person making the design change is a designer and has designer duties. When altering a crane design it is likely the designer will need to perform engineering calculations on the crane design to determine that it complies with relevant technical standards.

**Item registration**

Plant item registration applies to a specific item of plant and each item requires registration. The person with management or control of the crane must ensure that all registrable cranes are registered.

To have a crane item registered, it must be inspected by a competent person and a statement provided to certify it is safe to operate. A person is a competent person to inspect an item of plant for registration if the person has:

- educational or vocational qualifications in an engineering discipline relevant to the plant to be inspected, or
- knowledge of the technical standards relevant to the plant to be inspected.

**Once the crane is registered**

The regulator will issue a registration document including an item registration number. The registration document must be kept readily accessible near the crane.

The item registration number must be marked on the crane. For large cranes this can be done simply by fixing a plate with the number to the crane where it can be easily read and seen and is not likely to be damaged or removed.

For some cranes, such as a tower crane which comprises many parts assembled in different configurations to suit a particular site, it may be difficult to mark each component of the crane. In such cases the item registration number should be marked on those components which are easily seen when the crane is assembled.

**Item registration renewal**

Plant item registration expires after five years. An application to renew it must be made before it expires and requires a declaration that the crane has been maintained, inspected and tested in accordance with the WHS Regulations.

**Changes to item registration**

You must tell the regulator, within 14 days, if the:

- the name of the registration holder changes
- crane is altered in a way that new measures to control the risk are needed
- crane is usually at a fixed location but has been moved, or
- the registration holder no longer has management or control of the crane.

## 3.5 Information, training, instruction and supervision

**S.19:** A person conducting a business or undertaking must ensure, so far as is reasonably practicable, the provision of any information, training, instruction or supervision that is necessary to protect all persons from risks to their health and safety arising from work carried out as part of the conduct of the business or undertaking.

**R.39:** A person conducting a business or undertaking must ensure that information, training and instruction provided to a worker is suitable and adequate having regard to:

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

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

Information, training and instruction for all people involved in crane operations should include:

- the risks associated with the work and safe work procedures to be used when setting up and operating the cranes, including traffic rules and safe distances from overhead electric lines
- knowledge of the crane manufacturer's operation and service manuals
- methods used to inspect and maintain the cranes and how often this should be carried out
- how to use, care and store tools and equipment correctly, including personal protective equipment
- emergency procedures.

Crane operators must, so far as is reasonably practicable, be supervised until they are competent to operate the crane.

Where necessary, the person operating the crane and the people working with a crane, for example a dogger or rigger, must hold a relevant high risk work licence.

You must ensure only workers who hold a relevant high risk work licence or have received the required training and instruction and are competent carry out the work.

Systems should be in place to monitor the work to ensure that agreed safe work procedures are being followed, including using personal protective equipment.

A person conducting a business or undertaking involved in crane operations must ensure, so far as is reasonably practicable, safety information is provided to people who are involved in installing, commissioning, testing, maintaining or repairing cranes, as well as decommissioning, dismantling or disposing of cranes. This should include information on the types of hazards and risks the crane may create for people when they are involved in these activities.

**Training**

Cranes can be different in their design, operation, control layout and configuration. For example, there are three basic types of tower crane: luffing, hammerhead (including topless) and self-erecting. There are a range of crane designs in each type, for example a commonly used form of a hammerhead crane is referred to as a 'topless' tower crane.

Crane operators should be familiar with the type of crane they operate including with the design, layout, operating functions and maintenance and inspection requirements. Crane operators should be provided with training to help them become familiar with the crane they will be using before starting work on a crane for the first time. The training should be provided by a competent person, for example a representative from the crane supplier or manufacturer, particularly when the crane is new. The trainer should have detailed knowledge of the operational and safety features of the crane and should also be endorsed by the crane supplier or manufacturer as being competent to deliver any familiarisation training. Training should be recorded in the crane operator's logbook.

Regular refresher training is also important to help ensure crane operators, doggers and riggers maintain their competencies gained when they undertook their high risk work licence as well as to understand the cranes they are working with. Refresher training should be conducted as often as necessary to ensure that the crane crew continues to work safely.

A training needs analysis may be conducted to identify the particular training needs of individual workers, or the needs may be determined by issues identified during supervision.

Refresher training should include:

- using and applying new technology, particularly for those people who gained their licence class while working on older or different types of cranes
- health and safety hazards, risks and controls
- operating, maintaining and inspecting a crane safely
- relevant changes to workplace health and safety legislation, manufacturer's instructions and technical standards which impact on how to operate a crane safely.

Refresher training may also include providing technical and theoretical information and practical demonstration and supervision.

## 3.6 Installing and commissioning a crane

**R.201:** A person who conducts a business or undertaking that installs, constructs or commissions plant that is to be used, or could reasonably be expected to be used, as, or at, a workplace must ensure that the plant is installed, constructed or commissioned having regard to:

- the information provided by the designer, manufacturer, importer or supplier of the plant under the Act and these Regulations, or
- the instructions provided by a competent person to the extent that those instructions relate to health and safety.

**R.204:** A person with management or control of plant at a workplace must not commission the plant unless the person has established that the plant is, so far as is reasonably practicable, without risks to the health and safety of any person.

A person with management or control of plant at a workplace must ensure that:

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

Installing and commissioning cranes involves performing necessary adjustments, tests and inspections to check the crane is working safely and meets the specified requirements before it is used. It should involve checking that:

- the crane is installed and commissioned according to the crane designer's or manufacturer's instructions and any specified technical standards
- the proposed method for installing or commissioning the crane will not adversely affect other plant and structures in the area
- installing and commissioning activities are supervised by a competent person
- only parts and components meeting the specifications of either the crane manufacturer or a competent person are used
- the components are assembled in the correct sequence using appropriate tools and equipment including special tools, jigs and appliances
- the crane is stable during installing and commissioning
- adequate fall controls measures are implemented where workers are working at a height
- entry to and exit from the crane including in an emergency meets relevant technical standards
- environmental factors, including ground load bearing capacity, wet or windy conditions are taken into account
- relevant electrical installations associated with the crane meet the relevant technical standards, including AS/NZS 3000: *Electrical installations.*

## 3.7 Falling objects

**R.54:** A person conducting a business or undertaking at a workplace must manage risks to health and safety associated with an object falling on a person if the falling object is reasonably likely to injure the person.

**R.55:** If it is not reasonably practicable to eliminate the risk, the person conducting the business or undertaking at a workplace must minimise the risk of an object falling on a person by providing adequate protection against the risk.

A person provides adequate protection against the risk if the person provides and maintains a safe system of work, including:

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

Examples

1 Providing a secure barrier.
2 Providing a safe means of raising and lowering objects.
3 Providing an exclusion zone persons are prohibited from entering.

Installing and commissioning activities may create a risk of people being hit by falling objects. Control measures based on a risk assessment should be implemented to minimise the risk. For example:

- erect and maintain effective barricades at a distance around the work area to prevent access—only people who are directly involved in crane installing and commissioning activities should be allowed inside this area
- erect and maintain protective hoardings to protect people near the work, or
- schedule the crane installation and commissioning for when the movement of people and mobile plant at the workplace is at a minimum.

## 3.8 Public safety and site security

A person conducting a business or undertaking must ensure, so far as is reasonably practicable, that the health and safety of people near and around the workplace is not put at risk, for example on roads, walkways, or water courses. Control measures to protect the public include street closures, barricades, hoardings, scaffolding and other types of overhead protection. These are often used in combination.

**R.298:** A person with management or control of a workplace at which construction work is carried out must ensure, so far as is reasonably practicable, that the workplace is secured from unauthorised access.

Further guidance on securing a construction workplace is available in the *Code of Practice: Construction Work*.

## 3.9 Emergency Plan

**R.43:** A person conducting a business or undertaking must ensure that an emergency plan is prepared and maintained so it remains effective for the workplace, and provides for the following:

- emergency procedures, including:
  - an effective response to an emergency
  - evacuation procedures
  - notifying emergency service organisations at the earliest opportunity
  - medical treatment and assistance
  - effective communication between the person authorised by the person conducting the business or undertaking to co-ordinate the emergency response and all persons at the workplace
- testing of the emergency procedures, including the frequency of testing
- information, training and instruction to relevant workers in relation to implementing the emergency procedures.

Check whether the workplace where the crane will operate has an emergency plan to provide an effective response in various types of emergencies, including how to evacuate people near the crane in a controlled way.

The plan must include procedures for notifying emergency service organisations as soon as possible, and effective means of communication between the person responsible for co-ordinating the emergency response and everyone at the workplace.

Contact numbers for emergency services should be easily seen or found. All workers should know what system is in place to contact emergency services and how to use it.

Rescue equipment should be available and easily accessible so an injured worker, including the crane operator, can be removed quickly.

Signs displaying evacuation locations should be placed where they are easily seen by workers and others at the workplace.

Emergency procedures should be communicated to all workers and include information about:

- how to use warning systems and what to do when they sound
- how to shut-down the crane safely
- how to evacuate the crane and the area nearby safely, e.g. in controlled way
- evacuation points
- effective communication between all workers near the device to evacuate safely
- how to use fire fighting and rescue equipment and where to find it
- training workers to respond to injured people and evacuate people, e.g. what to do if someone contacts an energised overhead electric line.

# 4. USING A CRANE

## 4.1 High risk work licences

**R.85:** A person conducting a business or undertaking at a workplace must not direct or allow a worker to carry out high risk work for which a high risk work licence is required unless the person sees written evidence provided by the worker that the worker has the relevant high risk work licence for that work.

Schedule 3 to the WHS Regulations sets out the types of plant that require a licensed operator.

A person who operates a crane must hold a high risk work license relevant to the type of plant they operate. The operator of multi-purpose powered mobile plant configured as a crane, for example a telescopic handler configured as a non-slewing mobile crane over 3 tonnes, must hold a relevant high risk work licence to operate the plant in that configuration.

Doggers and riggers must also hold a high risk work licence relevant to the work they are carrying out.

Where the person responsible for slinging a load needs to exercise judgement about the suitability and condition of lifting gear and the method of slinging the load and sling accessories, this person must hold a dogger or rigger high risk work licence or be a directly supervised trainee. A crane operator may only supervise a trainee to carry out dogging work if the crane operator holds a dogger's licence and the trainee is carrying out the work as part of training towards a certification to be licensed as a dogger.

A matrix showing the types of plant requiring registration and for which an operator must hold a high risk work licence is included at Appendix C.

A person who carries out work with a crane does not need to be licensed as a crane operator if the work is carried out:

- as a trainee—set out above
- is solely for manufacturing, testing, trialling, installing, commissioning, maintaining, servicing, repairing, altering or disposing of the plant
- is solely for moving the plant in the workplace where the plant is operated or used without a load, except when standard weights with predetermined fixing points are used for calibration and other testing, or
- is limited to setting up or dismantling the crane and the person carrying out the work holds a high risk wok licence for rigging which qualifies the person to carry out the work.

Moving plant in the workplace does not include loading or unloading the plant from a vehicle or equipment used to move the plant. A person must hold a high risk work licence to operate a crane or elevating work platform for loading or unloading such plant from a transport vehicle.

**Driver's licence requirements**

A mobile crane may be a registered vehicle under state and territory road laws. Like a truck driver, a crane operator must hold a current drivers licence for the class of vehicle before driving a mobile crane on the public road.

## 4.2 Documentation and markings

***Construction work***

Some construction activities are **high risk construction work** and extra control measures should be put in place for this type of work. Examples of high risk construction work which may involve using a crane includes construction work:

- where there is a risk of a person falling more than 2 metres
- carried out on a telecommunication tower
- carried out on or near energised electrical installations or services

- involving tilt-up or precast concrete
- carried out in an area at a workplace where powered mobile plant moves around.

Safe work method statements (SWMS) must be prepared for high risk construction work. SWMS may include or be accompanied by a documented lifting procedure for a crane lift. For example, erecting and dismantling a tower crane (not self-erecting) at a construction workplace would involve a risk of a person falling more than 2 metres and a SWMS must be prepared.

Further guidance on construction work and SWMS is available in the *Code of Practice: Construction Work*.

**Load charts**

A crane of variable radius, for example a tower or mobile crane, has a specific load chart that sets out how its lift capacity varies depending on how the crane is set up, boom extension and boom angle. Using the load chart correctly is critical to ensuring the crane is safe to use.

Bridge and gantry cranes do not have load charts but have a maximum rated capacity or Working Load Limit (WLL) that should be marked on the crane and not exceeded.

Where the crane has one main load chart, this should be fixed in the operator's cabin in a place which is easy to see and read. Where the crane has more than one load chart, for example for different boom and fly jib configurations, the charts should be easily accessible for the operator to verify that the crane is not overloaded and may be kept electronically or in hard copy.

The lifting capacity of a crane is limited by:

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

If a crane is overloaded, a structural or mechanical component of the crane may fail or the crane may overturn.

The lifting capacities specified on a load chart should not be exceeded except during testing of the crane by a competent person under controlled conditions.

On some mobile cranes there may be more than one load chart for different boom and counterweight configurations. The load charts may be complex and include many conditions that should be complied with to ensure the crane can safely lift a load.

Each load chart should include enough information to identify the crane configuration that it applies to, for example:

- the counterweight mass
- whether a fly jib is fitted, in use, in place or stowed
- outrigger extension or pick-and-carry mode
- number of falls of rope in the hook block
- main or auxiliary hoist in use
- whether the hook block is included or excluded.

Two important factors which can be overlooked when reading load charts are:

- Subtracting the mass of the hook block and lifting slings from the capacity of the crane at the particular radius. This should be noted on the load chart. For example, if the load chart states that 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 more than 19 tonnes. This issue is critical for heavier hook blocks and lifting gear for example, spreader beams.
- Subtracting 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. This should be 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 crane is likely to overturn.

### Crane markings

All operator controls must be marked to indicate their function and operation so the person using them can understand what the controls mean. The crane's computer should be compatible with these requirements and clearly indicate the control function, options and settings.

## 4.3 Crane operating personnel

A risk assessment can help you decide how many people you need in the crane crew and what competencies they should have to use the crane safely. Work practices and systems of work must be arranged to eliminate or minimise, so far as is reasonably practicable, the risk of collision between cranes and other plant and people and between loads and structures, overhead electric lines or people. A person conducting a business or undertaking must not allow a mobile powered plant such as a mobile crane to collide with a person. A risk assessment should help you consider what plant to use and the size and complexity of the lifts to be carried which will help determine a crane crew, including crane operators and people to sling loads.

## 4.4 Setting up the crane

### Siting the crane

You should choose where to site a crane in the planning phase after considering relevant factors, including:

- the risk of the crane overturning or collapsing from the:
  - foundations or supporting structure failing
  - crane not being able to withstand the forces likely to be imposed on it
- the risk of the crane colliding with other plant, structures or objects at the workplace
- the loads and lift paths, including the load pickup and drop off or installation locations.

### Tower Cranes

A range of specific issues should be considered when setting up tower cranes, for example the design of the crane standing, footings and foundations. See Appendix B for specific information on tower cranes.

### Mobile cranes

**R.214:** The person with management or control of powered mobile plant at a workplace must manage risks to health and safety associated with the plant overturning.

A mobile crane can be set up in a range of locations and environmental conditions. Some mobile cranes, for example a pick-and-carry, can also carry a load while moving (mobiling) and de-rating can be required for this purpose. Consider crane design, ground conditions and loads when siting and setting up a mobile crane, see Appendix D.

### Crane standing

The crane standing design should conform to the crane manufacturer's instructions. A competent person, like an engineer, may design a crane standing area to suit a specific site. The crane standing should be designed to withstand the forces likely to be imposed on it by the crane while in-service, out-of-service, and during erecting and dismantling. These forces include:

- the dead weight of the crane
- the dead weight of the load and any lifting attachments
- dynamic forces caused from the crane moving
- wind loadings
- other loads identified by the designer of the crane standing.

When a crane is to be supported on, or tied to a permanent or temporary structure, the design of the structure should be capable of withstanding the forces designed to be imposed on it by the crane ties. Adequate precautions should also be taken to ensure the stability of the crane when the crane will be sited near underground services, excavations or embankments.

***Collision between the crane and other plant and structures***

**R.214:** The person with management or control of powered mobile plant at a workplace must manage risks to health and safety associated with the plant colliding with any person or thing.

**R.215(4) and (5):** A person with management or control of powered mobile plant at a workplace must ensure that the plant does not collide with pedestrians or other powered mobile plant. If there is a possibility of the plant colliding with pedestrians or other powered mobile plant, the person must ensure that the plant has a warning device that will warn persons who may be at risk from the movement of the plant.

When siting a crane you should consider hazards including:

- overhead electric lines and other services
- nearby structures or trees
- other cranes or high obstructions, including at nearby workplaces, e.g. concrete placement booms
- other mobile equipment moving within the crane working area
- the location of airports and aircraft flight paths

Cranes should be positioned so the clearance between the crane and its load and other plant, structures and workers minimises the risk of collision. A collision between the crane or its load and other plant or structures may:

- damage crane components, including the boom, may weaken the component causing the crane to collapse and lose its load
- result in overturning cranes or other plant
- result in dropped loads
- damage the structure or other plant making it unsafe
- result in injury to people near the crane, including workers and members of the public.

A risk of injury from collision may exist for example where:

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

Cranes operating near one another may share the same airspace. The people in control of each work area should consult and develop safe systems of work to ensure there is enough space between the cranes and where they work. Each work area should nominate a person to implement the safe system of work to minimise the risk of collision.

This issue is particularly important where mobile cranes are set up on public roads. Traffic control procedures of the road controlling authority should be complied with. Where cranes are set up in or near flight paths the Civil Aviation Safety Authority imposes requirements, for example height restrictions. You should contact the local airport operator to find out what these are in the area where the crane is operating. Where necessary, aircraft warning lights should be fitted to the highest part of the crane.

## 4.5 Working near electric lines

**R.166:** A person conducting a business or undertaking at a workplace must ensure, so far as is reasonably practicable, that no person, plant or thing at the workplace comes within an unsafe distance of an overhead or underground electric line.

If this is not reasonably practicable to ensure the safe distance, the person must ensure that a risk assessment is conducted for the proposed work and control measures implemented are consistent with the risk assessment and the requirements of an electricity supply authority where it is responsible for the electric line.Overhead electric lines create significant risks, including electrocution, for people operating cranes near electric lines.

The following should be considered:

- Will the work mean the crane or its load could go near electric lines? If so, how high are the lines and the crane, including any attachments?
- Has the relevant electrical supply authority been contacted to eliminate the energised electricity risk by isolating the electricity supply for the duration of the work?
- Has the electrical regulator been contacted for information on specific requirements when working near electric lines, including safe approach distances and qualifications required for people working near electric lines?
- Does the crane operator, dogger and rigger have the appropriate training and competency to operate or direct the crane near power lines?
- Overhead lines may be hard to see in the sky or hidden by trees.
- Is a safety observer in place to watch the crane when it is operating close to electric lines?
- Emergency rescue procedures, including calling the electrical supply authority to isolate the electricity supply before trying to rescue a person receiving an electric shock.

Most risks can be controlled by observing safe working distances for people and plant working near electric lines. Safe working distances will depend on the type of work being carried out and the voltage of the electric lines.

Further information about electrical safety is available in the *Code of Practice: Working in the Vicinity of Overhead and Underground Electric Lines* and the regulator.

Contact with energised overhead electric lines may have an impact on mechanical aspects of the plant, for example tyres, hydraulic, electrical systems. The plant should be immediately made out-of-service until the plant has been inspected by a competent person and proven to be safe to resume normal operation.

## 4.6 Crane stability

Failure to maintain stability is one of the key factors associated with serious crane incidents. Things to consider are:

- crane operation parameters that result in an overturning moment greater than the stabilising moment of the crane—the crane counterweight generally provides the primary stabilising moment
- the ground conditions and means of supporting the outrigger pads or the crane tyres
- the slope of the ground—both side slope and slope in direction of crane travel
- wind conditions—this will vary depending on the size and shape of the suspended load and crane boom
- the manner in which loads are lifted or moved, e.g. when mobiling a load a sudden stop may cause the load to swing, destabilising the crane.

### Wind conditions

Strong winds impose extra loads on a crane and affect the crane's stability. For example, some crane manufacturer's set the maximum wind speed for a mobile crane at 10 m/second (36 km/hour). Crane configurations designed for wind speeds more than 10 m/second should have the design wind speed marked on the rated capacity chart.

Where wind speeds are greater than those set by the crane manufacturer for a specific mobile crane, crane operations should stop and the crane stowed. Crane operators should recognise that dependent on the boom length and luffing angle, 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. Also, wind gusts have a different effect on the crane than a constant wind. Given these variables, crane operators should base their decision to make a lift based on the information provided by the crane manufacturer, advice provided by competent people like an engineer or rigger, and their experience as a crane operator. If the crane operator believes it is unsafe to lift the load, it should not be lifted:

- until written authorisation is provided by a competent person, confirming that the load is safe to lift and how it is to be lifted, or
- the conditions change and the operator believes it is safe to make the lift.

For example, it is important mobile cranes are operated within their engineered design capacity. To ensure the stability of a mobile crane in windy conditions, the following factors should be considered:

- The crane manufacturer's instructions should state the maximum wind speed that the crane may be operated in irrespective of the size of the load.
- Although a crane manufacturer may specify a maximum wind speed, a lower wind speed may be appropriate, for example where the load and boom have large surface areas.
- Where the crane is lifting close to its rated capacity, wind speed is a critical factor as the safety margin is lower and wind can more easily impact on the crane's stability.
- Nearby thunderstorm activity may cause sudden very high speed wind conditions called microbursts which can lead to unexpected changes in the wind load on the crane and make the load and crane unstable.
- Where the lift is a non-standard lift, with a suspended load or large surface area to be carried out in windy conditions, a competent person should provide written advice on safe lifting conditions, for example a lower maximum wind speed than that identified by the manufacturer may be applied.
- Attaching a wind gauge to a crane or another reliable method of measuring wind speed, for example a handheld wind gauge. Where wind gauges are 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. You should get guidance from the crane manufacturer or supplier.

Further information on crane stability is included at Appendix D.

## 4.7 Documented lifting procedures

Documenting lifting procedures can help to define responsibilities and approach the crane lift in a logical, systematic way meaning the crane operation is more likely to be carried out safely. For example, documented lifting procedures should be developed in the following situations:

- large or complex tilt-up and precast concrete lifts
- multiple crane lifts, where more than one crane is used to lift a load at any one time, including de-rating
- single lifts of multiple loads at different heights, also known as staggered lifting
- lifting work boxes with people in the work box
- installing bridge beams during bridge installation work
- working near live overhead electric lines
- lifting over live plant
- when using cranes for demolition work
- lifting large pressure vessels or tanks
- using mobile cranes on barges
- erecting tower cranes
- erecting wind turbines

- for rotating loads
- lifting a load close to the maximum capacity on the relevant load chart or the cranes maximum rated capacity.

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

- specify the loads to be lifted, including the mass of the lifting equipment, e.g. slings and spreader beams
- specify the load working radius range to be used for the cranes and confirm that at this radius the loads are within the crane's capacity
- the slinging and lifting sequence.
- where a spotter is needed, e.g. to prevent a collision or contact with electric lines—the tasks, who is responsible for performing them and what communications systems is to be used
- position of the crane, load to be lifted and the final position to which it is to be lifted, where practicable, e.g. a diagram that shows a plan view of the site may assist
- maximum wind speed for the crane and any lower wind speeds for specified loads, e.g. where the load has a large surface area
- verification that the crane standing will support the maximum ground bearing pressure to be imposed by the crane during operations
- allowance for any factors that may require de-rating of the crane, e.g. for multiple crane lifts, extra radius caused by tilting of tilt-up panels
- rigging requirements of the job.

## 4.8 Minimising risk when lifting loads

Lifting loads may create a risk to the health and safety of people near a crane from:

- damaged or inadequate lifting gear
- the crane moving unexpectedly while mobiling or slewing
- crane overload or instability, and
- falling objects, e.g. from poorly secured and dropped loads.

**R.219:** The person must ensure that the lifting and suspending is carried out:

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

The person with management or control of plant at a workplace must ensure, so far as reasonably practicable, that:

- no loads are suspended or travel over a person unless the plant is specifically designed for that purpose
- loads are lifted or suspended in a way that ensures that the load remains under control during the activity, and
- no load is lifted simultaneously by more than 1 item of plant unless the method of lifting ensures that the load placed on each item of plant does not exceed the design capacity of the plant.

### Limiting and indicating devices

Limiting devices are a higher order engineering control which stops the crane moving beyond its operating limits into an unsafe situation.

Indicating devices are a lower order engineering control which relies on a person taking action. Indicating devices 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 and are intended as an aid to crane operators. The devices should not be relied on to replace the use of the

crane's load chart and operating instructions or compliance with the rated capacity for bridge and gantry cranes. Relying only on these devices in place of good operating practices may cause an incident. Some cranes use computerised load charts linked with limiting devices that are designed to stop the crane exceeding the load chart values.

There are many limiting devices including rated capacity limiters. Further guidance on limiting and indicating devices is provided in Appendix E.

**Lifting gear**

Lifting gear should be checked before and after use, and inspected regularly to determine whether it is suitable to keep using. Checks should include that:

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

All lifting gear, including slings, hooks and material boxes, should be periodically inspected for damage and wear by a competent person and inspection records kept. How often lifting gear should be inspected depends on how much it is used and how heavy the loads are being lifted but should generally not exceed 12 months. The period between inspections of synthetic slings and fibre rope slings should not exceed 3 months.

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 sharp, the sling may be damaged when it is placed under tension.

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.

**Unexpected crane movement**

If the crane moves unexpectedly while mobiling or slewing, the load may swing unexpectedly. Cranes should only be sited and operated on stable surfaces, with adequate bearing pressure and without significant holes or indentations that may cause the crane and load to move unexpectedly from being unstable.

**Crane overload**

A crane should never be overloaded. The crane operator and dogger should:

- verify if the marked load mass is correct and not lift a load in excess of the crane's rated capacity
- verify the correct counterweight is correctly mounted and the outrigger settings are in accordance with the load chart being used
- control crane movement, including mobiling, to stop excessive load swing that may overload the crane.

Before starting to hoist a load, the crane operator or dogger should check that the hoist rope hangs vertically over the load. Care should be taken to stop the load swinging when lifting the load. The crane operator should always have the load under control when lowering loads or when the load is suspended.

Except in an emergency, the crane operator should never leave the crane cabin or controls while a load is suspended from the crane.

**Falling objects**

Where possible, handling loads over public access areas, including footpaths, roads, highways, railways, waterways and buildings, should be avoided. If lifting over these areas cannot be avoided, appropriate control measures, for example exclusion zones or suitably designed gantries should be in place to control the risk of being hit by falling objects during the lifting operation.

**Exclusion zones**

Exclusion zones should be established around cranes and adjoining areas to stop people entering the area and being injured by the crane or falling objects. The size of the exclusion zone should be based on a risk assessment.

Where the exclusion zone is a public footpath or roadway to be closed, you should seek approval from the relevant authority. People should be safely directed to an alternative footpath. Lane closures and other operations requiring barricades and signs to be erected should meet local road traffic authority, local government authorities and relevant building or local laws.

## 4.9 Lifting materials

Crane-lifted loads should be slung and secured so that the load, or any part of it, cannot fall. Tag lines or similar control devices should be used to control loads while being lifted or suspended.

Loads must, so far as is reasonably practicable, only be lifted or suspended over a person using a crane that is specifically designed for this purpose, see Regulation 219 (5). For example the crane is equipped with a secondary back-up system that will prevent the load from falling if the primary lifting device fails.

**Material boxes**

- The tare mass and working load limits should be clearly marked on all material boxes.
- Material boxes should be appropriate for the material being lifted and be engineer-designed and certified.
- Four chains (one in each corner) should be attached to material boxes during lifting.
- Specifically designed material boxes should be used to lift smaller components. Boxes should have enclosed sides or robust mesh, with openings less than the minimum size of materials being lifted.
- Material boxes should be inspected and maintained and inspection records kept.
- Loads within material boxes should be secured against movement.
- Materials should not be stacked higher than the side of the material box unless they are adequately secured, but at no time should the material box become top heavy.

**General lifting**

- Formwork frames should be either tied together or lifting slings should be wrapped around the load or secured in a lifting frame
- Loads of joists or bearers should be strapped together before lifting to prevent movement
- Timber sheeting should be strapped together and lifted in a flat position to prevent individual timber sheets slipping
- Sheets of plasterboard may be lifted in a specifically designed material box. If a material box is not used, then the lifting system should:
    - be certified by an engineer or a person who holds and intermediate or advanced rigging licence
    - specify the minimum and maximum number of sheets

  - specify the number and locations of lifting slings
  - specify the capacity of lifting slings.
- Tag lines should be used as needed to control loads.
- Loads should be supported where possible with dunnage, with the load distributed over the supporting surface.
- Basket hitches should not be used wherever people may be located near a lifted load, unless the sling is positively restrained from sliding along the load.

## 4.10 Lifting people

**R.219:** The person with management or control of plant at a workplace must ensure, so far as is reasonably practicable, that the plant used is specifically designed to lift or suspend the load.

***Work boxes***

If it is not practicable to use plant that is specifically designed to lift people, a crane-lifted workbox may be used to enable workers to perform minor work for a short amount of time in an elevated work area. Generally, crane-lifted work boxes do not provide a level of safety equivalent to properly erected scaffolding, elevating work platforms and other specifically designed access systems. However, using crane-lifted work boxes is considered to provide a higher level of safety than fall-arrest systems when used as the primary control measure.

Work boxes, including first aid boxes, must have their design registered with the regulator. See Schedule 5 to the WHS Regulations for a full list of design registrable plant.

First aid boxes should be clearly identified as first aid boxes and only used to retrieve injured people.

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

- be equipped with a secondary back-up system that will prevent the load from falling if the primary lifting device fails
- have a minimum rated capacity of at least twice the total load of the workbox and its contents, at the maximum radius for the task to be performed and not less than a 1000 kg
- be fitted with an upper hoist limit (anti-two block) that stops operation of the hoist, luff and telescope functions of the crane, or be designed so that two-blocking cannot damage any part of the crane or lifting gear
- levers and foot pedals should be fitted with a constant pressure system that stops the crane's motions when the operator removes pressure from the controls
- if fitted with a free fall facility, the free fall function is to be positively locked out to prevent inadvertent activation.

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

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

If the crane is to be used to lift other loads, the above test should be repeated before re-lifting the workbox.

During operation of the crane with a workbox, the line pull of the hoist winch shall not exceed that used in the above test.

Crane-lifted work boxes and first aid boxes should:

- have the safe working load and tare mass and design registration number marked on the workbox or first aid box
- have fall-arrest anchorage points
- be correctly tagged

- lifting slings should supplied with the work box or first aid box and attached to the lifting points by means of hammerlocks or moused shackles
- have a safety factor for each suspension sling of at least eight for chains and 10 for wire rope
- if the work box is provided with a door, this should be inward opening only, self-closing and provided with a latch to prevent unintentional opening—first aid boxes may be provided with outward opening doors
- have sides not less than one metre high.

**Safety of people in crane-lifted workboxes**

- the persons are lifted or suspended in a work box that is securely attached to the plant
- the persons in the work box remain substantially within the work box while they are being lifted or suspended
- if there is a risk of a person falling from a height, a safety harness is provided and worn by the person to prevent, so far as is reasonably practicable, injury to the person as a result of the fall, and
- means are provided by which the persons being lifted or suspended can safely exit from the plant in the event of a failure in its normal operation.

**R.219:** The person with management or control of plant at a workplace must ensure, so far as is reasonably practicable, that the plant used is specifically designed to lift or suspend the load. If it is not reasonably practicable to use plant that is specifically designed to lift or suspend the load, the person must ensure that:

- the plant does not cause a greater risk to health and safety than if specifically designed plant were used, and
- the persons are lifted or suspended in a work box that is securely attached to the plant
- the persons in the work box remain substantially within the workbox while they are being lifted or suspended
- a safety harness is worn if there is a risk of a worker falling from a height, and
- means are provided by which the persons being lifted or suspended can safely exit from the plant in the event of a failure in its normal operation.

To ensure the safety of people in a crane-lifted workbox:

- all people in the workbox should 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 peoples' heads
- it is important for directions to the crane operator to only be provided by a person holding a dogger or rigger licence—the dogger should provide these directions from the workbox
- emergency retrieval arrangements are implemented before the lift to ensure workers can safely exit the work box in the event of a failure in the crane's normal operation.

## 4.11 Communication

A reliable method of communication between the crane operator and dogger or rigger 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 people from:

- dropped loads
- collision with other plant and structures.

Only one dogger should give signals at any time, these may be visual or audible or a combination. When more than one dogger is involved in a lift, each dogger should understand when responsibility for their part of the lifting operation should be handed over to another dogger.

An effective means of communication is particularly important where:

- the crane operator cannot see the load
- the crane operator cannot see the load's landing area
- the crane operator cannot see the path of travel of the load or the crane
- the crane operator cannot make an accurate judgement of distance
- it is possible for the crane or the load to come into contact with overhead electric lines.

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 with other radio equipment being used in the vicinity of the crane. Work should stop immediately if there is a loss of radio communication.

The safe use of radio communication involves:

- the crane operator and dogger performing an operating safety check to ensure the radios are operational, dry, performing satisfactorily and a fully charged battery and spare are available
- ensuring operators are familiar with the specific procedures for using radio communication for that workplace
- adopting a constant talk method between radio users so that all involved people are aware of the progress of the lifting operations at all times
- ensuring the crane operator 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 cannot be used, other forms of communication, including hand signals and bell, buzzer and whistle signals should be used. Mobile phones should not be used for directing mobile crane operations

## 4.12 Minimising the risk of falling from a height

People undertaking the installation, erection and dismantling of some types of cranes will be exposed to the risk of falling when working at height.

Undertaking a construction activity where a person could fall more than two metres is high risk construction work and requires the preparation of a safe work method statement before the work starts.

Risk control measures must provide adequate protection against the risk of workers falling from height by implementing risk control measures, including:

- temporary work platforms, e.g. an elevating work platform
- travel restraint systems
- fall-arrest harness systems
- edge protection systems.

Further guidance on controlling the risk of falls is available in the *Code of Practice: Managing the Risk of Falls in the Workplace.*

## 4.13 Operator position

### Protective devices

**R.214:** The person with management or control of powered mobile plant at a workplace must manage risks to health and safety associated with things falling on the operator of the plant.

**R.215(2):** A person conducting a business or undertaking with management or control of powered mobile plant at a workplace must ensure, so far as is reasonably practicable, that a suitable combination of operator protective devices for the plant is provided, maintained and used.

Suitable operator protective devices must, so far as reasonably practicable, be provided for powered mobile plant, including cranes. Typically these could include falling object protective structures (FOPS) and operator restraints. For example, if a person travels in a mobile crane driver's cabin while the crane is driven by another person a seat belt should be worn.

**Safe access**

Cranes should be fitted with a way to enter the crane cabin and other access points safely. Safe access includes providing ladders, footholds, steps and grabs rails.

Access provisions provided by the crane manufacturer should not be removed or modified unless a competent person specifies otherwise.

Clear access ways should be provided for the operators of pendant and remote controlled cranes.

**Seating**

The design of crane seating should take account of the extensive periods of time the crane operator may spend in the seat. The seating should be comfortable, have adequate back support and be adjustable so that the crane controls can be easily accessed by the operator.

**Windows and windscreens**

Clear vision should be provided in the operator's cabin at all times. Windows and windscreens should be easily accessible for regular cleaning.

**Working in heat**

Heat stress may occur in hot work environments when heat is absorbed faster than the body can release it. One way to reduce heat stress on crane operators is to minimise the heat in the crane cabin. Temperature control units supplied with the crane should be maintained and kept in a serviceable condition according to the crane manufacturer's instructions.

Further information on managing hot environments is available in the *Code of Practice: Managing the Work Environment and Facilities*.

## 4.14 Noise

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

Engineering controls, for example enclosing the engine in a noise absorbing cabinet and ensuring that exhaust mufflers are effective, should be applied to manage exposure to the noise created by the operation of a crane's diesel engine. Engineering controls are preferred to lower order controls such as supply of personal hearing protection like earplugs.

Further guidance about managing risks associated with noise is available in the *Code of Practice: Managing Noise and Preventing Hearing Loss at Work*.

## 5. INSPECTING, MAINTAINING, REPAIRING AND DISMANTLING

### 5.1 Inspecting and testing a crane

Failure to carry out appropriate planned inspections, tests and preventative maintenance programs according to the manufacturer's instruction or those of a competent person may lead to structural or mechanical failure, collapse, decreased safety and efficiency in the operation of cranes.

Inspection and appropriate testing should be carried out frequently to ensure parts of the crane subject to deterioration through corrosion, damage, wear or abrasion are replaced before they become unserviceable.

**R.213:** The person with management or control of plant at a workplace must ensure that the maintenance, inspection and, if necessary, testing of the plant is carried out by a competent person.

The maintenance, inspection and testing must be carried out:

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

Inspecting and testing cranes must include the:

- major inspection required for registrable mobile and tower cranes
- regular inspection and testing required for all plant, and
- inspection and testing for plant item re-registration.

Inspecting and testing should include:

- annual inspections
- commissioning inspection and tests
- routine inspections and maintenance, and
- pre-operational inspections.

The inspection and testing regime for tower cranes should also include inspecting and testing the crane before erecting it.

**R.266(2)(h):** An application for the registration of an item of plant must include a statement that the item of plant has been inspected by a competent person and assessed by that person as being safe to operate.

Inspection records should include a statement from the appropriate competent person confirming the item of plant has been inspected and is safe to operate. As item registration must be renewed every five years, major inspection and relevant annual inspections will enable appropriate statements to be prepared for re-registration.

Inspection records should include the following information:

- What was looked at? For example, specification of components or areas of the plant inspected.
- What is looked for? For example, checks were conducted for signs of wear, damage, cracking, corrosion.
- What were the pass and fail criteria? For example, specifying rejection criteria in accordance with requirements of a published technical standard.
- How was it looked for? For example, the techniques used, including visual inspection for damaged parts, taking of measurements of components and comparing those to specifications, non-destructive examination & testing.

- What was found? For example, specifying the results of the examinations, this may include photographs or measurements recorded.
- What recommendations were made? For example, a competent person may specify components should be replaced or repaired before continued use, or after a nominated operational period.
- What actions were carried out based on the recommendations made? For example, recording that recommendations were acted upon, and the date that any tasks were completed.

**Major inspection**

**R.235:** The person with management or control of a registered mobile crane or tower crane at a workplace must ensure that:

- the maintenance, inspection and, if necessary, testing of the crane is carried out by a competent person who:
  - has the skills, qualifications, competence and experience to inspect the plant and is registered under a law that provides for the registration of professional engineers, or
  - is determined by the regulator to be a competent person.
- the crane is inspected:
  - at the end of the design life recommended by the manufacturer for the crane, or
  - if there are no manufacturer's recommendations, in accordance with the recommendations of a competent person, or
  - if it is not reasonably practicable to comply with the above, every 10 years from the date that the crane was first commissioned or first registered, whichever occurred first.

A major inspection must be completed for registered mobile and tower cranes. Similarly, non–registrable mobile cranes and bridge and gantry cranes should have a regular ‘major’ inspection completed and the results recorded so that they continue to be safe to operate.

**Inspecting a crane**

An engineer who has been engaged to oversee a major inspection of a crane should have suitable knowledge and experience in undertaking major inspections of cranes. This person should be able to make judgements about the maximum allowable amount of wear and deformation in mechanical and structural components, and the associated quantifiable pass and fail criteria. The person should also be able to demonstrate experience in the inspection of the specific crane type.

In forming their opinion, the person may use the advice of other competent persons involved in the crane inspection including persons who are not engineers. These decisions should be based on information contained in the crane manufacturer's instructions, relevant technical standards, sound engineering principles or a combination of all these.

These other competent persons may, for example dismantle and inspect specific items for wear or to carry out non-destructive testing (NDT) and provide a report to the engineer. This work can also be referred to as part of the maintenance and testing requirements of the major inspection.

A person who inspects, maintains or tests a specific part of a crane for the engineer as part of a major inspection should have suitable experience and knowledge and be competent in the inspection of that part of the crane. For example:

- 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 NDT methods and technical standards and to determine the appropriate NDT method for the component being tested.

- 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.
- A competent person inspecting electrical systems on the crane should have suitable knowledge and experience in electrical systems, control systems and motor control, including the ability to read circuit diagrams and understand relevant technical standards. This person must be a qualified and licensed or registered electrician where required by other legislation.
- A competent person carrying out NDT testing on crane components should have suitable knowledge and experience in NDT methods.

In these instances, the competent person should make a statement that the particular part of the crane, for example the welding, hydraulic system or electrical system, has been inspected in accordance with the relevant technical standard and engineering principles and whether it meets the manufacturer's or a competent person's specifications.

**Inspection parameters**

A major inspection should be more comprehensive than the annual inspection, as it needs inspection of components that do not warrant inspection on an annual basis. Even if the crane has not been exposed to regular operation during the operating period, the crane may have deteriorated due to the way it has been stored or the environment it has been operated in, for example, dirty or corrosive environments.

Where the crane manufacturer specifies instructions for the major inspection, these instructions should be followed. Where this information is not available or no longer meets accepted technical standards, a competent person should specify the requirements that provide an equivalent level of safety to the minimum requirements established by relevant technical standards. The extent of inspection performed during the major inspection will largely depend on this information. However, a number of key items should form part of the major inspection.

Further guidance on the inspection of Tower and Mobile cranes can be found in Appendices B and D respectively.

**Annual inspection**

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 should include:

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

**Routine inspection and maintenance**

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

- all functions and their controls for speed, smoothness of operation and limits of motion
- all emergency and safety switches and interlocks, including limiting and indicating devices
- lubrication of all moving parts
- inspection of filter elements and fluid levels

- visual inspection and measurements as necessary of structural members and other critical components including brakes, gears, fasteners, pins, shafts, wire ropes, sheaves, locking devices and electrical contactors
- signage, including warning signs and control markings
- wear on wheels
- extra 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 prepared on completion of the inspection.

**Pre-operational inspection**

The crane operator should carry out a visual inspection and functional tests before the start of each work shift, including inspecting and testing the following:

- all relevant items indicated in the operations manual
- operating and emergency controls
- brakes
- safety switches and interlocks, including limiting and indicating devices
- visual inspection of the structure
- wire ropes to ensure they are on the drum, correctly reeved on the sheave and are not damaged or excessively worn.

Where access to the crane structure has been deemed impracticable due to safety or other reasons, a regular inspection of the crane structure should be performed to ensure the structural integrity of the crane.

All personal protective equipment should also be inspected to ensure it is functioning correctly.

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

Where issues are identified these should be recorded, reported and rectified before the crane is used.

## 5.2 Maintaining, repairing and cleaning a crane

Cranes should be maintained, serviced and cleaned according to the manufacturer's instructions, competent person specifications or, in the absence of such specifications, according to relevant technical standards and engineering principles

All worn or damaged parts of a crane that constitute a hazard or impair the operation of the crane should be repaired or replaced. In particular:

- repairs are carried out according to manufacturer's or a competent persons instructions to retain the crane within its original design limits
- replacement parts and components should be identical or equivalent to the original equipment parts and components

When a crane has been damaged to the extent that its function or condition is impaired, resulting in increased risk to health or safety, it should be immediately taken out of service. A competent person should assess:

- the nature of the damage
- whether the crane is able to be repaired, and if so what repairs should be carried out.

Operator controls must stop the person carrying out maintenance or cleaning and others from operating the plant. However, if the plant needs to be operating during maintenance or cleaning risk control measures must enable this to occur without risk to health and safety.

## 5.3 Unattended cranes, parking and storage

Leaving a crane parked and unattended may encourage unauthorised use of the crane by person who are not competent crane operators. Cranes may also present a risk to health and

safety if measures are not taken to prevent them moving of their own accord for example, rolling down a sloping surface.

A crane should not be left unattended unless:

- all loads are removed from the hook or lifting device
- the hook has been secured or raised to a position where is clear of other operations
- all powered motions have been disabled
- the keys removed or the starting device locked out.

Where there is no risk of a tower crane boom contacting other structures, the crane should be left to weathervane when unattended according to the crane manufacturer's instructions.

Where it is necessary to restrict the movement of the boom of a tower crane the method of tethering, that is securing the boom to prevent slewing, should be according to the crane manufacturer's instructions or determined by an engineer.

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

If a crane is to be stored it should be prepared as above and:

- the manufacturer's storage instructions followed
- any remote control equipment isolated
- the power supply and controls isolated and locked off
- storm anchors applied, if fitted
- doors and windows locked to prevent unauthorised access.

## 5.4 Decommissioning and dismantling

**R.204:** A person with management or control of plant at a workplace must not decommission or dismantle the plant unless the decommissioning or dismantling can be carried out, so far as is reasonably practicable, without risks to the health and safety of any person.

A person with management or control of plant at a workplace must ensure that:

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

The crane should be decommissioned and dismantled according to the manufacturer's instructions or where these are not available recommendations prepared by a competent person.

## 5.5 Record keeping

**R.237:** The person with management or control of the plant at a workplace must keep a record of all tests, inspections, maintenance, commissioning, decommissioning, dismantling and alterations of the plant for the period that the plant is used or until the person relinquishes control of the plant.

Crane records should include:

- the unique plant item registration number, if applicable
- plant design registration information, if applicable
- final, i.e. as-built, and approved design drawings and calculations
- relevant methods of test and inspection results and data from commissioning
- compliance statements and test certificates

- manufacturer's specifications
- results of inspections
- results of tests on safety devices
- information on maintenance and major repairs carried out
- information on major modifications
- information on approved uses that deviates from intended operating or design conditions
- results of risk assessments
- information, instruction, training provided to workers
- log books, and
- operator competencies.

A modification to the design of a tower crane can occur, for example if a different base is designed to install the tower crane at a different site. Record the alteration, including where a static base on a self-erecting tower crane is different to that included in the original design registration.

Records may be kept in any suitable format and should be transferred with ownership of the crane. A crane service record, for example a maintenance logbook, of the significant events concerning the safety and operation of the crane should be kept and readily available. All entries in the maintenance logbook should:

- clearly describe the work carried out and parts replaced
- identify the person or business who completed the work and be dated.

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.

Complete routine, annual and major inspection reports must be maintained and made available for examination as required.

# 6. CONTROLLING RISKS: SPECIFIC CRANE OPERATIONS

## 6.1 Mobile Cranes

There are four general types of mobile crane operating in Australia:

- hydraulic slewing cranes
- lattice boom cranes, including crawler cranes
- hydraulic pick-and-carry (non-slewing) cranes
- vehicle-loading cranes.

### Road travel

Failure to follow proper precautions before and during road travel may increase the risk of injury to the crane operator and other people, including pedestrians and other drivers. The crane manufacturer's instructions should be followed when preparing a mobile crane for road travel.

Precautions for road travel include:

- checking that tyre pressures meet the manufacturer's instructions for road travel
- 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
- storing loose components in appropriate storage areas according to the crane manufacturer's instructions or any other relevant published guidelines for the safe carriage of loads on road vehicles for example, the Load Restraint Guide (2nd ed. 2004)
- disengaging all drives to hydraulic pumps, booms and outriggers, and putting the controls in the off position
- restraining the boom according to the crane manufacturer's instructions to ensure there is no unintended movement of the boom.

### 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. They should not be operated:

- with the boom at an angle less than that shown on the load chart, or
- 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.

### Hydraulic boom cranes

When extending the boom on hydraulically operated cranes, ensure that the boom sections are extended or retracted according to 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.

### 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:

- the intended path is inspected to identify any problem areas, for example pot holes and undulations to be corrected or avoided

- the speed is appropriate to the ground conditions and the load. Avoid undulations, pot holes or other obstructions that could tilt the crane beyond its allowable operational level
- the slew brake is applied at all times other than when the slew motion is being used, except where not recommended by the manufacturer of the crane
- the load is carried as close to the ground as practical
- where fitted, axle locks are engaged as specified in operators manual
- 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. Where possible, avoid travelling the mobile crane across slopes or over potholes, depressions, soft ground, irregular and uncompacted ground, road chambers or shoulders, rail tracks, dunnage wood or any objects, as these could destabilise the crane or load.

**Sloping ground**

Crane roll over can occur when pick-and-carry cranes travel with a load along a side slope. 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
- articulation of an articulated crane. .

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 mobile cranes with pick-and-carry capability specify the cranes should only be operated on firm level ground. Manufacturers and suppliers should provide clear documented information on the maximum side slope a crane can safely travel over while in pick-and-carry mode. For example, specifying the maximum allowable side gradient will provide more specific information to the operator compared to the term ‘firm level ground’.

It is very difficult for a pick-and-carry crane to consistently operate on side slopes 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 to be applied on side slopes if the crane is designed to travel on gradients of up to five degrees. Where the crane is not rated for gradients in excess of 1% the manufacturer should state that the crane is not to be travelled on ground that is not firm and level and where the gradient is in excess of 1%.

Where possible, avoid working or travelling on sloping or uneven ground. Travel on a slope should be up or down the slope, not across the slope. If working or travelling on a slope is unavoidable, use the crane within the manufacturer’s specified capacity for operating on the relevant degree of slope. Reference should be made to side de-rating capacity charts before carrying out this work.

**Ground pressure**

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.

## 6.2 Special uses for mobile cranes

### Working 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. Suspended floors are not usually designed or 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.

Before positioning the crane on the elevated area, written documentation should be obtained that demonstrates the design floor loading of the building is not being exceeded or details the extra support required to support the maximum bearing pressure imposed by the crane and the maximum load. Where the floor requires strengthening, for example by propping, an engineer should provide written instructions that detail the dimensions, locations and other specifications of the strengthening to be used. Installation of props and other strengthening measures should be checked by a competent person before structural loading to ensure they meet the requirements detailed by the engineer.

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

### Demolition

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

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

The hoist rope should be 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 should 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.

Further guidance on demolition is available in the *Code of Practice: Demolition Work*.

### Using cranes for tree lopping

In limited circumstances a crane may be used to place a person in a tree to trim or remove the tree. This is known as the crane access method.

Before a decision is made to use the crane access method a risk assessment must be conducted to assess that the use of this method does not create a greater risk to the health or safety of the worker than climbing a tree, or using plant specifically designed to lift a person to access the tree. If the risk assessment shows the crane access method can be used the requirements in Regulation 221 must be followed.

Further guidance on using cranes for accessing a tree for tree trimming and removal work is available in the *Code of Practice: Tree Trimming and Removal Work – Crane Access Method.*

## 6.3 Vehicle-loading cranes

Vehicle-loading cranes 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 and unloading the truck on which they were mounted. However, with the introduction of larger capacity vehicle-loading cranes and proportional control, these types of cranes are sometimes used for more traditional crane operations where:

- 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
- the load is lifted both to and from locations remote from the vehicle on which the crane is mounted
- the load is lifted into place and held whilst it is connected to a structure, e.g. installing a sign.

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

Unless a vehicle-loading crane has been designed for pick-and-carry operations, it must never be used in this mode.

**Crane and vehicle suitability**

Vehicle-loading cranes should only be mounted on the vehicle types and models specified by the crane manufacturer. Installing a crane on an inappropriate vehicle could lead to structural failure of the crane or vehicle, or make the vehicle and crane combination unstable. Where second-hand vehicle-loading cranes are imported from overseas, transport laws require the crane and vehicle combination to have a compliance plate attached by an authorised person in compliance with the relevant transport laws.

The method of mounting the crane to the vehicle should be according to the crane manufacturer's specifications and the recommendations of a competent person. Any adverse effects to both the vehicle and crane should take into consideration. Welding the crane to the vehicle chassis is unacceptable as it can damage the chassis and also lead to fatigue failure of the connection.

**Design of controls on vehicle-loading cranes**

Controls on vehicle-loading cranes should be of the constant pressure "deadman" type, and permanently marked with clearly visible symbols.

The position and layout of controls on vehicle-loading cranes should be designed so that the risk of the operator being crushed against the vehicle or controls by inadvertent operation of the crane is eliminated. For new vehicle-loading cranes, administrative controls are not suitable to prevent injury and engineering controls should be used.

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

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

**Operational issues for vehicle-loading cranes**

The vehicle-loading crane should be operated according to the manufacturer's instructions. Consider:

- operators of vehicle-loading cranes with a maximum load moment capacity of 10 metre-tonnes or more must hold the relevant HRW licence

- operators should be trained in the operation of the particular vehicle-loading crane
- 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 licensed dogger or rigger
- the vehicle-loading crane may only be used with all stabilisers extended according to the crane manufacturer's instructions—where multiple positions can be used on stabiliser legs, the legs should be set up in compliance with the manufacturer's load chart
- the stabiliser legs should be clearly marked with 'zebra striping' to improve visibility
- the vehicle-loading crane should only be used when it is level and according to the crane manufacturer's specifications—usually not exceeding one degree or less
- timbers or other pads specified by the crane manufacturer should be used under the stabiliser feet
- crane hooks should be provided with spring-loaded safety latches and be adequately maintained
- vehicle-loading cranes should never be used for lifting people
- where provided, spring lock-outs on the vehicle should activate during crane operation
- the vehicle-loading crane should only be used with a load suspended vertically from the hook—the crane should not be used to drag a load across a supporting surface.

## 6.4 Multiple crane lifts

**R.219:** The person with management or control of plant at a workplace must ensure, so far as is reasonably practicable, that no load is lifted simultaneously by more than 1 item of plant unless the method of lifting ensures that the load placed on each item of plant does not exceed the design capacity of the plant.

Lifting a load with two or more cranes requires more detailed planning and supervision to control the risks. This is because the effects of the relative motion between the cranes may create extra loadings on the cranes, the load and the lifting gear. Therefore, the design capacity of the crane is not the maximum rated capacity but the de-rated capacity relevant to the multi-crane lift to be carried out.

**Safety measures for multiple crane lifts**

Where possible, avoid hoisting a load with more than one crane.

Where it is necessary to lift a load using more than one crane, the person in control of the lift must hold an intermediate rigger's high risk work licence as a minimum.

The following steps should be taken:

- make an accurate assessment of:
  - the share of the load which is to be carried by each crane throughout the complete lift cycle
  - how the load sharing is to be proportioned
  - how the proportioning is to be maintained during the lift
- the instructions to each crane operator and other people involved should be clear and documented, for example in a safe work method statement, and rehearse the operation wherever possible
- use cranes of equal capacity and similar characteristics, unless the lift plan is designed to ensure neither crane is overloaded during the lift
- if possible, align the cranes in the same direction
- use luffing up in preference to luffing down.

Multi-crane lifts should not be carried out unless all cranes are fitted with a load indicator. Load indicators should be fitted to all mobile cranes with a maximum rated capacity of more than three tonnes.

**Calculated share of the load**

Where multi-crane lifts are carried out, a documented lift plan and procedure should be prepared by a competent person, for example an engineer, and followed. Typical minimum capacity de-rating requirements for each crane involved in a multi-crane lift are:

- for two cranes—de-rate each crane by 20%
- for three cranes—de-rate each crane by 33%
- for four or more cranes—de-rate each crane by 50%.

The crane de-ratings for multi-crane lifts should be according to the plan developed by a competent person, generally not be less than those identified above and in some circumstances an increase in the de-rating may be required. For example, where multiple cranes are used for the mid-air rotation of a precast concrete panel, the following issues should be considered and allowed for:

- the load on each crane will change during rotation
- the radius for one or both cranes will change during the lift
- rotation should take place with adequate clearance from the ground for full rotation to ensure that the panel does not strike the ground, the cranes or any other objects.

**Principles for multiple crane lifting**

Factors to be considered when planning multiple crane lifts include the:

- mass of the load
- position of the centre of gravity
- mass of the lifting gear
- safe working capacity of the lifting gear
- synchronisation of crane motions.

**Mass of the load**

The total mass of the load and its distribution should either be known or calculated. Where the information is taken from a design drawing, allowances should be made for manufacturing tolerances. The accuracy of the design drawing should be confirmed before starting the lift.

**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 be uncertain and adequate allowances should be made. This will involve reducing each crane's capacity further.

**Mass of the lifting gear**

The mass of the lifting gear and its distribution should be accurately known and included as part of the calculated load on the cranes.

**Safe working capacity of the lifting gear**

The distribution of the forces within the lifting gear that will occur during the lifting operation should be established. The lifting gear should have a rated capacity 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.

**Synchronising crane motions**

If possible, minimise the variation in the direction and magnitude of forces acting on the cranes by synchronising the cranes' motions. Where possible, use cranes of equal capacity and similar operating characteristics. 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, so 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.

## 6.5 Single crane multiple winch lifts

A single crane may be used to lift a load using both its main and auxiliary winches if designed to do so and in accordance with the manufacturer's instructions, for example, when erecting precast concrete panels.

To move the concrete panel into its vertical position from a horizontal storage or transport position, the concrete panel may be rotated by using two hoist ropes. Even though the concrete panel will be suspended by two hoist ropes, both ropes usually need to support more than 50 per cent of the concrete panel weight during the rotation and one will have to support the full weight. Therefore unless each hoist is capable of supporting the full load it is important to use the main hoist to support the full load. The actual load should be calculated and documented by a competent person before the element is manufactured.

Where a single crane is to be used for mid-air rotation, the following should be considered:

- The crane is designed and manufactured for simultaneous multiple winch use as set out in the manufacturer's instructions.
- Some cranes may have to be reconfigured before they can be used in this manner.
- The main winch and auxiliary winch drives should be independent.
- Rigging should ensure that the maximum design fleet angle is not exceeded, for example, lifting an element that is placed perpendicular to the boom may place excessive side load on sheaves.
- Rotation should be as near as possible to the plane of the boom.
- The load on the main and auxiliary winches should be monitored separately and simultaneously to avoid overloading of either line and to ensure that the combined load of both lines does not exceed the rated capacity of the crane.
- The included angle between the main hoist rope and auxiliary hoist rope is not to exceed 10 degrees unless otherwise specified by the manufacturer.
- Rotation should take place with adequate clearance from the ground for full rotation to ensure that the panel does not strike the ground, crane or any other objects.

An engineer should verify the minimum required capacity of each hoist ropes, that is, the maximum load placed on each rope during the rotation. The auxiliary winch line passes over the 'Rooster sheave' which is the name given to the sheave mounted on the short boom extension. Do not overload the rooster sheave as many rooster sheaves are not rated for the full line pull of the auxiliary winch and are not suitable for this application. Rooster sheaves and the associated rigging on the boom head should be designed and certified by an engineer.

## 6.6 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, that is the load is not pinned to the boom or on tynes but is suspended from the boom by means of a chain or wire rope sling. Mobile plant that is sometimes used in this way includes backhoes, front-end loaders, excavators, forklifts, and telescopic handlers. This is also known as 'telehandlers' and 'multi-purpose tool carriers'.

When other mobile plant is used as a mobile crane, the level of safety produced, including stability of the plant under its' potential load conditions provided by the lifting set-up, should be at least equal to that when a mobile crane is use.

Further guidance on using other plant as a mobile crane is provided in Appendix F.

## 6.7 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:

- the effect on freeboard i.e. distance between the vessel's deck and the water
- the strength of the vessel to support the crane structure
- the installation of stops to prevent the crane driving off the vessel's side
- the degree of capacity de-rating required for the crane
- the method of securing the crane when working outside of smooth water limits.

A competent person should determine the list, that is the deck tilt and freeboard, allowed 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 must be certified by the Australian Marine Safety Authority, which is responsible for managing survey and certification arrangements for Australian ships.

As a general guide, the maximum list of the vessel under rated capacity conditions should not exceed $\pm 5^{o}$ 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% 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, for example by chains of adequate strength.

### Testing before use

The crane and vessel combination should be inspected after erecting and before applying a load to check:

- all ties, anchorages and ballast are in place and correctly secured
- the crane is configured according to the crane manufacturer's or a competent person's specifications, and
- 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. After these tests have been completed, a competent person should 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.

## 6.8 Tower cranes

There are three general types of tower crane used in Australia:

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

Failure to erect or dismantle tower cranes according to the crane designer's or crane manufacturer's instructions may result in injury to people and property damage from:

- crane collapse
- falls from heights
- falling objects.

A high risk construction work safe work method statement prepared to erect a tower crane should consider the following:

- the crane designer's or crane manufacturer's instructions
- technical standards relevant to access and egress
- the crane's stability
- any adverse effects on other plant, structures or work processes at the workplace
- the use of special tools, jigs and appliances necessary to minimise the risk of injury
- control measures for securing crane components
- the interaction of the crane with other plant
- environmental factors, including wet or windy conditions
- all relevant electrical installations associated with the crane comply with *AS 3000: Electrical installations*.

Further guidance on how to erect, use and dismantle tower cranes safely is provided in Appendix B.

## 6.9 Bridge and gantry cranes

Bridge and gantry cranes are commonly used in manufacturing environments where loads are regularly moved from one location to another within a workplace.

Operating a bridge or gantry crane is skilled work and as there can be a wide range of crane configurations, operators must hold a relevant high risk work licence where required and be trained and competent in their use. Typical independent powered operations of bridge and gantry cranes include:

- traversing—the movement of the crab from one end of the bridge to the other
- travelling—the movement of the crane along its runway
- hoisting—raise and lower are considered to be one powered operation
- rotation – powered rotation of the hook/attachment.

Bridge and gantry cranes can also manipulate other lifting attachments including the operation of clamps, magnets, friction, vacuum and coil grabs.

Where a bridge or gantry crane is to be configured for a special use, this requirement should be discussed with the crane manufacturer and supplier before purchase. For example, if a multi-hoist mechanism is required and it is intended to simultaneously use both hoists to lift a common load that exceeds either hoist capacity, load limiting and movement controlling devices should be installed to prevent either hoist or the crane from being overloaded. If these are not installed then the capacity of each hoist should be adequately de-rated as recommended by the manufacturer or supplier.

Safety devices that can assist in controlling risks include:

- Anti-collision devices—these prevent two or more bridge and gantry cranes operating on the same runway from colliding with each other and when approaching the end of the runway.
- Deceleration devices—for example limit switches and two-stage decelerators, slow the bridge or gantry crane down regardless of what control is being pressed when a travelling crane is approaching the end of the runway, to prevent end stop collision or over run.
- Load-limiting devices—these devices assess the load and prevent lifting should the rating capacity of the crane be exceeded.
- Upper and lower limit devices – these prevent the hoist from winding the hook into the hoist drum or winding the hoist rope off the hoist drum.
- Anti-fall devices—for example, anti-drop plates, can be fitted to bridge and gantry cranes to prevent falls of plant in the event of travel-wheel failure.

**High risk work licences**

An operator must hold a high risk work licence to operate a bridge crane or gantry crane that is:

- controlled from a permanent cabin or control station on the crane, or
- remotely controlled where the remote control (including pendant controls) has more than 3 powered operations.

A high risk work licence is required to remotely operate, for example by way of pendant or radio, a bridge or gantry crane that has:

- a single hoist with 4 powered operations, e.g. traverse, travel, hoist and rotate
- multiple hoists with 4 or more powered operations, e.g. two non-synchronised hoists would typically have at least 5 powered operations (traversingx2, hoistingx2, and travelling).

A high risk work licence is not required to remotely operate a bridge or gantry crane that only has a maximum of three powered operations for example, traverse, travel and hoist.

A dogging or rigging high risk work license is required by:

- any person other than a licensed bridge or gantry crane operator who exercises judgement in the selection of slings, slinging techniques, the weight of the load, or its centre of gravity when slinging a load on a bridge or gantry crane, or
- any person who directs a bridge or gantry crane operator in the movement of the load when the load is out of view of the operator.

A dogging or rigging licence is not required if the lift does not require the person slinging the load to exercise judgment. For example, this could occur where a safe work procedure for undertaking routine, repetitive lifts has been developed and approved by a competent person and the worker slinging the load has been provided with training to allow them conduct the work safely. A safe work procedure is a documented procedure that defines the details of a lift, including, for example: the weight of the load, the equipment to be used, resources and procedures.

## APPENDIX A – DEFINITIONS

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| **Barrier** | A physical structure which blocks or impedes something. |
| **Barricade** | Any object or structure that creates a barrier to control, block passage or force the flow of traffic in the desired direction |
| **Boom-type elevating work platform** | A telescoping device, hinged device, or articulated device, or any combination of these, used to support a platform on which personnel, equipment and materials may be elevated. |
| **Bridge Crane** | A crane that:<br>• consists of a bridge beam or beams, that are mounted to end carriages at each end<br>• is capable of travelling along elevated runways, and<br>• has one or more hoisting mechanisms arranged to traverse across the bridge. |
| **Competent Person** | For the *annual inspection of a crane* means a person who:<br>• either:<br>o has the skills, qualifications, competence and experience to inspect the plant, and<br>o is registered under a law that provides for the registration of professional engineers, or<br>• is determined by the regulator to be a competent person.<br>For *design verification* means a person who has the skills, qualifications, competence and experience to design the plant or verify the design.<br>For *inspecting an item of plant for registration* a person is competent if the person has:<br>• educational or vocational qualifications in an engineering discipline relevant to the plant to be inspected; or<br>• knowledge of the technical standards relevant to the plant to be inspected.<br>For any other case is a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task. |
| **Dogging work** | Means:<br>• the application of slinging techniques, including the selection and inspection of lifting gear, to safely sling a load, or<br>• the directing of a plant operator in the movement of a load when the load is out of the operator's view. |
| **Exclusion zone** | An area from which people are excluded during the work. |
| **Electricity Supply Authority** | A person or body engaged in the distribution of electricity to the public or in the generation of electricity for supply, directly or indirectly, to the public. An electricity supply authority may also be known as a network operator. |

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| **Fail safe** | A state or condition where, if any component or function of the plant fails, a system exists to prevent any increase in the risks.<br>The reliability or safety integrity of the fail safe system should be commensurate with the determined level of risk, for example Category 1 to Category 4 applied in *AS 4024: Safety of Machinery*. |
| **Gantry crane** | A crane that:<br>• consists of a bridge beam supported at each end by legs mounted on end carriages<br>• is capable of travelling on supporting surfaces or deck levels, whether fixed or not, and<br>• has a crab with one or more hoisting units arranged to travel across the bridge. |
| **Hoist** | An appliance intended for raising or lowering a load or people, and includes an elevating work platform, a mast climbing work platform, personnel and materials hoist, scaffolding hoist and serial hoist but does not include a lift or building maintenance equipment. |
| **Load chart** | A notice fitted or displayed in electronic form on or in a crane or hoist specifying the rated capacities as supplied by the manufacturer or competent person. |
| **Mobile crane** | A crane capable of travelling over a supporting surface without the need for fixed runways and relying only on gravity for stability. |
| **Non-slewing mobile crane** | A mobile crane incorporating a boom or jib that cannot be slewed, and includes:<br>• an articulated mobile crane, or<br>• a locomotive crane,<br>but does not include vehicle tow trucks. |
| **Operator protective device** | A roll-over protective structure (ROPS), falling object protective structure (FOPS), operator restraining device and seat belt. |
| **Overturning moment** | The moment that tends to tip the crane over. When the overturning moment exceeds the stabilising moment, the crane will overturn, see also 'Stabilising moment'. |
| **Portal boom crane** | A boom crane or a jib crane that is mounted on a portal frame that, in turn, is supported on runways along which the crane travels. |
| **Powered mobile plant** | Plant that is provided with some form of self-propulsion that is ordinarily under the direct control of an operator. |
| **Rated capacity** | The maximum gross load that may be applied to the crane while in a particular working configuration and under a particular condition of use, see also WLL. |
| **Reach stacker** | A powered reach stacker that incorporates an attachment for lifting and lowering a shipping container. |
| **Rigging work** | Means:<br>• the use of mechanical load shifting equipment and associated gear to move, place or secure a load using plant, equipment or members of a structure to ensure the stability of those members, or |

- the setting up or dismantling of cranes or hoists.

**Self-erecting tower crane**

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

**Slewing mobile crane**

A mobile crane incorporating a boom or jib that can be slewed, but does not include:
- a front-end loader
- a backhoe
- an excavator, or
- other earth moving equipment,

when configured for crane operation.

**Slinging techniques**

Means the exercising of judgement about the suitability and condition of lifting gear and the method of slinging, by consideration of the nature of the load, its mass and its centre of gravity.

**Stabilising moment**

The moment that tends to keep the crane upright. 'Moment' is the engineering calculation of force multiplied by the perpendicular distance between the force and the turning point.

**Structure**

Anything that is constructed, whether fixed or moveable, temporary or permanent, and includes:
- buildings, masts, towers, framework, pipelines, transport infrastructure and underground works, including shafts or tunnels
- any component of a structure, and
- part of a structure.

**Temporary work platform**

- a fixed, mobile or suspended scaffold
- an elevating work platform
- a mast climbing work platform
- a work box supported by a crane, hoist, forklift truck or other form of mechanical plant
- building maintenance equipment, including a building maintenance unit
- a portable or mobile fabricated platform, or
- any other temporary platform that:
    - provides a working area, and
    - is designed to prevent a fall.

**Tower crane**

Means:
- a boom crane or a jib crane mounted on a tower structure, and
- in Schedule 3:
    - the crane, if a jib crane, may be a horizontal or luffing jib type; and
    - the tower structure may be demountable or permanent,

but, in Schedule 3, does not include a self-erecting tower crane.

**Vehicle-loading crane**

A crane mounted on a vehicle for the purpose of loading and unloading the vehicle.

**Work box**

A personnel carrying device, designed to be suspended from a crane, to provide a working area for a person elevated by and working from the device

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| **Working Load Limit (WLL)** | The maximum gross load that may be applied to the crane and lifting attachments while in a particular working configuration and under a particular condition of use, see also ‘Rated Capacity’. |

## APPENDIX B – TOWER CRANES

### 1. Pre-erection inspections and tests—on ground inspection

Tower crane components should be inspected and tested by a competent person according to the manufacturer's instructions before being delivered to the workplace or jobsite and before being erected.

Where a tower crane owner is aware a crane will be erected when the scheduled annual inspection is due, then the owner may consider carrying out an annual inspection during the pre-erection inspection.

These inspections and tests should include the following:

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

Further information on NDT is provided in part 7 of this Appendix.

Once the tower crane components have been delivered to the workplace, they should be inspected by a competent person for any possible damage and wear that may have occurred during transport.

Inspections should include:

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

Crane owners should develop their own pre-erection inspection and test report that satisfies the requirements of the WHS Regulations and the manufacturer's instructions. The report should also reflect the specific type and model of crane and reference all relevant design drawings and test certificates.

## 2. Commissioning tower cranes

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

Commissioning tower cranes involves performing necessary adjustments, tests and inspections to ensure the crane is in full working order to specified requirements before the crane is used. Further information on inspecting and testing is provided in section 5 of this Code.

Written instructions regarding the commissioning of a tower crane should be available to all 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 reconnected and tested in accordance with a written procedure before the crane is put into operation.

### *Responsibilities of people who commission tower cranes*

A person who commissions tower cranes should ensure that:

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

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

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

### *Commissioning inspections and tests*

Commissioning inspections and tests should be carried out by a competent person once the crane has been erected and before it is put into service. Once the performance of the crane has been satisfactorily verified by the commissioning inspections and tests, the crane may be placed into service.

Commissioning inspections and tests should include:

- crane electricity supply where used
- crane base weights or ballast where used
- tower section identification and access
- tower bolts to correct tension
- pins and fastenings

- climbing frame and connection
- jib connection pins and retainers
- A-frame connections and retainers where applicable
- jib and deck pendant pins and retainers where used
- machinery guarding
- leakage in lines, tanks, valves, pumps, and other parts of air or hydraulic systems
- the condition of the ropes and sheaves, e.g. erecting, hoisting, trolley and counterweight, and correct rope tracking
- isolating switches
- the condition and phase of the power supply cable
- verification that the crane wiring complies with AS/NZS 3000: *Electrical installations*
- effective operation of controls including interlocks
- effective operation of indicating devices
- effective operation of travel deceleration switches
- effective operation of hoist upper and lower, where needed, working limit switches
- effective operation of warning devices
- effective operation of the hoist and travel brakes when the crane is laden to the maximum rated capacity
- effective operation of the rescue controlled descent device
- other tests specified by the crane manufacturer.

***Commissioning report***

Crane owners should develop their own commissioning report that satisfies the requirements of the WHS Regulations and the manufacturer's instructions. It should reflect the specific type and model of crane and reference all relevant design drawings and test certificates.

## 3. Pre-operational inspection

A visual inspection and functional test of the crane should be carried out by the crane operator before the start of each work shift. This should include inspection and testing of the following:

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

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

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

## 4. Routine inspection and maintenance

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

Routine inspection and maintenance should include the following:

- all functions and their controls for speed, smoothness of operation and limits of motion
- all emergency and safety switches and interlocks, including limiting and indicating devices
- lubrication of all moving parts and inspection of filter elements and fluid levels

- visual inspection and measurements as necessary of structural members and other critical components, e.g. brakes, gears, fasteners, pins, shafts, wire ropes, sheaves, locking devices and electrical contactors
- signage, including warning signs and control markings
- wear on wheels and rails
- extra items nominated in the crane manufacturer's instructions.

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

## 5. Annual inspections

An annual inspection should be carried out by a competent person according to the crane manufacturer's instructions.

Where a tower crane owner is aware a crane will be erected when the scheduled annual inspection falls due, the owner may consider carrying out an annual inspection before erecting the crane or during the pre-erection inspection.

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

Annual inspections should include:

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

## 6. Major inspection

Tower cranes must undergo a major inspection at the end of the design life recommended by the manufacturer or if these are not available, at the recommendations of a competent person. If it is not reasonably practicable to inspect a tower crane according to either of these, inspect the crane every 10 years from the date the crane was first commissioned or registered, whichever was first. This must include inspection of the structure as well as mechanical components.

The following are examples of some of the key items requiring inspection. Some of the items may not apply, for example where the feature does not exist on the crane. The full list of items to be inspected must be determined by the competent person.

***Slew Ring***

The slew ring should be inspected in accordance with manufacturer's requirements and may include the following:

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

***Hydraulic motors***

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

***Hydraulic pumps***

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

***Valve blocks (bodies)***

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

***Hoist and luff drums***

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

***Braking systems***

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

***Rope sheaves***

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

***Hydraulic luffing cylinder***

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

***Gear boxes and drive shafts***

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

***Boom***

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

***A-frame***

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

***Pins with moving parts (for example, boom heel pins, ram pins)***

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

***Static pins***

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

***Steel wire ropes***

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

***Electrical systems (hazardous voltage)***

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

***Control systems (non-hazardous voltage)***

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

***Electric motors***

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

***Hook trolley (non-luffing cranes)***

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

***Hook assembly***

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

## 7. Requirements for non-destructive testing (NDT)

Non-destructive testing 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.

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

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

NDT of specific tower crane components should take place at set intervals, for example pre-erection tests and major inspection. The following table indicates the minimum frequency of NDT for particular crane components.

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

### *Crack testing of booms and counterweight sheave bracket welds*

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

In addition to carrying out crack testing of connection clevises, luffing crane booms have a history of cracking in the following areas:

- counterweight sheave bracket welds
- welds in cruciform area
- butt heal bosses.

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

### *Crack testing of band brakes*

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

Crack test the weld between the band and the end fitting by NDT before each time a luffing tower crane fitted with band brakes is erected. Note there may not be a weld on some brake bands.

### *Crack testing of slew ring bolts*

The integrity of slew ring bolts is critical for ensuring both the machine deck and boom remain attached to the tower. Slew ring bolts may become damaged, and their effective life reduced if bolts are either under or over-torqued. Once removed, slew ring bolts should be replaced unless the manufacturer's instructions state they can be reused. If bolts can be reused they should be tested.

For tower cranes where the slew ring needs to be split each time the crane is moved, NDT 10% of slew ring bolts. Bolts to be tested should be selected from the slew ring by a competent person. If any cracks are detected, all bolts should be discarded and replaced with new bolts.

The preferred system of testing slew ring bolts is to completely remove the bolts from the slew ring and examine them by magnetic particle testing.

### *Crack testing of tower bolts or pins*

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

Once removed, tower bolts should be replaced unless the manufacturer's instructions state they can be reused. If bolts can be reused, crack test a minimum of 10% of tower bolts by NDT before each crane erection. If any cracks are found, all tower bolts should be discarded and replaced with new.

A system that ensures all tower bolts or pins are tested over time is preferred, however a random system of testing may also be used. For example, a crane owner may decide to test more than 10% of bolts where deemed necessary due to a history of cracking. The tested bolts should be identified by a method that does not damage the bolt.

### *Chord thickness testing*

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

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

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

### *Records of inspections and maintenance*

A crane service record, for example a maintenance logbook, of the significant events concerning the safety and operation of the crane must be kept and readily available. Records may be kept in any suitable format and must be transferred with ownership of the crane. All entries in the maintenance logbook are to:

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

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

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

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

## 8. Tower crane maintenance and repair

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

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

The owner of the tower crane must ensure that:

- the necessary facilities and systems of work are provided and maintained to minimise the risks to health and safety of people maintaining, inspecting, repairing or cleaning the crane
- repair, inspection and, where necessary, testing is carried out by a competent person
- inspections, maintenance and cleaning are carried out according to procedures recommended by the crane designer and manufacturer, or the relevant Australian Standard, or as developed by a competent person
- all safety features and warning devices of the crane are maintained and tested
- when the crane has been damaged to the extent that its function or condition is impaired, resulting in an increased risk to health and safety, a competent person should assesses the damage and tell the owner about:
    - the nature of the damage

    - whether the crane is able to be repaired, and if so, what repairs must be carried out to minimise risks to health and safety
- repairs to the crane are carried out to retain the crane within its design limits
- annual maintenance, repair and inspection records are kept for the crane.

***Tower crane repair***

All worn or damaged parts of a crane that constitute a hazard, impair the operation of the crane, or may constitute a hazard before the next routine inspection, should be repaired or replaced. All repaired or new parts should comply with the crane manufacturer's recommendations or specifications. Where these are not available the repaired or new parts should comply with the recommendations of a competent person.

## 9. Safe design of tower cranes

***Crane stability***

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

Tower crane stability depends on:

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

***Stabilising and overturning moments***

Load charts

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

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

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

Counterweights

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

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

***Crane Siting***

When siting a 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
- public access areas, including footpaths, roadways and railways.

The size and design of a tower crane base should take into account factors including tower height, tie spacing, wind speed, terrain type, ground type and bearing capacity, boom length and crane lifting capacity.

A documented procedure, like a safe work method statement, should be prepared to minimise the risk of injury from a collision. This procedure should address the following issues:

- 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 that 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
- 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 tower cranes share the same air space but are sited on adjacent workplaces, the principal contractor from each workplace must, so far as is reasonably practicable, consult and co-operate with the others to implement safe systems of work to maintain sufficient 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 method of communication between the workplaces.

### *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

Crane ties

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

### *Wind conditions*

Operational wind speeds

Strong winds will impose extra loads on a crane and may affect the crane's stability. A maximum permissible operational wind speed will be included for in the tower crane design but this may not apply for operational purposes, that is 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 of 72 km/hour (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.

A crane manufacturer will generally only specify a maximum wind speed in which to operate the crane, ignoring the type of load to be lifted. In some cases, there may not be a maximum wind speed specified for the crane itself. The effect of wind gusts will also have a different effect on the crane than a constant wind. A crane operator 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. Guidance should be sought from the crane manufacturer or a competent person regarding the conditions under which a lift can take place safely.

### *Dual braking systems*

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

## 10. Ongoing stability of tower cranes

Tower cranes must, so far as is reasonably practicable, be operated within their engineered design capacity so they are being operated safely. To ensure the stability of a tower crane in windy conditions, the following factors should be addressed:

- The crane manufacturer should state the maximum wind speed that the crane may be operated in. However, such maximum operating wind speeds as stated by the manufacturer may in particular circumstances be excessive, especially when the crane boom and loads have large surface areas.
- An anemometer (wind gauge) should be fixed on each tower crane, in an appropriate location, to provide an accurate wind speed reading. The placement of the anemometer should not be shielded from the wind, and will vary according to the type of crane. For example, anemometers should be fixed on:
  - the top of the A-frame on luffing tower cranes, or
  - either the A-frame or machine deck hand-rail on non-luffing tower cranes.
- Where a non-standard lift with a suspended load or large surface area is to be carried out in windy conditions, the competent person should provide written advice on safe lifting conditions.

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

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

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

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

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

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

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

## 11. Signs on tower cranes

The attachment of signage on tower crane structures is not recommended as the signage will affect the operation of the crane in windy conditions. Signs that are inappropriately attached to the structure may detach during crane operations and result in injury to people in the vicinity of the crane.

Check the design engineer for a tower crane installation is aware of a requirement to attach signs to the structure to allow for the size and weight of the signage. This information should be included and allowed for in a crane base drawing. Signs should not be attached to the tower crane structure unless consideration has been given to the potential wind loading of the sign, and the resulting impact on the design of the crane base, tower sections and crane ties.

Certification must be obtained from an engineer that the design of the sign and its attachments to the crane are 'fit for purpose'. This includes ensuring that maintenance on the sign will not be needed for as long as the crane is on site.

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

Solid signs should be attached to the crane structure by bolted connections that clamp around the outside of the chords or lacings of the structure. An effective way of locking the nuts on the bolts should be used.

When attaching solid signs:

- holes should not be drilled into the crane structure
- joints should not be welded on to the crane structure
- strapping should not be used
- cable ties should not be used.

## 12. Erecting and dismantling tower cranes

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

- crane collapse
- falls from heights
- falling objects.

### *Responsibilities of people erecting or dismantling tower cranes*

Risks to health and safety during the process of erecting or dismantling a tower crane must be eliminated or minimised so far as is reasonable practicable.

A safe work method statement for the high risk construction activity of erecting or dismantling a tower crane must be prepared and consider the following:

- the crane designer's or crane manufacturer's instructions
- technical standards relevant to entry and exit
- exclusion zones to prevent unauthorised people accessing the area
- the crane's stability
- adverse effects on other plant, structures or work processes at the workplace
- the use of special tools, jigs and appliances necessary to minimise the risk of injury
- control measures for securing crane components
- the interaction of the crane with other plant
- environmental factors, e.g. wet or windy conditions
- all relevant electrical installations associated with the crane comply with AS 3000: *Electrical installations*.

## 13. Minimising risk of injury from crane collapse

### *Erecting and dismantling*

Tower crane components must be inspected and tested before being delivered to the workplace.

Written instructions about erecting and dismantling activities should be readily available on site. It is important not to erect or dismantle a tower crane unless it is in conditions within the crane manufacturer's specifications, or where the wind is such that components will not become uncontrollable when suspended. Consider wind loading during erecting and dismantling, including increased wind loads caused by funnelling effects between adjacent buildings or structures, and the wind effect on large sections.

Erecting and dismantling activities should be supervised by a competent person and be carried out according to the manufacturer's instruction or those prepared by a competent person.

Duty holders should ensure that the crane manufacturer's instructions are followed for the assembly of components in the correct sequence, and that the correct equipment and tools are used. Crane manufacturers may require the countrerjib, counterweights and boom components to installed or removed sequentially.

Only parts and components that meet the specifications of either the crane manufacturer or a competent person should be used when erecting a tower crane. Tower sections should be clearly and permanently identified with their model type and serial number. Only tower sections of the same model, or a model of greater strength, should be used to minimise the risks to health and safety when using the crane. It is important for the tower sections used to be the same as those specified on the engineer's crane base drawing or the crane will not be safe to use.

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

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

### *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:

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

All people involved in climbing operations must, so far as is reasonably practicable, receive thorough training and instruction in the climbing procedure for the particular model and type of crane involved in the climbing sequence.

The climbing sequence 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 preclude the crane rigging crew from ceasing work at their discretion if they think safety will be compromised at a lesser speed. Climbing operations should not start if either the recommended maximum wind speed or the actual wind speed is unknown.

***Precautions for certain tower cranes with moving counterweights***

Some tower cranes are provided with moving counterweights on rails that slope either towards or away from the crane. These types of tower cranes require the counterweight to be positioned at the top of the counterweight rail during the climbing process. The counterweight is kept in position by means of a latch that locks onto a lug on the bottom of the rail. To help prevent inadvertent release of the latch, a secondary and independent means of securing the latch in place should be provided.

## 14. Safe access on tower cranes

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

***Tower ladders***

Where ladders are used, the type of ladder access may be determined by available space in the tower. Landings, 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 the risk of injury to workers, for example in the event of them falling off the ladder. It also allows workers to take rest breaks while climbing.

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

The use of continuous vertical ladders for accessing the total length of the tower is not recommended. Where the tower design results in long ladders the risk of fall must be managed, for example by using a fall-arrest system that does not require the person to constantly hook on and off. The system may incorporate a vertical rail or rope with a locking cam device. The risk of injury to a person falling off a ladder can be reduced by ensuring the length of lanyard between the person and the vertical rail or rope does not exceed 300 mm.

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

***Self-erecting tower cranes without cabins***

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

***Internal guardrail on tower landings***

Internal guardrails on tower landings will minimise the risk of a person falling internally down the tower. Some tower cranes should be 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

provided. 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
- entrapment of people on the top tower landing.

***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.

***A-frame ladder cage issues***

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

***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. Climbing over the machine deck guardrail and down a ladder leading onto the platform is not recommended to ensure people do not fall off the tower crane when accessing the saddle bag platform.

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

***Crane jib—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. When people use the static line, two lanyards, or a lanyard with a 'pigtail' at one end, should be used to ensure the person is attached to the crane at all times.

## 15. Self-erecting tower cranes

The use of self-erecting tower cranes is becoming more common, particularly on small to mid-sized building sites. Some self-erecting tower cranes can be erected on site without using a mobile crane. Self-erecting tower cranes are generally made up of a horizontal boom that folds out during erection and can include a telescopic boom. The counterweight is provided at the base of the crane.

**Figure 1** Self-erecting tower crane

Unlike most other tower cranes, self-erecting tower cranes do not require fixing to a crane base. On both hammerhead and luffing tower cranes, the operator's cabin is typically located at an elevated position, close to the butt of the boom. However, self-erecting tower cranes are rarely provided with a cabin and instead are operated by remote control. While this feature can sometimes be an advantage, as it allows the operator to walk around the site, it has also led to incidents where the crane has collided with electric lines or other obstacles.

### *Operation of self-erecting tower cranes*

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

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

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

### *Remote operation*

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

- hard-wired or 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 at all times. A sufficient 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
- effective communications should be maintained between the crane operator and other personnel at all times.

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

***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 fence, should be erected around the base of self-erecting tower cranes to prevent people from entering this area and being hit by the crane's counterweights. The barricade should be positioned to provide enough room to avoid entrapment between the barricade and the counterweights.

## APPENDIX C – REGISTRABLE CRANES AND HIGH RISK WORK LICENCES

The following matrix shows specific types of plant which require design registration, item registration or a High Risk Work licence to operate about cranes:

| Class of plant | Type of plant included in this class | Design registration | Item registration | HRW license required to operate or erect this plant |
|---|---|---|---|---|
| Boom type elevating work platform | Self-propelled | ✓ | No | ✓ if boom extends >11m |
| | Trailer mounted | ✓ | No | ✓ if boom extends >11m |
| | Vehicle mounted | ✓ | No | ✓ if boom extends >11m |
| Bridge crane | Top running bridge crane | ✓ if rated capacity >10 t | No | ✓ if certain conditions apply |
| | Underslung bridge crane | ✓ If rated capacity >10 t | No | ✓ if certain conditions apply |
| Concrete placement units | Static mounted with delivery boom | ✓ | ✓ | ✓ |
| | Truck mounted with delivery boom | ✓ | ✓ | ✓ |
| Gantry crane | Gantry crane | ✓ if rated capacity >5 t | No | ✓ if certain conditions apply |
| | Semi-gantry crane | ✓ if rated capacity >5 t | No | ✓ if certain conditions apply |
| | Portside container crane | ✓ | No | ✓ |

| Class of plant | Type of plant included in this class | Design registration | Item registration | HRW license required to operate or erect this plant |
|---|---|---|---|---|
| Hoist | Scaffold hoist | ✓ if lift is >2.4m | No | ✓ |
| | Personnel and materials hoist | ✓ if lift is >2.4m | No | ✓ |
| | Platform hoist | ✓ if lift is >2.4m | No | ✓ |
| Mast climbing work platform | Single mast climber | ✓ | No | ✓ to install |
| | Double mast climber | ✓ | No | ✓ to install |
| Mobile crane, including:<br>• Articulated<br>• Crawler<br>• Trailer mounted<br>• Truck mounted | Slewing crane | ✓ if rated capacity >10 t | ✓ if rated capacity >10 t | ✓ if rated capacity >10 t |
| | Non slewing mobile crane | ✓ if rated capacity >10 t | ✓ if rated capacity >10 t | ✓ if capacity>3 t |
| Multi-purpose tool carrier or Telescopic handler | When equipped as a boom-type elevating work platform | ✓ | No | ✓ if boom extends >11m |
| | When equipped as a slewing crane | ✓ if rated capacity >10 t | No | ✓ if rated capacity >10 t |
| | When equipped as a non-slewing crane | ✓ if rated capacity >10 t | No | ✓ if rated capacity >3 t |
| Reach Stacker | Reach Stacker | ✓ if rated capacity >10 t | ✓ if rated capacity >10 t | ✓ if capacity>3 t |
| Tower crane | Articulated jib<br>Luffing<br>Self-erecting<br>Topless<br>Trolley jib | ✓ | ✓ | ✓ |
| Vehicle loading crane | Vehicle mounted crane for | ✓ | ✓ | ✓ |

| Class of plant | Type of plant included in this class | Design registration | Item registration | HRW license required to operate or erect this plant |
|---|---|---|---|---|
| | loading and unloading the vehicle | if rated capacity >10 t | if rated capacity >10 t | if capacity >10 metre tonnes |
| Work box | Personnel work box<br>First aid box | ✓ | No | ✓<br>to direct the crane in certain conditions e.g. dogger |

## APPENDIX D – MOBILE CRANES

### 1. Major inspection

Registered mobile cranes must undergo a major inspection at the end of the design life recommended by the manufacturer or if these are not available, at the recommendations of a competent person. If it is not reasonably practicable to inspect a mobile crane according to either of these, inspect the crane every 10 years from the date the crane was first commissioned or registered, whichever was first. This must include inspection of the structure as well as mechanical components.

The following are examples of some of the key items requiring inspection. Some of the items may not apply, for example where the feature does not exist on the crane. The full list of items to be inspected must be determined by a competent person

***Inspecting a mobile crane***

For mobile cranes the items to be inspected should include:

- chassis including outriggers and boxes
- drive train and suspension components
- slew ring
- slew ring bolts
- hook rollers
- drive systems, including winches, hydraulic motors, gearboxes and drive-shafts
- control systems
- braking systems
- electrical systems
- hydraulic systems—all cylinders, including outrigger cylinders
- booms
- safety devices, including rated capacity limiters and load indicators
- outriggers
- steel wire ropes
- rope sheaves.

The list of items inspected will be considerably larger and will be based on the requirements of the crane manufacturer and the instructions of a competent person. It should be noted that:

- completion of a major inspection does not indicate that the components inspected will have an extra life of 10 years
- it should 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, for example at annual and other inspection intervals, according to the crane manufacturer's instructions.

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

### 2. Mobile crane stability

***Stability function of load charts***

The stability factor of mobile cranes allows for variables, for example:

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

The stability factor of mobile cranes is typically based on 75% of tipping for stationary mode and 66.6% 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 these stability requirements as the stability factors used in other countries may be different.

When the load chart is based on 75% of tipping, the maximum capacity in the stability range of the load chart will be 75% of the suspended load that will cause the crane to overturn. In other words, the actual overturning load will be 33.3% 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.

### *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. A crane can fall over backwards due to the effect of the counterweight in situations when:

- the counterweight is too heavy for the boom configuration
- the crane is travelling up a slope with the boom luffed up
- inadequate timbers are placed under the outrigger pads below the counterweight when the crane is positioned on soft ground
- 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 cranes, counterweights are designed to be removed for road travel, or when lighter loads are lifted. 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 carried out.

The crane manufacturers' instructions specify how to secure the counterweights. 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, otherwise the crane will create a risk to health and safety. This also applies to the boom configuration being used on the crane.

In some unusual circumstances, additional counterweights not included in the load charts or not authorised by the manufacturer are attached to the crane to increase its capacity. If this is done, an engineer must check the complete crane design and certify that the amended design complies with relevant technical standards, and notify the regulator of the changes to the design before use.

### *Roles and responsibilities regarding crane stability*

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

- the crane designer, manufacturer and supplier
- the principal contractor or person with management or control of the crane
- the crane owner, and
- doggers.

### *The crane operator*

Crane operators should 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 become unstable. The operator should have the final say about whether a lift should proceed and be satisfied that:

- the crane is adequately supported on the ground and the crane is level to within the tolerance specified by the crane manufacturer
- materials placed under the outriggers 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
- the suspended load will remain within the rated capacity of the load chart
- the functions of the crane are operating properly, including all crane motions, brakes, load moment systems and indicators
- 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 and doggers 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.

***The crane designer, 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 designed and manufactured so it will be safe to operate. The crane manufacturer should be able to demonstrate the stability of the crane at the stability factor marked on the load chart.

The crane supplier should ensure that the information about the crane's stability factor is provided to the crane user. For imported cranes, the supplier should check that the load moment indicator (LMI) is calibrated to the correct load chart and stability factor.

***A principal contractor or person with management or control of the crane***

A principal contractor or person with management or control of the crane should supply the crane crew with all relevant information on the location of trenches, underground pipes, backfilled excavations and covered penetrations at a construction 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 person with management or control of the crane on ground bearing capacity, this information should be made available to the crane operator.

The principal contractor or person with management or control of the crane should get documented information about the ground bearing pressure from a geo-technical engineer or other competent person when a mobile crane is needed to perform at close to capacity, including bridge beams and large tilt-up or precast concrete elements.

A principal contractor or person with management or control of the crane should 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 lift.

### *The crane owner*

Information on the loads imposed by each of the outriggers should be available from the manufacturer. The crane owner should ensure that the timbers or pads supplied with the crane will adequately support the crane. The crane owner may seek the advice of a competent person when selecting appropriate materials to support the outriggers.

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 $m^2$ the crane owner should clearly state the minimum ground bearing capacity. This information should be placed in the operator's cabin.

The crane owner should be given information about the ground bearing capacity from the principal contractor or person with management or control of the crane before a mobile crane can be supplied 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.

### *The dogger*

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

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

## 3. 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.

### *Ground factors*

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

- 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
- the type of ground, e.g. clay, sand, rock or a mixture of these
- backfilled ground that was previously an excavation or trench
- cavities or penetrations in the ground that have been covered but still exist
- continued operation of the crane in one location.
- location of pressurised underground services for example a shallow fire hydrant main which may burst if an outrigger is located directly above it.

When a mobile crane is being set up, the crane operator can only make a decision based on the surface of the ground. Where there is a concern, documented information about the ground bearing pressure should be obtained from a geo-technical engineer. 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. Extra risks created when outriggers are positioned close to an excavation must be managed.

Check whether the ground 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. Check that the crane has not compacted the ground to the extent that the crane is more likely to overturn.

***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. 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, for example 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:

- Where the ground is compact and non-friable, that is not crumbling, the distance of any part of the crane outrigger support dunnage from the excavation should be at least equal to the depth of the excavation (general 1:1 rule).
- Where the ground is loose or backfilled, that is crumbling, the distance of any part of the crane outrigger support dunnage from the excavation should be determined by a competent person, e.g. a geotechnical engineer.

***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 with rectangular cross sections (see Figure 2) are the most common form of outrigger pad. However, timber and plastic pads are also provided for some cranes (see Figure 3).

**Figure 2** Typical outrigger pad of timbers

**Figure 3** Crane specific outrigger pads


For heavier lifts, bog mats usually consisting of steel plate are often used under mobile cranes and may be used under the tracks of crawler cranes or where larger lifts are carried out.

Crawler cranes will generally apply considerably less point load to the ground than a crane on outriggers. 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 needed.

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 used as outrigger pads:

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

### *Performing lifts close to the maximum capacity of the crane*

The likelihood of a mobile crane overturning is greater when the crane is operated near its maximum rated capacity or with loads at long radius and maximum load chart capacity.

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 that is, boom length and centre of gravity, and the mass of load on the hook. The ground bearing capacity should be greater than the maximum pressure applied by the crane to the ground to ensure adequate crane support. If not, then appropriate control measures, for example using appropriate outrigger pads, must be in place to increase the ground bearing capacity before the lift is performed. If not, the crane will not be safe to use.

### *Cranes on outriggers (or stabilisers)*

Using 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 be placed under the outriggers except where engineering indicates a direct outrigger pad application.

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

Many older cranes are not designed for lifting with partially extended outriggers. Modern cranes may have multiple position 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 and appropriate overload interlocks to lift with partially extended outriggers should be used this way. If a lift is to be carried out with partially extended outriggers use the correct outrigger configuration shown in the appropriate load chart.

Manufacturers of cranes should provide documented information on the maximum load and pressure applied by the outriggers to the ground for the different boom configurations supplied with the crane. This information should be included in the operation manual kept in the operator's cabin.

***Calculating pressure applied by outriggers***

A number of crane manufacturers provide information on the maximum ground pressure 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. 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. The table below indicates the typical maximum permissible ground pressure according to the ground type.

| Ground type | Maximum permissible ground pressure, PMAX (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:

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

The crane will not overturn if it is operated according to the manufacturers load charts.

***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 under the boom of the crane. If there is no load suspended on the crane, the ground pressure will be greater under the counterweight

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

## APPENDIX E – LIMITING AND INDICATING DEVICES

The purpose of limiting devices is to stop a specific crane motion before the crane moves out of its load-radius 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.

### Reliability of devices

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

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

- a reliability level of Category 4 under AS 4024: *Safety of machinery*, or
- a safety integrity level (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'.

### Rated capacity limiters

When an overload is detected a rated capacity limiter prevents further overloading of the crane by stopping all relevant 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, and 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.

#### *Mobile cranes*

Rated capacity limiters should be provided on all mobile cranes manufactured since 2002 with a rated capacity of more than three tonnes. The limiter should prevent:

- hoisting of a load, within the tolerance of 100 to 110% of the maximum rated capacity
- the radius being increased when the load exceeds 100 to 110% at the particular radius.

#### *Tower cranes*

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

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

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

#### *Vehicle-Loading Cranes*

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

- a maximum rated capacity of one tonne or greater
- 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.

## 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.

### *Mobile cranes*

Motion limiting devices should 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:

- the highest position of the hook—generally known as ‘anti-two block’
- the extreme permissible operating positions of the jib luff limiter
- the end positions of horizontally telescoping or movable jibs.

### *Tower cranes*

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

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

## Working radius indicator

### *Mobile cranes*

A radius indicator displays the radius of the suspended load generally measured from the centre of the slew ring. A radius indicator should be fitted on all mobile cranes that were originally designed with this feature. The indicator should be displayed in metres and be accurate to +10% and -3% of the actual radius.

### *Tower cranes*

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

## Load indicators

### *Mobile crane*

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.

### *Vehicle-loading Cranes*

All vehicle-loading cranes manufactured after 2003 are to be fitted with a load indicator. The load indicator should warn the crane operator when the load exceeds 90% of the rated capacity.

The load indicator should give a separate warning to the operator and people in the vicinity of the crane if the rated capacity is being exceeded.

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

### Free fall lock-out

When a crane is fitted with a free fall facility, the free fall function should be positively locked out and not able to be inadvertently activated.

## APPENDIX F – USING OTHER PLANT AS A MOBILE CRANE

### *Competency of operators*

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

### *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, for example buckets or quick-hitch, should be deducted, unless the rated capacity chart allows otherwise.

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

- 75% of tipping load in the stationary mode
- 66% of tipping load in the pick-and-carry mode
- 50% of tipping load for articulated wheel loaders and tool carriers.

### *Rated capacity limiters*

A rated capacity limiter prevents overloading of the plant by stopping all relevant functions when an overload is detected. Rated capacity means the maximum load that may be attached and handled and may not include the weight of the hook block, falls of rope, slings and rigging hardware. The load to be raised should include the weight of all lifting appliances that are not permanently attached to the plant.

### *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:

- manufacturer's name and model
- boom and dipper arm identification and length, particularly where different boom configurations may be used
- track width, where this is variable
- deductions for attachments, e.g. bucket or quick-hitch devices, so that the net allowable load to be lifted can be determined
- one of the following:
  - the rated load at the least stable position
  - where variable load rating is provided for, means to clearly determine the load position according to the rated capacity chart.

### *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 should form a closed eye, to which a load rated shackle may be attached.

A static strength test at 200% of the rated capacity of each lift point should 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, for example 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 should be followed.

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

- 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.
- 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.
- The lifting chain or sling can be damaged when a bucket is fitted because it may pass over the front edge of the bucket.
- Lifting lugs on buckets may be damaged when the bucket is used for digging activities.

### *Quick-hitches*

A quick-hitch is a latching device that enables attachments to be rapidly connected to the dipper arm or boom end 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. All quick-hitch devices should be fitted with a locking pin unless the following can be ensured:

- A system is provided to ensure the quick-hitch device is fully engaged on the bucket or other attachment. Note: the system should not rely on the operator carrying out a visual check on the quick-hitch attachment from the operator's cabin.
- Where the quick-hitch latching device relies on stored energy, for example hydraulic fluid pressure or a spring, to be activated, the latching device should be designed so that it remains engaged in the event of failure of the source of stored energy, for example drop in hydraulic pressure or spring breakage.
- Any factors that will affect the reliability of the latching device are listed in the quick-hitch manufacturer's instruction manual, including that any contaminants in the hydraulic fluid do not exceed limits specified by the manufacturer of the pilot-operated check valve, or other equivalent device. Evidence demonstrating these conditions are being met must be kept with the earthmoving plant, for example in the plant's logbook.

### *Burst protection and rated lifting capacities*

Burst protection should 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 should comply with the performance requirements of *ISO 8643: Earthmoving machinery – Hydraulic excavator and backhoe loader boom-lowering control device – Requirements and tests*.

The following extra conditions should be applied:

- The maximum rated capacity is to be according to the manufacturer's specifications for the plant.
- Single rated capacity: Unless the excavator is fully compliant with design requirements of a mobile crane the lifting capacity of the plant at its maximum lifting radius is the rated capacity and is to be marked on the boom or dipper arm. The rated capacity should 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.

- Variable rated capacities: Where the plant has variable lifting capacities it should be fully compliant with the design requirements for mobile cranes The manufacturer's rated capacity chart or 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.
- Burst protection device should not be provided with the ability for the operator to switch the device off.
- Where the rated capacity of the plant is 1 tonne or less and the decision is made not to fit burst protection, the plant should 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.