GUIDANCE NOTE

Working on Windmills

Scope

This code of practice provides detailed guidance on safe working practices on and around windmills including the prevention of falls. However, it is not possible to deal with every situation that maybe found at a windmill.

Who should use this code of practice?

This code should be used by everyone who has a duty to prevent, as far as practicable, falls at workplaces. This includes farmers and pastoralists, employers, employees, self-employed people, engineers, designers, contractors, manufacturers, suppliers, safety and health representatives and safety and health committees. The practical guidance in this code of practice should be considered in conjunction with the general duties in the *Occupational Safety and Health Act 1984*.- but most particularly as a guide to those associated with the maintenance of windmills, as a aid to creating a safe work environment.

Why have a Code of Practice?

The Windmill is the most reliable, least expensive, and most enduring method that mankind has developed to pump water. Without the windmill, Australia's pastoral industries will become uneconomic. By their nature a Windmill must involve height and movement (a rotating Windwheel, a yawing mechanism (to face the wind), and a reciprocating Pump Rod). Where there is movement there is a danger of being struck, pinched, or pushed. Where there is height there is a danger of falling, or having tools and other loose items being dropped. However these dangers are largely obvious – unlike the hidden danger that exists with electric based pumping systems (electrocution) and diesel systems (fire and explosion).

Definitions

For the purpose of this code of practice:

"the Act" refers to the *Occupational Safety and Health Act 1984.*

"Australian Standard", "Australian/New Zealand Standard", "AS" and "AS/NZS" refer to standards developed and published by Standards Australia. These are voluntary technical and commercial standards, which are sometimes referenced in the Occupational Safety and Health Regulations 1996. See appendix 1 for more information.

"competent person", in relation to the doing of anything, means a person who has acquired, through training, qualification or experience or a combination of those things, the knowledge and skills required to do that thing competently.

"duty of the employer", where an employer has a duty under a provision of this code of practice to do something, but the employer is not the person in charge of

the workplace at which an employee works, the employer has the same duty under that provision as the person in charge of the workplace has, except that the employer's duty is limited to an employee.

"employer" will mean either the employer, the pastoralist, the farmer, the manager, the owner, or contractor.

"employee" will mean any person employed by an employer, pastoralist, farmer, manager, owner or contractor.

"falling", in this code of practice, is a reference to a person falling and includes a reference to a person falling from, through or into a place or thing.

"person in charge of a workplace" means the person who has the management or control of the workplace, farm, station, or property.

"the Regulations" or **"Regulation"** refer to regulations in the Safety and Health Regulations 1996.

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1. General duties at the workplace

The *Occupational Safety and Health Act 1984* (referred to in this document as the Act) contains general duties which describe the responsibilities of people who affect safety and health at work. The Act and the Occupational Safety and Health Regulations 1996 (referred to in this document as the Regulations) should be read in conjunction with this guidance note.

The Occupational Safety and Health Act 1984, specifies the legal duties of employers and employees in the area of occupational safety and health. The Act and the duties specified apply to employers (including farmers, pastoralists, managers, and contractors) and all employees involved in erecting or maintaining windmills, and all places where work on windmills is carried out.

Farmers, Pastoralists, their Managers, and Contractors must, so far as practicable:

- Provide a workplace and safe system of work so employees are not exposed to hazards;
- Provide employees with information, instruction, training and supervision to enable them to work in a safe manner;
- Consult and co-operate with safety and health representatives (if any) and other employees in matters related to safety and health at work;
- Ensure that adequate protective clothing and equipment is available for use where hazards cannot be eliminated; and
- Ensure plant can be used, cleaned, maintained, transported and disposed of safely.

Employees of Farmers, Pastoralists, Managers, and Contractors must:

- Take reasonable care to ensure their own safety and health at the work site and avoid adversely affecting the safety and health of other persons through any act or omission at work.
- Comply, so far as is possible with instructions given by their employer;
- Use protective clothing and equipment provided, in the manner in which it has been instructed for its use.
- Not misuse or damage any equipment provided in the interest of safety or health.
- Report all hazardous situations, or injury, or harm (whether personal or to property or equipment) that arises in the course or in connection with the work being done.

Safe systems of work: workplace policies and procedures

Policies and procedures should be developed and implemented for each workplace to ensure safe systems of work and include:

- Hazard identification and risk assessment and control processes;
- Monitoring performance and reviewing control measures;
- Mechanisms for consulting with employees;
- Induction and training programs;
- An agreed system for reporting and recording information on identified hazards or other relevant safety and health information;
- Safe work methods (such as job or task procedures);
- Ongoing inspection and maintenance programs;
- Emergency rescue procedures; and
- Review of safety management policies and procedures.

Other people at the workplace

The Act also sets out duties for other parties at the workplace:

Employees must take reasonable care to ensure their own safety and health at work, and the safety and health of others affected by their work.

Self-employed people must take reasonable care to ensure their own safety and health at work, and the safety and health of others affected by their work.

Employment or engagement of contractors and their employees
The person (called the principal in the Act) must ensure the safety and health of anyone they engage (called the contractor in the Act) to do the work. The principal is considered to be the employer of a contractor and any people employed or engaged by the contractor to carry out work. Thus the principal has an employer's 'duty of care' to contractors and their employees for matters over which the principal has control.

Designers, manufacturers, importers and suppliers of plant must ensure that plant intended for use in a workplace is safe to install, maintain and use at workplaces. Safety and health information must be provided when plant and substances are supplied for use at work, and whenever requested for substances.

Designers and builders of a building or structure for use at a workplace must ensure, so far as is practicable, that persons constructing, maintaining, repairing, servicing or using the building or structure are not exposed to hazards.

Children. The Windmill is not a playground, and presents special dangers because of the movement of Pump Rods and other parts. Parents should take special care in instructing the children of the dangers associated with playing near and on the Windmill structure.

Further information

The Commission's guidance note, *The General Duty of Care in Western Australian Workplaces* has more information on the 'duty of care' requirements.

It is available on the Internet (at: www.safetyline.wa.gov.au) or for purchase from WorkSafe at the Westcentre, 1260 Hay Street, West Perth [Tel. (08) 9327 8777].

Consultation

Consultation and co-operation between employers and employees are the keys to providing and maintaining a safe and healthy workplace.

Employers are required to consult with safety and health representatives (if any) and employees on safety and health matters

Employer and employee involvement in the process of identifying hazards and assessing and controlling the risks will help to ensure that:

- The risks from injury and falls are identified because employees are most likely to know about risks associated with their work;
- Employees have a commitment to this process and any changes, such as control measures, that are implemented; and
- Injury and fall incidents are eliminated or minimised.

2. Hazard identification, risk assessment and risk control- the risk management process for working safely on Windmills.

2.1 An Overview

Employers have a duty to ensure, as far as practicable, that employees are not exposed to hazards at the workplace. They can do this by following a risk management process to identify hazards and assess and control risks.

In addition, there is a specific requirement for employers to carry out this risk management process for the prevention of falls. This involves a three step process to:

- Identify hazards;
- Assess risks; and
- Control risks.

To assist in identifying hazards and assessing and controlling the risks, consideration should be given to:

- Previous injuries, 'near miss' incidents or accidents arising which have occurred at the workplace or other similar workplaces;
- Relevant codes of practice and guidance notes;
- Consultation with employees, safety and health representative (if any), safety and health committees, self employed people and contractors to find out what problems may be associated with performing tasks/jobs;
- Walk through inspections of the workplace (consider using checklists); and
- Any other records or statistics which indicate potentially unsafe work practices.

2.2 Identifying hazards

Identifying hazards involves recognising things that may cause injury or harm to the health of a person, such as where a person may fall from, through or into a place or thing.

There are a number of ways to identify potential things or situations that may cause a fall to occur. Choosing an appropriate process or procedure for identifying hazards will depend on the nature of the work environment and hazards involved.

A hazard identification process or procedure may range from a simple checklist for specific equipment, such as a ladder of fall-arrest system inspection checklist, to a more open-ended appraisal of a group of related work processes. Generally, a combination of methods will provide the most effective results.

A hazard identification tool commonly used is the Job Safety Analysis (JSA).

Check List of Common Windmill Hazards

Hazard	Risk Assessment
The Site • Star Pickets or Fence around site • Clutter around the Tower • Uneven ground	Safe access and movement around the site is essential. Any unnecessary equipment left at the site will become a potential accident. Snakes can harbour in long grass around the Bore Casing or Pump Housing.
• Weather Conditions – Wind, Rain, & Heat	Bad weather can make a normally safe site hazardous. Water mixed with oil on the Tower can make the holding points slippery. On very hot days care is needed handling tools. Also be aware of Heat stress
• Size and condition of Well	The bore or a well is a place that tools can be dropped down. An open well (without a cover) has the risk of falling.
• Stability of Soil	If the soil at the base of the Windmill is loose or prone to water logging the stability of the Tower is uncertain.
The Tower • Rust in Anchor Posts	Where the Anchor Post protrudes through the concrete there is opportunity for rust. Rust weakens the structure
• Missing Bolts • Missing or damaged Girts and Braces • Missing Ladder Steps	Missing Bolts, Braces and Girts all weaken the structure of the Tower. Missing or damages parts should all be replaced.
• Location of Ladder	Is the Ladder on the leeward side if the Tower – away from the most common prevailing wind.
• Tower Height	Working at heights is dangerous. If the Tower must be climbed, ensure that all procedures associated with climbing the Tower have been addressed.
Platform • Old Timber	Platform timbers age, shrink, and split and Bolts come loose. The Platform must be checked to ensure that it is suitable for standing on.
• Grease and Oil on platform	The Platform should not be used if it has been raining. The Platform is often coated with oil from the Mill.

Hazard	Risk Assessment
Pump Column & Rods • Age & Condition of Pipe Clamps • Pinch points in Rod String. • Old Pipe & Rods • Wood Rod and Guides. • Loose items overhead	U-Bolts and Hook Bolts will rust. Timber Cross Guides will wear, shrink, and split. Pump Rod Couplings, and Wood Rod Splices, can all form pinch points with guides and Compensators. Pipe and Rods made of steel will rust and can form jagged edges that can cause cuts and abrasions. Wood Rod and Guides all wear. These can easily break if they become too thin. Check they are sound. If Cross Guides become loose, they could fall on those working below.
Windmill • Size, Make, and Model • Missing Sails • Work (Rotating) Ladder • Furl Wire and Handle	It is important to understand the size and power of the Windmill being worked upon. Missing Sails cause the windmill to operate "out of balance". They should be replaced. Does the Windmill have a Work Ladder. Are all bolts and nuts in place and secure. Is the Furling system free and operational.
Tools & Equipment • Condition of tools • Condition of Ropes and Slings • Appropriate safety equipment • Appropriate Clothing • Tool straps	Tools, Safety equipment, and Clothing must be in good condition. This is personal safety equipment and must be cared for. Tool straps should be fitted to all tools to be used by those working up the Tower to ensure that tools are not dropped.
Work Process • Number of people on site. • Work position in Tower	Too many people around the site can be cumbersome. Be mindful of where each person is on the job.
Experience • Training • Competency	Are those undertaking the work properly trained in the task?

2.3 Assessing and analysing risks

This involves looking at the chance or likelihood of a fall or an injury occurring and, if a fall did occur, the extent of any harm or injury (i.e. the consequences). This is a way of deciding which hazards need to be tackled first (i.e. where there is the highest risk of falls).

This step should provide information on:

- Where, which, and how many employees are likely to be at risk of incurring injuries;
- How often this is likely to occur; and
- The potential severity of any injuries.

Risk assessment is not an absolute science – it is a 'best estimate' on the basis of the information available. It is therefore important that:

- A person undertaking a risk assessment has the necessary information, knowledge and experience of that work environment and work process; or
- The risk assessment involves people with information, knowledge and experience in the process.

In carrying out a risk assessment, it is necessary to break down each activity or process into a series of parts or smaller tasks and assess each one separately. A Job Safety Analysis (JSA) can assist with this.

Information for risk assessments

Ways to determine the likelihood and potential consequences of each hazard include:

- Looking at similar workplaces or processes;
- Looking at the workplace's previous incident and injury reports and data for falls;
- Consulting with safety and health representatives (if any) and other employees;
- Looking at the way jobs/tasks are performed;
- Looking at the way work is organised;
- Determining the size and layout of the workplace;
- Assessing the number and movement of all people at the workplace;
- Determining the type of operation to be performed;
- Identifying the type of machinery/plant to be used;
- Assessing adequacy of inspection and maintenance processes;
- Examining the way all materials and substances are stored and handled;
- Assessing what knowledge and training is needed to perform tasks safely and the adequacy of current knowledge and training (e.g. gap analysis); and

- Examining adequacy of procedures for all potential emergency situations (e.g. accidents and rescues).

2.4 Controlling risks

The next step is to implement control measures to eliminate or reduce the risk of a person being injured or harmed (e.g. eliminate or reduce the likelihood of a person falling) and to ensure those measures are monitored and reviewed on an ongoing basis.

There is a preferred order of control measures, ranging from the most effective to the least effective in eliminating or reducing the risk of falls. This is outlined below.
The preferred way of controlling risk is by design, substitution, redesign, separation or administration. These control measures generally eliminate, reduce or minimise risk more effectively than personal protective equipment.

Specific regulations set out certain mandatory methods that are required to control the risk and some of these, such as the protection of holes and openings, are outlined later in this document.

Preferred order of control measures to eliminate or reduce the risk of falls

1. **Elimination** - removing the hazard or hazardous work practice from the workplace (e.g. eliminating the need to access the fall risk area such as by having Pump Rod disconnection points at ground level, installing hinges on Tower, etc.

2. **Substitution** - substituting or replacing a hazard or hazardous work practice with a less hazardous one (e.g.using a crane or cherry-picker);

3. **Isolation** – isolating or separating the hazard or hazardous work practice from people involved in the work or people in the general work areas (e.g. barring unqualified persons from working on the windmill);

4. **Engineering control –** if the hazard cannot be eliminated, substituted or isolated, an engineering control is the next preferred measure. This includes the use of a fall injury prevention system designed to restrain or arrest a person's fall from one level to another and minimise the risk of injury or harm to a person if they fall (e.g. a restraint system or fall-arrest system

5. **Administrative control –** this includes introducing work practices that reduce the risk, such as implementing measures to ensure that procedures, instruction, training and warning signs are in place to warn and protect persons exposed to a particular hazard. These controls should be used in conjunction with physical controls and appropriate supervision.

In some instances, a combination of control measures may be appropriate.

Examples of control measures include:

- Designing, planning and modifying equipment to prevent injuries and falls;
- Looking at the way jobs can be done safely to eliminate or reduce the likelihood of injuries and falls (e.g. checking that ladders are safe and used correctly);
- Organising and sequencing work so that people do not interfere with or increase the risk of injury for themselves or others;
- Identification, collection and presentation of information and knowledge required by employees and contractors to enable them to work safely;
- Identifying the training required to work safely if there is no risk of a fall; and
- Identifying areas requiring non-slip surfaces for stairs or ladders.

Other means of reducing the risk

Other means of reducing risks may be more appropriate to a particular case than the ones mentioned in this section, if they can eliminate or reduce the risk of an injury or a fall.

For example, qualified and experienced contractors are available to undertake the work. It may be advantageous to utilise the services of these people, who are trained in handling the risks and who will know of better solutions than someone who does the job once a year.

The risks associated with the maintenance and servicing of peripheral equipment must also be considered. Ie – Electric submersible pumps acting as a supplementary water supply.

In all cases, the three basic steps of hazard identification, risk assessment and risk control must be carried out.

2.5 Monitoring and review of control measures

Deciding on and implementing a risk control measure is not the end of the risk management process. It is important to constantly monitor and review control measures to ensure that they continue to prevent or control exposure to hazards or hazardous work practices.

A risk management process should be conducted as an ongoing process because workplaces are usually constantly changing environments with new hazards being

introduced; for example, when new equipment or plant is introduced or the work environment or standards are changed.

In determining the frequency of the monitoring and review processes, consider such things as:

- The level of risk (high risk hazards need more frequent assessments); and
- The type of work practice or plant involved (there may be particular stages in the life of a piece of equipment where more frequent assessments are appropriate, ie when bearings need to be replaced).

Each Workplace should:

- Have a planned program of inspections and maintenance;
- Undertake a review each time the work environment changes; and
- Regularly review the process for hazard identification, risk assessment and risk control to ensure it is effective.

Maintenance of plant, equipment and structures

Maintenance and repair programs should be reviewed regularly to ensure their effectiveness. Performance testing and evaluation standards should be established. Such items as flow rate, and system pressure should be recorded and regularly monitored. For example if the pressure in the delivery pipeline should unexpectedly increase, this could cause the windmill to be overloaded. If the windmill is overloaded it could lose its windwheel.

Incorporating the manufacturer's recommendations, repair and maintenance programs should specify:

- Where servicing is required;
- The extent of servicing required;
- The nature of the servicing required;
- The frequency of servicing;
- Who is responsible for maintaining repair and maintenance programs; and
- How defects will be corrected.

In order to keep accurate maintenance records, a recording or reporting system should be developed, implemented and maintained.

3. Instruction and Training

Employers, Pastoralists, Farmers, Owners, and Contractors must provide proper safety and health instruction and training to employees. This requirement applies to all aspects of the work to be done, but specific reference is directed towards the work to be done on the Windmill.

Instruction and training are an important part of ensuring safe systems of work and should take into account the functions of each employee and provide them with the necessary skills and knowledge to enable them to do their work safely.

In providing training, it is also essential to address the intent of the Act and Regulations so that employees understand that, in some instances, the prevention of falls depends on them doing a particular work activity in a particular way, such as when using ladders and fall injury prevention systems and working on restricted and volatile areas such as around windmill heads.

The type of instruction and training given should include:

- General safety and health induction, including the 'duty of care' responsibilities under the Act and Regulations and workplace policies and procedures;
- Task specific induction;
- 'On the job' training;
- 'In house' training programs designed to address specific needs, such as specific training for working from heights and correct use of ladders; and
- Industry-based formal training, such as accredited or certificated courses.

Training programs

In developing and implementing an effective training program, employers should include:

- Analysis of training needs, including the identification of the tasks to be performed and associated hazards and risks;
- Identification of any pre-requisites or entry standards;
- Definition of learning objectives and clear identification of the extent/level of competencies to be achieved, such as what will be covered;
- Selection of appropriate training aids depending on the environment and the targeted trainees (use of hardware, graphics, videos and printed materials);
- Adequate assessment (e.g. the assessment includes a practical component where the trainee has to demonstrate applied skills);
- Recognition of skills attained where applicable (e.g. accreditation or certification);
- Delivery of training by a competent person; and
- Evaluation of effectiveness of training.

Induction

Induction programs are essential:

- For new employees;
- Where work situations have changed; and
- Where work practices are being introduced for the first time.

In addition to providing general safety and health information, an induction should include:

- 'On the job' training, including how to carry out a job or task in a safe manner and not be exposed to injury and falls;
- Information on the hazards and risks from injury and falls at that windmill;
- Information on the selection, fitting, use, care, maintenance and storage of personal protective clothing and equipment, such as fall injury prevention equipment; and
- Emergency rescue procedures.

Further training or re-training

Employees may need further training where:

- New methods, equipment, hazards, policies or procedures are introduced;
- The type of operation or environment changes; or
- Their particular job requirements change.

Certification or accreditation

There may be occasions when a person is required to obtain formal accreditation or certification (for example, certificates of competency are required under the safety and health legislation for scaffolders, riggers and doggers).

Where a particular type of accreditation or certification is required before a job or task can be carried out, employers must ensure that such accreditation or certification is valid and current.

Employers must also ensure that people who are being trained to obtain accreditation or certification are supervised during the training.

The possession of a certificate of competency does not provide any exemption from the requirements for fall protection to be provided for a person working at heights.

Prevention of falls training

Training in the prevention of falls should include:

- safe work systems and practices to prevent falls, including how the systems installed prevent falls. This should include a specific review of which Tower Girts and Braces will carry a person's weight.

- hazard and incident/accident reporting systems;

- the correct selection, fitting, use, care, maintenance and storage of personal protective equipment (see the following page for fall injury prevention systems);

- correct selection, use, care and storage of tools and equipment to be used (for example, using a tool belt instead of carrying tools);

- emergency rescue procedures;

- safe methods of working on brittle and fragile material (ie old wooden platforms);

- electrical safety; and

- maintaining record keeping procedures and systems.

Training in the use of fall injury prevention systems

Where a fall injury prevention system is used, the instruction and training given should include at least:

- what each individual piece of equipment is intended for and how it works;

- the correct selection, fitting, use, care, inspection, maintenance and storage of individual fall-arrest and restraint equipment (in accordance with the manufacturer's instructions and Australian/New Zealand Standard, AS/NZS 1891.4), their strengths and weaknesses and the positioning of temporary fall-arrest systems;

- the method to be used in carrying out a specified work task, including the access and attachment method;

- maintenance of evidence of training undertaken; and

- emergency rescue procedures.

4 Supervision

Employers, Pastoralists, Farmers, Owners, managers, and Contractors must provide supervision to ensure that employees are not exposed to hazards on and about their Windmills, and that they are taking reasonable care where there is a risk of injury, or a risk of falling from, through or into any place or thing.

Supervision by a competent person is important, especially if the people being supervised are undergoing training or are unfamiliar with the working environment.

Employers should monitor the work to ensure that agreed safe work practices are followed; for example, monitoring the use and care of fall injury prevention systems.

Supervision around Windmills should not focus solely on the obvious. Just because Windmills have a working a heights component, this is not necessarily the only safety aspect. Supervision should look at every risk of injury. It is often the least obvious danger that causes the most injury.

Supervision of the use of fall injury prevention systems

Where fall injury prevention systems are used, the employer must ensure that:

- only employees who have received training and instruction in relation to the system of work are authorised to carry out the work;
- employees use the fall injury prevention system in the correct manner; and
- adequate safety and health systems are in place, are functional, and safe work practices have been adopted and are used.

Employees must follow instructions

It is also important to ensure employees understand that they must comply, so far as they are reasonably able, with instructions given by their employer, where those instructions are for their own safety and health or for the safety or health of other persons.

5 Design and Planning of Plant, Building and Structures

Any person designing and planning a Windmill Water Pumping System has a general 'duty of care' to ensure that the design and construction allows people to properly construct, maintain, repair, service or use the windmill in a safe manner.

The aim of this 'duty of care' obligation is to ensure that designers and builders of buildings and structures or designers, manufacturers, importers or suppliers of windmills eliminate completely or significantly reduce risks before they actually reach the workplace.

This 'duty of care' also extends to any person who may be involved in the modification, renovation, maintenance or normal operation of the windmill. For example, thought should be given to planning the installation of a windmill and tower. By observing where the prevailing winds come from, it is possible to position the ladder away from where the windwheel will be. Also in new installations it may be possible to install hinges on the Tower to make raising the Tower easy. In some cases it may be necessary to retrofit platforms, and safety drop cables to the ladder arrangement.

Therefore, at the design and planning stage, it is important to give consideration to prevention of falls systems, and impact injuries, not only for use during the construction stage, but also for use during the maintenance of the windmill and associated equipment..

In designing a windmill pumping system it is important not to lose sight of the fact that windmill is a passive device. While it is important to consider every possible risk of injury and possible fall situation, it is important not to forget that greater dangers exist if the operation of the windmill is interfered with in any way. The golden rule of windmills is that the windwheel must be 5 Metres above any obstruction within 100 Metres. Turbulence, not the tower height is the greatest danger in windmills. Turbulence is created if any structure is placed around the windwheel area. Turbulence will cause the windmill to react violently and this in itself is a danger to persons working on or near the windmill.

To ensure that risks to safety and health are considered fully during the design and planning process, system planners and designers:

- identify hazards associated with the design of the windmill pumping system that may arise while it is constructed and maintained, to which a person at the workplace is likely to be exposed;
- assess the risk of injury or harm to a person resulting from the hazards arising as a result of the design; and
- consider the means by which the risk may be reduced.

5.1 Plant (machinery, equipment and vehicles)

Designers, manufacturers, importers or suppliers of windmills and windmill pumping systems must eliminate or significantly reduce risks before they actually reach the workplace. Thoughtful consideration of system can eliminate risks of injury and falls from heights from the beginning.

The definition of 'plant' in the Act includes any machinery, equipment, appliance, implement or tool and any components or fittings of the plant. Therefore, the duty of care obligations for the safe design and manufacture of plant apply to a wide range of items, including farm machinery, transport vehicles, overhead crane systems and the use of mechanical loaders.

The elimination or reduction of risks of injury and falls from plant might include:

- providing adequate steps and hand rails on a transport vehicle;
- ensure that cranes, hydraulic systems, pulleys, and winches are well maintained and serviceable.
- incorporating a fall injury prevention system in cranes
- ensuring workers who will be maintaining or cleaning the plant are able to do so safely; and
- considering the safety of others in the immediate vicinity.

Careful manufacture can also ensure the plant is as safe as the designer intended it to be, thus significantly reducing the chances that people may be exposed to risks.

Providing information on hazards and safe use of plant is vital. This can make users aware of any risks the designer has been unable to eliminate and ensure that users do not create any new risks of injury by not using the plant properly.

5.2 Building and Structures

Designers or constructors of windmills (building or structure) must ensure that workers who will be involved with the construction, use or subsequent maintenance work are not exposed to risks of injury and falls. Therefore, at the design and planning stage, it is important to consider providing fall prevention systems as part of the building or structure.

A 'building or structure' is defined in the Regulations as any erection, edifice, wall, chimney, fence, bridge, dam, reservoir, wharf, jetty, or ship or other floating structure, and includes any part of any of these things.

Windmills can be erected on wet or sodden ground. The design of a windmill system in this situation should consider the carrying capacity of the ground that the windmill tower is built upon. The manufacturers recommendations (for the

size of footings) are for good soil conditions, and special advise is required if the windmill site is near a waterlogged region.

As it is unlikely that all design work on larger projects will be carried out by one designer, liaison should occur between the builder and other designers so that the work can be coordinated to ensure the safe interaction of the different design aspects.

When risks remain in the design work, information must be included with the design to alert others to the risks. Providing information about safety issues is a key component to ensure proper, adequate and suitable design and installation.

Design and Planning Checklist

Safety considerations for the design and planning stage include:

• designing safe access to or egress from the base of the windmill;

• if livestock are to be excluded from the windmill area, then ensure that star pickets are a safe distance away from the site;

• the use of temporary work platforms (e.g. scaffolds, and elevating work platforms, cherry-picker);

• the availability of specialized lifting equipment for erection, maintenance, and servicing;

• the provision of suitably located temporary and permanent anchorage points and struts with safety line attachment to hook harnesses and lanyards for the use of fall injury prevention system; or an assurance that appropriate personal safety equipment is available and those using it have suitable training in its use.

• possible use of Tower Hinges:

• specific safety requirements for workers doing subsequent installation, maintenance or repair work, for example:
- access to the site for maintenance equipment
- with appropriate lifting equipment the windmill can be lowered to the ground for maintenance.

• the pre-fabrication of structures on the ground before they are lifted into position; and
• assessment of how close construction plant will have to go to roads or overhead power lines. (although windmills are most often used away from grid power it is possible for powerlines to cross a property but not be able to be used by that property – therefore this danger can still exist)

Design and Planning for the safety of Construction Workers

The design and planning considerations for the construction stage include:

• reducing the risk for those working at heights, such as the installation of hinges for the tower.

• reducing the time spent working at heights by pre-fabricating the windmill and tower on the ground, before lifting it into position;

• sequencing of the work to be performed at heights;

• the siting and condition of access roads, for example, to enable a crane to place the windmill into position;

• preparation of the base of the tower prior to installation – by concreting a plinth at the base of the tower a secure and clean work area is created for on-going maintenance;

• identification of underground services including drainage, for example, for the safe setting up of cranes;

• provision of safety signs and warnings;

6 Ladders and Platforms

Most Windmill Towers are already fitted with a Ladder. The instruction in this section is directed towards the safe use of the installed ladder and of the temporary use of portable ladders.

Many falls from heights result from the non-use of ladders, for example, where crates, the Ute or truck are used to access heights instead of properly setting up a ladder. However, each type of ladder has specific safety requirements and considerations.

Portable ladders

Extension or single ladders should be used as a means of access to or egress from a work area, not as a working platform.

The Regulations set specific requirements for the use of a single or extension ladders, which are included in the checklist on the following pages.

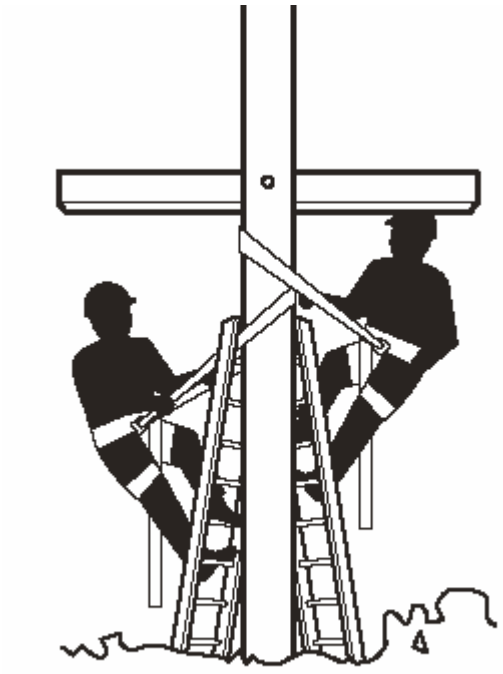
In addition, the minimum recommended safe practices and requirements for the selection; safe use and care of portable ladders are set out in the Australian/New Zealand Standard, *AS/NZS 1892* series.

Other means of preventing falls may be necessary with the use of portable ladders, where a risk assessment determines additional protection will be needed. The additional means of protection include:

• use of a permanent or temporary fall-arrest system attached to a ladder where a person may fall three metres or more;

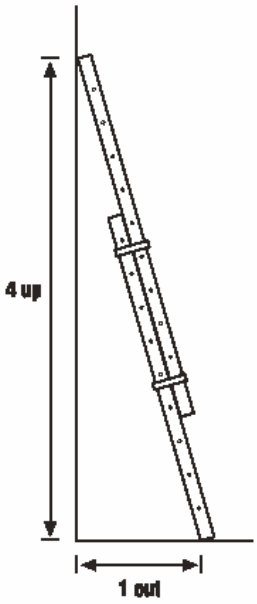
• use of pole straps (see the following diagram), which should be inspected regularly and at least daily when in use. Refer also to the relevant section in Australian/New Zealand Standard, *AS/NZS 1891.4*; or

• the installation of fixed ladders.

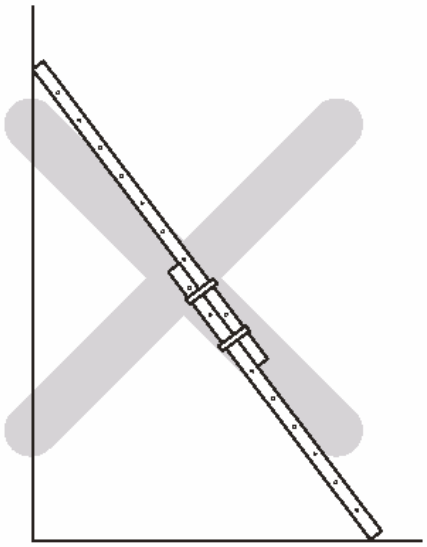


Right - An example of pole straps used with portable ladders to provide fall protection. In this situation, a secondary independent anchor point should be used (this is not shown in the diagram).

Positioning of portable ladders



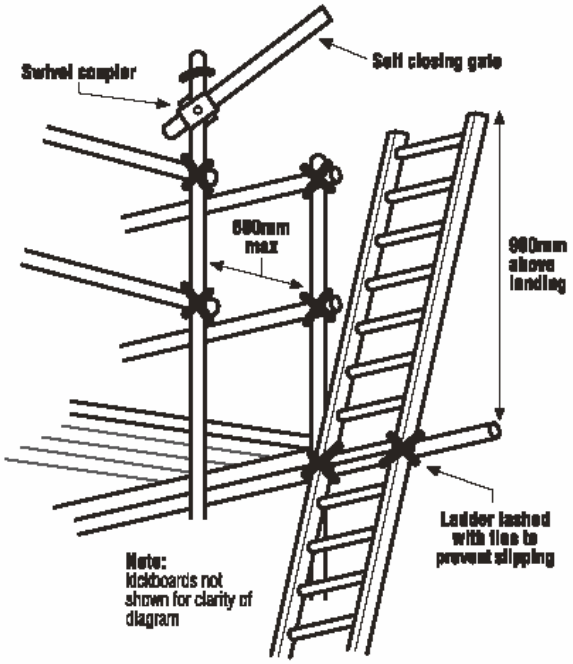
Above: The distance between the ladder base and the supporting structure should be about one metre for every four metres of working ladder height. Horizontal benching of ground ensures vertical alignment of ladder.



Above: Unsafe arrangement of ladder, which will create instability. Base of ladder positioned too far from wall. Sudden slipping can occur.

Always position the ladder so that **the rungs are at a right angle** to the edge of the working platform (i.e. the roof, scaffolding or gutter). The adjacent diagram illustrates this point.

Right: Position the ladder at a right angle to the edge of the working platform.



Ladder Checklist

If a ladder is used, check that:

• the type of ladder is appropriate to the task. Do not use 'domestic' or 'home-made' ladders. All ladders must comply with Australian Standard/New Zealand, *AS/NZS 1892* series and users should follow the manufacturer's recommendations on safe use;

• the ladder is in good condition. Before it is used, the ladder should be inspected for faults, such as broken rungs, rails and footing. Consult the manufacturer's checklist, if available;

• damaged ladders are removed from service;

• the ladder is on firm, stable and level ground;

• the ladder is the correct height for the task to avoid reaching or stretching. Keep the body centred between side rails at all times. Never over-reach;

• the ladder is not too close or too far from the support structure. The ratio must be one to four. For example, the distance between the ladder base and the supporting structure should be about one metre for every four metres of working ladder height. (See the diagrams on the previous page);

• the ladder is secured against displacement (i.e. slipping or sliding) and/or there is another person holding the base of the ladder;

• if used at a construction site, the ladder must not be suspended from a parapet hook;

• the ladder is not placed so that the weight of the ladder and any person using the ladder is supported by the rungs. (See the diagram on the next page);

• all the locking devices on the ladder are secure;

• the ladder is always faced while climbing up or down;

• materials or tools are not carried while climbing the ladder. Tools should be carried in a tool belt or side pouch;

• only light duty work is undertaken while on the ladder, where three points of contact can be maintained and tools can be operated safely with one hand;

• no person should stand on a ladder any higher than 900 mm from the top of the ladder;

• no other person is allowed on the ladder at the same time;

• slip resistant base, rungs or steps are provided;

• slip resistant shoes are worn;

• metal or wire bound ladders are never used close to energised power lines; non-metallic ladders should be used instead; and

• ladders are not used in access areas or next to doors when the work involves hot work, such as welding or oxy cutting, on scaffolding or an elevating work platform to get extra height, next to power lines, in very wet or windy conditions and next to traffic areas unless the working area is barricaded.

Access or egress

Where fixed/extension ladders are used for access or egress, check that:

• they are used only for access to or egress from a working area, not as a working platform. Consider whether an elevating work platform or scaffolding would be safer;

• there is a firm and level work platform, free from obstructions, to step onto from the ladder;

• the ladder extends at least 900 mm above the stepping-off point on the working platform. Sufficient platform area must be provided at the stepping off point; and

• edge protection is provided at the stepping off point where people access the working platform.

Working platforms

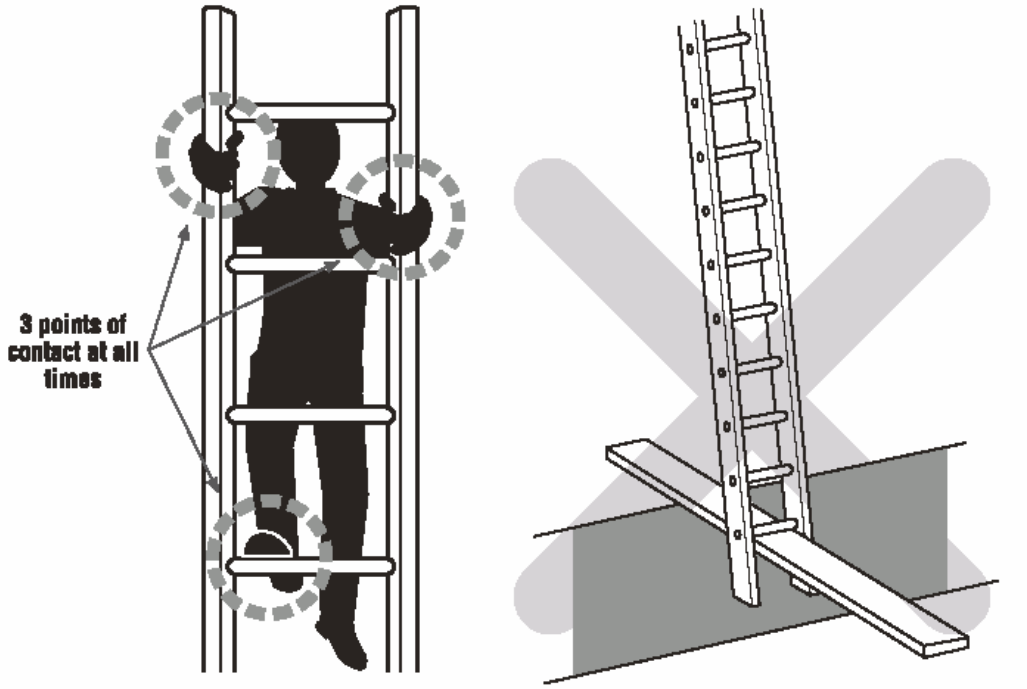
Where portable or fixed ladders are used as working platforms, check that:

• a fall-restraint or arrest system is used, if the person is exposed to a fall of three or more metres.

Refer to *AS/NZS 1891.4* for anchorage requirements;

• **three points of contact with the ladder are maintained at all times.** This means that there should be *two feet and one hand* or *two feet and the frontal D ring on the harness attached to the fall-arrest/restraint line or inertia reel* (see the diagram below); and

• no work is carried out over another person. Ensure signage is used to warn people of work above.

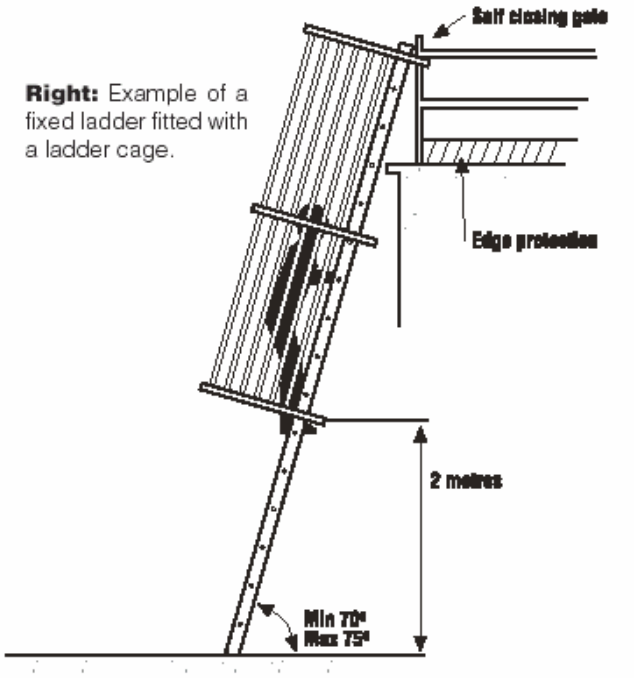


Above left: Three points of contact with the ladder should be maintained at all times, i.e. two feet and one hand, two hands and one foot or two feet and the frontal D ring on the harness attached to the arrest/restraint line or inertia reel. Tools and materials should not be carried by hand. They should be in a tool belt or side pouch.

Above right: The ladder should not be placed so that the weight of the ladder and any person using the ladder is supported by the rungs.

Fixed ladders

Ladder and tower safety systems should be installed on . xed ladders (for example, rung ladders). More information on these systems is provided below and on the next page.



Right: Example of a fixed ladder fitted with a ladder cage.

The ladder cages in fixed ladders have been shown not to stop a fall but simply funnel a fall and, in some cases, more injuries can occur from striking the protective backguards on the way down and the cages may also hinder rescues. Therefore, fixed ladders with angles exceeding 75degrees to the horizontal should be fitted with a permanent or temporary

fall-arrest system.

The ladder cages may also increase the risk of falling by giving the climber a false sense of security.

In areas where fixed ladders are installed, they should be in accordance with Australian Standard, *AS 1657 Fixed Platforms, Walkways, Stairways and Ladders - Design, Construction and Installation.*

The angle of slope should not be less than 70 degrees to the horizontal and not greater than 70 degrees to the horizontal. **In no case should the ladder overhang the person climbing the ladder**. If the angle is more than 75degrees, a safe system of work to prevent falls should be provided such as a permanent fall-arrest system (see ladder and tower systems below) or a double lanyard harness (see the next page).

A specifically designed rescue procedure should be developed for use in ladder cage situations, in consultation with the safety and health representative, if any, and employees. Training in the rescue procedures should occur prior to the use of the fixed ladder.

Ladder and Tower safety systems

Ladder and tower safety systems are temporary or permanent fall-arrest systems, which can be installed to provide continuous fall protection for persons using ladders or climbing towers (see diagram opposite). These can be used on different types of plant, such as tower cranes, as well as buildings or structures.

Right: With the use of a ladder tower system, the person climbing has continuous fall protection by being attached to the anchorage by a drop line and harness.

Platforms

Platforms are the most common cause for concern on Windmill Towers. The traditional timber platform has a limited life – nowhere near the longevity of the Windmill and Tower. It is critical to **check the soundness of the platform prior to standing on it.**

Ladder and Tower safety Checklist:

The safety considerations include:

• temporary systems should comply with the requirements of droplines (see Appendix 6);

• the locking device should be attached to the side or frontal attachment point of the harness and the lanyard assembly should be a maximum of 300 mm length;

• the locking device should not be capable of damaging the line in the event of a fall;

• the point of connection onto the ladder by the climber must be near the base of the ladder to allow the connection before ascending begins and also to provide continuous connection to the disconnecting point when at a safe higher level;

• limited free fall should be to a maximum of 600 mm;

• permanent systems should be of wire or rail construction and should be installed according to the manufacturer's instructions;

• wire systems should be in accordance with Australian/New Zealand Standards, *AS/NZS 1891.3* and *AS/NZS 1891.4* and sited in the middle or side of the ladder;

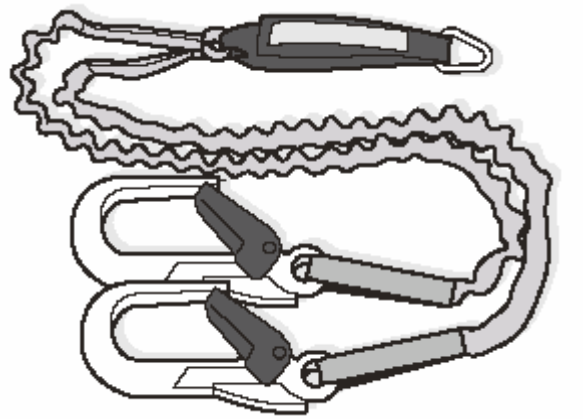
• the entire device should be capable of sustaining a load of 12 kN (approximately equivalent to 1200 kg); and

• rail devices should be anchored in accordance with Australian/New Zealand Standard, *AS/NZS 1891.3*. They should be sited to allow clearance of the self-locking device. Junction points may be installed to allow both vertical and horizontal movement.

Double lanyards

An alternative to ladder and tower systems is the use of a double lanyard (also known as a twin tail or 'Y' lanyard). The opposite diagram shows how the use of a double lanyard means that the person climbing can always be connected to the ladder or

structure and, if there is a fall, it should be a short distance. However, double lanyards are easy to misuse – there should be no back hooking, they are not suitable for frequent use (because of possible misuse or muscle injury) and the ladder or structure points must be capable of arresting forces generated by a fall with the double lanyard. Adequate training must be provided on their use.



Fall-arrest Systems

Individual fall-arrest systems are designed to arrest an accidental fall and consist of some or all of the following:

- anchorages;
- lifelines;
- inertia reel;
- lanyard that will not allow a person to fall more than two metres;
- retractable lifelines;
- rope grabs;
- wire grabs;
- rail system;
- shock absorbers – both personal and industrial;
- harness;
- snap hooks (double or triple action to prevent rollout);
- karabiners (double or triple action to prevent rollout); and
- rescue equipment.

7. Fall injury prevention systems and anchorage;

An Overview

'Fall injury prevention system' means a system designed to arrest a person's fall from one level to another and also minimise the risk of injuries or harm during the fall. 'Anchorage' means an anchorage point for a fall injury prevention system (i.e. the means for attaching a lanyard, lifeline or other components of the system to a secure point).

Fall injury prevention systems include:

• restraint systems;
• fall-arrest systems;
• catch platforms;
• scaffolding;
• safety nets; and
• safety mesh.

A fall injury prevention system must be used where a person could fall three Metres or more from an edge at a workplace, unless edge protection complying with the Regulations is used. For a Windmill, catch platforms, scaffolding, safety nets, and safety mesh are impractical additions to a Tower – the nature of the windmill and the wind that drives it, means that mobility around and through the tower are of greatest importance. The work area extends from the ground level right up to the Windmill itself. The structure with its Girts and Braces means that there are unlimited anchoring points throughout the Tower.

Key points on the use of fall injury prevention systems;

• choosing the most appropriate fall injury prevention system is essential;

• the correct selection, installation and use of equipment is critical to their effectiveness when arresting a fall;

• the fall injury prevention system and the anchorages must be designed, manufactured, constructed, selected or installed so as to be capable of withstanding the force applied to them as a result of a person's fall;

• fall injury prevention systems should be such that a person falling travels the shortest possible distance before having the fall arrested;

• ensuring the lanyard and harness are actually connected to the fall injury prevention system is critical (rather than just wearing the equipment); and

• fall-arrest equipment must not be used after it has arrested a fall until it has been inspected and certified as operational by a competent person.

The Australian/New Zealand Standard, AS/NZS 1891 series, *Industrial Fall-Arrest Systems and Devices* should be consulted for further information on fall-arrest systems.

Consideration should be given to slip resistance surfaces or coatings that render the surface trip or slip free to eliminate, where possible, any chance of a slip or trip or fall.

Marking of fall-arrest systems with instructions and other relevant information

Relevant Australian/New Zealand Standards for personal fall-arrest and restraint equipment require that they be permanently marked or labelled to indicate their purpose, correct use and limitations together with other relevant information.

The aim of this marking and labelling is to reduce the incidence of misuse or misfitting of the equipment. It is important to maintain the legibility of these instructions through the life of the equipment.

Restraint Systems;

A restraint system comprises:

• anchorage point(s);

• a static line or restraint line of appropriate strength and length; and

• a harness or restraint belt.

Its purpose is to limit horizontal movements from an anchorage point or a horizontal life line or life rail so that the user is totally restrained from reaching a position where either a free fall or limited free fall is possible.

A restraint system is suitable for use where:

• the user can maintain secure footing without having to tension the restraint line and without the aid of any other hand hold or lateral support. When deciding whether secure footing can be maintained, consider:

- the slope of the surface;
- the supporting material type; and
- the surface texture of the surface and whether it is likely to be wet, oily or otherwise slippery;

• the static lines are fitted with an industrial shock absorber when required; and

• the restraint system conforms with the Australian/New Zealand Standard, *AS/NZS 1891* series.

Use of a fall-arrest system instead of a restraint system

A fall-arrest system should be used instead of a restraint system if any of the following situations apply:

• the user can reach a position where a fall is possible;

• the user has a restraint line that can be adjusted in length so that a free fall position can be reached;

• there is a danger of the user falling through the surface (e.g. roo. ng material);

• the slope is over 15degrees; or

• there is any other reasonably likely misuse of the system which could lead to a free fall.

Fall-arrest systems;

Individual fall-arrest systems are designed to arrest an accidental fall and consist of some or all of the following:

• anchorages;

• lifelines;

• inertia reel;

• lanyard that will not allow a person to fall more than two metres;

• retractable lifelines;

• rope grabs;

• wire grabs;

• rail system;

• shock absorbers – both personal and industrial;

• harness;

• snap hooks (double or triple action to prevent rollout);

• karabiners (double or triple action to prevent rollout); and

• rescue equipment.

Fall-arrest system Installation checklist

When planning the site layout and sequence of construction for installing a static safety line system, the safety considerations include:

• selection of the most appropriate fall-arrest system and method of installation;
• the system conforms with the Australian/New Zealand Standard, AS/NZS 1891 series;

• provision of anchorage points (see Appendix 6 for details of static lines capable of supporting imposed loads);

• the requirements for lateral and vertical mobility whilst a person is connected to the system and working;

• the potential for different types of falls (e.g. free fall and restrained fall);

• fall distances and clearances (both vertically and laterally);

• provision of safe access to and egress from a work area for persons installing anchorage points;

• installation in a location where it will be possible to assist or rescue a person; a and

• development of emergency rescue procedures before setting up and ensuring appropriate emergency equipment is available on-site, including a self-rescue kit if training in use has been provided, although these should not be relied on as the main means of rescue.

8. Safe access to and egress from the work area

Before work commences, the employer or person who has control of a workplace and employees should ensure that there is safe access to and egress from the work area. This includes:

• assessment of wind and weather;

• organising of:

- fall prevention equipment;
- access;
- personal protective equipment;
- specific instructions for workers; and
- means of rescuing persons from safety harnesses following arrested falls;

and

• provision of a safe means of access to an anchorage point. This should take into account the possibility of a fall prior to the operator connecting securely to the anchorage and after disconnection at the conclusion of the task.

A person using a fall-arrest or industrial rope access system should not work alone.

Signage

Signage should be in place permanently at entry points of static line systems to advise users on the fall prevention system and inspection details.

The signage should include statements on:

• the system it has been designed for (e.g. a restraint system or a fall-arrest system);

• how many people should use the system at any one time;

• any personal protective clothing and equipment the operator should wear;

• the date of the last inspection;

• the date of the next inspection; and

• the name of the person doing the inspections.

Inspection of fall injury prevention systems;

Users of fall injury prevention systems must be aware that fall prevention depends upon the continued efficiency and durability of fall injury prevention systems.

It is essential that all equipment is correctly maintained, with inspections and examination of all components by a competent person at regular intervals.

All fall injury prevention system equipment should have an established inspection regime for an effective inspection by a competent person. The following checklist provides information on inspection regimes.

Inspection of fall injury prevention systems checklist

The safety requirements and considerations include:

• the inspection regime should include details of:

- the equipment to be inspected (including its unique identification);
- the frequency and type of inspection (pre-use checks, detailed inspections and, where appropriate, interim inspections);
- designated competent peoples to carry out inspections;
- action to be taken on finding defective equipment;
- means of recording the inspections;
- training of users; and
- the system of monitoring the inspection regime to verify that inspections are carried out appropriately.

Employers should consult the manufacturer and/or supplier of the equipment for any productspecific requirements.

• the employer must ensure that each component of the system and its means of attachment to an anchorage is inspected by a competent person:

- after it is installed but before it is used;
- at regular intervals; and
- immediately after it has been used to arrest a fall.

• if any signs of wear or weakness are found during the inspection, the employer must ensure that the components or means of attachment are withdrawn from use until they are replaced with properly functioning components. The manufacturer's specifications for inspections should also be checked for their recommendations on inspection intervals;

• all safety belts and harnesses, which are not in regular use during any six month period, are inspected before use;

• the fall prevention systems are inspected at least once every 12 months **and** after any extended storage period;

• consideration is given to environmental factors that may have affected the condition of equipment, such as water, oil, grease, sharp edges and grit; and

• there is consultation with the manufacturer if there is any doubt that a belt or harness could be affected by cleaning materials, atmospheric contaminants or hazardous substances.

Inspection of anchorages

The lattice style Windmill Tower affords many anchor points. Either at the join of the Girts and Braces, or in the case of fall-arrest systems with large double action hook gates, where the Girts and Braces themselves will provide adequate anchor points. Care will be required to ensure that such hook gates are only applied at or above a Girt/Brace/Main Post junction, where the maximum strength is to be found. Hook gates should not be applied on Girts (which may bend if a shock load is applied.

It is critical that all Girts and Braces be inspected along with all bolts and nuts holding them to ensure that they are sound.
Where special anchor points are applied, these should be fixed to existing bolt holes in the Main Posts only. Do not drill holes in the Girts, Braces, or Main Posts of the Tower without first consulting the manufacturer.

Employers must ensure that a permanently fixed anchorage is inspected by a competent person and it is regularly inspected, at not less than six month intervals, if it is permanently fixed and in regular use.

If a permanently fixed anchorage is not in regular use, it must be inspected before it is used.

When the competent person doing an inspection assesses the anchorage as being impaired, the employer must ensure that:

• the anchorage is not used and is tagged to indicate it is not to be used; and

• the repaired anchorage is not used until it is inspected by a competent person who can confirm that it is safe to use.

All anchorages should be visibly checked prior to use.

Inspections for faults and condition

Inspection of inertia reels checklist

Inspections of inertia reels by the competent person should include inspecting:

• the rope or webbing including anchorage lines in Type 2/3 fall-arrest device (for example, inspecting for any defects or damage and checking the anchorage);

• the fall-arrest device body (for example, inspecting for any damage to the mounting ring or the body, checking the activation of the fall-arrest indicator and that labels are present);

• the locking mechanisms and rope guides (for example, inspecting the visible rope guides for excessive wear and checking that the rope runs freely through the anchorage and that the locking mechanisms work properly);

• the hardware (for example, checking that the snap hooks or links work properly); and

• the snap hooks and double or triple action karabiners (for example, inspecting for any damage and checking the movement of the latch).

Inspection of Harness checklist

The inspection of the harnesses by the competent person should include inspecting:

• the webbing (for example, inspecting for any damage or defects);

• the D rings (for example, inspecting for any damages or wear and tear and checking the vertical movement); and

• the buckles and adjusters (for example, inspecting for any damage).

The inspection checklist for possible faults and the condition of fall-arrest devices, belts and harness in the Australian/New Zealand Standard, *AS/NZS 1891.4* should be consulted, as well as the inspection checklist for static lines and anchorages in Australian/New Zealand Standard, *AS/NZS 1891.2 Supp 1.*

Inspections before work starts

Before starting work

Items in the fall injury prevention system to inspect or check before work starts include:

• ensure that the harness attachment point for the lanyards is the correct one, i.e:

- the fall-arrest lanyards are attached to a D ring at the back between the shoulder blades;
- fall-restraint lanyards are attached at hip level; and
- lifeline lanyards or rope grabs are attached to a D ring at the chest.

Note that some harness attachment points may not be rated for fall-arrest;

• if a lifeline is being used with a rope grab, ensure that the rope and all rope grabs are compatible, especially with regard to rope diameter and direction;

• when setting up the fall-arrest equipment, inspect it for sharp edges, pinch points and sources of heat, which could wear, cut or burn through the lanyard if a worker should fall and be left dangling;

• ensure an emergency rescue procedure is in place;

• ensure that there is always assistance from another person when the fall-arrest equipment is in use. People who are working at a height or an elevated position should not work alone. This is important if there is a risk of a fall;

• ensure that there is no climbing above the anchorage point of a fall-arrest lanyard since the falling distance could double;
• ensure that fall-restraint components are not mixed with fall-arrest components. Fall-arrest components must incorporate a shock absorber;

• do not allow fall-restraint anchorage points, which have a much lower strength requirement, to be confused with fall-arrest anchorage points. Attach signs at each anchorage point indicating the type of anchorage point (i.e. whether it is for fall-restraint or fall-arrest);

• always inspect the snap hook visually after attaching it to a harness or anchorage point; merely hearing it click is not enough. There have been fatal accidents in which it was later found that the connector had not been closed properly;

• always set up the attachment point for fall-arrest or fall-restraint between the safe access point and the hazard. If a worker has to walk past the hazard to reach the attachment point, the purpose of the whole fall-arrest system is defeated; and

• always inspect all fall prevention equipment and hardware before use and, if there any doubts about the equipment, it should not be used because the boundary between safe and unsafe equipment is not well-defined. If the item is damaged, it must be taken out of service and inspected by a competent person prior to re-use.

Welding and the protection of fall injury prevention systems

A large part of the equipment and components of fall injury prevention systems consists of material which may be badly damaged and weakened by hot particles or sparks from welding or any allied process.

Therefore, people using the system and the system itself must be protected from hot particles or sparks with, for example, fire retardant harnesses and lanyards, lanyards with a cable wire core or fire retardant blankets.

Welding on or around the Windmill site also has other dangers. Because of the usual amount of dry grass (fuel) around the site, special care should also be taken not to cause paddock fires.

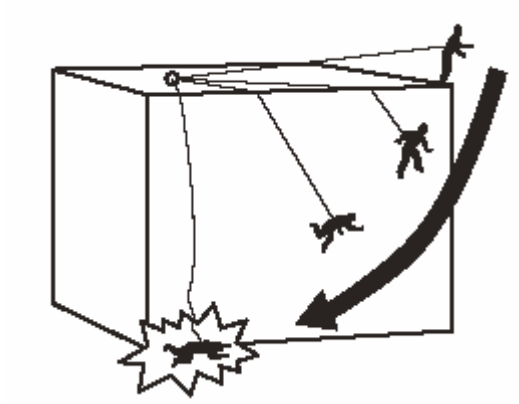
Hazards with the use of fall-arrest systems

Pendulum effect

With the use of a fall-arrest system, a potential hazard is that, in some situations, the worker may swing onto the ground (which is called 'swing down') or swing back into the tower (which is called 'swing back'). These hazards are caused by two lines offsetting one another, i.e. the line from the anchorage point to the worker and the line (direction) of the fall.

Both swing down or swing back can also occur both within the tower, and outside the tower.

Swing down



With the hazard of swing down, the fall arrest line extends diagonally from the anchor point, following the perimeter edge of the structure. If the worker falls, the fall arrest line will slide back along the perimeter until it is at a right angle with the edge of the structure. When this happens, the worker will drop and may hit the ground (see diagram right) or the arrest line may break when contacting the edge of the roof and the worker will fall to the ground.

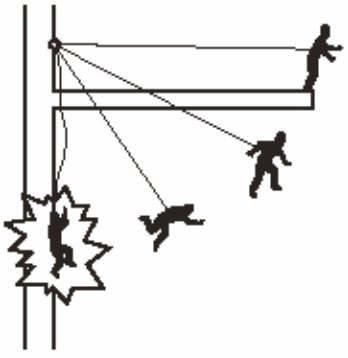
Consideration should be given to the following measures to address the hazard of swing down:

• use a fall-restraint system;

• put the anchorage point at a right angle to the position of the line at the perimeter edge. The use of a mobile anchorage will assist; or

• install a second anchorage point and belay devices, which are intermediate anchorages.

Swing back



With the hazard of swing back, in a fall, particularly from a perpendicular edge, the worker will swing back into the building

structure and collide with any obstructions in the path of the swing (see diagram right).

If there is a risk of swing back occurring, then the use of an individual fall-arrest should be reassessed.

Other dangers also exist within the confined space of a windmill tower. Swing down and swing back may result in entrapment with the lattice structure of the tower.

Assistance of another person

People who are working at a height or an elevated position should not work alone. This is important if there is the risk of a fall. A person suspended in a full body harness must be rescued as soon as possible.

Workers must be trained in rescue techniques and be familiar with on-site rescue equipment and emergency rescue procedures.

Suspension trauma

Suspension trauma may occur when a person has an arrested fall because they are suspended and caught in an upright position. Suspension trauma cause serious health problems and even death. It is important to understand both the cause and remedy for suspension trauma.

'Suspension trauma' can occur when a person's legs are immobile in an upright posture for a prolonged period because the lower legs have a large storage capacity for blood and gravity pulls blood into them. Thereturn blood flow to the heart is reduced as blood accumulates in the legs. Because the blood supply to the heart is then restricted, the body suddenly slows the heart causing the person to faint.

With the use of a fall-arrest system, suspension trauma may occur when a person has an arrested fall because they are suspended and caught in an upright, vertical position and the harness straps cause pressure on the leg veins. The blood flow to the heart is reduced, resulting in fainting, restriction of movement or **loss of consciousness in a few minutes**. This may lead to renal failure and eventually death, depending on a person's susceptibility. The condition may be worsened by heat and dehydration.

Susceptibility to suspension trauma may be unrelated to . tness level or any other obvious physical conditions. Therefore, the quick rescue of a person suspended in a full body harness, as soon as is possible, is vital. For this reason, workers should be capable of conducting a rescue of a fallen worker and be familiar with onsite rescue equipment and procedures.

Workers and emergency response personnel must be trained in the rescue procedures and be able to recognise the risks of suspension trauma and act quickly in the rescue of a person.

Preventing Suspension Trauma

Recommendations for preventing suspension trauma as a result of an arrested fall include:

• workers should never work alone when using a harness as fall protection;

• workers spending time hanging in a harness should use a sit type harness, which allows legs to be kept horizontal;

• the time a worker spends in suspension after a fall should be limited to less than five minutes. When a suspension is longer than . ve minutes, foothold straps or a way of placing weight on the legs should be provided.

• Workers should be trained to do the following when they are hanging in their harness after a fall:

- try to move the legs in the harness and push against any footholds, where these movements are possible. In some instances, the harness design and/or any injuries received may prevent this movement; and

-

This factor should be considered when selecting a harness for use at the workplace; and

• harnesses should be selected for specific applications, with consideration given to comfort, potential injuries and suspension trauma.

- try to move the legs as high as possible and the head as horizontal as possible, where these movements are possible. These movements are not possible in some of the harnesses available.

9. Wells and unprotected openings

Older windmill installations were over open wells. The use of wells is not common today, but there are many of the old wells still in use. An open well poses a unique set of risks when working on the windmill. Some of these include:

- the danger of falling down the well,
- dropping tools and equipment into the well,
- loose earth around the top of the well (many old wells were dug without a lining. Whereas modern wells are dug with a concrete lining, old wells had either brick, timber, or mulga lining. Most of these old lining are now frail,
- Snakes,
- Foul air. People have died going down old wells, unaware of the danger of lack of oxygen. Still others have died when using petrol driven motors down wells. It is critical that the well be completely ventilated prior to entering.
- Rotten and rusted cross members.
- Rotten or flimsy well covers. Water spilling from the rising column can cause timbers to become rotten. These timbers are sometimes covered by sheets of old iron, or mesh. These coverings are intended only to stop livestock falling into the well and are inadequate to support a persons weight.
- Well ladders could be too old to be serviceable.
- People working above may drop items on those working below.
- Fragile soil around the windmill tower anchor posts could cause the windmill to lean, or fall.

Wells often provide the best source of water, and by their nature they last longer than bores (this is due to the surface area afforded by a well, compared to a bore). There is the temptation to keep the well in service. However like any other piece of equipment it must be properly maintained. If dangers exist these should be properly repaired.

A perfectly constructed or renovated well will have a concrete pipe lining, joined with galvanized straps, a galvanized well ladder, secure cross members (anchor points for the ladder and column), a weld mesh cover with a closable access gate, and a solid galvanized well cover (able to support a persons weight).

Checklist for working in or around wells.

Safety considerations should include:

- Inspect the top of the well for loose, fragile, corroded, or rotten materials,
- Become informed about the history of the well – its age, condition, depth, amount of water, construction, recent improvements, presence of unsafe gas,
- Inspect the windmill tower anchor posts for rust, and proximity to the edge of the well. Ensure that the anchors are in solid concrete.
- Inspect under the well cover that there is solid support, and that that support can hold your weight (if necessary)
- Consider alternatives to leaning over, or standing on well top supports. Ie working off the windmill bottom girt.
- Consider anchor points for fall-restraint devices.
- Check for evidence of snakes.
- Clear all foliage from around the base of the tower.
- Ensure free access to and egress from around the well.
- If it is necessary to work down the well, ensure that there is a capable person in attendance at the surface.
- Ensure that all persons are aware of the dangers associated with working in a well and that there is a clear understanding of rescue procedures.

10. Emergency rescue procedures

Appropriate rescue procedures must be in place for the rescue of a person in an emergency situation.

Employees must be provided with:

• information on emergency rescue procedures;

• procedures in the event of different emergencies such as rescues, accidents or injuries;

• an induction on the emergency rescue procedures;

• training in the emergency rescue procedures; and

• training in the use of fall-arrest systems (where used).

First aid facilities

Employees must be provided with first aid facilities and first aid training for those who may be required to provide first aid.

The Commission for Occupational Safety and Health's code of practice, *Codes of Practice First Aid Facilitiesand Services, Workplace Amenities and Facilities, Personal Protective Clothing and Equipment* should be consulted for guidance on the legislative requirements for first aid facilities and workplace amenities.

The document is available on the Internet [www.safetyline.wa.gov.au] or for purchase from WorkSafe at the Westcentre, 1260 Hay Street, West Perth [Tel. 08 9327 8777].

Emergency rescue procedures for fall-arrest systems;

Procedures should take into account the need for:

• a plan and timeframe to carry out any rescues;

• the immediate rescue of a person after an arrested fall, without the need to rely on emergency services. See the following section for information on suspension trauma, which can occur when a person is suspended in a harness;

• the neccessary equipment required to carry out a rescue. This should include an emergency rapid response kit with man-made . bre rope, according to Australian/New Zealand Standard, *AS/NZS 4142.3* and auto-stop descent devices according to Australian/New Zealand Standard, *AS/NZS 4488.2*;

• the installation of individual fall-arrest systems and individual rope access systems in locations where it is possible to assist or rescue a person quickly if required;

• ensuring that all workers who will be working with the fall injury prevention system receive information, instruction and training in emergency rescue processes and are familiar with fall-arrest systems and devices, prior to work commencing;

• ensuring that any persons using a fall-arrest system or industrial rope access are not working alone. This is important if there is a risk of a fall;

• the availability of and access to first aid facilities or services, including trained first aiders. The rescue team should include a person or people trained in the provision of first aid so that it can be administered to the fall victim in the event of an injury occurring during a fall;

• the details of additional support facilities, including the location, contact information and availability (hours open) of emergency services, such as . re brigade, ambulance and hospitals; and

• an effective and readily available means of communication.

Training for rescues;

The training for rescues of persons who have fallen and are suspended in an upright position should address the following factors to prevent suspension trauma:

• the rescue process should be quick to start because a suspension in an upright position for longer than five minutes has the potential to cause death; and

• the victim should be moved from suspension in stages, i.e. the procedure should take 30-40 minutes with the victim moved first into a kneeling position, then into a sitting position, and finally into a horizontal position. The victim should not be moved too quickly into a horizontal position because this can kill them.

Appendix 1 - References and other sources of information

Standards
Australian Standards and Australian/New Zealand Standards

AS 1319	*Safety Signs for the Occupational Environment*
AS 1418.1	*Cranes, Hoists and Winches – General Requirements*
AS 1418.10	*Cranes (Including Hoists and Winches) – Elevating Work Platforms*
AS 1418.13	*Cranes (including hoists and winches) – Building Maintenance Units*
AS 1418.17	*Cranes (including hoists and winches) – Design and Construction of Workboxes*
AS/NZS 1576 series	*Scaffolding*
AS 1657	*Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation*
AS/NZS 1891.1	*Industrial Fall-Arrest Systems and Devices: Safety Belts and Harnesses*
AS/NZS 1891.2	*Industrial Fall-Arrest Systems and Devices: Horizontal Lifeline and Rail Systems*
AS/NZS 1891.2 Supp1	*Industrial Fall-Arrest Systems and Devices: Horizontal lifeline and Rail systems: Prescribed Configurations for Horizontal Lifelines*
AS/NZS 1891.3	*Industrial Fall-Arrest Systems and Devices: Fall-Arrest Devices*
AS/NZS 1891.4	*Industrial Fall-Arrest Systems and Devices: Selection, Use and Maintenance*
AS/NZS 1892 series	*Portable Ladders*
AS 2317	*Collared Eyebolts*
AS 2319	*Rigging Screws and Turnbuckles*
AS 2359 series	*Powered Industrial Trucks*
AS 2550.1	*Cranes, Hoists and Winches – Safe Use – General Requirements*
AS 2250.10	*Cranes – Safe Use – Elevating Work Platforms*
AS 2550.13	*Cranes – Safe Use – Building Maintenance Units*
AS 2626	*Industrial Safety Belts and Harnesses – Selection, Use and Maintenance*

AS 2865	*Safe Working in a Confined Space*
AS 3569	*Steel Wire Ropes*
AS 3838	*Guidelines for the Erection of Building Steelwork*
AS 4142 series	*Fibre Ropes*
AS/NZS 4389	*Safety Mesh*
AS/NZS 4488 series	*Industrial Rope Access Systems*
AS/NZS 4576	*Guidelines for Scaffolding* (an approved code of practice by the Commission for Occupational Safety and Health).

Available from:
Standards Australia
165 Adelaide Terrace, East Perth WA 6004
Tel.: 1300 30 89 89
Internet address: www.standards.com.au

National Standard

National Occupational Health and Safety Certi. cation Standard for Users and Operators of Industrial Equipment. [NOHSC: 1006 (2001)]

Internet address: www.nohsc.gov.au

British Standards Institution

BSEN 1263-1:2002 Safety Nets: Safety Requirements, Test Methods

BSEN 1263-2:2002 Safety Nets: Safety Requirements for the Positioning Limits

Internet address: www.bsi-global.com

Codes of Practice and guidance material

Commission for Occupational Safety and Health
Code of Practice: Excavation
Plant in the Workplace: Making it Safe: a Guide for Employers, Self-Employed Persons and Employees.
Plant Design: Making it Safe: a Guide for Designers, Manufacturers, Importers, Suppliers and Installers of Plan
.
These can be obtained from WorkSafe and are also available on the Internet at www.safetyline.wa.gov.au

DOCEP Energy Safety Directorate

Code of Practice for Personnel Electrical Safety for Vegetation Control Work Near Live Power Lines.

This can be obtained from:

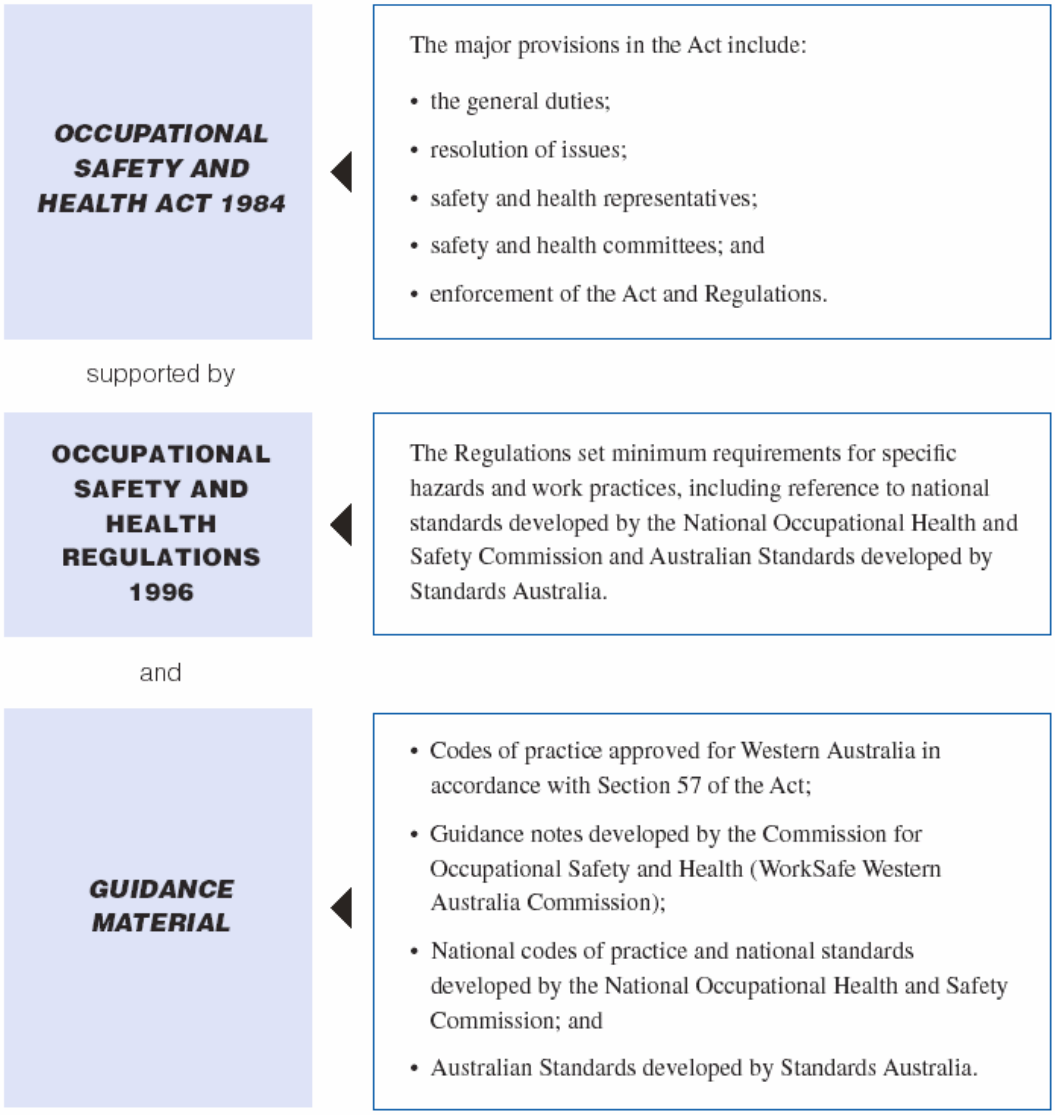
Energy Safety
20 Southport Street LEEDERVILLE WA 6007
Tel: (08) 9422 4200

It is also available on the Internet at www.energysafety.wa.gov.au

Appendix II Legislative framework for safety and health in Western Australia

Legislative Framework

The *Occupational Safety and Health Act 1984* sets objectives to promote and improve occupational safety and health standards. The Act sets out broad duties and is supported by more detailed requirements in the Occupational Safety and Health Regulations 1996. The legislation is further supported by guidance material such as approved codes of practice. This legislative framework is depicted below.



The meaning of "Practical"

Some of the general duty provisions in the Act and some requirements in the Regulations are qualified by the words “so far as is practicable”.

‘Practicability’ applies to general duties for employers, self-employed people, people with control of workplaces, designers, manufacturers, importers, suppliers, erectors and installers and to certain requirements in the Regulations. These people are expected to take practicable and reasonable measures to comply with the requirements.

If something is practicable, it is capable of being done. Whether it is also reasonable takes into account:

• the severity of any injury or harm to health that may occur;

• the degree of risk (or likelihood) of that injury or harm occurring;

• how much is known about the hazard and the ways of reducing, eliminating or controlling it; and

• the availability, suitability and cost of the safeguards.

The risk and severity of injury must be weighed up against the overall cost and feasibility of the safeguards needed to remove the risk.

Common practice and knowledge throughout the relevant industry are taken into account when judging whether a safeguard is ‘reasonably practicable’. Individual employers could not claim that they did not know what to do about certain hazards, if those hazards are widely known by others within industry, and safeguards were available.

The cost of putting safeguards in place is measured against the consequences of failing to do so. It is not a measure of whether the employer can afford to put the necessary safeguards in place. While cost is a factor, it is not an excuse for failing to provide appropriate safeguards, particularly where there is risk of serious, or frequent but less severe, injury.

Where a regulation exists and is not quali. ed by the words “as far as is practicable”, the regulation must be complied with as a minimum requirement.

Provision of Information

Employers must identify and provide information to employees to make them aware of areas where the risk of injury or falling may exist and to enable them to perform their work safely in these areas.

Information should be provided in a form that all employees at the workplace can understand.

Ways should be developed so that employees with a non-English speaking background or those with disabilities can be provided with information and included in the consultation process. These may include:

• organising information to be provided in groups for people with the same language;

• using interpreters;

• using audio-visual aids;

• using graphics;

• using short, simple English phrases; and

• demonstrating points.

Ensuring that a person understands the information is extremely important. Checks will be necessary to ensure this.

Access to the Act, Regulations and other relevant documents

Employers are required to provide information to employees, to alert them to areas where hazards may exist and to improve their understanding of safe systems of work and work practices.

Regulation 3.2 nominates specific documents, which must be made available upon request, for perusal by employees at the workplace. The documents include an up-to-date copy of:

• the Act;

• the Regulations;

• all Australian Standards, Australian/New Zealand Standards and NOHSC documents or parts of those standards or documents referred to in the Regulations that apply to that workplace;

• all codes of practice approved under Section 57 of the Act that apply to the workplace; and

• certain guidelines or forms of guidance referred to in Section 14 of the Act.

Copies of the *Occupational Safety and Health Act 1984* and Occupational Safety and Health Regulations 1996 and codes of practice and guidance notes published by the Commission for Occupational Safety and Health can be purchased from WorkSafe, Westcentre, 1260 Hay Street, West Perth [Tel. (08) 9327 8777].

These documents are also available on the Internet at: www.safetyline.wa.gov.au

Appendix III Job Safety Analysis (JSA)

Working with a JSA

Safety management is about reducing the risk of injury or harm for any person who may be affected by the work. This includes employers, contractors, all workers, visitors and members of the public who may be at or near a work site.

The work should be organised so that all of these people can carry out their usual activities safely.

Coordination

A JSA is one way of providing information to everyone involved in a particular task. It sets out the method that will be used and the way that hazards associated with the task will be managed on that site.

JSAs also provide the information that is needed for principal contractors and site supervisors to coordinate the work. They can refer to the JSAs to ensure that everyone is following the steps to be taken to complete the job safely.

Preparing for Work

JSAs are an important part of preparing for each job.

JSA's should be completed before the job begins.

Each worker involved with the job should know what is in the JSAs for the work they are doing.

Taking it step-by-step

Completing a JSA does not have to be a complicated process. It can be as simple as writing a few dot points under each of the headings in the blank JSA form on the next page.

Taking it one step at a time will make the whole process easier. It is best done with the people who usually carry out the tasks because they know the job well and they will have to follow the JSA when it is completed.

1. Break the job down into steps and record the steps in the Work activity column in the order that they would usually occur on site.

2. In the Hazard column, list the ways that anyone could be injured or harmed during each step. Think about all workers and any visitors or members of the public that may be affected.

3. Work out what could be done to make the job safer and prevent the injuries or harm that may occur. Write this in the Risk control column.

4. In the Persons Responsible column, write down the name of the person who has to make sure the risk controls are actually carried out on the site.

4. Make sure everyone understands that the JSA should be changed if there is a change to the site and different risk controls are required. The JSA should be reviewed and updated regularly.

Training and Supervision

A JSA provides a written record of the way a particular task should be done.

The JSA does not replace the information, instruction, training and supervision that are required to ensure the task is done that way.

It is up to the employer/principal contractor to ensure that each person has the skills to work safely and there is adequate supervision of the work underway at each site.

Introducing JSAs

It is a good idea to start with high-risk work activities. Gradually the number of situations where JSAs are used will grow and they will become a regular part of managing safety on the site.

Appendix IV Terms

Anchorage – means an anchorage point for a fall injury prevention system. It is the means for attaching a lanyard, lifeline or other components to a secure point.

Arrest force – is the force imposed upon the worker and the anchorage point, the moment the fall-arrest system stops the fall, measured in kilonewtons (kN).

Body containment devices – are designed to contain the body of a falling worker and to distribute forces resulting from an arrested fall to minimise the likelihood of injury. They consist of a full body harness (parachute type) together with associated components such as a lanyard and personal energy absorber.

Harnesses can be used for restraint systems and work positioning systems according to relevant sections in *AS/NZS 1891.1* and *AS/NSZ 1891.4*.

Droplines – are vertical lifelines.

Double or triple action device – is a self-closing hook or karabiner with a keeper latch which will automatically close and remain closed until manually opened. These units have a minimum of at least two distinct and deliberate consecutive actions to manually open them.

Fall-arrest devices – there are three types: Type 1 fall-arrester device, Type 2 and Type 3 fall-arrest device (see definitions on following page).

Fall indicator – is a visual indicator that shows that the fall-arrest system or device has been used to arrest a fall.

Fall injury prevention system – means a system designed to arrest a person's fall from one level at a workplace to another and minimise the risk of injury or harm to a person who falls from one level at a workplace to another.

Force – this is measured in technical terms in Newtons (N). The weight of something in Newtons (N) is calculated by multiplying its mass in Kilograms (kgs) by the value of Gravity, which is 9.81 (m/s2). A Kilogram (kg) is a unit of mass (i.e. the weight of a static object).

Force = Mass X Acceleration

For rough calculation purposes:
1000N=1kN
1kN=100 kg
10kN=1 000 kg

Free fall – is any fall or part of a fall where the person suffering the fall is under the unrestrained influence of gravity over any fall distance, either vertically or on

a slope on which it is not possible to walk without the assistance of a handrail or hand line. The maximum allowed free fall is 2 metres.

Inertia reel (also known as a self-retracting lanyard or fall-arrest block) – is a mechanical device that arrests a fall by locking onto a dropline and at the same time allows freedom of movement.

Job Safety Analysis (JSA) – these are a means of setting out the ways that hazards associated with a task will be managed on a site and the work methods that will be used. They are usually a standardised form produced by an association, employer or State Government agency. Refer to Appendix 4.

Karabiners – these are metal types of connectors that can be attached to anchorage points. They come in a variety of sizes, shapes and locking mechanisms to suit various applications and provide the most convenient type of connector as they can be easily attached and detached. They should be self-closing and self- or manual-locking and capable of being opened only by at least two consecutive deliberate manual actions.

Lanyard – is a line usually used as part of a lanyard assembly to connect a harness to an anchorage point or static line in situations where there is risk of a fall.

Lanyard assembly – is an assembly of a lanyard and a personal energy absorber.

Locking traveller (horizontal) – is a travelling anchorage. It has a walking sprocket device that connects the user to a static line system allowing the user to travel the entire length of the line without having to unclip and re-clip when passing the line supports.

Locking traveller (incline) – arrests falls on surfaces up to an angle of 30 degrees.

Personal energy absorber (deceleration device) – this is an attachment designed to reduce the deceleration force imposed by a suddenly arrested fall. A personal energy absorber is designed to be used with a fall arrest harness and lanyard.

Restraint line – is the line securing workers to a point of anchorage and is used to prevent a person from reaching a point from which he or she could fall.

Safety factor – this factor accounts for complex and variable dynamic forces and unknowns, such as rope ageing, metal fatigue, abrasion, bending and structure contact. It can, for example, be used to work out:

• the ratio of the ultimate strength of the material to the permissible stress;

• the ratio between the weakest link in the system compared to the maximum expected static load; or

• the minimum breaking load and the safe working load.

Formulas $SF = \frac{BF}{SWL}$ $SWL = \frac{BF}{SF}$ $BF = SF \times SWL$

(SF IS SAFETY FACTOR, BF IS BREAKING FORCE AND SWL IS SAFE WORKING LOAD)

Static line – is a horizontal or substantially horizontal line to which a lanyard may be attached and which is designed to arrest a free fall.

Total fall distance – is the total distance a person is likely to fall during both the free and restrained parts of a fall and includes the maximum dynamic extension of all supporting components.

Type 1 fall-arrester device (includes rope and rail grabs) – this is a fall-arrest device that travels along an anchorage line and, when loaded, locks to the line. The user is connected via a short lanyard to the activating lever, which locks the device in the event of a fall. A typical use of a Type 1 device is as a ladder fall-arrest system, using a rigid rail or a flexible line attached to the ladder.

Type 2 and Type 3 fall-arrest device (also known as an inertia reel or self-retracting lifeline) – this is a fall-arrest device from which a spring loaded anchorage line pays out, and which locks when loaded and releases when the load is removed. When incorporating a retrieval winch, it becomes a Type 3 fall-arrest device.

Appendix V Components of fall-arrest and restraint Systems

Key points on components of fall-arrest and restraint systems include:

• all components of a fall-arrest system must be compatible;

• do not 'mix and match' systems with different components made by different manufacturers; and

• check with the manufacturer and/or supplier to ensure compatibility of components.

i) Cable (in the fixed static safety line)

The safety requirements for the use of the cable include:

• the cable used in the installation of safety lines should comply with Australian Standard, *AS 3569 Steel Wire Ropes*;

• the cable should be of a minimum diameter of 10 mm and provide a minimum safety factor of 10;

• the cable should have a guaranteed breaking strain (GBS) of 60 kN (approximately equivalent to six tonne);

• the cable support at each column should be in accordance with an engineer's specification;

• consideration should be given to the many variables important in the erection of fixed static lines. These include:

- the number of people on the system at any one time;
- the length of the system; and
- the length between intermediate supports, length of lanyard of the user and distance below the user.

Engineer-designed systems are necessary to consider all these variables;

• industrial shock absorbers should be used to ensure the force generated in simultaneous falls on the safety system will not generate more than 12 kN (approximately equivalent to 1 200 kg) at the anchorage points, unless the anchorage points have been designed by an engineer to withstand a greater force;

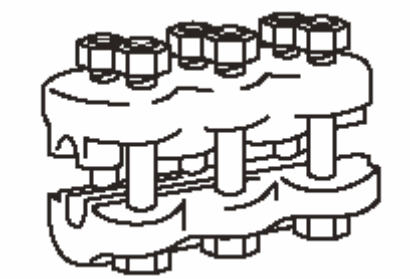
• tensioning of the fixed static line should be achieved by installing turnbuckles or other appropriate means.

Where turnbuckles are used, they should be installed as recommended on the following pages; and

• the cable should be placed to eliminate the risk of tripping. Where practicable, the cable should be located between two metres and 2.2 metres above the floor of the work area.

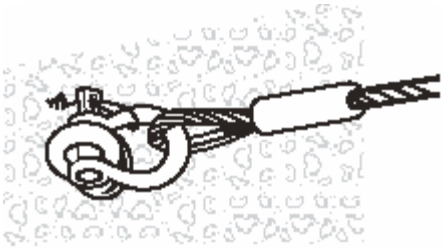
ii) Cable end (termination of the fixed static lines)

The termination of the cable should be by the installation of a thimbled eye. Where practicable, the ends should be secured by one of the following:

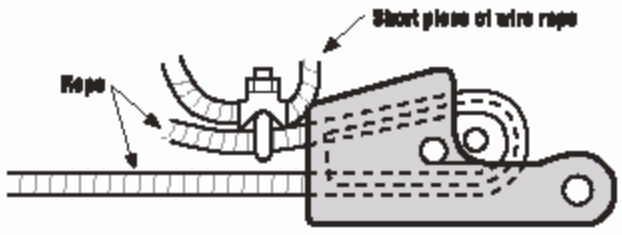


• double base clamps, with a minimum of three installed at equal spaces, with a minimum 200 mm tail past the last clamp;

• a hand splice with thimble eye or a machine splice with thimble eye; or



• wedge sockets.



Note: Cables and fittings may be secured directly to anchorage points with D or bow shackles of a minimum size of 12 mm or by having a safe working load of not less than 20 kN (approximately equivalent to two tonnes). The pin of the shackle should be moused (lashed) to the shackle.

iii) Anchorage points

Anchorage points are secure points of attachment for the . xed static line and lanyards.

The safety requirements for the use of anchorage points include:

• anchorage points used should be located as high as equipment permits, as it is dangerous to work above the point of anchorage;

• the diameter of the threaded sections of bolts and their anchorages should not be less than 16 mm; all eyebolts should comply with Australian Standard, *AS 2317 Collared Eyebolts*; and

• all anchorages should be visibly checked prior to use.

The following types of anchorage points are acceptable when used in concrete:

• anchorage points cast 'in situ':

- a wall tie (shee bolt) purpose designed; or
- an engineer-designed anchorage point;

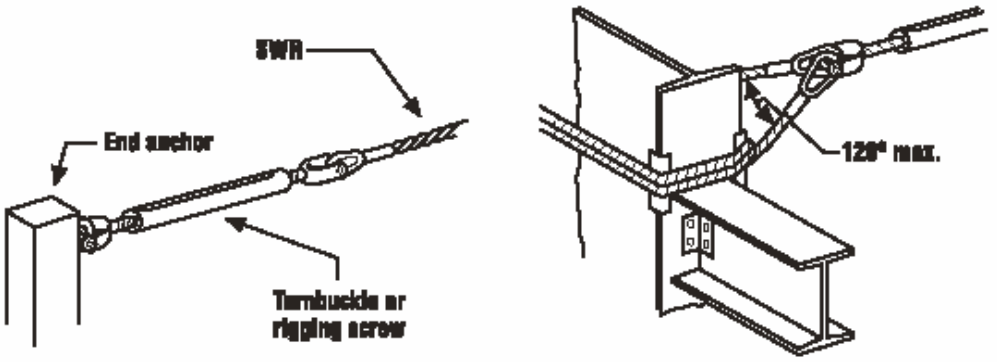
• chemical-type anchorage points incorporating a 16 mm diameter bolt and 110 mm embedment and used in shear; and

• friction-type anchorage points with a collared eye or eyebolt, used in shear, with the threaded section being no less than 16 mm diameter. The collared eye nut should be fastened tightly against the concrete surface.

Chemical or friction-type anchorages should be used in shear only, i.e. the bolt should be at right angles to the static cable.

Anchorages should have a design capacity of 15 kN (approximately equivalent to 1 500 kg) each, except where verification of a lesser design load provides for a minimum safety factor of 10.

Anchorages must be designed, manufactured, constructed, selected, or installed so as to be capable of withstanding the force applied as a result of a person's fall at the workplace.



Above: (Left) Direct connection anchorage and (Right) Sling anchorage.

iv) Turnbuckles (to adjust the tension in the fixed static line)

Turnbuckles are an open body consisting of two integral rods connecting two bosses that are threaded internally on the central axis in opposite hand and into which end fittings of optional with screwed clamps type (e.g. round eye, elongated eye or clevis) are fitted.

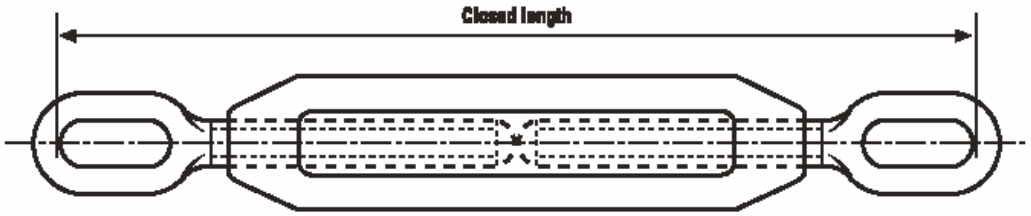
The safety requirements for the use of turnbuckles include:

• the threaded section shall be a minimum of 12 mm diameter;

• turnbuckles should be of a type that will allow visual inspection of the condition and extension of the threaded sections;

• the frame should be locked or moused (lashed) to the eye bolt to prevent slackening due to vibration, shock or spin in the line attached; and

• turnbuckles should be in accordance with Australian Standard, *AS 2319 Rigging Screws and Turnbuckles*.



Above: Turnbuckle assembly with elongated eyes.

v) Temporary static lines (horizontal life line systems)

Temporary static lines are linear anchorages, which allow users of fall-arrest equipment the flexibility of lateral movements without having to disconnect from the anchorage.

The safety requirements for the use of temporary static lines include:

• a 16 mm diameter nylon rope of Kernmantle construction that complies with Australian Standard, *AS 4142.3 Fibre Ropes – Man-made Fibre Rope for Static Life Rescue Lines* and which provides a minimum safety factor of 10 may be used.

The line must have a guaranteed breaking strain (GBS) of 80 kN (approximately equivalent to eight tonnes);

• tension may be achieved by using a self-tensioning block, which must be capable of automatically locking the line and manually releasing the line. Too

much tension on the line will affect the overall strength of the system, too little will affect the ground clearance required;

• for shock absorption, the self-tensioning block must be designed to reduce shock loading by means of a dynamic friction facility which guarantees that the maximum force generated on the line will not be greater than 6 kN (approximately equivalent to 600 kg);

• the line end (termination of the temporary static line) should be secured by one of the following:

- a hand splice with a thimbled eye;
- a machine splice (ferrule); or
- a figure of eight knot;

• the maximum span between anchorage points for a temporary static line should be no greater than four metres, unless speci. cally designed by an engineer to be a longer length. This is due to the dynamic sag factor of the temporary static line and should be taken into account when calculating the maximum ground clearance (MGC) requirement for a fall-arrest system;

• total fall distance is defined in the Australian/New Zealand Standard, *AS/NZS 1891.1 Industrial Fall-Arrest Systems and Devices: Safety Belts and Harnesses* as the total distance a person is likely to fall during both the free and restrained parts of a fall and includes the maximum dynamic extension of all supporting components.

Designers of temporary static lines should ensure the system is designed so that persons falling will not crash to the ground. Calculations should consider:

- tension on the static line;
- a person's height;
- lanyard length and extension;
- shock absorber extension;
- personal energy absorber of the person's lanyard; and
- slide of the D ring.

The person's weight will have a signi. cant effect on the sag of the temporary static line. Other factors to be considered include:

- climate (temperature and wet or dry);
- type of knots; and
- age of the system.

Rail systems

Rail systems are rigid systems which are generally comprised of a steel or other metallic structural member, along which one or more mobile attachment devices

run, each providing a travelling anchorage for connection of a personal lanyard assembly on a fall-arrest system.

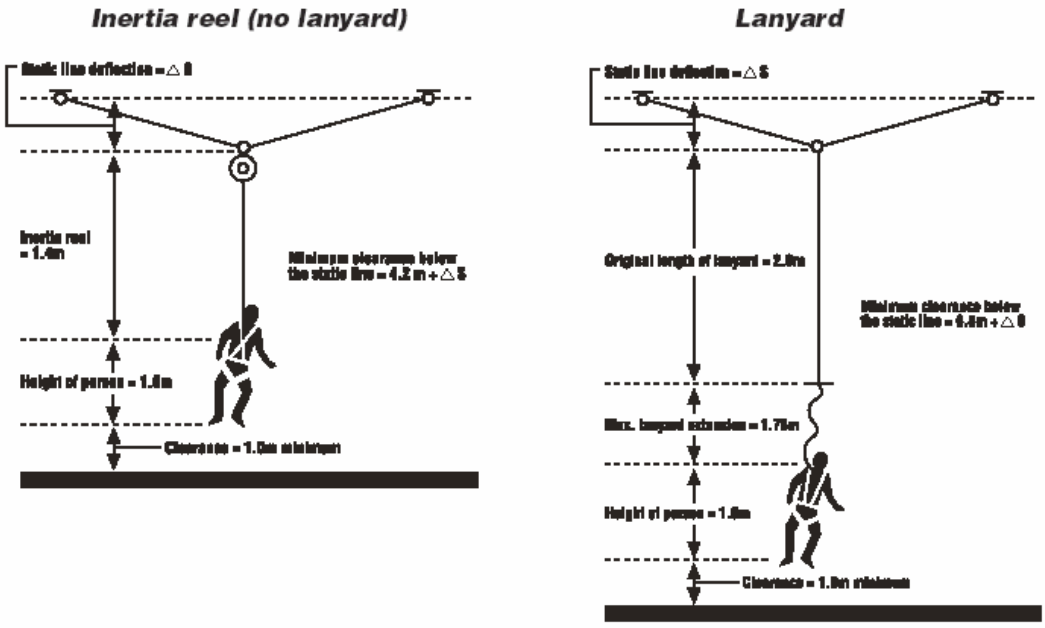
Safety requirements for the use of a temporary static line and rail system include:
• unless there is a ground clearance under the temporary static line of at least 6.55 Metres plus the distance of sag in the line under load, the user of fall-arrest equipment will probably not have their fall arrested and will strike the ground. (See the diagram on the right below);

• inertia reels (self-retracting lanyards) on temporary static line systems could be used. These willsignificantly reduce the 6.5 metre ground clearance due to the inertia reel lock-out. (See the diagram on the left below);

• in some circumstances, the ground clearance might be reduced. Using the 'preferred order of control measures', a combination of different equipment (such as a restraint system, elevating work platform and scaffolding) should be considered to give different results and create maximum ground clearance;

• personal energy absorbers must be worn at all times where there is a possibility of a fall; and

• Australian/New Zealand Standard, *AS/NZS 1891.2 supp:1-2001* should be consulted.



Above: Required minimum fall clearance below the level of the line anchorage.

vi) Harnesses, lanyards and equipment

Waist-type belts and sit harnesses must not be used as a fall-arrest system.

The lanyard is a line, usually used as part of a lanyard assembly, to connect a fall-arrest safety harness to an anchorage point or permanent or temporary static line, in situations where there is a risk of a fall.

The safety requirements for the use of harnesses, lanyards and equipment include:

• body-type harnesses of the parachute-type should be used;

• the length of any lanyard assembly should not exceed two metres;

• the harness should be connected to the lanyard or temporary static line at the top dorsal (back) position or front (sternum) fall-arrest attachment point;

• if a temporary or permanent static line and rope grab device are used on steeply sloping surfaces, the user needs to have the device in the front fall-arrest attachment point. This will allow safe manual operation of the mechanism;

• lanyards should be checked for the faults listed in the following checklist;

Defects and Damage to lanyards checklist

Lanyards should be checked for defects or damage, including:

• cuts of 1 mm or more at the edges of the webbing lanyards (e.g. where the lanyard may have been choked hitched around steelwork);

• surface abrasion across the face of the webbing and at the webbing loops, particularly if localised;

• damage to stitching (e.g. cuts or abrasion);

• a knot in the lanyard, other than those intended by the manufacturer;

• chemical attack resulting in local weakening and softening, which is often indicated by flaking of the surface. There may also be a change to the colour of the fibres;

• heat or friction damage indicated by . bres with a glazed appearance, which may feel harder than surrounding fibres;

• UV degradation, which is dif. cult to identify, particularly by visual appearance, but there may be some loss of colour (if dyed) and a powdery surface;

• a partially-deployed energy absorber (e.g. short pull out of tear webbing);

• contamination (e.g. from dirt, grit, sand or paint etc.) which may result in internal or external abrasion;

• damaged or deformed fittings (e.g. karabiners, screw link connectors, scaffold hooks or shackles etc);

• damage to the sheath and core of a Kernmantle rope (e.g. rucking of the core detected during tactile inspection); and

• internal damage to a cable laid rope.

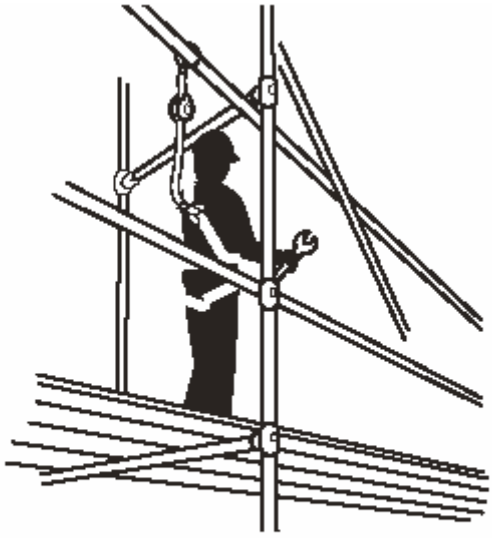
For additional information, refer to the Australian/New Zealand Standard, *AS/NZS 1891* series and/or the manufacturer's recommendations.

• anchorage points shall not be sited below the attachment point of the harness, e.g. not below the dorsal (back) position;

• there should be a minimum of slack in the temporary static line between the person and attachment to the anchorage.
The fall-arrest system should be so designed to limit a free fall to a maximum of two metres;

• lanyards must incorporate a shock absorber and be fitted with double action devices and, as an assembly, they must comply with Australian/New Zealand Standard, *AS/NZS 1891.1*;

• the attachment hardware should be checked for susceptibility to roll-out. A possible problem with the use of attachment hardware is inadvertent roll-out release caused by either:



Above: Scaffolders must have a safe system of work or use fall protection devices, including harnesses and inertia reels.

- a simple roll-out, when either a small diameter eyebolt or a rope loop can roll-out of a single action snaphook or a double action snaphook if the locking gate is first tripped (see the top diagrams below); or

- when gate loading occurs, which is when two or more large cross-section components in a snaphook of inadequate size exert undue force on the gate when loaded (see the bottom diagrams below); or

- inadvertent tripping of the locking gate occurs.

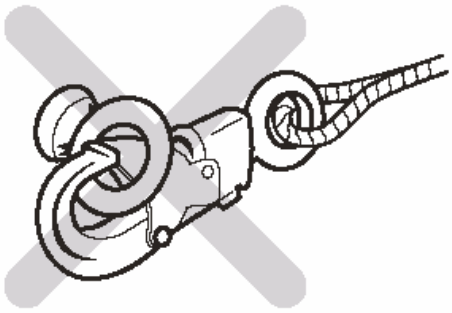
To check a connection for possible susceptibility to roll-out:

- firstly, determine how easily moving contact with clothing or equipment can cause initial tripping of the locking gate; and

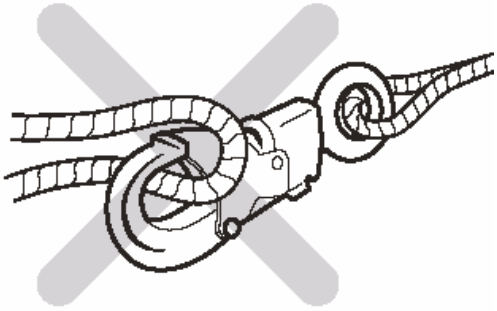
- if it looks like tripping is relatively easy, simultaneously twisting the connection in all possible directions will determine whether subsequent roll-out is possible after the locking gate has been tripped.

Australian/New Zealand Standard *AS/NZS 1891.4* should be consulted for information on common usage problems;

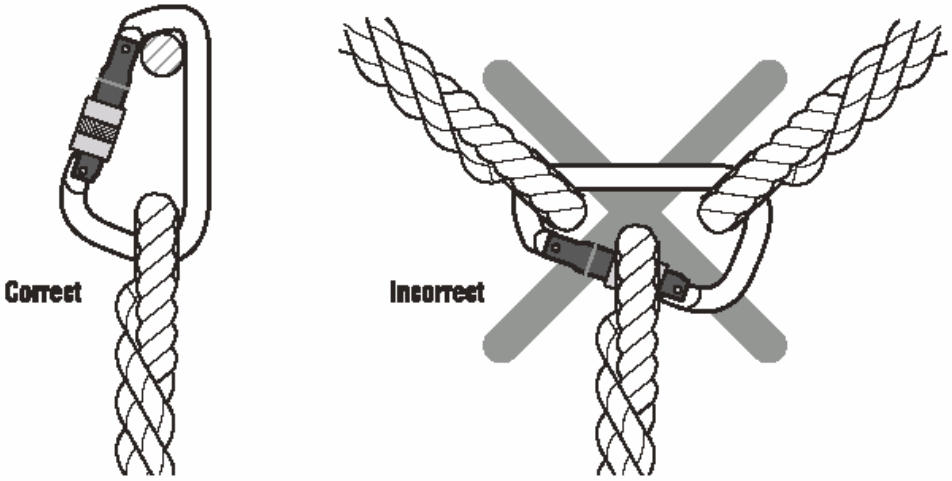
Snaphooks or karabiners without a double or triple locking device or action must not be used.



Above: Roll-out on small diameter eyebolt.



Above: Roll-out on rope.



Above: Side and gate loading of a karabiner.

• consideration must be given to any special requirements of the materials used in manufacture of the equipment, when choosing the most appropriate fall-arrest equipment for a particular application. For example, when fall-arrest equipment is used while operating chain saws (e.g. tree pruning, trimming or removal operations), pole straps or belts should be steel core to minimise the effects of accidental cutting;

• equipment must be inspected regularly, including inspecting for signs of any damage from cutting, abrasion or heat sources. See also the defects and damage to lanyards checklist in *vi) Harnesses, lanyards and equipment*;

• workers using safety harnesses, who are outside the safety of handrails, must be attached to an anchorage point or a fall-arrest safety system at all times;

• workers using safety harnesses should not work alone; and

• emergency rescue procedures must be developed before work commences.

vii) Inertia reels (self-retracting lanyards)

Inertia reels attach to an anchorage point and pay out a line that is attached to the person's harness. The line is controlled by a spring-loaded reel, which adjusts the line length as the person moves up and down while working. Under fall-arrest conditions, the reel locks in position by the same principle as a car seatbelt. Inertia reels can be used to prevent falls, where workers are required to carry out their work near an unprotected edge.

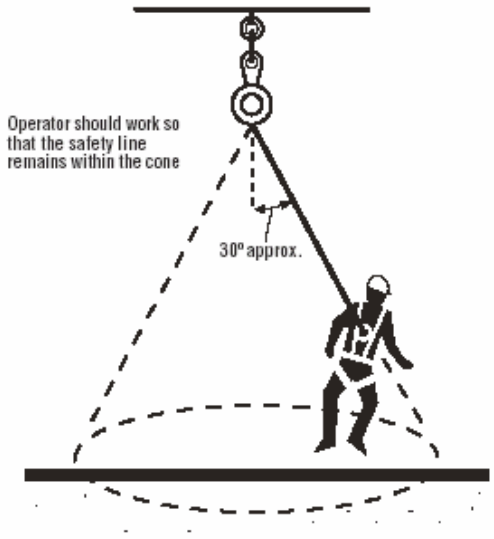
The safety requirements for the use of inertia reels include:

• the line of the inertia reel must be attached directly to the D ring of the harness;

• when using an inertia reel, do not use a lanyard;

• inertia reels are not designed for continuous support but become effective in the event of a fall. They should not be used as working supports by locking the system and allowing it to support the user during normal work; and

• inertia reels may be less effective for certain applications, such as stopping a person falling down an inclined surface. They should be sited only from vertical to 30 degrees, unless specified otherwise in the manufacturer's instructions.



Above: Inertia reel and safety harnesses can be used with a static line or fixed anchorages.

viii) Drop lines

Drop lines are vertical temporary static lines.

The safety requirements for the use of drop lines include:

• drop lines should be of a minimum knotted strength of 22 kN (approximately equivalent to 2200 kg) and

be of a nominal diameter of 11-12 mm;

• drop lines should have a . xed eye at one end for attachment to an anchorage point or temporary static line and be knotted at the other end to stop a rope grab device from becoming detached; and

• a drop line should be of Kernmantle or three strand construction.

Vertical lifelines

A vertical lifeline is a secondary safety drop line used as a back up to arrest a limited free fall in the event of failure of the working line or its attachments.

The safety requirements with the use of a vertical lifeline include:

• use vertical lifelines in connection with work from a swing seat (bosun's chair) or ladder; and

• only one person should be attached to any one lifeline.