

Technical Advisory for  
Safe Operation of  
Lifting Equipment





# 1. Introduction and Background

Fatal accidents involving lifting equipment include the collapse of cranes and workers struck by fallen or swinging objects being lifted (see Figure 1)

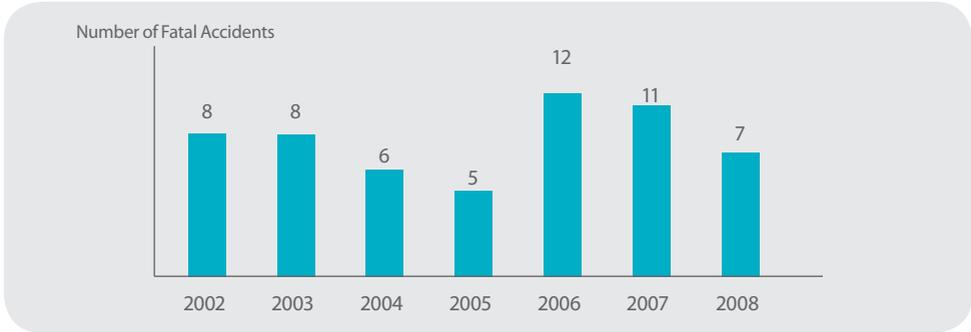


Figure 1: Fatal accidents caused by lifting equipment for the period 2002 to 2008

Cranes alone accounted for five fatalities in 2008 (see Figure 2), including the tower crane collapse that killed three workers.

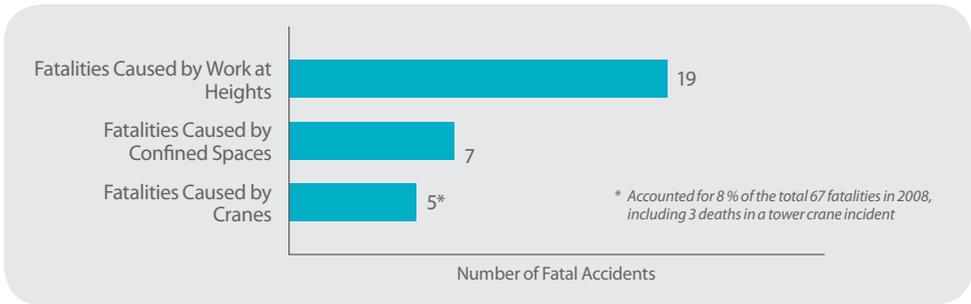
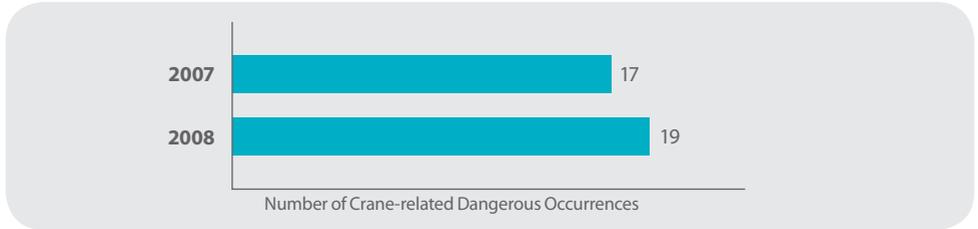


Figure 2: Top accident agents for fatal workplace injuries in 2008

There is an increase in the number of Dangerous Occurrences (DOs) involving cranes from 2007 to 2008. Such collapses could potentially lead to serious injuries for both workers and the public.



**Figure 3: Dangerous Occurrences (DOs) involving cranes**

Lifting operations are considered to be high-risk activities that require thorough risk assessment and careful planning prior to commencement of work.

Past cases had proven that serious injuries can be inflicted during lifting operations involving even light or small loads.

Hence, a proper lifting plan should be developed for all lifting operations which comprises risk assessment procedure, permit-to-work system, selection of safe and proper equipment as well as assignment of competent personnel.

This technical advisory emphasises the following:

- That ALL lifting operations have the potential for serious consequences;
- That having a proper lifting plan that emphasises risk assessment, selection of equipment and competency of personnel is critical for the safe and proper execution of a lifting operation; and
- That it is mandatory to have Permit-to-Work system in place for lifting operations involving tower, mobile or crawler crane, as specified in Part III of the WSH (Construction) Regulations.

## 2. Case Studies of Accidents Involving Lifting Equipment

### Case Study 1

#### Worker Crushed by Dislodged Electrical Distribution Board

##### The Incident

The worker and a lorry crane operator were unloading scrap metal materials using a lorry crane. While the worker was on the deck of the lorry guiding a scrap electrical distribution board (DB) which was hoisted by the lorry crane, he accidentally slipped and fell to the ground. The hoisted scrap electrical DB was then dislodged from the lifting gear and crushed the worker, who was below it. The worker was immediately rescued and sent to the hospital. Unfortunately, he succumbed to his injuries the following day.

##### Investigation Findings

- The lifting hook used to hoist the scrap electrical DB, was not fitted with a safety latch.
- The hook was also found to be defective, as it had deformed beyond its original shape.
- The occupier was unable to provide any documentation to prove that the lifting gear used to hoist the scrap electrical DB, was examined by an authorised examiner, prior to the accident.
- The occupier did not appoint any lifting personnel such as lifting supervisor, rigger or signaller to oversee the lifting operation.
- The improper rigging of the DB was performed by the worker who was not a trained rigger.



- 1 New hook with narrow throat opening and safety catch
- 2 The widened throat opening on the defective hook



- 1 Lifting gear used for the hoisting of the scrap electrical DB at the time of the accident

## Case Study 2

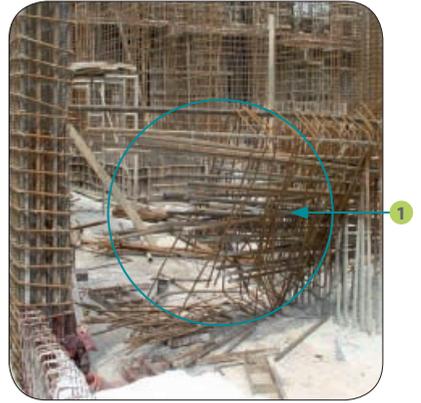
### Worker Killed by Falling Prefabricated Cage

#### The Incident

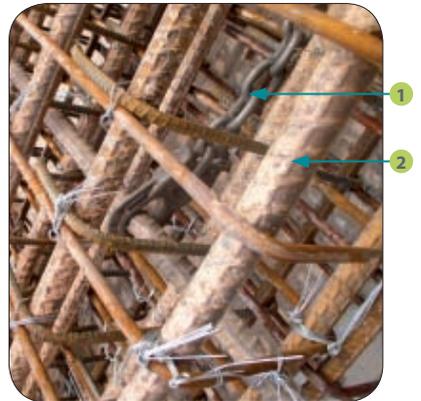
A rebar cage weighing about 1,200kg, meant for the construction of a wall structure, was fabricated on site. A 2-legged chain sling fastened with shackles, and a 2m T25 rebar were used to rig the cage. The T25 was slotted through the cage and the shackles and tied by steel wires at both ends of the cage before it was rigged up by the chain slings. The cage that was being hoisted suddenly dislodged from its lifting gears and dropped to the ground. A worker who was working below was pinned by the falling rebar cage and was killed on the spot.

#### Investigation Findings

- The T25 rebar was found bent after the accident and one of the shackles of the chain slings was still attached to it. There was no design calculation to show the adequacy of the rigging method. Improper rigged load could have led to imbalance in load distribution and caused the load to fall.
- There was no procedure implemented on site to prevent any person from standing underneath the suspended load during the hoisting operation.



1 Rebar cage involved in the accident



1 Sling  
2 T25 rebar

## **Improper Rigging Method for Prefabricated Reinforcement Cage**

- Prefabricated reinforcement cages such as welded wire fabric and prefabricated cages are widely used in the construction industry. The use of prefabricated reinforcements has been known to raise productivity, reduce site labour and shorten construction time.
- Most factory-produced prefabricated reinforcements adhere to design table and fabrication details and usually include appropriate lifting points. However, for prefabricated reinforcements produced on site, the lifting details are usually omitted.
- Without proper lifting points and proper rigging method, lifting operations involving these prefabricated reinforcements may lead to accidents causing serious injuries or even death.

## Case Study 3

### Collapse of Mobile Crane due to overloading

#### The Incident

A newly registered mobile crane operator took over the operation of a mobile crane from another crane operator after lunch break. He was to operate the crane to lift a bucket containing sand from one location to another. After the bucket was filled with sand, he operated the crane to move it to the location for unloading. As the crane was approaching the unloading location, it toppled forward due to overloading. Fortunately, no person was injured but the crane boom was damaged in the process.



1 Damaged crane boom

#### Investigation Findings

- There was a daily lifting checklist used by the lifting supervisor and both crane operators. The lifting checklist, endorsed by the three lifting personnel, was however completed with the wrong values of both load's weight and the safe working load for the expected crane's working radius.
- When taking over the duty, the newly registered crane operator did not verify the load's actual weight nor refer to the crane's load chart to verify the safe working radius at the unloading location before commencing the lifting.
- The collapse of the crane was due to overloading.

## 3. Common Systemic Failures of Accidents Involving Lifting Equipment

- No risk assessment conducted for the lifting operation
- No implementation of the control measure identified even when risk assessment has been conducted
- Lack of lifting plan and hazard analysis for each lifting operation
- Absence of management system for lifting personnel
- Failure to adopt a proper rigging method
- Poor control and maintenance of lifting machine and lifting gears
- Poor site control, i.e. workers were allowed to walk or work under suspended loads and lack of barricades for the lifting zone

# 4. Essential Safety Principles for Lifting Operation

## Lifting Plan

All lifting operations should have a lifting plan supported by a risk assessment. By categorising a lifting operation in accordance with its risk level and complexity, suitable controls can be applied to eliminate hazards or reduce risks. Frequent or routine lifting operations may only require a generic lifting plan supported by an on-site risk assessment and briefing to related personnel. High risk or complex lifts however, will need additional engineering design efforts to ensure that the lifting is conducted safely (Please refer to Appendix 1 for a flow chart of a typical lifting operation).

The lifting plan should, although not limited to, address the following:

- The personnel required;
- The personnel's roles, responsibilities and competencies;
- Permit-to-Work system is mandatory for all lifting operations involving tower, mobile or crawler crane, as specified in Part III of the WSH (Construction) Regulations;
- Nature and weight of load;
- Type and location of lifting points;
- Selection of appropriate lifting gears and equipment;
- Assessment of the need for tagline to control movement of suspended load;
- Means of communication during lifting operations;
- Factors detrimental to the lifting operations such as adverse weather and poor illumination; and
- Provision of a safe place of work for all personnel during lifting operations.

The lifting plan should include a set of written safe work procedures.

The occupier of a worksite has to implement a permit-to-work as specified in Part III of the WSH (Construction) Regulations to ensure effective execution of the lifting plan involving tower, mobile or crawler crane.

The lifting operation should be ordered to stop immediately, if it deviates from the plan. (Please refer to Appendix 2 for an example of a lifting plan.)

- A lifting plan is required for every lifting operation.
- Hazard identification and risk assessment are integral parts of a lifting plan.
- Permit-to-Work system is mandatory for all lifting operations involving tower, mobile or crawler crane, as specified in Part III of the WSH (Construction) Regulations.

## Risk Assessment

Prior to any lifting operation, a risk assessment should be conducted to identify the hazards that are likely to occur. By assessing the likelihood and severity of the accidents that may occur, appropriate risk control measures can be undertaken to eliminate the hazards or reduce risks.

Where lifting operation is concerned, perform the risk assessment process right from the start, during the planning stage of the work, so that the operation can be made safer with very little extra effort during the operation itself.

Risk assessment should be conducted prior to any lifting operation.

## Permit-to-Work (PTW)

To have safe lifting carried out in the worksite, all occupiers of worksites must implement a PTW system for any lifting operation involving tower, mobile or crawler crane. After the proper conduct of risk assessment and a written lifting plan has been developed, a lifting operation can only be executed if approval is granted through the following PTW system as specified in the WSH (Construction) Regulations:

Apply	After the proper conduct of risk assessment and a written lifting plan has been developed, the supervisor who is to carry out the lifting operation is required to apply to the project manager or the occupier of a worksite for permission to proceed with the lifting operation. The application, containing the lifting plan, shall be given to the worksite's appointed safety assessor for evaluation of the lifting operation.
Assess and Inspect	<p>The appointed safety assessor who is either a workplace health and safety officer or a competent person, upon receipt of the application for a permit-to-work, shall :</p> <ul style="list-style-type: none"> <li>• Assess whether all reasonably practicable measures have been taken to ensure the safety and health of the persons who will be carrying out the lifting operation in the worksite;</li> <li>• Inspect the site (including its surroundings) where the lifting operation is to be carried out together with the supervisor of the person who is to carry out the work to ensure that the lifting operation can be carried out safely;</li> <li>• If the appointed safety assessor is satisfied that the lifting operation can be carried out safely, he endorses the application and forwards it to the project manager.</li> </ul>
Approve	The project manager shall evaluate the application endorsed by the safety assessor. If he is satisfied that all reasonably practicable measures are taken and provided to ensure safe lifting operation, he will approve and issue the PTW to the supervisor carrying out the work.
Monitor	<p>The project manager of the worksite shall continually review the progress of the lifting operation being carried out in the worksite to ensure that the lifting operation is carried out safely.</p> <p>The supervisor of any person who carries out the lifting operation in a worksite is:</p> <ul style="list-style-type: none"> <li>• To ensure that the measures necessary to ensure the safety and health of the person at work are taken and are in place at all times during the validity period of the permit-to-work; and</li> <li>• To inform the project manager of the worksite upon completion of the lifting operation.</li> </ul>
Revoke	If the project manager of a worksite who, after issuing a permit-to-work in respect of the lifting operation, is of the view that the carrying out of the lifting operation poses or is likely to pose a risk to the safety, health and welfare of persons at work in the worksite, he may order the lifting operation to cease immediately and revoke the permit-to-work.

## Examination, Inspection and Maintenance

Lifting equipment comprises lifting machine, lifting appliance, lifting gears, to name a few. To ensure that the lifting equipment is fit for the lifting operation, the lifting equipment should be designed and manufactured in accordance with acceptable international standards. The manufacturer or supplier of a lifting equipment is required to:

- Provide proper information on the safe use of the lifting equipment;
- Ensure that the lifting equipment is safe for use;
- Ensure that the lifting equipment has been tested and examined so that it is safe for use.

### Statutory Inspection

Under the Workplace Safety and Health (General Provisions) Regulations, the statutory inspection of lifting equipment by an authorised examiner should be carried out at least once every 12 months for those lifting goods / materials or 6 months for those lifting personnel. Such inspections should also be conducted where the lifting equipment had been involved in instances such as:

- An incident or accident;
- Modification or repairs of the load bearing components;
- Change in equipment configuration such as alteration of the boom length.

During the statutory inspection by an authorised examiner, critical components or working parts of the lifting equipment should be dismantled to allow for a more thorough examination of the equipment.

### Pre-use Inspection

All lifting equipment should be visually inspected by a competent person before each lifting operation. This is to ensure that the equipment is suitable, safe and correctly installed for the task. Some pre-use checks include the following:

- Visual inspection of the lifting equipment;
- Functional test of the equipment;
- Functional test of the safety system and devices; and
- Functional test of the emergency stop device.

Any faults or defects spotted during the pre-use inspection should be reported to the supervisor and the equipment should not be used until all the faults have been fully rectified.

## Maintenance of Lifting Equipment

To ensure that the lifting equipment is in satisfactory operating condition at all times, owners of lifting equipment should establish and implement a maintenance programme in accordance with the manufacturer's recommendation. Preventative maintenance through the scheduling of routine repairs, maintenance work and inspection, aids in the monitoring and prevention of premature equipment failure, thereby avoiding unnecessary production downtime.

- All lifting equipment for goods or materials should be thoroughly examined by an authorised examiner at least once every 12 months.
- All lifting equipment for lifting personnel should be thoroughly examined by an authorised examiner once every 6 months.
- Pre-lift inspection of the lifting equipment should be conducted to ensure that the equipment is suitable and safe for use.
- Lifting equipment should be properly maintained.

## Competency of Personnel Involved in the Lifting Operation

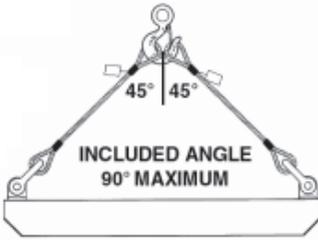
Employers of personnel involved in a lifting operation such as the operator, rigger, signalman and lifting supervisor have the duty to ensure that these personnel are trained to carry out their task competently and safely. Additional training and supervision should be provided for new and inexperienced workers as this group of workers is less competent and lacking in experience.

All personnel involved in the lifting operation should be:

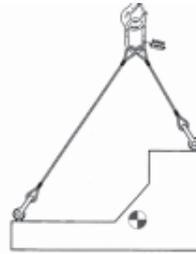
- Adequately trained and/or supervised;
- Competent; and
- Fully aware of their statutory duties as imposed under the legislative requirements.

## Recommended Rigging Practices

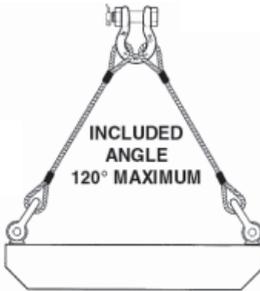
The following are some recommendation of good rigging practices:



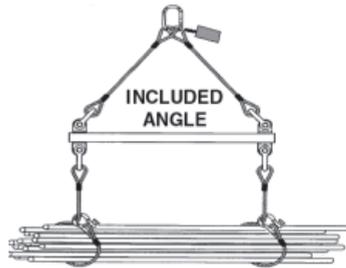
For rigging configurations with two legged slings, the included angle should not exceed 90° and the slings must sit in the base of the hook and clear of the latch to prevent fouling of the latch.



Good load control starts with rigging to the centre of gravity directly below the hook.



Collector rings such as shackles or mast links should be used when the included angle exceeds 90° but is less than 120°.



The clamps should be applied to the load in accordance with the instruction manual and it should not be used to handle any load for which it is not designed for. It is important to note that unless stated, the clamp should not be used to lift more than one plate at a time in a vertical lift.

Ensure that:

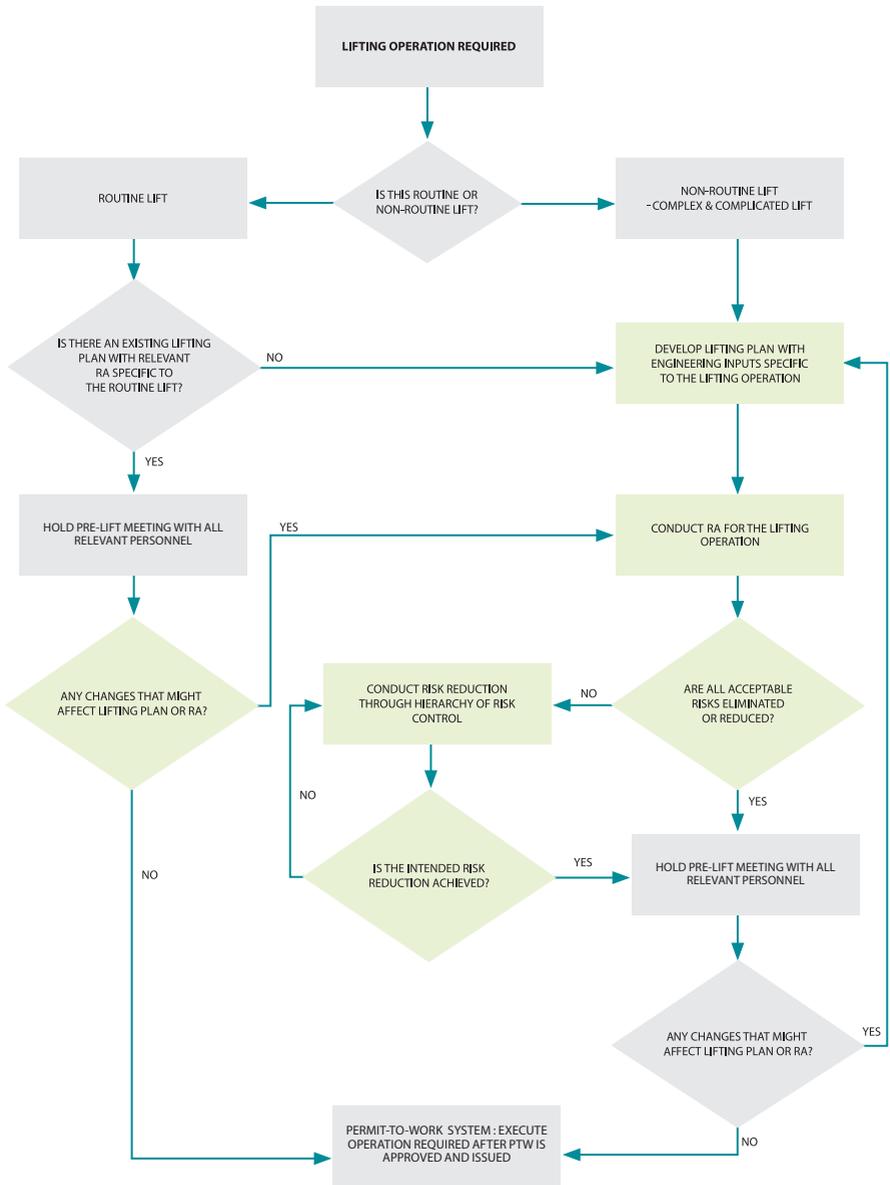
- The plate surface is free of grease, oil, dirt or other contaminants that may impede the contact of the teeth with the plate.
- The load is completely at the back of the clamp throat before locking or using the clamp.



# 5. Summary

To ensure that lifting operations are carried out in a safe manner, the following minimum requirements should be met before starting any lifting operations:

- A lifting plan should be developed and made available to all personnel involved in the lifting operation;
- A competent person should have performed a risk assessment, established the lift method and selected the right equipment;
- Lifting equipment, inclusive of lifting machine, lifting appliances and lifting gears should be visually examined prior to use by a competent person;
- Lifting equipment should have a valid lifting equipment certificate and should have been inspected by an authorised examiner at least once in every 12 months;
- The safety system and safety devices should be in proper functioning order;
- Rigging of the load should be carried out by a trained rigger;
- The weight of the load should be established and should not exceed the safe working load of the lifting equipment;
- All personnel such as the equipment operator, lifting supervisor, rigger and signalman should be trained and be competent to carry out the lifting operation;
- No load should be lifted above personnel and action should be taken to prevent personnel from entering into the lifting zone where they may be hit by falling load or objects; and
- A means of communication should have been agreed and tested.



note: RA = Risk Assessment

<b>LIFTING PLAN</b>		<b>Factory No</b>
		<b>Date of Lifting Operation</b>
Location of Lifting Operation		
Lifting Plan No.		
Risk Assessment No.		
Method Statement No.		

Description of Lifting Operation (Step by Step Description) :		
Type of Lifting Operation	<input type="checkbox"/> Routine Lift	<input type="checkbox"/> Non-routine Lift
Weight of Load :		
List the personnel involved in the lifting operation		

Description of lifting equipment to be used :

Attach the lift geometry diagram for the designated lifting points.

Has the lifting operation considered items as listed in the pre-lifting operation checklist? (Refer to Appendix 3)

Yes

No

Radio

Hand signals

Visual

Prepared by

Name :

Signature :

Date :

Reviewed by

Name :

Signature :

Date :

Approved by

Name :

Signature :

Date :

S/N	Description		
1	<b>Load</b>		
	<ul style="list-style-type: none"> <li>Has the actual weight of the load inclusive of the rigging accessories been established?</li> </ul>		
	<ul style="list-style-type: none"> <li>Is the established load within the safe working load of the lifting equipment?</li> </ul>		
	<ul style="list-style-type: none"> <li>Is the load rigged to its centre of gravity?</li> </ul>		
	<ul style="list-style-type: none"> <li>Is a tag line provided to control movement of the load?</li> </ul>		
	<ul style="list-style-type: none"> <li>Is the load being lifted in a level and stable manner?</li> </ul>		
2	<b>Lifting equipment</b>		
	<ul style="list-style-type: none"> <li>Is the selected lifting equipment fit for purpose and appropriate for the lifting operation?</li> </ul>		
	<ul style="list-style-type: none"> <li>Has the lifting equipment been examined at least once in the last 12 months (or 6 months for those lifting personnel) by an authorised examiner and does it possess a valid lifting equipment certificate?</li> </ul>		
	<ul style="list-style-type: none"> <li>Has the lifting equipment been marked conspicuously with the maximum working load which it can safely carry?</li> </ul>		
3	<b>Lifting operation</b>		
	<ul style="list-style-type: none"> <li>Is there a lifting plan available for the operation?</li> </ul>		
	<ul style="list-style-type: none"> <li>Has risk assessment been conducted to ensure that all possible hazards are eliminated and risks are reduced?</li> </ul>		



## 6. Useful References

The following legislations:

- Workplace Safety and Health Act
- Workplace Safety and Health (General Provisions) Regulations
- Workplace Safety and Health (Construction) Regulations
- Workplace Safety and Health (Risk Management) Regulations
- Factories (Operation of Cranes) Regulations - to be replaced with Workplace Safety and Health (Operation of Cranes) Regulations in due course are available for download at: <http://www.mom.gov.sg/publish/momportal/en/legislation/OccupationalSafetyandHealth.html>
- CP 2: 2000 Code of Practice for Installation, Operation and Maintenance of Electric Passenger and Goods Lifts (currently undergoing revision)
- CP20: 1999 Code of Practice for Suspended Scaffolds
- SS 536 : 2008 Code of Practice for the Safe Use of Mobile Cranes
- CP62: 1995 Code of Practice for Safe Use of Tower Cranes (currently undergoing revision)
- SS343 – 1: 2001 Lifting Gear – Wire Rope Slings
- SS343 – 2: 1989 Lifting Gear – Hooks
- SS343 – 3: 1990 Lifting Gear – Shackles
- SS497: 2002 Design, Safe Use and Maintenance of Overhead Traveling Cranes
- More information and guidelines on Risk Assessment are available for download at: [http://www.mom.gov.sg/publish/momportal/en/communities/workplace\\_safety\\_and\\_health/maintaining\\_a\\_safe\\_workplace/occupation\\_safety/risk\\_management.html](http://www.mom.gov.sg/publish/momportal/en/communities/workplace_safety_and_health/maintaining_a_safe_workplace/occupation_safety/risk_management.html)

### Singapore Standards

**All listed Singapore Standards including Codes of Practice can be obtained from:**

SNP Corporation (Legal) Ltd  
Legal Publications Retail Outlet  
1 Kim Seng Promenade #18-01/06  
Great World City East Tower Singapore 237994  
Tel: (65) 6826 9691  
Fax: (65) 6820 3341  
[www.singaporestandardseshop.sg/Product/Home.aspx](http://www.singaporestandardseshop.sg/Product/Home.aspx)



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