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Guidebook for Lifting Supervisors

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Contents

1. Introduction and Background

Accident statistics have shown that fatalities and dangerous occurrences[1] at workplace involving lifting equipment such as cranes has been on an uptrend over the last few years (see Chart 1). Such accidents include failures or toppling of heavy lifting equipment such as cranes during lifting activities, as well as workers being struck by falling or swinging objects while being lifted. From these statistics, there is still much to be done to improve our crane and lifting safety practices at our workplaces. The safe execution of lifting activities is a multi-party effort. Every stakeholder in the value chain (i.e., manufacturers, crane contractors, engineers and designers, project managers, lifting supervisors, operators and workers) has a stake in the lifting operation and must do their part to ensure the safe operation of the lifting work at all times.

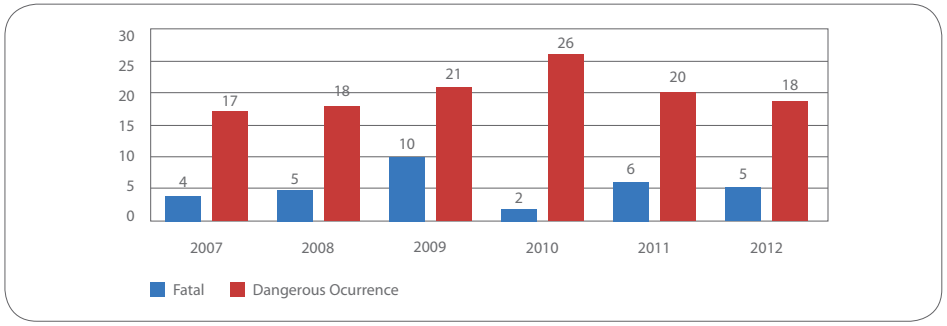


Chart 1: Crane-related fatalities and dangerous occurences, 2007-2012.

The role of the lifting team, which comprises the lifting supervisor, crane operator, rigger and signalman, is crucial to ensure safe lifting activities at workplaces. Many of these past accidents had shown that proper planning, co-ordination and supervision of the lifting work could have prevented the accidents and the needless loss of lives. In particular, the role of the lifting supervisor is key especially given the collaborative nature of the work and the importance of ensuring that the various parties are trained and competent, and that they carry out their roles safely and effectively. This Guidebook for Lifting Supervisors is developed to provide greater practical guidance for lifting supervisors to ensure safe supervision of lifting work at the workplace. The Guidebook not only provides guidelines on the roles and responsibilities but also information on common hazards associated with lifting, Lifting Plans, Risk Assessment (RA), Permit-to-Work (PTW) System and Safe Work Procedures (SWP), and recommended rigging and crane signals.

[1] Dangerous occurrences are incidents involving collapse or failure of a crane, derrick, winch, hoist, piling frame or other appliance used in raising or lowering persons or goods, or any load bearing part thereof (except breakage of chain or rope slings), or the overturning of a crane.

2. Common Systemic Lapses Involving Lifting Activities

Accidents involving lifting activities occur due to many reasons. However, investigations into such accidents often reveal that the primary causes could be attributed to poor planning, supervision and co-ordination of the lifting operations. Effective implementation of a comprehensive Lifting Plan which comprises comprehensive RA, clear method statement/ SWP, use of suitable lifting equipment, competent lifting team, and PTW system will ensure safe lifting operations at all workplaces. The following is a list of common systemic lapses that often lead to accidents involving lifting activities.

- Absence or lack of RA prior to lifting operation.
- Lack of implementation of relevant control measures identified in RA.
- Absence or lack of proper Lifting Plan for each lifting operation.
- Absence or lack of a PTW system to manage the lifting operation.
- Failure to adopt a proper rigging method for the lifting operation.
- Poor maintenance of lifting equipment (e.g., safety devices, lifting gears).
- Poor site control (e.g., failure to maintain a "safe exclusion zone" with barricades/ barriers so that workers not involved in the lifting operation are prohibited from entering the lifting area).

3. Roles and Responsibilities of Lifting Supervisors

Lifting supervisors appointed for tower or mobile cranes at the worksites must complete the Lifting Supervisors Safety Course conducted by an accredited training provider. They must also have relevant experience in lifting operations for at least one year.

The duties and responsibilities of a lifting supervisor include:

- co-ordinating and supervising all lifting activities in accordance with the Lifting Plan;
- briefing all lifting team members (i.e., crane operators, riggers and signalmen) on the Lifting Plan, risk control measure and safe lifting procedure before the commencement of any lifting operation;
- ensuring that only registered crane operators, appointed riggers and appointed signalmen participate in any lifting operation involving the use of mobile and tower cranes;
- ensuring that the ground conditions are safe for any lifting operation to be performed by mobile cranes;
- be present during all lifting operations; and
- if unsafe conditions are reported to him, to take suitable measures to rectify the conditions so that the lifting operation can be conducted safely.

4. Common Hazards Associated with Unsecured/ Slippage of Loads

Many accidents occurred due to unsecured loads or loads that slipped off during lifting. The following are some common hazards associated with lifting of loads:

- defective or damaged lifting gears such as slings, hooks, inserts, eyes, shackles;
- improper rigging of loads;
- lack of proper receptacles for loose loads such as bricks; or
- under capacity of lifting gears.

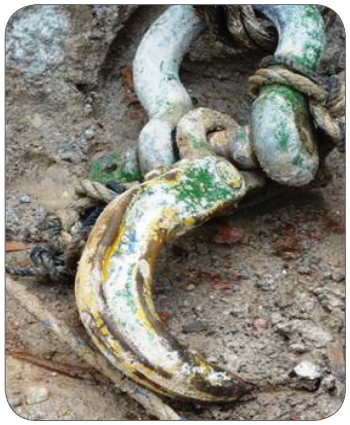


Figure 1: Defective or damaged crane hooks.

5. Common Hazards Associated with Lifting Operations Involving Mobile Cranes

Accidents involving mobile cranes are one of the more common types of crane-related incidents. Many accidents occurred due to either structural failure of the load bearing part of the crane or toppling or collapsing of cranes when they became unstable. The following are some common hazards associated with lifting operations involving mobile cranes.

(a) Structural failure of crane component such as the boom, jib, hydraulic rams or wire rope due to the crane being loaded beyond its loading capacity.

(b) The stability of the cranes can be affected by:

- poor ground conditions (e.g., unstable ground);
- failure to use or fully extend outriggers or stabilisers;
- failure to level the crane;
- rapid derricking, slewing or manoeuvring;
- overloading of cranes;
- bypassing of safety devices; or
- high wind conditions.

(c) Contact or collision due to insufficient safe clearance space between mobile crane and other buildings or structures (e.g., other cranes, overhead power lines, etc).

(d) Falling objects as a result of improper securing of loads during lifting operations, or during erecting or dismantling activities. Falling objects present a risk of injury to workers and the public.

6. Lifting Plans

The purpose of a Lifting Plan is to facilitate common understanding amongst the lifting team for a safe lifting operation. A typical basic Lifting Plan incorporated with PTW as shown in Annex A is recommended for use at the workplaces. It addresses some key factors affecting safe lifting operations such as:

- details of the load;
- details of the lifting equipment/ lifting gears used;
- means of communications;
- personnel involved in the lifting operation;
- physical and environmental considerations;
- sequence/ special precautions; and
- sketch of the zone of operation.

Lifting supervisors must brief the lifting team members, which typically consists of the crane operator, rigger and signalmen, on the Lifting Plan before commencement of any lifting operation. The lifting supervisor must stop the lifting operation immediately if it deviates from the Lifting Plan that has been approved by the project manager.

7. Risk Assessment and Permit-to-Work

Risk assessment (RA) is the process of evaluating the probability and consequences of injury or illness arising from exposure to an identified hazard, and determining the appropriate risk control measures. The three basic steps of RA are:

1) Hazard Identification

Identify the hazards associated with each work activity and the type of potential accidents/ incidents that can result from the hazards. Some of the examples of hazards associated with lifting operations are poorly maintained wire ropes, defective safety devices of cranes, improper rigging methods, and so on.

2) Risk Evaluation

The process of estimating the risk levels of the identified hazards in terms of the severity of any injuries/ damage if an accident were to occur and the likelihood of its occurrence. For example, the risk level of workers working underneath a suspended pre-cast component should be assessed as high risks as the consequences of the load dropping could result in killing the workers underneath it.

2) Risk Control

Identify appropriate risk control measures to reduce the risk level to an acceptable level. Using the last example of a suspended pre-cast component, an appropriate risk control measure would be the establishment of "safe exclusion zones" to prohibit workers from working directly underneath a suspended load. The exclusion zone should also be demarcated to prevent any unauthorised entry.

Permit-to-Work (PTW) System is a system to manage and control certain types of hazardous work including lifting operations. The contractor's supervisor co-ordinating the lifting operation is to apply for the PTW to carry out the lifting operation. In the application for PTW, he should state the scope and conditions in which the lifting operation is to be carried out. An independent inspection is then conducted on-site to verify that appropriate control measures have been taken to mitigate any foreseeable risks. After confirming that the measures have indeed been taken, the application would then be approved by an authorised person (typically the project manager).

Lifting supervisors must ensure that a permit is issued by the project manager before he instructs the lifting team to carry out any lifting operation at the worksite. Table 1 illustrates a typical workflow for the application and approval of a PTW for a lifting operation.

Apply	After a proper RA has been conducted and a written Lifting Plan has been developed, the supervisor, who is coordinating 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	The appointed safety assessor who is either a Workplace Safety and Health (WSH) officer or a competent person, upon receipt of the application for a PTW, shall: • 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; • 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; and • 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.
Approve	The project manager shall evaluate the application endorsed by the safety assessor. If he is satisfied that all reasonably practicable measures to ensure safe lifting operation are taken and provided, he will approve and issue the PTW to the supervisor carrying out the work.
Monitor	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 being carried out safely. The supervisor of any person who carries out the lifting operation in a worksite shall: • 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 PTW; and • inform the project manager of the worksite upon completion of the lifting operation.
Revoke	If the project manager of a worksite who, after issuing a PTW for the lifting operation, finds that carrying out 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 PTW.

Table 1: Workflow for the application and approval of a permit for a lifting operation.

8. Statutory Inspection of Lifting Equipment

Under the WSH (General Provisions) Regulations, lifting equipment such as cranes, lifting appliances and lifting gears shall be inspected by an authorised examiner:

- at least once every 12 months; or
- at least once every six months for lifting equipment carrying persons.

An authorised examiner must also be engaged to inspect the lifting equipment:

- after modification or repairs of its load bearing components;
- when there is a change in equipment configuration, such as alteration of the boom length or tower crane height; or
- after an incident or accident involving the lifting equipment.

9. Pre-use Inspection of Lifting Equipment

Lifting supervisor must ensure that the crane operator conduct pre-use inspection before each lifting operation to ensure that the equipment is suitable, safe and correctly installed for the lifting operation. The pre-use checks must include:

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

Lifting gears must also be inspected to ensure that they are free of any faults or defects before any lifting operation can begin.

Lifting supervisor must *not* allow the lifting operation to be carried out if any defects are spotted during the pre-use checks by the crane operator until all the faults of the cranes are fully rectified. Similarly, lifting gears must *not* be used if defects are spotted and reported by the riggers.

10. Selection of Lifting Gears for Lifting Operations

Factors affecting the choice of lifting gear for each lifting operation are:

- weight and type of load;
- available lifting points;
- position of the centre of gravity of load;
- mode of use (See Table 2 for a sample chart of Mode Factors which lists the appropriate types of sling and methods of securing loads to slings.); and
- environment factors (e.g., wind speed conditions).

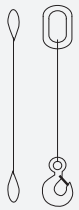
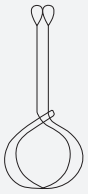
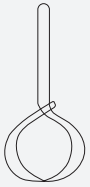
MODE FACTORS Maximum load to be lifted = mode factor x SWL marked on the sling Key: NP = non preferred, NA = not applicable								
1	2	3	4	5	6	7	8	9
Material	Single leg in line 	Single leg choked 	Single leg basket 	Single leg back hooked 	Single leg halshed 	Endless in line 	Endless choked 	Endless basket 0-90° 
Chain	1	0.8	1.4	1	NP	NP	1	NP
Wire rope	1	1	1.4	1	2	NP	1	1.4
Webbing	1	0.8	1.4	NA	NP	1	0.8	1.4
Fibre Rope	1	0.8	1.4	1	1.6	1	0.8	1.4
Roundsling	NA	NA	NA	NA	NA	1	0.8	1.4

Table 2: A sample Mode Factors chart.

11. Estimation of Weight of Load

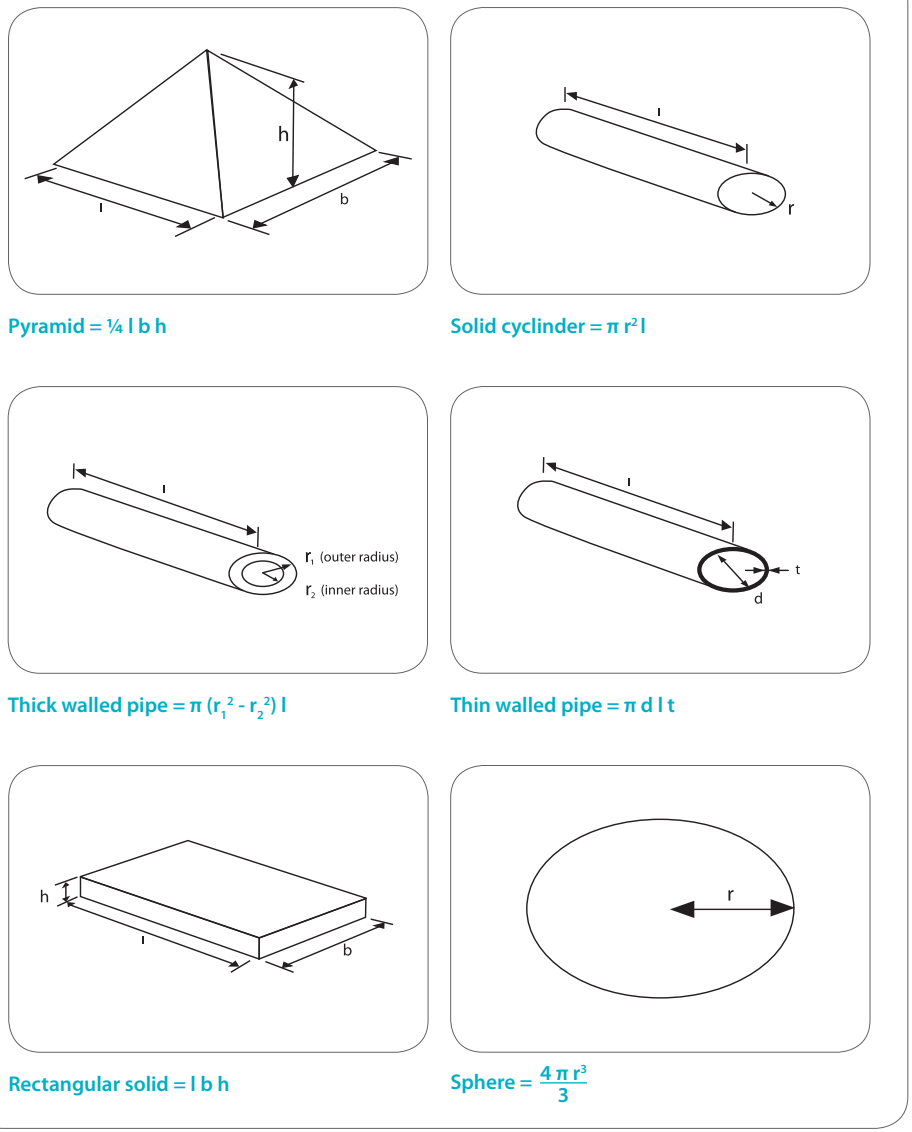
The following may be used as a general guidance to estimate the weight of load going to be lifted in the lifting operation.

- Check if the weight is marked on the load.
- Check if the weight is indicated on any documentation (e.g., shipping documents).
- Check if the weight is indicated on the construction drawing of the load.
- If the load is still on a trailer or truck, weigh it physically over a bridge.
- Estimate the weight using Table 3 or the formulae in Figure 2 (note that factors such as site conditions, water content, decomposition, irregular shapes and residues in vessels can affect the accuracy of load weight to be estimated).

Material Type	Weight (kg) per m^3
Oil	800
Concrete	2,400
Brick	2,100
Water	1,000
Steel and Iron	7,700
Aluminium	2,700
Earth	1,600
Paper	1,120
Copper	8,800
Lead	11,200
Wood	800

1,000 kgs = 1 ton

Table 3: Average weight of various materials.



Pyramid = ¼ l b h

Solid cyclinder = π r² l

Thick walled pipe = π (r_1^2 - r_2^2) l

Thin walled pipe = π d l t

Rectangular solid = l b h

Sphere = $\frac{4 \pi r^3}{3}$

Figure 2: Volumes of common shapes.

12. Recommended Rigging and Slinging Methods

The Included Angle of Slings

- It is important to be aware of the increased loadings on the slings when lifting at larger included angles or smaller sling angles. For rigging configurations with two-legged slings, the included angle should not exceed 90° as this will reduce the SWL of the slings.
- The slings must sit in the base of the hook and be clear of the latch to prevent fouling of the latch.

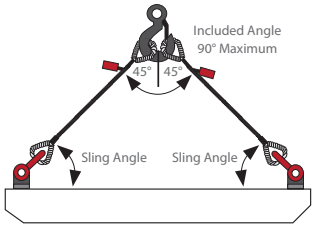


Figure 3: The working load limit is valid for a single leg or multiple legs.

Rig to the Centre of Gravity (C.G.)

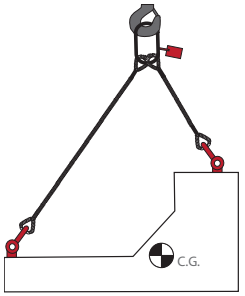


Figure 4: Good load control starts with rigging the load to the centre of gravity directly below the load hook.

Hinge Points Chain Slings

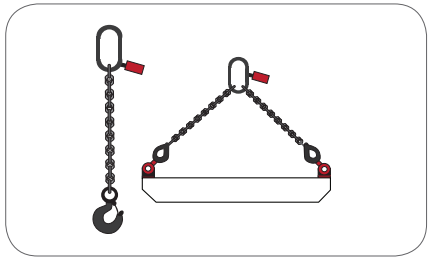


Figure 5: Use a single master link for a single and two-legged chain slings.

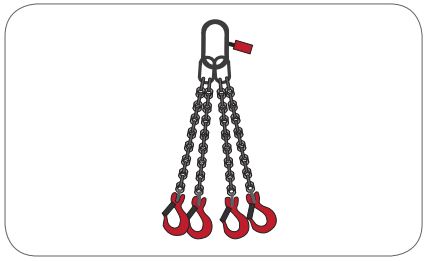


Figure 6: Use a master link with sub-links for three- or four-legged chain slings.

Hinge Points Wire Rope and Synthetic Slings

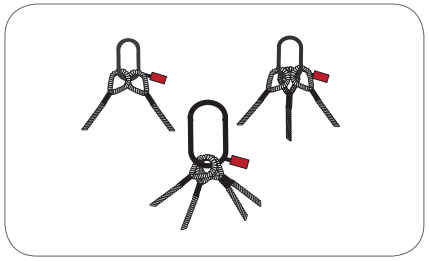


Figure 7: Use a single master link instead of placing wire rope slings directly on the load hook.

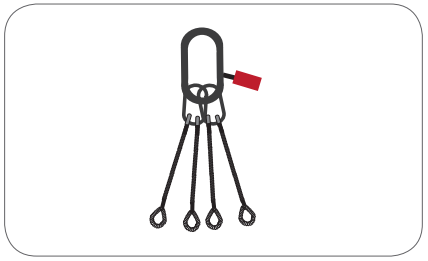


Figure 8: Use a master link with sub-links for all three- or four-legged wire rope slings.

Fouling of Latch

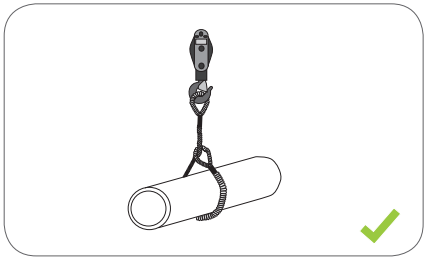


Figure 9: Prevent fouling of safety latch on load. Sling in base of hook.

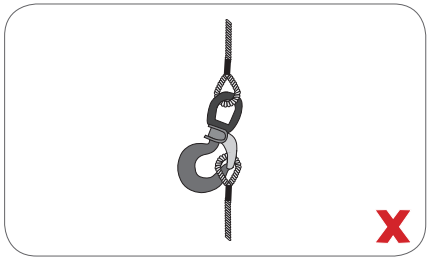


Figure 10: Sling fouled on latch.

Connection of Slings to Shackles

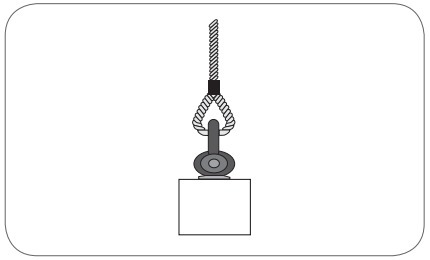


Figure 11: Use a shackle with diameter greater than wire rope diameter if there is no thimble in the eye.

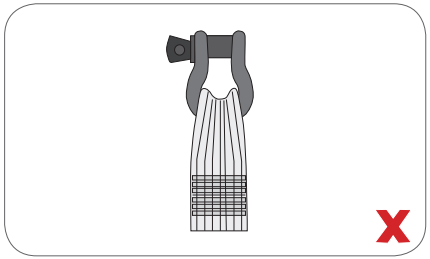


Figure 12: Use a shackle that is large enough to prevent pinching of the synthetic slings.

13. Recommended Crane Signals

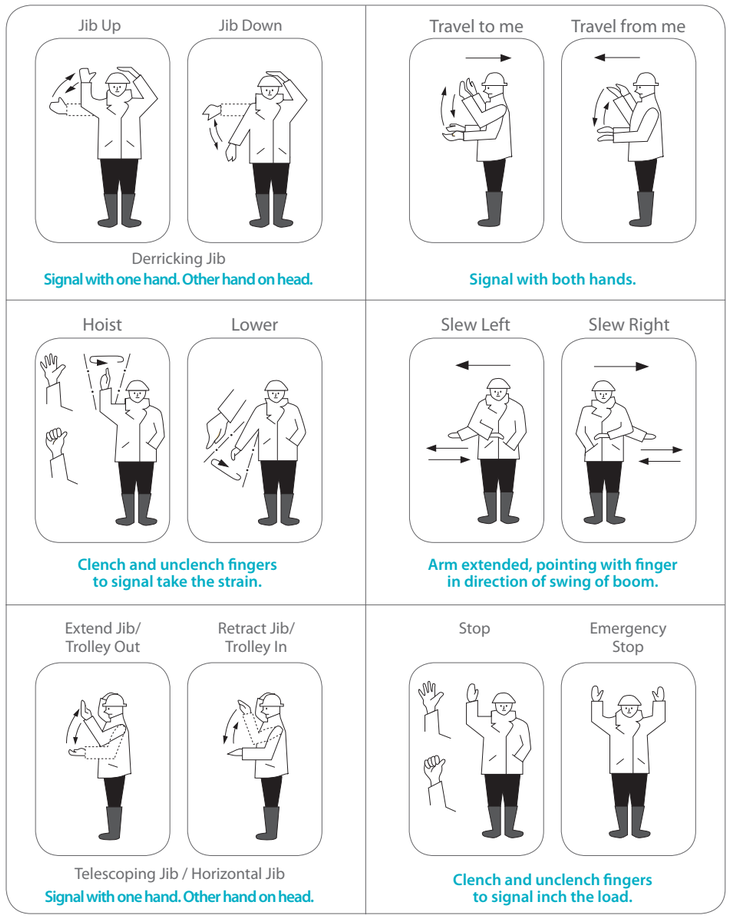


Figure 13: Recommended crane signals.

14. Annex A: Sample Basic Lifting Plan

Sample Basic Lifting Plan

1. General			
Project			
Location of lifting operation			
Contractor carrying out the lifting operation		Date/ time of lifting operation Validity period of lifting operation	

2. Details of the Load/s			
Description of load/s			
Overall dimensions			
Weight of load	Kg / tonne	☐ Known weight	☐ Estimated weight
Centre of gravity	☐ Obvious	☐ Estimated	☐ Determined by drawing

3. Details of the Lifting Equipment/ Lifting Gears			
Type of lifting equipment:			
Maximum SWL as certified on the LM cert		Date of last certification	
Max boom / Jib length	m	Fly jib / offset	
Intended load radius	Distance between the load and the crane	SWL at this radius	
Type of lifting gears	Slings / webbing / chains / shackles / spreader beam / receptacle		
Combined weight of the lifting gears	Kg / tonne	Certification of lifting gears	☐ Yes
SWL of LG	Kg / tonne		☐ No

4. Means of Communications
Can the operator see the loading and unloading point for the load from his position?
☐ Yes ☐ No
What are the means of communication between the lifting crew?
☐ Standard hand signals ☐ Radio ☐ Others _____

5. Personnel Involved In Lifting Operation		
Position	Name	Qualification/ Experience
Site Supervisor		
Lifting Supervisor		
Crane Operator/ Lift Equipment Operator		
Rigger		
Signalman		
Others (please state)		

6. Physical and Environmental Consideration (please include any details in the space provided)		
Ground conditions:	Is the ground made safe (e.g., placing steel plate)?	☐ Yes ☐ No
	Are the outriggers evenly extended?	☐ Yes ☐ No
Obstacles:	Are there any overhead obstacles such as power lines?	☐ Yes ☐ No
	Are there nearby buildings or structure, equipment or stacked materials that may obstruct lifting operation from being carried out safely?	☐ Yes ☐ No
Lighting:	Is the lighting condition adequate?	☐ Yes ☐ No
Demarcation:	Has the zone of operation been barricaded (with warning signs and barriers) to prevent unauthorised access?	☐ Yes ☐ No
Environment:	Do not proceed with the lifting operation under the following circumstances: ☐ Thunderstorm and lightning strikes in the area. The ground condition must be checked after a thunderstorm. ☐ Strong winds that may sway the suspended load. ☐ Other circumstances (please specify).	

7. Sequence / Special Precautions	8. Sketch of the zone of operation:
	(It is recommended that you include the initial location of the load, the final location and path of the load. It is also important to indicate any obstructions or equipment that may obstruct the lifting operation).

Applied by: **Name:**	**Signature:**	**Date:** **Time:**
Prepared by: **Name:**	**Signature:**	**Date:** **Time:**
Assessed by: **Name:**	**Signature:**	**Date:** **Time:**
Approved by: **Name:**	**Signature:**	**Date:** **Time:**

Note:

1. This is only a sample Lifting Plan, the content is by no means comprehensive. Users would have to include key critical document and information such as load capacity chart, range diagram, rigging method, sling angle, etc to ensure safe lifting operations.

2. Further guidance can be obtained from the following collaterals:
   - Guidebook for Lifting Supervisors
   - Worker's Handbook for Crane Operator
   - Worker's Handbook for Rigger and Signalman

15. Useful References

- Code of Practice on Safe Lifting Operation in the Workplace, First revision 2013.
- SS536: 2008 Code of Practice for the Safe Use of Mobile Cranes.
- SS559: 2010 Code of Practice for the Safe Use of Tower Cranes.
- SS343 – Part 1: 2001 Specification for Lifting Gear – Wire Rope Slings.
- SS343 – Part 2: 1989 Specification for Lifting Gear – Hooks.
- SS343 – Part 3: 1990 Specification for Lifting Gear – Shackles.
- SS497: 2002 Specification for Design, Safe Use and Maintenance of Overhead Travelling Cranes.
- Lifting Equipment - A User's Pocket Guide published by LEEA, UK.
- The Lifting Engineers Handbook published by LEEA, UK.
- Best Rigging Practices by Crosby Group Inc.
- Worker's Safety Handbook for Crane Operator, 2011.
- Worker's Safety Handbook for Rigger and Signalman, 2011.
- Worker's Safety Handbook for Lorry Crane Operator, 2012.

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