# Workplace Safety and Health Guidelines

## Lifting Plan Development

WSHCOUNCIL

Tripartite Alliance for Workplace Safety and Health

# Contents

# 1. Introduction

The use of lifting equipment such as cranes to lift large objects is a common activity at construction sites, shipyards, and factories. Good practices and correct lifting methods ensures lifting operations are performed safely. However, unsafe lifting practices can lead to accidents resulting in injuries and even fatalities.

Carrying out correct and safe lifting operations involves a range of factors which must be considered during the planning process of any lifting operation.

The Workplace Safety and Health (Operations of Cranes) Regulations require a lifting plan to be established and implemented before any lifting operations involving cranes. This lifting plan has to be in accordance with the generally accepted principles of safe and sound practice.

This guidelines should be read in conjunction with the Code of Practice (CP) on Safe Lifting Operations in the Workplaces. The CP is the main guiding document on safe lifting operations and safe use of lifting equipment.

## 1.1 Objective

This guidelines aims to provide guidance and practical considerations when developing a lifting plan, and explains the essential components and factors needed when preparing a lifting plan, so as to ensure a safe lifting operation.

## 1.2 Responsible Person

Under the WSH (Operations of Cranes) Regulations, a Responsible Person refers to the employer of the person operating the crane or the principal under whose direction the operator operates the crane.

It is the Responsible Person's duty to establish and implement a lifting plan in accordance with the generally accepted principles of safe and sound practice for all lifting operations involving the use of any crane at a workplace.

Regardless of a load's size and weight, it is important to establish and implement a lifting plan for all lifting operations involving in any crane. Details documented in the lifting plan may vary according to the complexity of the lifting operation.

## 1.3 Components of a Lifting Plan

The essential elements of a lifting plan can be found in the Annex of this guidelines. The subsequent sections explain in greater detail for each element of the lifting plan.

# 2. General Information

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

Table 1: Part 1 of Annex

The general information required in a lifting plan includes details of the project site, name of contractor and the location within the site where the lifting operation will be carried out.

The date and time of the planned lifting operation and the validity period of the lifting plan should also be captured. If the lifting plan is no longer valid or the conditions have changed, the plan should be revised accordingly.

# 3. Details of Load

| 2. Details of 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 | |

Table 2: Part 2 of Annex

## 3.1 Description of Load(s)

The overall description of the load identifies the load prior to the lifting operation. Load description may include items such as pallet, rebar cage, sand, rubbish skip, empty concrete bucket, full load or half load of wet concrete, precast slab etc.

## 3.2 Overall Dimensions

The overall dimensions of the load assist in the determination of the centre of gravity and help the lifting team to establish the vertical lifting height clearance required, particularly in restricted and confined areas. Load dimensions are also needed to calculate and determine the permissible operating wind speed for handling loads with a large surface area.

## 3.3 Weight of Load

The most important information for establishing the lifting plan is the weight of the load. It must be established at the beginning of the planning stage of a lifting operation to assist in the selection of crane and other relevant components.

The weight of the load must be accurately determined or closely estimated. The overall gross weight of the load must include the weight of the lifting gears used in the lifting operation. Lifting gears include the hook block, wire ropes, beams, shackles, frames, slings, etc.

The crane should never be used as a weighing machine for the loads it is carrying. Lifting loads exceeding the capacity of the crane can potentially lead to toppling of the crane. Therefore, the weight of the loads must be known by other means such as documentation from previous lift, material and product specifications or calculations. At any point during the lift where the load exceeds the estimated weight, the lifting operation must be suspended, and the Responsible Person must review the lifting plan. The WSH Council's Guidebook for Lifting Supervisors

provides information on the unit weight for common material types.

All details on the load must be included in the lifting plan. Figure 1 shows an example of description of a load for a typical lift:

| | |
|---|---|
| Description of load | Electrical Equipment, Transformer with estimated load of 8500kg |
| Lifting Points | Transformer have 4 lifting points, using 4 Wire sling and webbing sling connected to hook block |
| (c) Weight of Hook Blocks | L 5.25m x W 3.5m x H 2.38m |
| Center of gravity | ■ Given ■ Calculated ☐ Unknown |

| **Example of Load Calculation** | |
|---|---|
| (a) Weight of Transformer | 8500 KG |
| (b) Weight of Lifting Gear | 100 KG |
| (c) Weight of Hook Blocks | 700 KG |
| Total Weight: (a) + (b) + (c) | 9300 KG |
| Crane SWL | 13300 KG |
| Crane capacity usage $\left(\frac{\text{Total weight}}{\text{Crane SWL}}\right)$ | 70% |

Figure 1: Example of description of a load for a typical lift

## 3.4 Centre of Gravity

To ensure that every lifting operation is safe and can proceed as planned, the centre of gravity (CG) of the load must be known. The CG must be directly below the centre line of the crane hook block when slung.

## 3.5 Control of Load

A load suspended by the crane may swing back and forth or rotate due to wind or other external factors. The movement of the crane or boom can also cause the load to swing out of the crane's safe operation radius which is a hazard. All lifting operations must make use of tag lines (shown in Figure 2), push/pull sticks, and hooks to limit the movement of the load. These load-handling equipment also ensures that the lifting crew stand a safe distance away from the load to reduce contact with the load and minimise injuries. The lifting plan must indicate the manner by which the load will be controlled.

Figure 2: Example of Tag Line

# 4. Details of the Lifting Equipment /Lifting Gears

| 3. Details of the Lifting Equipment/Lifting Gears | | | |
|---|---|---|---|
| Type of lifting equipment: | | | |
| Maximum SWL as certified on the LM cert | | Date of last examination | |
| | | Expiry date of certificate | |
| Max boom/jib length | m | Fly jib/offset | |
| Type of lifting gears | *Slings / webbing / chains / shackles / spreader beam / receptacle* | | |
| Combined weight of the lifting gears | Kg/tonne | Certification of lifting gears | ☐ Yes ☐ No |
| SWL of lifting gears | Kg/tonne | | |

Table 3: Part 3 of Annex

## 4.1 Type of Lifting Equipment

Selecting appropriate lifting equipment is critical in ensuring a safe lifting operation. The following needs to be addressed in determining whether a crane is able to lift a particular load:

- What is the weight to be lifted?
- At what radius will it be lifted?
- At what height must it be lifted?
- What are the dimensions of the load?
- Where is the load to be lifted to and where will it be placed?
- Are there any obstacles to avoid?
- What are the lifting points available and how should the load be lifted?
- Where is the centre of gravity of the load in relation to the lifting points?

The selected lifting equipment must also have sufficient lifting capacity for the load and adequate reach to transfer the load from the initial location to the intended location.

For good practice, the planned load MUST NOT exceed the safe working load (SWL) but preferably be less than 90% of the SWL.

For equipment such as the tower, mobile, crawler or lorry crane, the lifting capacity is dependent on the load radius of the crane boom. Therefore, it is important to know the distance of the load to the crane when planning a lifting operation. For multiple lifts involving various type of loads, factors such as weight, shape and size should all be taken into consideration.

Details of the selected lifting equipment should be included within the lifting plan:

- Type of lifting equipment (i.e. mobile crane, crawler crane, tower crane (luffing/ saddle jib), portal crane, overhead travelling crane, gantry crane or lorry loader;
- Make and model;
- Capacity;
- Jib length (plus fly/luffing jib with offset where required);
- Outrigger spread;
- Outrigger imposed load;
- Maximum ground bearing capacity required;
- Counterweights/super lift counterweight requirements; and
- Weight of the crane.

## 4.2 Maximum Safe Working Load as Certified on the Lifting Machine Certificate

It is common for cranes to be classified as or referred to according to their capacity. However, the capacity usually refers to its maximum lifting capacity at the closest load radius from the centre of the crane. For example, a 60-tonne telescopic mobile crane will have a maximum lifting capacity of 60 tonnes at the closest radius of about three metres from the centre of the crane. This means that the crane will not be able to lift 60 tonnes for a larger working radius contrary to its categorisation. Therefore, it is important to state the maximum SWL which is indicated on the crane's lifting machine (LM) certificate in the lifting plan.

## 4.3 Date of Last Examination and Expiry Date of Certificate

It is important to check the validity of the Certification of Test/Thorough Visual Examination of Lifting Equipment for the cranes being used at a worksite. The date of the last examination of the crane and expiry date of certificate should be indicated in the lifting plan. This will ensure that the crane has a valid LM certificate, and it will be reflected accordingly in the lifting plan.

## 4.4 Maximum Boom/Jib Length

The maximum boom and jib length must be recorded in a lifting plan. For cranes with a fixed boom length such as crawler cranes, a check on the actual configuration of the crane must be done to ensure it conforms to the certificate. For cranes with a variable boom length such as mobile cranes, check the crane configuration information for guidance if the selected crane is appropriate for its intended use and to prevent over-reaching.

## 4.5 Fly Jib/Offset

Fly jibs are common on both crawler and mobile cranes and its installation will affect the SWL of the crane. Information on the SWL must be reflected in the lifting plan to ensure that the correct load chart is being referred to when determining the SWL for the given radius. It is also common for the fly jibs to be installed with an offset which may affect the SWL, hence the SWL should be recorded in the lifting plan for clarity.

## 4.6 Type of Lifting Gears

The type of lifting gear selected should be compatible for its intended use and detailed in the lifting plan. For example, fabric slings should not be used on loads with sharp edges. Refer to Section 6 on the different types of lifting gears and their recommended usage.

### Combined Weight of the Lifting Gears

Weights of the lifting gears have to be included in the overall load weight, if not it may lead to overloading of cranes.

### Safe Working Load of Lifting Gears

Similar to the lifting equipment, lifting gears also has an SWL. The SWL for each lifting gear used in the lifting operation should be included in the lifting plan.

### Certification of Lifting Gears

Lifting gears are to be inspected at regular intervals as required by the WSH Act and its subsidiary legislations. This is generally one year for normal lifting gears and six months for man-cages. Every lifting gear must have a valid tag and it must be visually checked before every lift.

# 5. Details of the Lift

| 4. Details of the Lift | | | |
|---|---|---|---|
| Intended load radius of the lifting equipment | *Distant between the load and the crane* | SWL of the lifting equipment at this radius | |
| Sketch and description of rigging method | | | |

Table 4: Part 4 of Annex

## 5.1 Intended Load Radius

The load radius should be determined accurately through an onsite check and included in the lifting plan. If the onsite check is not possible, the Responsible Person should refer to a scale drawing to verify. Adequate allowance should be given to ensure that the actual radius is not greater than the calculated or estimated distance.

## 5.2 Safe Working Load at Specific Radius

Once the intended load radius has been determined, the SWL at this radius can be found by referring to the correct crane load capacity chart (refer to Figure 3 for an example). This information must be included in the lifting plan.

| Working Radius (m) | Main boom(m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Telescoping cyclinder I & outriggers fully extended, oversides and rear, 7.5t counterweight | | | | | | |
| | 11.5 | 15.9 | 20.1 | 26.4 | 32.7 | 39.0 | 45.0 |
| 3.0 | 60000 | 45500 | 35500 | | | | |
| 3.5 | 51500 | 45500 | 35500 | | | | |
| 4.0 | 48000 | 45500 | 35500 | | | | |
| 4.5 | 45000 | 43500 | 35500 | 27000 | | | |
| 5.0 | 41500 | 41000 | 33500 | 27000 | | | |
| 5.5 | 37400 | 37000 | 31500 | 27000 | | | |
| 6.0 | 34000 | 33800 | 30000 | 26000 | 19800 | | |
| 6.5 | 31200 | 30700 | 29000 | 25000 | 19800 | | |
| 7.0 | 28600 | 28000 | 28000 | 24000 | 19800 | | |
| 7.5 | 26200 | 26000 | 26000 | 23000 | 19000 | | |
| 8.0 | 24000 | 24000 | 24000 | 22000 | 18400 | 14400 | |
| 9.0 | 19800 | 19200 | 19000 | 20000 | 17000 | 13600 | |
| 10.0 | | 15400 | 15200 | 16500 | 15800 | 12800 | 10000 |
| 11.0 | | 12500 | 12300 | 13500 | 14000 | 12000 | 9600 |
| 12.0 | | 10500 | 10300 | 11500 | 12200 | 11500 | 9200 |
| 14.0 | | | 7300 | 8500 | 9200 | 9600 | 8400 |
| 16.0 | | | 5200 | 6400 | 7100 | 7500 | 7600 |
| 18.0 | | | | 4800 | 5500 | 5900 | 6200 |
| 20.0 | | | | 3700 | 4300 | 4700 | 5000 |
| 22.0 | | | | | 3400 | 3800 | 4100 |
| 24.0 | | | | | 2700 | 3100 | 3400 |
| 26.0 | | | | | 2000 | 2400 | 2700 |
| 28.0 | | | | | | 1900 | 2200 |
| 30.0 | | | | | | 1500 | 1800 |
| 32.0 | | | | | | 1100 | 1400 |
| 34.0 | | | | | | | 1100 |
| 36.0 | | | | | | | 800 |
| I (m) | 0 | 4.3 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 |
| II (m) | 0 | 0 | 0 | 6.3 | 12.6 | 18.9 | 24.9 |
| Reeving | 12 | 10 | 8 | 6 | 4 | 4 | 3 |
| Hook | 60t Hook | | | | | | |

Figure 3: Example of a crane load capacity chart identification for SWL
*(Photo courtesy of Antar Cranes Services Pte Ltd)*

## 5.3 Sketch and Description of Rigging Method

A comprehensive rigging method must include key information such as the type of lifting gears used, factors that may affect the lifting operation and the centre of gravity. The rigging method must be enclosed together with the lifting plan.

The rigging method should consist of a detailed drawing of the load indicating the rigging configuration of all the lifting points and information on the slings, beams, shackles, ropes, blocks etc, by their size and SWL. The rigging method must also show all the connection points, the forces applied to each connection and how it will be slung together.

The drawing may be a hand-drawn sketch showing the rigging configuration. However, a computer-drawn engineering diagram is recommended for complex lifts. An example of a rigging method is shown in Figure 4.

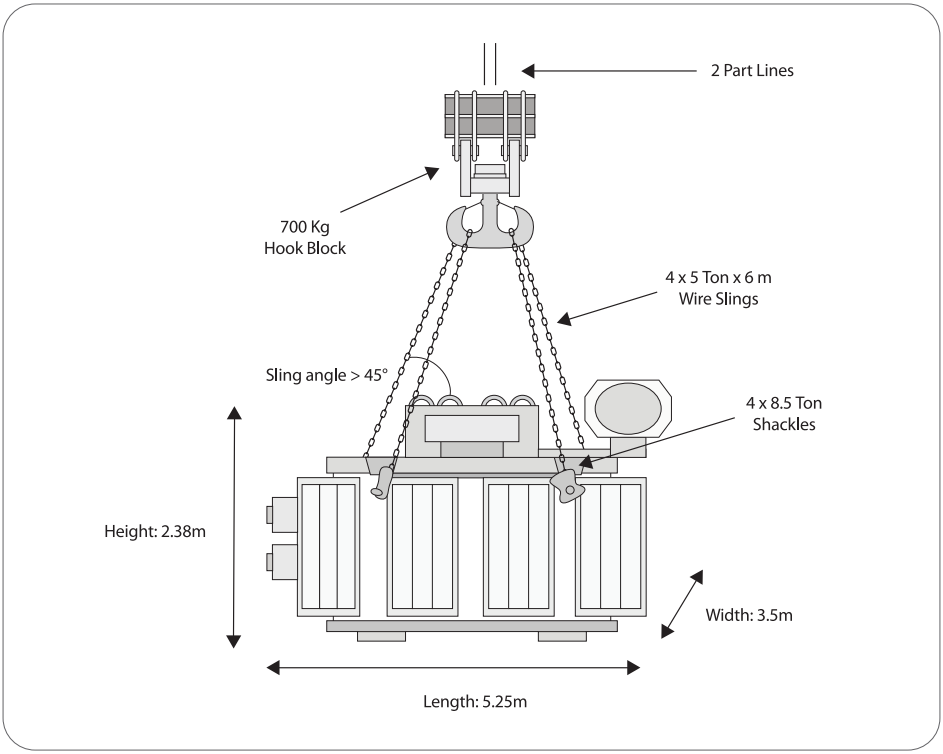


Figure 4: An example of a sketch of a rigging method

# 6. Further Information on Rigging

Accidents due to rigging can often be traced to a lack of knowledge on the part of a rigger. A safe rigging requires the rigger to know the following:

- Weight of the load and rigging hardware accessories;
- Capacity of the lifting or hoisting devices; and
- SWL of the slings, webbing and hardware.

After the weights and capacities are known, the rigger must then determine how to rig the load so that it is stable. This should be addressed in the rigging method.

## 6.1 Valid Certificates and Tags on All Lifting Gears

The lifting team must ensure all lifting gears have valid certificates prior to the commencement of any lifting operation. Any shackles or links being used to join slings together should also be sized to take into account the actual load each section will be taking. Synthetic web slings must be labelled to indicate their load rating capacity. Other factors affecting a safe rigging of lifting gears include the centre of gravity of load, sling angle and sling configurations.

For more information on sling configurations, refer to the Hoisting and Rigging Safety Manual by the Infrastructure Health & Safety Association.

## 6.2 Centre of Gravity of Load

When a crane is lifting a load, the centre of gravity (CG) is always vertically beneath the hook. If the CG is not under the hook when it is being lifted, the load will tilt until the CG is shifted vertically beneath the hook (see Figure 5). CG can be provided by suppliers/manufacturers of the load or determined through calculations.

After the CG is located, the load should be adjusted to stay horizontal. This can be done by either changing the lift point position of one of the slings or lengthening/shortening of one of the slings so that the CG is exactly under the hook when lifting the load.

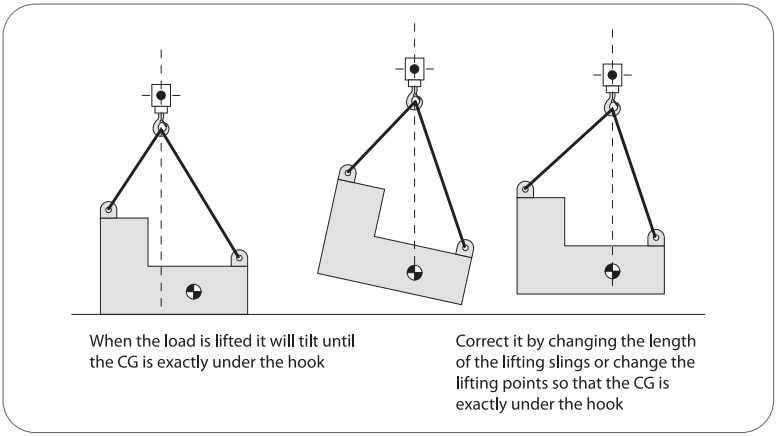


Figure 5: Centre of gravity beneath the hook

For larger and off-set/off-balanced loads, the CG is more difficult to determine. Figure 6 shows an example of a load with an off-set CG. Note the slinging arrangements and how a load becomes unstable when the CG is not directly below the hook block.

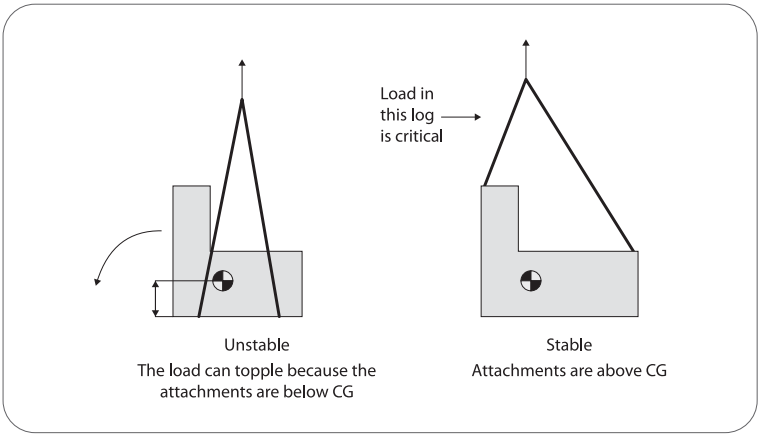


Figure 6: Example of a load with an off-set centre of gravity

For large objects, the CG will have to be determined during the design stage by designers. The lifting lugs will also need to be designed to ensure a safe lifting operation. Specific lifting gear may also be used to ensure that the hook is always above the CG during the lifting operation.

When the CG is not equally spaced between the rigging points, each set of sling and fittings will not carry an equal share of the load. The sling connected closer to the CG will carry the greater share of the load. See the Figures 7 and 8 for reference.

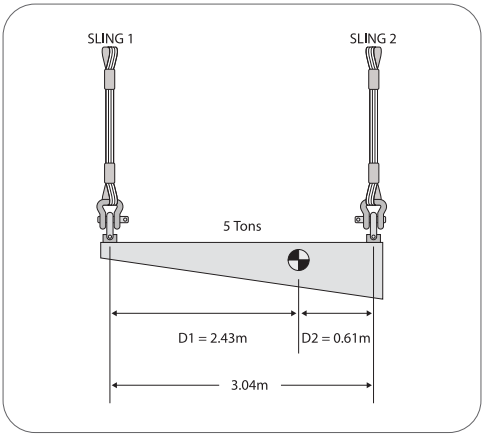


Figure 7: Example of a load with an off-set CG connected by two slings

**Sample Calculation:**

Sling 2 is connected closer to the CG, therefore it will carry the greater share of the load.

Tension in/Load carried by Sling 1 = 5 x 0.61 / 3.04 = 1.0 tons
Tension in/Load carried by Sling 2 = 5 x 2.43 / 3.04 = 4.0 tons

See Figure 8 for two legged slings joined to the hook.

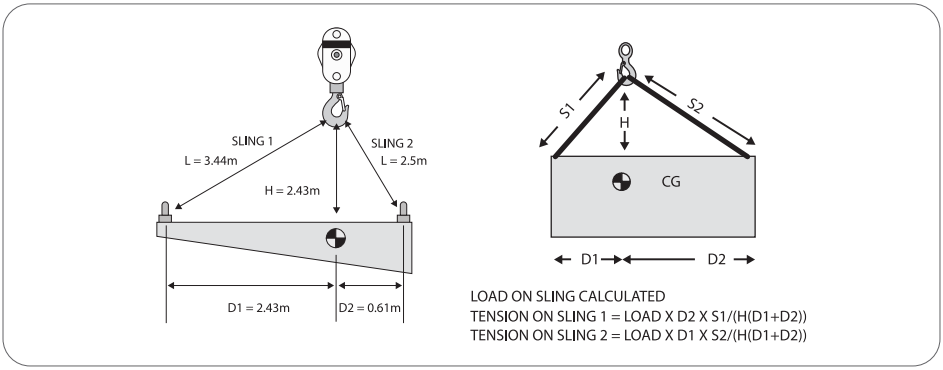


Figure 8: Example of a load with an off-set CG connected by two-legged slings joined to the hook

**Sample Calculation:**

Tension in/Load carried by Sling 1 = 5 x 0.61 x 3.44 / (2.43(2.43+0.61)) = 1.42 tons
Tension in/Load carried by Sling 2 = 5 x 2.43 x 2.5 / (2.43(2.43+0.61)) = 4.11 tons

## 6.3 Sling Angles

In any lifting operation, the rigging equipment should be selected based on the weight of the load to be lifted. It is important to look at the angle of the sling and the SWL indicated on the tag or certificate. If slings are being used as part of a lifting gear, they must be checked to ensure that the rigging angle does not reduce the lifting capacity to lesser than the load.

It is important to note that the total weight one can pick up with a set of slings is reduced when the slings are used at angles.

For instance, two slings used to lift 1,000 tons will have a 500-ton force on each sling (or leg) at a sling angle of 90 degrees. The force on each leg increases as the angle gets smaller. At 30 degrees the force will be 1,000 tons on each leg!

Keep sling angles greater than 45 degrees whenever possible. Using any sling at an angle smaller than 30 degrees is extremely hazardous. In such cases, an error of 5 degrees in estimating the sling can be very dangerous. The sharp increase in loading at low angles is shown in Figure 9.

Low sling angles also create large, compressive forces on the load that may cause buckling, especially in longer flexible loads. When the rigging exceeds this sling angle, detailed calculations should be done to determine the actual load on each leg of sling.

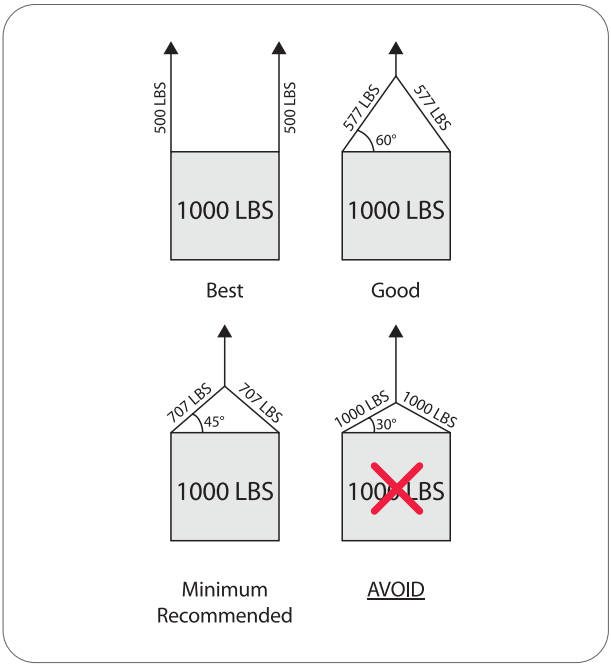


Figure 9: Effect of sling angle on sling load

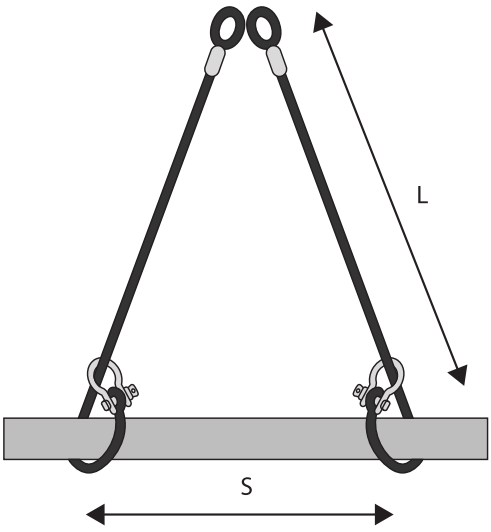


Figure 10: How to check on Sling Angle

- If L is greater than S, the sling angle is correct.
- Ensure the sling angle is always greater than 45° and preferably greater than 60°.
- The sling angle is greater than 60° when the horizontal distance between the attachment points on the load is less than the length of the shortest sling leg.

Further guidance on safe rigging can also be found in the WSH Council's Worker's Safety Handbook for Rigger and Signalman, and the Guidebook for Lifting Supervisors.

# 7. Means of Communications

**5. 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 _____

Table 5: Part 5 of Annex

Adhering to correct procedures for communication is vital as breakdown in communication is one of the root causes for lifting accidents. All members of a lifting team must be clear of their respective tasks and roles to ensure there is clear communication with one another during lifting operations.

The following factors should be taken into consideration when establishing a communication approach with workers:

- Are the workers concerned all from the same company?
- Do all of them speak and understand a common language?
- If not, is there an established system of signals that the workers know and understand?
- Are warning signages displayed where the workers can see clearly?
- Are they different methods of communication that can be used?

Clear communication is important when any part of the lifting operation is not clearly visible to any of the lifting team personnel. If a signal is not clear, the operation must be stopped until further instructions have been given.

Designated signallers should be clearly identified by using reflective jackets or other visible clothing or markings.

Communication also includes warning workers of the lifting activity and keeping the work area clear of personnel who are not involved in the lifting operation.

Figure 11 shows an example of how communications can take place for all relevant stakeholders during lifting operations.

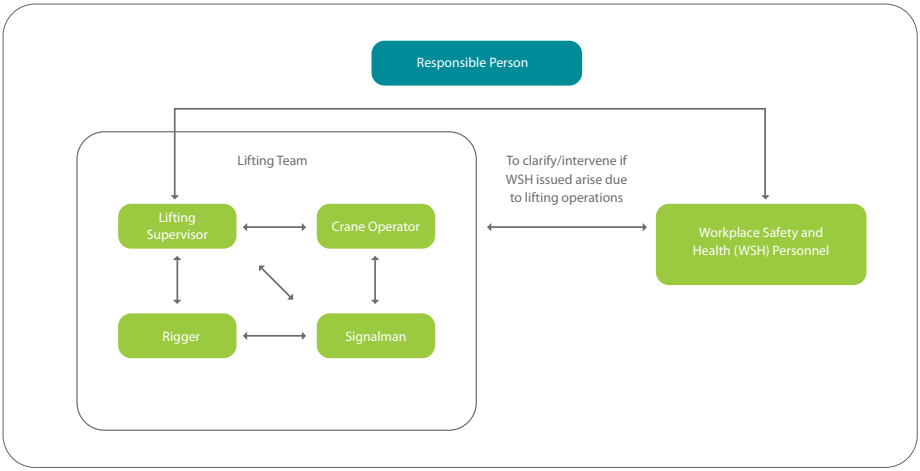


Figure 11: Example of communication flow during lifting operations

The lifting team should not start any lifting operation until all relevant personnel have been briefed on their roles and responsibilities in a pre-start meeting. The team must also sign the Permit-to-Work as required, or record of attendance at the pre-start meeting.

It is important to consider the following information in a lifting plan:

- Is the crane operator able to see the loading and unloading point for the load from his location?
- What is the means or platform of communication between the lifting crew?

# 8. Personnel Involved in Lifting Operations

| 6. Personnel Involved in Lifting Operation | | |
|---|---|---|
| Position | Name | Qualification/Experience |
| Responsible person | | |
| Lifting supervisor | | |
| Crane operator/lifting equipment operator | | |
| Rigger | | |
| Signalman | | |
| Others (Please state) | | |

Table 6: Part 6 of Annex

The names, qualifications and experience of the lifting team and supervisors should be indicated in the lifting plan to ensure a safe execution of the lifting operation. This includes:

- Responsible person
- Lifting supervisor
- Crane operator/lifting equipment operator
- Rigger
- Signalman
- Others (e.g. banksmen or general workers assisting with the lifting operation)

The lifting supervisor, rigger and signalman must have successfully completed the respective courses, i.e. WSQ Supervise Safe Lifting Operations and WSQ Perform Rigger and Signalman Tasks, and be formally appointed for the role.

The responsible person can be someone who has overall control of the worksite, e.g. project manager, or a competent person appointed by the occupier or employer who is able to take full control of the lifting operations, e.g. appointed person as stated in relevant Singapore Standard.

# 9. Physical and Environmental Considerations

| **7. Physical and Environmental Consideration** (pls 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 tapes) to prevent unauthorised access? | ☐ Yes ☐ No |
| Environment | Do not proceed with the lifting operation under the following circumstances:<br><br>☐ Thunderstorm and lightning strikes in the area. The ground condition must be checked after a thunderstorm.<br><br>☐ Strong winds that may sway the suspended load.<br><br>☐ Other circumstances (please specify). | |

Table 7: Part 7 of Annex

## 9.1 Ground and Surrounding Conditions

The responsible person must ensure that adequate considerations have been given to the issuance of crane outrigger loadings, and ground or floor bearing capacities of crane hardstanding areas. This is to make sure that the ground or floor can withstand the maximum outrigger loading imposed by the crane carrying the heaviest load during the lifting operation. Information regarding outrigger loading can be found in the manufacturer's outrigger load table. If the responsible person does not have the relevant expertise to assess the bearing capacity of the ground, he should engage a specialist/professional with relevant expertise in the relevant field.

Consideration must also be given to potential hardstand deterioration due to weather (for example the ground turning muddy due to rain) or construction activity (such as tunnelling works) around the lifting zone which may change or differ from the initial investigation/ assessment. This is to ensure it is still safe to continue with the lifting operations.

Outrigger loadings should be clearly identified on the lifting plan and the responsible person or other competent persons, e.g. a professional in the relevant field, must sign on their behalf confirming the adequacy of the hardstanding to receive the stated loading prior to commencing works.

**Outriggers or Crane Footing**

Lifting operations requiring the use of crane outriggers must follow the manufacturer's instructions with the outriggers beams and jacks extended. When drafting the lifting plan, the responsible person must review the proposed crane location to ensure there is sufficient space at the site for the required crane outriggers configuration. Figure 12 shows examples of poor outrigger set-up configurations which should be avoided.

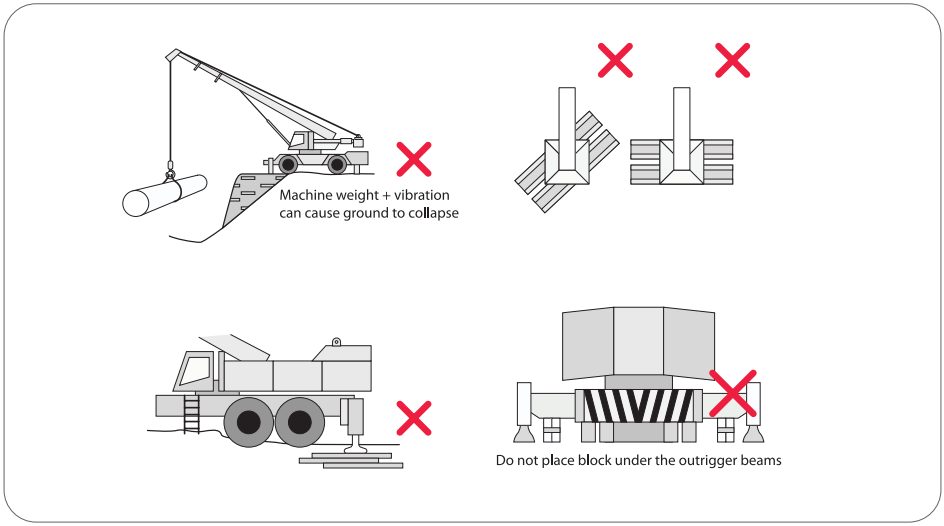


Figure 12: Example of poor outrigger set-up

Crawler and mobile cranes are designed to move from one location to another. The ground needs to be sufficiently strong to withstand the weight of the crane. To ensure the weight of the crane is evenly spread to the ground, ground support such as steel plate or load bearing mats (see Figure 13) should be used.


Figure 13: Load Bearing Mat

**Bearing Capacity**

Bearing capacity refers to the capacity of the soil/ ground to support the applied load. The area of the contact point between the crane (such as the outrigger supports/crawler tracks/wheels/ load bearing mats etc)and ground must be determined to ensure that the bearing capacity is not exceeded. This information should be recorded in the lifting plan.

The responsible person should note that ground which has been backfilled without any compaction might not have sufficient bearing capacity for the proposed lifting operations. He should also check the proposed crane location for voids, manholes and underground services to access if the location is suitable for lifting operations. The responsible may refer to external parties, e.g. a professional engineer, to assist in such determination.

**Access and Lifting Location**

To ensure that the public is not in danger during a lifting operation, the crane should be located such that its collapse zone is within the boundaries of the worksite. If this is not possible, a detailed risk assessment should be done to review the risks associated with crane collapse and measures adopted to minimise the risks.

While planning for lifting operations, the responsible person should also review the route to transport the crane and its corresponding equipment (such as ballast, boom, counterweights) to the actual crane setup location. The route must be on firm ground which can support the weight of the crane, transport vehicles and equipment being transported. For clarity, the route can be shown on the site plan.

**Excavations**

When planning any lifting operations, the proposed crane location should be away from any excavation sites or soil-retaining structures. If this cannot be avoided, the crane should be parked at a minimum safe distance in accordance with relevant standards.
The responsible person must confirm prior to the day of lifting operations that the ground/floor has been assessed and adequately prepared to withstand the relevant maximum outrigger loading. In the event that test on the bearing capacity of the ground is to be carried out, it is prudent to apply the relevant factor of safety to all calculations for the allowable bearing capacity according to the relevant standards.

## 9.2 Obstacles

All obstacles, e.g. overhead structures, must be taken into consideration during the initial survey. Provisions must be made to avoid collisions during the lifting operation. If there are obstacles in the path of the lifting operation, it must be clearly indicated in the lifting plan.

## 9.3 Lighting

Sufficient lighting must be provided to ensure adequate visibility during lifting operations. For specific requirements, refer to Enterprise Singapore's SS 531: Code of Practice for Lighting of Workplaces.

## 9.4 Demarcation

The lifting operation zone should be clearly demarcated with warning signs and barriers, e.g. barricades to ensure that personnel who are not involved in the lift do not enter.

## 9.5 Environment

Weather conditions can affect the safety of a lifting operation. More severe conditions such as heavy rain and with the possibility of lightning, must be monitored during lifting operations. The effect of rain on the load and crane must be taken into consideration during lifts. Water from the rain may also affect ground conditions, especially if the lifting location is near a slope. The ground should be inspected prior to the lifting operations to address any doubts about the weather conditions.

**Wind Influence on the Crane and Load**

Wind is a major hazard that can disrupt and put a lifting operation at risk. Cranes should not conduct any lifting operations at wind speeds beyond the recommended in the crane manufacturer's instructions. The crane operator must ensure that the crane is not exposed to any wind that could exceed the limits set by the crane manufacturer.

When wind hits against the load, it will swing with the direction of the wind. This means that the force of the load no longer acts vertically downwards on the boom. Depending on the wind's strength and direction, and the surface area exposed to wind, the radius of the load may increase or impermissible lateral forces may act on the crane boom. This can cause instability to both the crane and load which may result in overturning.

# 10. Sequence/Special Precautions

| 8. Sequence/Special Precautions |
| --- |
| |

Table 8: Part 8 of Annex

The sequence of all lifting operations must be recorded in a method statement with step-by-step instructions and included in the lifting plan where necessary. The lifting team must follow the method statement.

# 11. Sketch of Zone of Operation/ Layout Plan

**9. 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).*

Table 9: Part 9 of Annex

The layout plan can be in a form of a sketch for simple operations. For more difficult and complex operations, a detailed engineered drawing is recommended.

The objective of the layout plan is to ensure that the crane or lifting machine is placed in a correct location and the lifting operation can be done safely. Refer to Figure 14 for an example of a layout plan.

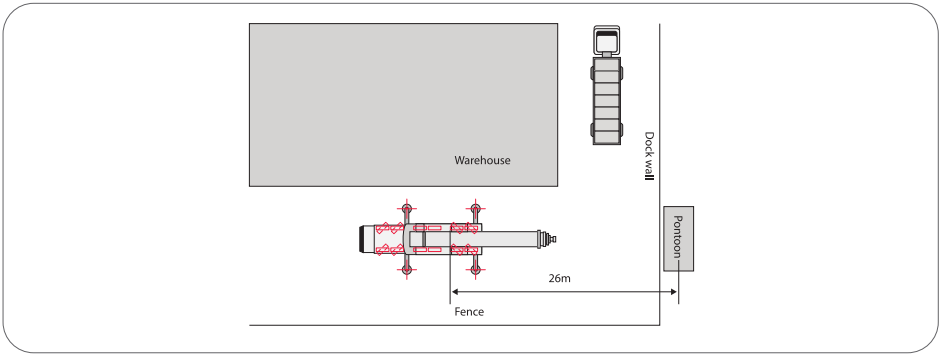


Figure 14: Example of a layout plan of the crane onsite

### Boom Clearance

There must be sufficient boom clearance space during lifting operations, especially in restricted and confined areas. The boom clearance and tail swing should be determined during the planning stage and recorded in the layout plan.

### Boom Height and Angle

The boom's angle and height must be recorded in the layout plan. This information helps in the selection of a suitable crane and calculation of clearances of buildings and other possible obstructions. Figure 15 show an example of a load chart showing the boom height and angle.

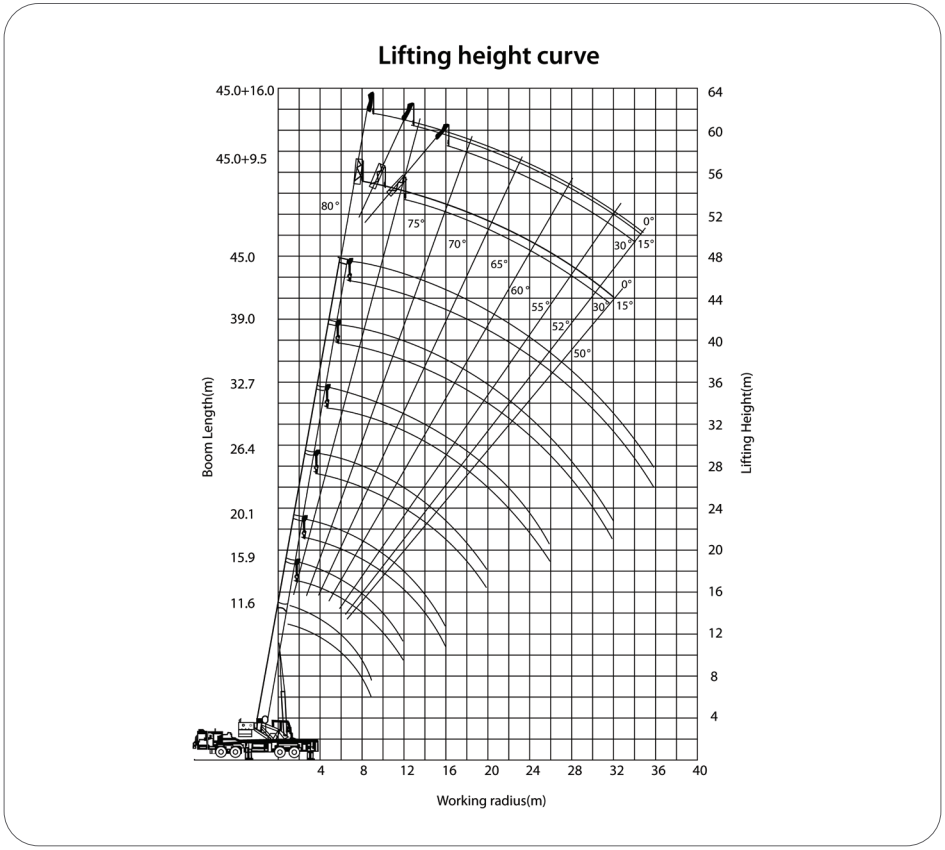


Figure 15: Example of a load chart showing boom height and angle
(*Photo courtesy of Antar Cranes Services Pte Ltd*)

### Pick Up and Place Down Position

Knowing the boom's radius is extremely important and fundamental to safe lifting. The "pick up and place down" measurements must be taken and recorded within the plan.

### Unit of Measurement Used in Drawing

The units of the weight and dimensions must be correctly recorded in drawings. Ensure that the same units of measurement are consistently used.

# 12. Annex

## Sample Lifting Plan/Permit-to-Work

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

| 2. Details of 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 examination | |
| | | Expiry date of certificate | |
| Max boom/jib length | m | Fly jib/offset | |
| Type of lifting gears | *Slings / webbing / chains / shackles / spreader beam / receptacle* | | |
| Combined weight of the lifting gears | Kg/tonne | Certification of lifting gears | ☐ Yes ☐ No |
| SWL of lifting gears | Kg/tonne | | |

| 4. Details of the Lift | | | |
|---|---|---|---|
| Intended load radius of the lifting equipment | *Distant between the load and the crane* | SWL of the lifting equipment at this radius | |
| Sketch and description of rigging method | | | |

## 5. 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 _____

## 6. Personnel Involved in Lifting Operation

| Position | Name | Qualification/Experience |
|---|---|---|
| Responsible person | | |
| Lifting supervisor | | |
| Crane operator/lifting equipment operator | | |
| Rigger | | |
| Signalman | | |
| Others (Please state) | | |

| **7. Physical and Environmental Consideration** (pls 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 tapes) to prevent unauthorised access? | ☐ Yes ☐ No |
| Environment | Do not proceed with the lifting operation under the following circumstances:<br><br>☐ Thunderstorm and lightning strikes in the area. The ground condition must be checked after a thunderstorm.<br><br>☐ Strong winds that may sway the suspended load.<br><br>☐ Other circumstances (please specify). | |

| 8. Sequence/Special Precautions | 9. 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:<br>Name: | Signature: | Date:<br>Time: |
| Prepared by:<br>Name: | Signature: | Date:<br>Time: |
| Assessed by:<br>Name: | Signature: | Date:<br>Time: |
| Approved by:<br>Name: | Signature: | Date:<br>Time: |

**Note:**

- This sample lifting plan/permit-to-work template highlights the key elements that should be considered. It is non-exhaustive and users should include other critical document and information such as load capacity chart, range diagram, sling angle to ensure safe lifting operations.

- Users of this template are encouraged to contextualise and customise this template in accordance with their work activities, work environment and relevant regulatory requirements.

- Some of the regulatory requirements that users of this template should take note of are:

  - Section 4(1) of the WSH (Operation of Cranes) Regulations states that for lifting operations involving the use of any crane in a workplace by a crane operator, a lifting plan needs to be established and implemented.
  - Part III of the WSH (Construction) Regulations states the need to implement a permit-to-work system and its requirements for lifting operations involving building operation or works of engineering construction.

# 13. Acknowledgements

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| S/N | Name | Organisation | Role |
|---|---|---|---|
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| 5 | Mr Eric Lum | ExxonMobil Asia Pacific Pte. Ltd | Member |
| 6 | Mr Tan Kay Yeow | Jurong Port Pte Ltd | Member |
| 7 | Mr Yeo Kim Hock | The Singapore Contractors Association Limited | Member |
| 8 | Mr Ng Yi Hang | Ministry of Manpower | Member |
| 9 | Mr Muhd Hafiz Md Jamil | Workplace Safety and Health Council | Member |
| 10 | Mr Royston Lim | Workplace Safety and Health Council | Member |

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