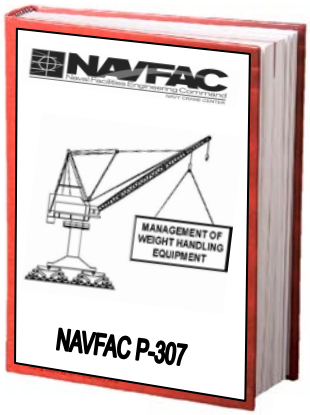
Navy Crane Center



NAVFAC P-307 Training

GENERAL CRANE SAFETY REFRESHER
WEB BASED TRAINING STUDENT GUIDE
NCC-GCSR-05

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TABLE OF CONTENTS

INTRODUCTION

Welcome

Welcome to General Crane Safety Refresher.

General Crane Safety Refresher is designed to refresh crane operators with Navy requirements for the safe operation of cranes.

Topics covered include crane inspection and lift types, crane communications, crane team concepts, safe operation and lifting requirements, determining load weight and rigging considerations, calculating capacities, and crane and rigging accident identification and response.

Course Learning Objectives

Upon successful completion of this course, you will be able to: perform an Operator's Daily Checklist, identify crane and lift types, determine load weights, load weight distribution, and sling angle stress, identify proper selection and use of rigging gear, explain the crane team concept, identify proper crane communication methods, and identify crane and rigging accidents.

Getting the Most Out of the Course

To get the most out of this training:
Pay close attention to the narrations and information provided on each screen. There may be information in the narration that is not shown on the screen. And vice-a-versa, there may be information on the screen that is not contained in the narration.
Replay narrations and screen content as often as needed by clicking on the topic title or the tab title, as applicable.
Complete all knowledge checks and module quizzes to help re-enforce your understanding of the material covered.

Navigating Through this Course

As you navigate through this course, you will find several helpful tools and features that will facilitate your learning. This interactivity enables you to easily navigate and access various training aids and tools using the following buttons:

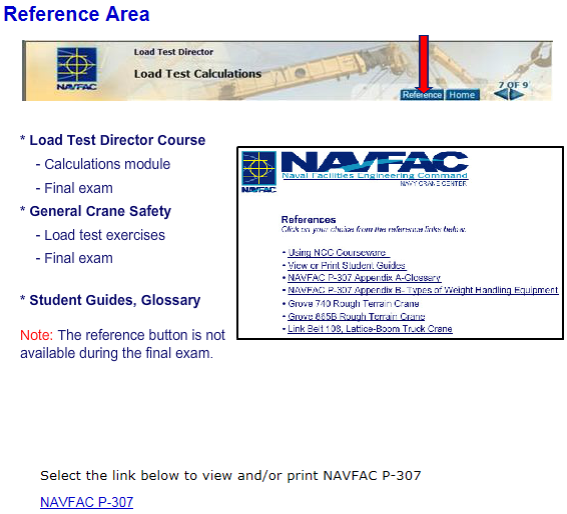
- The topic list, if present (on the left), displays the topics within the module. Topics can be selected by clicking on the title.
- The navigation buttons (top right) look like arrow heads and allow you to move forward to the next screen or backward to the previous screen by clicking on the arrowhead pointing to the right or left, respectively.
- The 'home' button (top right) returns you to the main module menu.
- The 'reference' button (top right) allows you to view various references, documents, or pictures provided to support your learning experience.
- The 'view narration' link (lower left on the content screen) allows you to view a text version of the audible narration.

Reference Area

Some courses require you to refer to other documents when completing the modules, exercises, quizzes and final exams. These documents are available in the reference area and can be copied to your computer or printed.

Load Test Director and General Crane Safety are two such courses and require you to have the load chart or certification packages handy. Note that the reference button is not available when taking the final exam.

Student Guides, a glossary of terms, and pictorial representations of equipment are also available from the reference area.



Knowledge Checks

These courses use various types of questions to help you retain the material presented. As you proceed through each topic, you will be asked questions in the form of knowledge checks.

The knowledge checks will help you prepare for the module quizzes and final exam.

Question types include: Fill in the Blank, Drag and Drop, Multiple Choice - Single Answer, Multiple Choice - Multiple Answer, and True/False.

Exam Directions

When taking exams, keep the following in mind…

Some questions require multiple answers and have check boxes next to the choices.

Single answer questions have circles next to the choices.

If you score less than 80% on a module quiz, review the necessary content, then return to retake the quiz.

You can go back and review any content prior to taking a quiz or final exam. You can review and change your answers any time before you select the ‘Score Exam’ button. A score of 80% or higher is required to pass.

The final exam score will be recorded in the Navy eLearning system and on your completion certificate.

If you fail a course, you can re-enroll and retake the course.

Feedback

Upon completion of the training, or at any time during the training, please feel free to provide feedback to Navy Crane Center on how to improve or better deliver this presentation. Include suggestions such as:

- Current WHE accidents, near misses, trends (with narratives and pictures)
- Content changes, additions, deletions
- Other topics
- Clarifications, corrections
- Delivery methodologies

Contact information is provided on the screen and in the student guide. You can come back to this screen at any time prior to passing the final exam. After passing the final exam, the course will roll up, your information will go to “My Transcripts”, and the course content will no longer be available. However, you may still refer to the student guide for contact information or you can go to the Navy Crane Center’s training web page and provide feedback via the links found there.

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Ready to Begin

You are now ready to begin your training. Navigate back to the main module menu, select the next module, and begin your training. Good luck.

NOTICE:
NOT ALL OF THE ONSCREEN CONTENT / NARRATION IS CAPTURED IN THIS STUDENT GUIDE; TAKING NOTES MAY BE NECESSARY.

NOTES

CRANE TYPES AND COMPONENTS

Welcome
Welcome to Crane Types and Components.

Learning Objectives
Upon successful completion of this module you will be able to define and identify crane types, critical crane components, load bearing parts, load controlling parts, and operational safety devices.

Category 1 Cranes
This is a list of some of the more common types of category 1 cranes. Category 1 cranes come in a wide variety of sizes and configurations and include: portal cranes, hammerhead cranes, locomotive cranes, derricks, YD floating cranes*, tower cranes, container cranes, mobile cranes, aircraft crash cranes, mobile boat hoists including self-propelled and towed types, and rubber-tired gantry cranes. They are considered category 1 cranes regardless of capacity. All category 1 cranes require a license to operate.
*Note: Other cranes on barges or floating mountings are the category of the crane itself, e.g., monorail, jib crane, gantry crane.

Category 1 Crane Examples
Here, and on the next few slides, are some un-narrated pictures and descriptions of different types of category 1 cranes. Review the various examples and their descriptions.

Category 1 Crane
Floating Crane

Types:
- barge, pontoon, or hull mounted with an integral base

Luffing booms:
- capable of continuous 360° rotation

Primary power
- supplied by a diesel-electric generator or diesel-driven hydraulic pumps
- While some are self propelled, most require tug boat assist to move about

Floating Crane

Category 1 Crane
Hammerhead

Consists of:
- rotating counterbalanced, cantilevered boom equipped with one or more trolleys that move in and out on the boom

Supported by:
- a pintle or turntable mounted atop a traveling or fixed tower

Hammerhead

Category 1 Crane
Container Cranes

Consists of:
- hinged boom and main beam
- with a traveling trolley mounted on a rail mounted traveling gantry structure

At military port facilities Used for:
- quickly transferring containers on and off ships

Container Cranes

Category 1 Crane
Derrick

Example:
• crane with a boom hinged near the base of a fixed mast

Typically:
• boom may rotate 90° or more between the mast supports or "stiff legs" or members capable of resisting both tensile and compressive forces

Derrick

Category 1 Crane
Portal

Consists of:
• Rotating superstructure mounted on a gantry structure with:
  - operator's cab
  - machinery
  - luffing boom

Primary power:
• diesel-engine driven generators or hydraulic pumps
• electric driven

Support:
• supported by wide gauge rail allowing the portal crane to move about the facility

Portal

Category 1 Crane
Mobile Crane

Example:
Truck mounted hydraulic Cranes
• most common mobile cranes

Consists of:
• rotating superstructure
• upperworks mounted on an specialized truck chassis equipped with a power plant and cab for traveling over the road

Primary power:
• one engine for both the upper works and the carrier or
• a separate engine for each

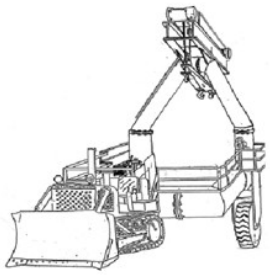
Mobile

Mobile Boat Hoist

A mobile boat hoist consists of a steel structure of rectangular box sections, supported by four sets of wheels capable of straddling and carrying boats.

Landing Craft Retrieval Unit

A landing craft retrieval unit, or L C R U, is a type of mobile boat hoist with self-propelled or towed carriers consisting of a wheeled steel structure capable of straddling and carrying boats.



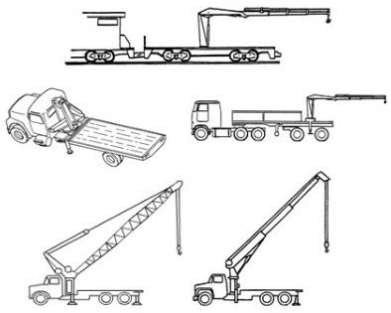
Rubber Tire Gantry

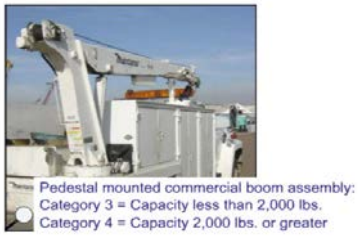
A rubber tire gantry crane may be single beamed or double beamed. Often it resembles a mobile bridge crane with its hoist mounted on a bridge which spans two beams. As shown in the illustration, it may be configured with two hoists mounted on opposing beams which utilize a spreader bar or similar mechanism to lift loads. The gantry style legs allow the crane to hover over loads, improving stability. The wheels and rubber tires may be motorized or non-motorized.

Category 4 Crane Examples

Screen 1, General: Typically, category 4 cranes are independently manufactured boom mechanisms that are subsequently attached to or mounted on commercially available trucks. These cranes are operated independent of the vehicle controls from standard ground control stations and may be powered by the truck engine or a power sending unit. The booms may rotate or articulate. Outriggers or stabilizers shall be used as required. Click on the right and left arrows at the bottom of the slide show window to view each of the 4 screens.

Screen 2, Booms and Mounts: Category 4 cranes have different types of boom configurations such as: telescoping, non-telescoping, and articulating. They may be mounted on flatbed trucks, trailers, stake beds, rail cars, barges and pontoons, or may be stationary mounted on piers, wharves, and docks.





Screen 3, Capacities & Categories: Pedestal mounted commercial fixed length and telescoping boom assembly cranes with less than 2,000 pounds capacity are considered Category 3 cranes. Capacities greater than 2,000 pounds are Category 4 cranes.

Screen 4, Standards & Licensing: Commercial truck mounted cranes, as described in ASME B30.5, and articulating boom cranes, as described in ASME B30.22, of all capacities, are Category 4 cranes and require a licensed operator - even if the crane is down rated for administrative purposes.

Category 2 and 3 Cranes

Category 2 and Category 3 cranes include: overhead traveling cranes; gantry cranes; wall cranes; jib cranes; davits; pillar cranes; pillar jib cranes; monorails and associated hoists; fixed overhead hoists, including fixed manual and powered hoists; portable hoists used continuously in a single location, that is, 6 months or more; portable A-frames and portable gantries with permanently installed hoists; and pedestal mounted commercial boom assemblies attached to stake trucks, trailers, flatbeds, or railcars, or stationary mounted to piers, etc., with certified capacities less than 2,000 pounds.

Category 2 and 3 Cranes: Capacity

The category of a category 2 or 3 crane is determined by its certified capacity. Category 2 cranes have a certified capacity of 20,000 pounds and greater. Category 3 cranes are those with a certified capacity of less than 20,000 pounds.

Category 2 and 3 Crane Examples

Here, and on the next few slides, are some un-narrated pictures and descriptions of different types of category 2 and 3 cranes.
Review the various examples and their descriptions.

Category 2 and 3 Cranes

Bridge or OET Crane

Example:
- cab-operated
- can be pendant or radio controlled

Principal parts include:
- Bridge girders, end trucks, trolley with hoisting mechanism, and operator's cab or pendant control

Mobility:
- limited to the area between the runways

Bridge or OET Crane

Category 2 and 3 Cranes

Jibs

Points:
- normally category 3 cranes
- category 2 if certified capacity of 20,000 pounds or greater

Consists of:
- a rotating horizontal boom (either cantilevered or supported by tie rods) carrying a trolley and hoist.
- usually mounted on a wall or building column

Jib

Category 2 and 3 Cranes

Pillar-Jib Crane

- A fixed crane consisting of a rotating vertical member with a horizontal arm supporting a trolley and hoist
- Normally rotates 360°

Pillar Jib

Category 2 and 3 Cranes

Trolley Mounted
Overhead Hoist

Consists of:
- an under-hung trolley
- one or more drums and sheaves for wire rope or chain

Powered by:
- manual
- electric
- hydraulic
- or pneumatic powered

Mobility:
- fixed
- or may travel on jib crane booms or monorail track

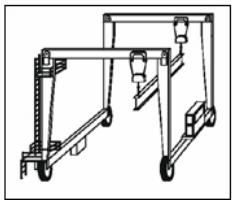
Trolley Mounted
Overhead Hoist

Knowledge Check

1. Select the best answer. A floating crane with a capacity of 200,000 pounds is a _____ crane.

   A. Category 1
   B. Category 2
   C. Category 3
   D. Category 4

2. Select the best answer. What is the category of this crane?



   A. Category 1
   B. Category 2
   C. Category 3
   D. Category 4

3. Select the best answer. What is the category of a jib crane with a capacity of less than 20,000 pounds?

   A. Category 1
   B. Category 2
   C. Category 3
   D. Category 4

4. Select the best answer. An OET Bridge crane with a capacity of 80,000 pounds is a _____ crane.

   A. Category 1
   B. Category 2
   C. Category 3
   D. Category 4

5. Select the best answer. A commercial truck mounted crane with a capacity of 14,000 pounds is a _____ crane.

   A. Category 1
   B. Category 2
   C. Category 3
   D. Category 4

Types of Power

Category 1 and 4 cranes generally use electric or hydraulic power that is supplied by a diesel engine.

A collector ring system conveys electrical current from the revolving portion of the crane to the lower crane structure.

Category 2 and 3 Crane Power

Category 2 and 3 cranes may be manually-operated or power-operated.

A manually-operated crane hoist mechanism is driven by pulling an endless chain. The crane travel mechanism is driven in the same manner or by manually moving the load or hook.

A power-operated crane is driven by electric, pneumatic, hydraulic, or internal combustion means. Pneumatic and hydraulic power may be delivered to the crane via pipes and/or hoses.

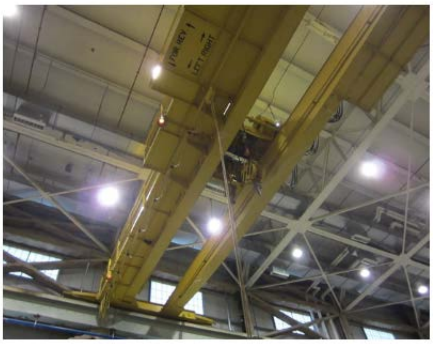
Electricity or current is usually carried from the building or shore power to the bridge and trolley by an insulated electrification conductor system, festoon system, or cable track system.

Category 1 and 4 Crane Components

The principal parts of most Category 1 and 4 cranes are: the boom, machinery house, roller path or rotate bearing, supporting structure, and travel system.

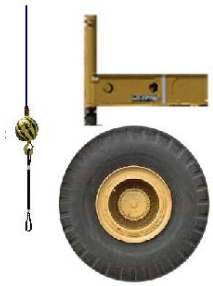
Category 2 and 3 Crane Components

The principal parts of overhead traveling cranes are: bridge girders, end trucks, trolley with hoisting mechanism, and operator's cab or pendant control.



Critical Crane Components

Careful repair and maintenance are essential to safe crane operations.
To ensure repairs are not compromised by sub-standard parts, critical crane components are clearly identified.
NAVFAC P-307, Appendix F provides examples of load bearing parts, load controlling parts, and operational safety devices.



Load-bearing Parts

Load-bearing parts support the load.
Failure of a load-bearing part can cause dropping, uncontrolled shifting or uncontrolled movement of the load.
There are many different load bearing parts; this picture shows three examples.

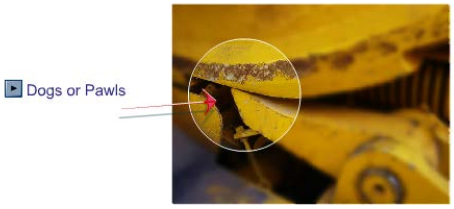
Examples

Examples of load-bearing parts are wire rope, sheaves, hooks, hook blocks, and hoist drum pawls.

The next example screen shows a boom dog, used to prevent unwanted rotation of a boom or hoist drum.

Wire rope, Hooks, & Blocks

Sheaves



Carrier Frame Structures

The carrier frame provides a working base for the upper works of the crane.
The tires, wheels, and axles support the carrier frame for transporting and for lifting loads on rubber.
Outriggers, stabilizers, and locking devices provide support for on-outrigger operations.
Failure of any one of these components or systems can cause the load to drop or cause uncontrolled movement of the load. These are critical components that must be carefully checked before operations or testing.

- Carrier Frame
- Tires, Wheels, & Axles
- Outrigger beams, Jacks & Devices

Load Bearing Parts - Bridge Cranes

Two examples of load-bearing parts found on bridge cranes include the bridge girders that carry the weight of the trolley including hoisting machinery and the load; and the wire rope drum and hoisting machinery that lifts and supports the load.
Appendix F of NAVFAC P-307 provides additional examples of load-bearing parts.

Load Controlling Parts

Load-controlling parts are crane components that position, restrain, or control movement of the load.
Malfunction of these parts can cause dropping, uncontrolled shifting, or movement of the load.
Shown are two examples of load controlling parts.

Foot-controlled Brakes

Travel-Gear Assemblies

Rotate-Gear Assemblies

Load Controlling Parts – Examples 1

Examples of load-controlling components are foot-controlled brakes used as secondary brakes for hoist speed control, travel gear assemblies, rotate gear assemblies, and rotate locks.

Appendix F of NAVFAC P-307 provides additional examples of load-controlling parts.

Load Controlling Parts – Examples 2

Some additional examples are crane-mounted diesel engines and generators, electrical-power-distribution systems, and electrical crane-control circuits related to rotate and travel including brakes and clutches.

Safety Devices

Safety devices are divided into two groups, general safety devices and operational safety devices.
Operational safety devices affect the safe lifting and handling ability of the equipment.
Operational safety devices are critical crane components.
General safety devices provide protection for personnel and equipment on or in the crane operating path.

General Safety Devices

General safety devices are those devices that protect or alert the operator or personnel working in the vicinity of the crane.
Some general safety devices used to warn personnel working on or around the crane are horns, bells, whistles, travel alarms, and travel warning lights.

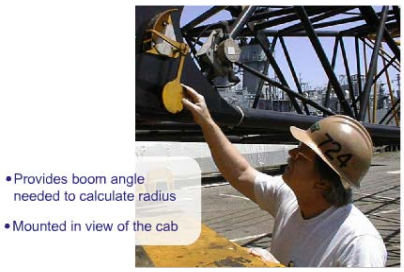
Load Moment Indicators

Load-moment indicators are operational aids providing the crane operator necessary information to stay within the capacity of the crane.

Load-moment indicators that provide shutdown capabilities are operational safety devices. They may provide the operator with load weight, boom angle, and boom length.

As the operator approaches critical limits, load moment devices may sound an audible alarm, illuminate warning lights, or lock out functions that could possibly allow the operator to overload the crane.

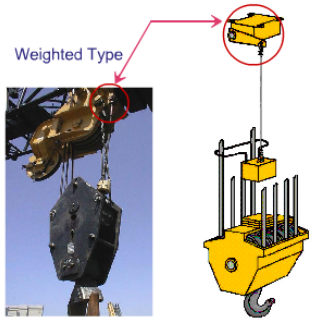
If a load moment device has lockout capability, it must be treated as an operational safety device.



Boom Angle Indicators

Mechanical boom angle indicators are operational safety devices.
These devices provide the operator with the boom angle needed to calculate the radius of the crane.
Mechanical boom angle indicators are usually mounted on the boom where they can easily be read from the cab.

Operational Safety Devices – Limit Switches



Limit switches are operational safety devices that prevent damage to the crane if a loss of control occurs. Most cranes are equipped with limit switches.

The purpose of a hoist limit switch is to prevent over-travel of the hook block and the possibility of two-blocking.

Two-blocking occurs when the hook block comes in contact with the upper sheave block during hoisting of the hook (or lowering the boom). Two-blocking is dangerous because it could result in damage to the crane, parting of the hoist lines, and dropping the load.

These images are examples of weighted-type hoist upper-limit switches.

A spring-loaded switch opens the circuit when the hook block raises the weight. Interruption of power to the hoist function stops the upward movement of the hoist block to prevent two-blocking.

Operational Safety Devices – Over-Speed, Pressure, and Temperature Devices

Over-speed, pressure, and temperature devices on crane-mounted engines are operational safety devices. When the engine provides the power to move loads, the devices provide shutdown ability to protect the engine from damage.

Appendix F of NAVFAC P-307 provides additional examples of operational safety devices.

Knowledge Check

1. Select the best answer. What types of power does a Category 1 or 4 crane generally use and what is its source?

   A. Pneumatic and hydraulic power supplied by a compressor
   B. Pneumatic and electric power supplied by a backup generator
   C. Electric or hydraulic power supplied by a diesel engine
   D. Hydraulic and water power supplied by a compressor

2. Load - _____ parts are those that restrain, position, or control the movement of the load.

   A. Bearing
   B. Handling
   C. Operation
   D. Controlling
   E. Lifting

3. Select the best answer. A hook is what type of component?

   A. Load-Bearing Part
   B. Load-Controlling Part
   C. General Safety Device
   D. Operational Safety Devices

4. Select the best answer. Hydraulic foot brakes are what type or group of components?

   A. Operational Safety Device
   B. Load-Bearing Parts
   C. General Safety Device
   D. Load-Controlling Parts

5. Select the best answer. Load - _____ parts are those that support the load.

   A. Operational
   B. Controlling
   C. Handling
   D. Lifting
   E. Bearing

6. Select the best answer. How is electrical current conveyed from the revolving portion of the crane to the lower crane structure?

   A. Through transistors
   B. Through the main circuit board
   C. Through the electrical panels
   D. Through the collector ring system

7. Select the best answer. Safety devices that provide protection for personnel and equipment are considered _____ safety devices.

   A. Load bearing
   B. General
   C. Universal
   D. Operational

8. Select the best answer. Safety devices that affect the safe load lifting and handling capabilities of equipment are considered _____ safety devices.

   A. General
   B. Load bearing
   C. Operational
   D. Universal

9. Select the best answer. Which of the following does not affect the safe operation of the crane?

   A. General Safety Devices
   B. Operational Safety Devices
   C. Load-Controlling Parts
   D. Load-Bearing Parts

10. Select the best answer. A travel alarm is what type or group of components?

   A. Operational Safety Devices
   B. Load-Controlling Part
   C. General Safety Device
   D. Load-Bearing Part

NOTES

OPERATOR'S DAILY CHECKLIST (ODCL)

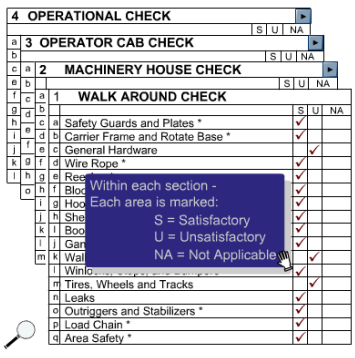
Welcome
Welcome to the Operator's Daily Checklist module.

Objectives
Upon successful completion of this module you will be able to state the purpose of pre-operational checks, explain the frequency of pre-operational checks, and properly complete an Operator's Daily Checklist.

Introduction
An Operator's Daily Checklist or ODCL is a safety checklist. The ODCL aids the operator in doing a complete check and provides a record of inspections.

Purpose
The daily inspection conducted by the operator is a general check by sight, sound, and touch. It helps the operator identify conditions that may render the crane unsafe to operate and enhances crane reliability.

Frequency
A complete check of the crane is performed by the operator prior to the first use of the crane each day using a Crane Operator's Daily Checklist, referred to as the ODCL. The operator signs the ODCL at the completion of this initial check. Subsequent operators review, perform the operational checks, except boom limit switches, and sign the initial ODCL prior to operating the crane. If a load is suspended from the hook for a period that spans more than one operator, the operator who completes the lift shall perform appropriate checks immediately upon completion of the lift, unless he or she will not operate the equipment again. For operations not involving a lift, such as moving the crane to a new location, the operator needs to check only the functions to be used.
When a crane is used in construction, a complete pre-use check must be performed by each operator.
A documented pre-use check is not required for non-cab operated Category 3 cranes; however, for bridge, wall, and gantry cranes, a documented pre-use check shall be performed at least once each calendar month the crane is in use.



Sections of the Pre-Operational Check
A proper pre-operational check is performed in four sections: the walk around check, the machinery house/machinery area check, the operator's cab check, and the operational check.
The operator may perform the check from the various groupings in parallel.

Knowledge Check

1. Select the best answer. A complete check of the crane is performed by the operator prior to:

A. the first use of the crane each day
B. complex lifts only
C. moving the crane to a new location
D. securing the crane each day

2. Select the best answer. The ODCL is used to identify:

A. Conditions that may render the crane unsafe
B. Members of the current crane team
C. Who is licensed to operate the crane
D. Necessary and missing paperwork

3. Select all that apply. What are the four sections of a properly performed pre-operational check?

A. Electrical function check
B. Stability check
C. Operator's cab check
D. Operational check
E. Walk around check
F. Machinery House/Machinery Area Check

4. Select the best answer. What method of inspection is used in the operator's daily check of the crane?

A. Observing the crane in operation
B. CCI Inspection
C. Review of OEM manual
D. Sight, sound and touch

Warning Tags

Before energizing the crane, look for warning tags. You may find warning tags posted with the certification card or information, attached on the pendant controller or other types of crane controls, or on the power source of the crane.

The red danger tag prohibits operation of equipment when its operation could jeopardize the safety of personnel or endanger equipment. If you discover one, never energize the crane with a danger tag attached! Energizing equipment with a danger tag attached may result in personnel injury or equipment damage.

The yellow caution tag generally gives some type of warning, precaution, or special instructions to the operator of the crane. Most caution tags inform of hazardous conditions such as rail stops, swing interference, crane clearance problems, etc. Always read and follow the written instructions on the tag before operating the crane. If you do not understand the instructions, ask your supervisor for clarification.

A Lockout Tag is installed to inform you that the energy has been locked out, and is used to protect the person or persons who hung the tag while they are working on the affected system or component. It is intended for one shift use and is usually accompanied by a physical locking device to prevent operation.

Another tag you may find is an “Out of Service” tag. An Out of Service tag is normally installed to perform maintenance, testing, or inspection. When you find this tag, do not use or operate the crane.

Remember, only authorized personnel may install or remove warning tags.

Who Can Remove Warning Tags?

Only authorized personnel may install or remove warning tags. Who are the authorized personnel? The person who applied the tag and sometimes his or her supervisor.

Critical Components

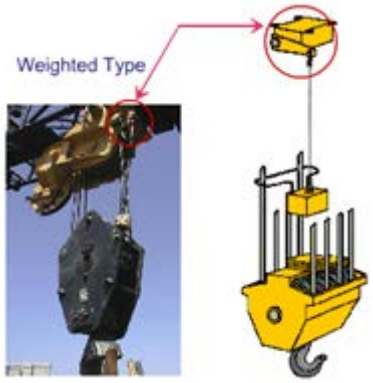
The ODCL identifies components that are critical to the safe operation of the crane. Critical components are load-bearing parts, load-controlling parts, and operational safety devices. They are identified by an asterisk (*) next to the item. Any deficiency to a critical component or safety hazard must be reported to your supervisor immediately, and the crane shall not be operated until resolved.

Limit Switches

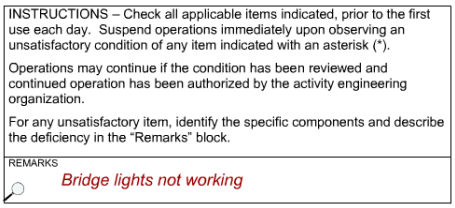
Limit switches are operational safety devices that prevent damage to the crane if a loss of control occurs. Most cranes are equipped with limit switches.

The purpose of a hoist limit switch is to prevent over-travel of the hook block and the possibility of two-blocking. Two-blocking occurs when the hook block comes in contact with the upper sheave block during hoisting of the hook (or lowering the boom). Two-blocking is dangerous because it could result in damage to the crane, parting of the hoist lines, and dropping the load.

These images are examples of weighted-type hoist upper-limit switches.



A spring-loaded switch opens the circuit when the hook block raises the weight. Interruption of power to the hoist function stops the upward movement of the hoist block to prevent two-blocking.


INSTRUCTIONS – Check all applicable items indicated, prior to the first use each day. Suspend operations immediately upon observing an unsatisfactory condition of any item indicated with an asterisk (*).

Operations may continue if the condition has been reviewed and continued operation has been authorized by the activity engineering organization.

For any unsatisfactory item, identify the specific components and describe the deficiency in the "Remarks" block.

REMARKS

Bridge lights not working

Unsatisfactory Conditions

You must give a detailed description of unsatisfactory conditions in the remarks block of the ODCL form. If you discover a load bearing part, load controlling part or operational safety device that is unsatisfactory, you must stop, secure the crane, and notify your supervisor.

The supervisor shall immediately report the crane deficiency to the crane inspection organization. The item shall be marked by the operator as unsatisfactory on the ODCL and the deficiency shall be described in the remarks block.

Minor deficiencies must be marked as unsatisfactory on the ODCL and the operator shall describe the deficiency in the remarks block.

The supervisor shall provide the ODCL to the organization responsible for corrective action.

Recording Results

Results of the inspection must be noted on the ODCL. Each item shall be marked "S" for satisfactory, "U" for unsatisfactory or "N/A" for not applicable.

The operator signs the ODCL after performing the pre-operational check.

The ODCL shall be turned in to the supervisor after the last use of the crane each day.

Knowledge Check

1. Select the best answer. On the ODCL, critical components are identified by _____.

   A. Asterisks (*)
   B. Bold letters
   C. Ampersand (&)
   D. Letter color: red for critical – yellow for cautionary

2. Select the best answer. Critical components must be carefully examined during the ODCL. Which of the following are considered critical components?

   A. Windlocks, Stops and Bumpers
   B. Emergency Stop Button
   C. Batteries

3. Select the best answer. If you discover a load bearing part, load controlling part or operational safety device that is unsatisfactory, you should:

   A. Report the situation to crane inspection
   B. Report the situation to crane maintenance
   C. Stop, secure the crane and notify your supervisor
   D. Resolve the situation before continuing

4. Select the best answer. Whether a critical component or not – any unsatisfactory conditions must be:

   A. Described in the “Remarks” block of the ODCL
   B. Delivered to maintenance and engineering for action

5. Select the best answer. Each item on the ODCL shall be marked:

   A. Correct, incorrect, not applicable
   B. Satisfactory, unsatisfactory, or not applicable
   C. Stable, unstable, or not applicable
   D. Serviceable, unserviceable, or not applicable

6. Select the best answer. What is the purpose of a hoist limit switch?

   A. To cut off power to the crane when contacted
   B. To cause the operator to slow down
   C. To prevent over-travel of the hook block and the possibility of two-blocking
   D. To prevent rotation of the hook

Walk Around Check

This is a sample walk around check section from an ODCL.
Begin this check by walking around the crane and the job site, observing anything that is out of order or out of place as well as any potential hazards or interference.

1	WALK AROUND CHECK	S	U	NA
a	Safety Guards and Plates *	✓		
b	Carrier Frame and Rotate Base *	✓		
c	General Hardware		✓	
d	Wire Rope *	✓		
e	Reeving *			
f	Block *			
g	Hook *			
h	Sheaves or Sprockets *			
i	Boom and Jib *			
j	Gantry, Pendants, and Boom Stops *			
k	Walkways, Ladders, and Handrails			
l	Winlocks, Stops, and Bumpers			
m	Tires, Wheels and Tracks			
n	Leaks			
o	Outriggers and Stabilizers *			
p	Load Chain *			
q	Area Safety *			

Safety Guards and Plates

Check for missing safety guards and plates.

Carrier Frame and Rotate Base

Check the carrier frame and rotate base thoroughly for obvious physical damage such as cracking, bending, or deformation of plates or welds.
Check for cracking or flaking of paint that may indicate a crack or damage in the structure beneath.
Check hook rollers, bull gear, and rotate pinion.

General Hardware

As you walk around the crane look for missing and loose hardware such as nuts, bolts, brackets and fittings.

Wire Rope and Reeving

Visually check wire rope for unusual wear, fraying, birdcaging, corrosion, and kinking. Check end connections, where visible, for proper configuration, seating, and condition of wire rope.
Visually check the condition of wire rope or load chain reeving. Ensure wire rope or load chain is running true in the hook block and boom point sheaves, and laying correctly on the drum or sprockets.

Block and Hook

Visually check the condition of the block and ensure all swivels rotate freely.
Check the condition of the hook for cracks, excessive throat opening, or twist. If rigging gear is on the hook and cannot be easily removed, check the hook to the maximum extent possible without removing rigging gear.

Sheaves or Sprockets

Check, where practical, the condition of sheaves or sprockets to determine that they are free to rotate and are not cracked or chipped.

Boom and Jib

Check the condition of the boom and jib for straightness and any evidence of physical damage, such as cracking, bending, or other deformation of the steel elements or welds.
When checking lattice booms, be especially watchful for bent lattices and dents in the main chords. It is important to have bent or dented crane boom members inspected and evaluated because they can greatly reduce the strength of a boom, possibly resulting in sudden collapse of the boom.

Gantry, Pendants, and Boom Stops

Check the condition of the gantry, pendants, and boom stops.
Check the gantry for distortion or other damage.
Check boom pendants for sags or other evidence of unequal length and that the anchor pins are set.
Check boom stops to ensure they are not damaged and telescoping struts are not jammed.

Walkways, Ladders, Handrails

Check the condition of walkways, ladders, and handrails for loose mountings, cracks, excessive rust, loose rungs, or any other signs of unsafe conditions.
Ensure safety chains and gates are functional.

Windlocks, Stops, and Bumpers

Check for free action of windlocks.
Check stops and bumpers on the crane for cracks or other damage.

Tires, Wheels, and Tracks

Check the condition of tires for inflation, serious cuts, or excessive wear. If lifts on rubber are planned, check tires with a gauge for proper inflation pressure per OEM load charts.
Check wheels to ensure they are not loose or damaged.
On track machines, look for excessive slack, broken or loose pads, or any other obvious defects.

Leaks

Check for evidence on the crane and on the ground beneath the crane, of any leakage of fuel, lubricating oil, hydraulic fluid, or engine coolant.

Outriggers and Stabilizers

Check outriggers and stabilizers for damage.
If floats or pads are not permanently installed on the outriggers, ensure they are on the carrier and that they are not damaged.

Load Chain

Check for damaged or deteriorated links.

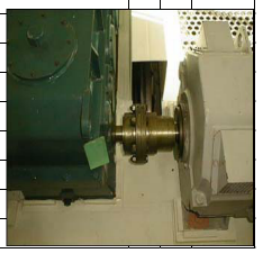
Area Safety

Check the work area and ensure that the exact locations of obstacles or hazards are known.
Ensure ground conditions are sufficiently firm to support a loaded crane.
Verify temporary connections are removed or cleared for operation (e.g., temporary shore power or hotel power).

Machinery House / Machinery Area Check

This graphic represents the machinery check section of a typical ODCL.
The operator shall perform a machinery house/machinery area check on those cranes and trolleys equipped with a safe access means.
For category 2 and 3 cab-operated cranes, the machinery area check shall be from the ground, the operator's cab, and the walkways.

2	MACHINERY HOUSE CHECK	S	U	NA
a	Housekeeping	✓		
b	Diesel Engine and Generator *	✓		
c	Leaks			
d	Lubrication			
e	Battery			
f	Lights			
g	Glass			
h	Clutches and Brakes *			
i	Electric Motors *			
j	Auxiliary Engine and Compressor			
k	Danger/Caution Tags *			
l	Fire Extinguishers			
m	Hoist Drum Pawls and Ratchets *			



Housekeeping

Check to ensure that the machinery house/area and accesses are clean.
The crane operator is responsible for the cleanliness and housekeeping of the crane.
Ensure tools and authorized materials are properly stored and that waste and debris are removed.

Diesel Engine and Generator

Check the diesel engine lube oil level, radiator coolant level, hydraulic oil level, and fuel level.
Check fan and drive belts for damage.
Check for evidence of loose fasteners, oil or grease splashes, and any indications of overheating.

Leaks

Inspect for excessive grease on machinery. Look for hydraulic brake fluid leaks around brake linings and cylinders. Check for lubricating oil leaks around gear cases. If they appear to be more than normal seepage, report the condition to your supervisor.

Lubrication

Check gear cases for lubricant level and evidence of over or under lubrication of crane components.

Battery, Lights, and Glass

Check the battery for excessive corrosion and leakage.
Check to ensure machinery house lights are working.
Check for broken or missing glass in machinery house doors or windows.

Clutches and Brakes

Check accessible portions of clutches and brakes for evidence of excessive heat, wear, or grease and oil on the linings. Check for evidence of loose fasteners and for missing or broken parts.
If a brake is equipped with a manual release mechanism, check to ensure the mechanism is not in the released position.

Electric Motors

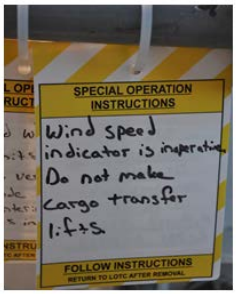
Check all motors for evidence of loose fasteners, oil or grease splashes, and any indications of overheating.

Auxiliary Engine and Compressor

Check lube oil level, radiator coolant level, hydraulic oil level, and fuel level.
Check fan and drive belts for damage.
Check for evidence of loose fasteners, oil or grease splashes, and any indication of overheating.

Danger/Caution Tags

If danger or caution tags are posted, read, understand, and follow the directions on the tags.
Check the appropriate ODCL column as follows: “S” – all tags are properly hung: “U” – tags improperly hung or otherwise deficient: “NA” – no tags.



Fire Extinguishers

Ensure fire extinguishers are in place, seals are unbroken, and inspection tags are up to date.

Hoist Drum Pawls and Ratchets

Check locking pawls and ratchets, where visible, for damage, alignment and proper engagement.

Knowledge Check

1. Select the best answer. Discoloration of the brake drum is usually caused by:

   A. Overloading the crane
   B. Normal operations
   C. Lubrication
   D. Overheating

2. Select the best answer. During inspection, cracked or flaking paint may indicate:

A. Aluminum paint on steel components
B. Latex paint over alkyd primer
C. Poor quality paint
D. Structural damage or loose bolts

ODCL Operator Cab Checks

This is a typical Operator's Cab Check section from an ODCL.
The operator should enter the cab and ensure all controls are in the neutral or off position prior to starting the engine.
Start the engine and check the items in the Operator Cab Check section.
Operators shall not carry articles in their hands, or carry large articles in their pockets when climbing ladders to access the cranes.

3 OPERATOR CAB CHECK				
		S	U	NA
a	Gauges		✓	
b	Indicator and Warning Lights	✓		
c	Visibility *	✓		
d	Load Rating Charts *	✓		
e	List/Trim Indicator (Floating Cranes) *			
f	Boom Angle/Radius Indicator *			
g	Fire Extinguisher			
h	Level Indicator (Mobile Cranes) *			
o	Danger/Caution Tags *			

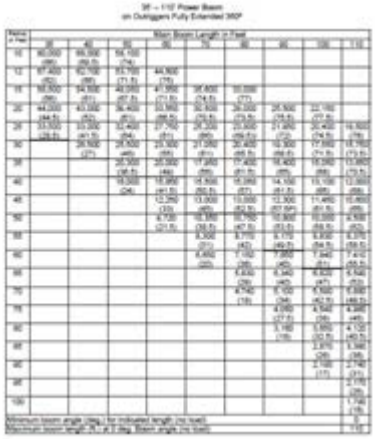
Gauges, Indicator and Warning Lights

Check gauges to ensure none are broken or missing and that they are operating normally.
Check indicator and warning lights to ensure none are broken or missing and that applicable indicator and warning lights are lit.

Visibility

Check visibility to ensure that all windows and mirrors are clean, unbroken, and that any vandal guards have been removed from windows.

Load Rating Charts



Ensure that the load rating charts are posted in the operator's cab and that they are legible.
Verify that the crane number is correct, the certification expiration date is not expired, and the crane capacity is listed.
The two expiration dates that are of particular importance to all crane operators are the expiration date of the certification of the crane being operated, and the expiration date of the operator's license. The operator cannot operate a crane if his or her license is expired, and a crane may not be operated to perform production lifts if the crane certification is expired.

List and Trim Indicator

On floating cranes, check list and trim indicators to ensure the crane is level within tolerances.
Ensure both list and trim bubble tubes are in their respective holders and not broken.

Boom Angle/Radius Indicator

Check indicator(s) for damage and ensure linkages are connected.
When electronic indicators are used, ensure power is supplied.

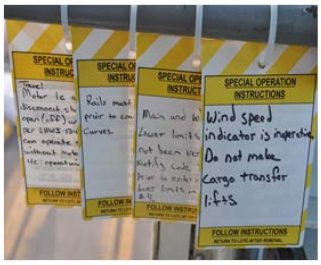
Fire Extinguishers

Ensure fire extinguishers are in place, seals are unbroken, and inspection tags are up to date.
Operators shall be familiar with the location, operation, and care of fire extinguishers provided.

Level Indicator

On mobile cranes, check the level indicator for damage.

Danger/Caution Tags



If danger or caution tags are posted, read, understand, and follow the directions on the tags.
Check the appropriate ODCL column as follows: “S” – all tags are properly hung: “U” – tags improperly hung or otherwise deficient: “NA” – no tags.

Instructions

Check to ensure all required instructions are available in the cab.
Required instructions may include: operating instructions, OEM operations manual, adverse weather operating instructions, and additional activity specific instructions.

Housekeeping

Check to ensure the operator's cab is free of clutter and unnecessary clothing, and that personal belongings, tools, maintenance products, waste, etc., are properly stored and not be permitted to lie loose about the cab or interfere with operation.

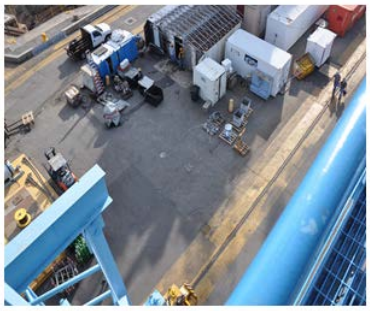
Operational Check

4	OPERATIONAL CHECK	S	U	NA
a	Area Safety *	✓		
b	Outriggers and Stabilizers *	✓		
c	Unusual Noises			
d	Control Action *			
e	Wire Rope or Chain *			
f	Brakes and Clutches *			
g	Boom Angle / Radius Indicator *			
h	Limit Switches *			
i	Emergency Stop *			
j	Other Operational Safety Devices *			
k	General Safety Devices			
l	Fleeting Sheaves			

The final check before placing the crane in service is the operational check. The operational check shall include operating the machine without load through all motions; using all controls through a range sufficient to ensure their proper operation; and verifying the proper operation of safety devices, gauges, meters, warning signals, limit switches, and other devices.
When possible, the operational check shall be conducted away from personnel and any hazardous surroundings.
A qualified rigger, if present during the operational check, should control access, observe crane operation, and report any unusual noises or other indications of unsafe conditions to the crane operator.
When performing the operational check portion of the ODCL in cold weather or icy conditions, the operator should raise the blocks and boom before lowering them to avoid damage when sheaves may be frozen.
Operators should inform rigging personnel to stand clear of the area below the blocks and boom prior to operation.

The operator should hoist up slowly, in small increments, to break any ice and/or snow free, and monitor the sheaves to ensure proper movement and operation of the sheaves and wire rope.

Area Safety



Check the work area and ensure that the exact locations of obstacles or hazards are known.
Ensure ground conditions are sufficiently firm to support a loaded crane.
It is not expected that all possible areas of travel be checked during the pre-use check. However, before any area of travel is utilized that has not been checked during the pre-use check additional attention should be focused on obstacles and potential hazards.

Outriggers and Stabilizers

Prior to initial set up, check outriggers and stabilizers to ensure they function freely.

Unusual Noises

After starting the engine, be alert for unusual noises, fluid leaks, improper functioning, incorrect readings of gauges, and loss of power or bad response to control of the engine or motors.

Controls and Control Action

Check control mechanisms for excessive wear of components and contamination by lubricants or other foreign material.
Check controls through a range sufficient to ensure that they operate freely and that the corresponding component actuates properly when controls are activated. Check hoist controls through the full speed range.

Wire Rope or Chain

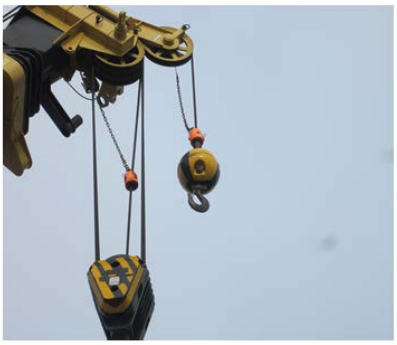
Check for proper paying-out of the wire rope or chain, that the wire rope or chain and hook blocks do not twist/spin, and that the wire rope or chain is running freely through the sheaves or sprockets and blocks.
If the boom and hoist drums or load sprocket are visible from the operator's station, check for proper spooling of the wire rope on/off the drum or chain on/off the load sprocket.
After lowering the hooks and the boom for limit switch tests and hook inspections, observe sections of wire rope or chin that may not be visible during the walk around check.

Brakes and Clutches

Check brake and clutch actions and ensure they are functioning normally and that there is no slippage, excessive play, or binding.
Exercise brakes and clutches to ensure they are dry.

Boom Angle/ Radius Indicator

Check operation of the boom angle and/or radius indicator.



Limit Switches

Checking of limit switches shall be performed at slow speed and include each upper hook hoist primary limit switch and the upper and lower boom hoist primary limit switches. (Except for cranes used in construction, verifying the operation of the upper and lower boom hoist limit switches is required only during the initial check of the crane each day.)
Checking of hook hoist lower limit switches is not required if the hook can be lowered to its lowest possible position (e.g., bottom of drydock being worked at minimum radius, floor level for a typical building crane) while still maintaining a minimum of two wraps of rope on the hoist drum (three wraps for ungrooved drums) or extra chain for a chain hoist.
For cranes that do not have the requisite number of wraps or sufficient chain, the hook hoist lower limit switch shall be checked where operationally possible, i.e., if the crane is at a location where the limit switch can be checked (where the lower limit switch is not

checked during the pre-use check, it shall be checked if the crane is subsequently relocated to a position where it can be checked).
When lower limit switch checks are not required, this shall be noted on the crane operators pendant, master switch, or operating instructions.
For cranes that have hoist overload clutches or two-block damage prevention features, do not check the overload clutches or damage prevention features. The ODCL shall be annotated to ensure that these features are not checked.
Checking of secondary limit switches is not required unless a specific operation is planned where the primary limit switch will be bypassed.

Emergency Stop

Check the emergency stop or power-off button. Know its location and ensure it is working properly. If the emergency stop is checked while a motion is in operation, check at the slowest possible speed.
Note: This is not applicable to diesel engine shutdowns on portal and floating cranes.

Other Operational Safety Devices

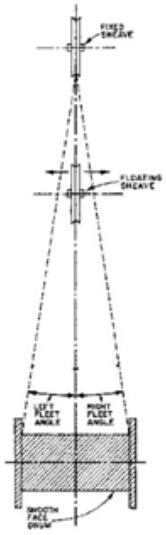
Check any other operational safety devices as directed by the activity engineering organization. An example would be deadman controls. Deadman controls refer to controllers that automatically stop operations when released.
These pictures show two types of deadman controls. A foot switch and a push-button thumb switch on top of the controller.

General Safety Devices

Check general safety devices such as sirens, horns, and travel alarms for proper operation.

Fleeting Sheaves

Check operation of fleeting sheaves, where visible, to ensure they travel freely on the shaft.
A fleeting sheave is a sheave that moves along its supporting shaft or pin.
The fleet angle is the angle formed by the lead of a rope at the extreme end of a drum with a line drawn perpendicular to the axis of the drum through the center of the nearest fixed sheave.
The picture shown provides an example of a fleeting or floating sheave.



Summary

Performing a thorough and complete pre-operational crane check is the first step toward safe and reliable crane operations.
The ODCL identifies unsafe conditions and enhances crane reliability. It verifies proper operation of the crane and is conducted once each day.
The ODCL is reviewed by subsequent operators. The operational check is required once per shift.
The ODCL is separated into four sections: the walk around check, machinery house/machinery area check, operator's cab check and the operational check.

Knowledge Check

1. Select the best answer. The crane number, certification expiration date and certified capacity are found:

   A. Posted on the crane
   B. In the EOM
   C. In the operator’s manual
   D. In the load lift review
   E. Posted in the crane maintenance area

2. Select the best answer. Dead man controls refer to controllers that automatically …

   A. Compensate for slow operator response
   B. Stop operations when released
   C. Push your hand away from the handle when the crane stops
   D. Change operational speeds to suit conditions

3. Select the best answer. If you observe a red tag on a piece of equipment, you should:

   A. Fix the problem and operate the equipment
   B. Under no circumstances operate this piece of equipment
   C. Verify the tag was from previous work
   D. Review the special instructions and operate accordingly
   E. Remove the tag and continue operations

4. Select the best answer. If you observe a yellow tag on a piece of equipment, you should:

   A. Remove the tag and continue operations
   B. Fix the problem and operate the equipment
   C. Under no circumstances operate this piece of equipment
   D. Verify the tag was from previous work
   E. Review the special instructions and operate accordingly

NOTES

DETERMINING LOAD WEIGHT

Welcome
Welcome to Determining Load Weight.

Learning Objectives
Upon successful completion of this module you will be able to identify the importance of knowing the weight of an item, choose acceptable ways to obtain weight information, calculate area and volume of basic objects and determine the weight of basic shapes.

Load Weight
Load weight determines the capacity of the crane and the rigging gear required.
If the weight is estimated to exceed 50 percent of the capacity of the hoist or 80 percent of the capacity of the rigging gear, platform/skid, below-the-hook lifting device, etc., the weight shall be verified by performing an engineering evaluation or using a local procedure approved by the certifying official or activity engineering organization. Alternatively, an LID shall be used.

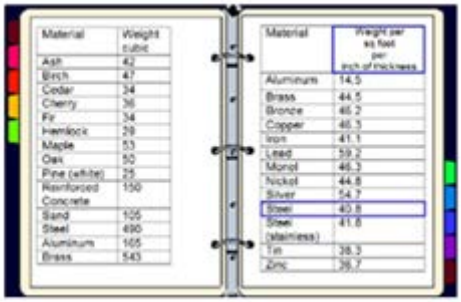
Acceptable Methods for Determining Load Weight
Load-indicating devices, label plates, documentation, engineering evaluation and calculation are all acceptable methods of determining load weight.

When using a load-indicating device (LID) to determine load weight, the rigger-in-charge shall have a reasonable estimate of the weight to be lifted. An appropriate stop point shall be established and the load indicating device shall be carefully monitored to ensure the stop point is not exceeded.

Unacceptable Methods for Determining Load Weight
Never take word of mouth to establish load weight! Word of mouth may be used as a starting point for sizing the crane and rigging gear so the component can be weighed with a load indicating device, but never shall it be used as the final determination of load weight.

To avoid overloading any equipment used in a crane lift, the rigger-in-charge shall know or have a reasonable estimate of the weight to be lifted. If the weight is estimated to exceed 50% of the capacity of the hoist or 80% of the capacity of the rigging gear, platform/skid, below-the-hook lifting device, etc., the weight shall be verified by performing an engineering evaluation or using a local procedure approved by the certifying official or activity engineering organization. Alternatively, a load indicating device shall be used.

Guidelines for Determining Load Weight
When determining the weight of an object you can always round up the dimensions and the weight, but never round down. Never mix feet and inches and double-check your answers.



Material	Weight cubic
Ash	42
Birch	47
Cedar	34
Cherry	36
Fir	34
Hemlock	29
Maple	53
Oak	50
Pine (white)	25
Reinforced Concrete	150
Sand	105
Steel	490
Aluminum	165
Brass	543

Material	Weight per sq foot per inch of thickness
Aluminum	14.5
Brass	44.5
Bronze	46.2
Copper	46.3
Iron	41.1
Lead	59.2
Monel	46.3
Nickel	44.6
Silver	54.7
Steel	40.8
Steel (stainless)	41.6
Tin	38.3
Zinc	39.7

Standard Material Weight

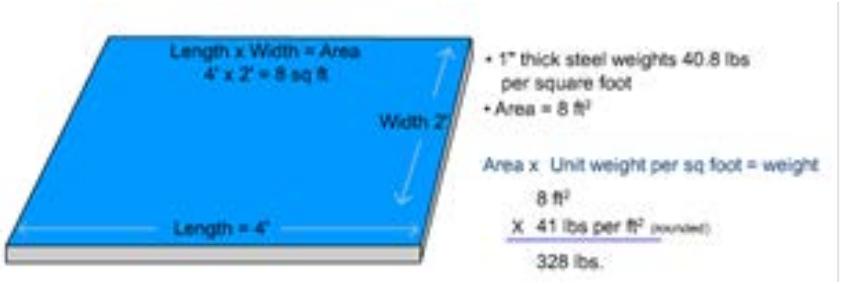
This is a standard chart showing the weights of various materials per square foot, per inch of thickness and weight per cubic foot of volume. This chart is used as an aid when calculating load weights.

Finding Weight

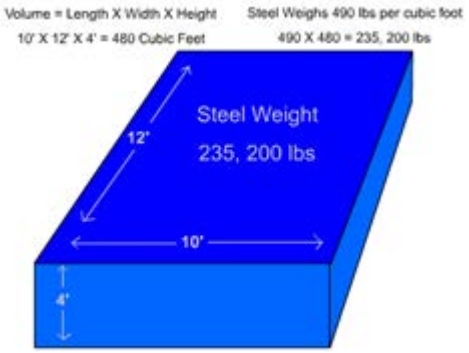
Weights may be calculated using either area or volume. Find the weight of objects such as plates by multiplying the area in square feet by the material weight per square foot, for a given thickness. To find the weight of three-dimensional objects multiply volume in cubic feet by the material weight per cubic foot. Which calculating method you use, will depend on the item. You may need to use both methods for complex objects.

Calculating Weight by Area

To calculate the weight of this plate, we must find the area and multiply it by the material weight per square foot.
Here, we have a steel plate, 4 feet by 2 feet by 1 inch thick.
The area is 8 square feet.



To calculate the weight, we need to find the unit weight, or weight per square foot for the material. Using the standard material weight chart, we find steel weighs 40.8 pounds per square foot per inch of thickness.
The math can be simplified by rounding to 41 pounds. Multiplying 8 square feet by 41 pounds per square foot gives us 328 pounds.

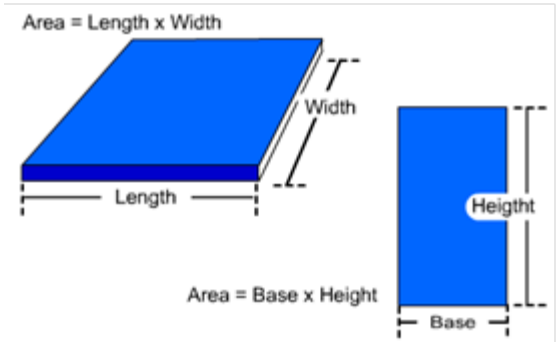


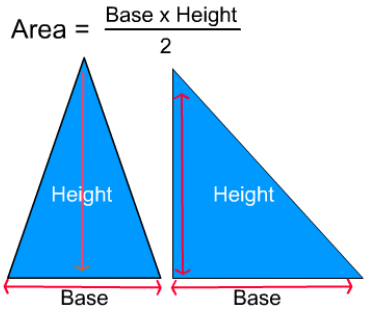
Calculating Weight by Volume

Volume is always expressed in cubic units, such as cubic inches, cubic feet, and cubic yards. Let's calculate the volume of this box. The formula is length, times width, times height. The length is 12 feet. The width is 10 feet. The height is 4 feet. When we multiply 12 times 10, times 4, the volume is 480 cubic feet.
Now we can use the standard materials weight chart and multiply the standard weight by the volume.

Calculating Area

The area of a square or rectangular shaped object is determined by multiplying length times width or base times height. The area is always expressed in square units such as square feet or square inches, even when the object is circular.



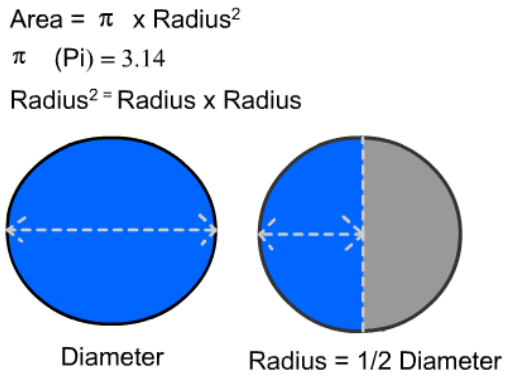


Calculating the Area of a Triangle

To calculate the area of a triangle multiply the base of the triangle by the height of the triangle and then divide by 2. The height of a triangle is the perpendicular distance from the point opposite from the base to the base.

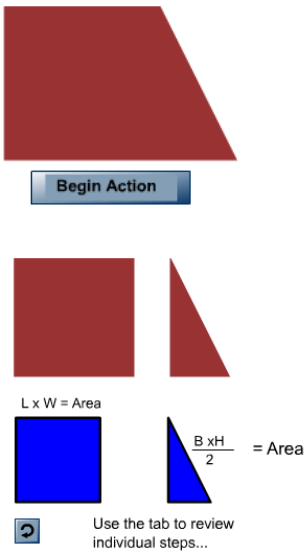
Calculate the Area of a Circle

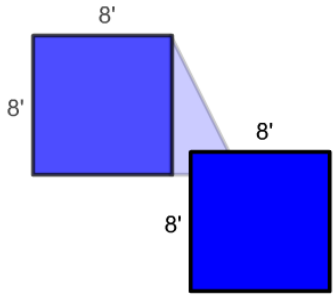
To calculate the area of a circle, multiply Pi, which is 3.14, by the radius squared. Find the radius of the circle by dividing its diameter in half. To square the radius, multiply the radius by itself. For example, if a circle has a diameter of 3 feet, the radius will be 1.5 feet. 1.5 feet times 1.5 feet equals 2.25 square feet. Therefore, the radius squared is 2.25 square feet. Pi times the radius squared would be 3.14 times 2.25 square feet, or 7.065 square feet.



Calculating the Area of Complex Shapes

Most complex shapes can be broken down into a series of simple shapes. To calculate the area of this complex shape, calculate the area of the square using the formula length times width. Next, calculate the area of the triangle using the formula base times the height divided by 2. Then add the areas together to get the total area of the complex shape.





Area = Length x Width

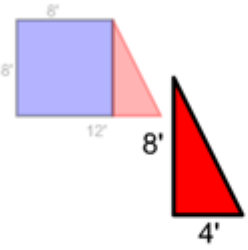
8' x 8' = 64 sq feet

Calculating the Area of Complex Shapes 2

The first step is to calculate the area of the rectangle, or square, as shown in this example. The formula for the area of a rectangle is, length times width. The length is 8 feet and the width is 8 feet. 8 feet, times 8 feet, equals 64 square feet.

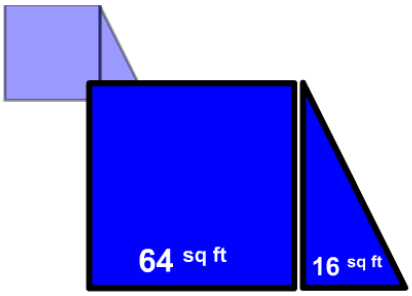
Calculating the Area of Complex Shapes

Next, find the area of the triangle. The formula for the area of a triangle is, base times height divided by 2. The base is 4 feet and the height is 8 feet. 4 feet times 8 feet equals 32 ft2. 32 ft2 divided by 2 equals 16 ft2.



$$\text{Area of a Triangle} = \frac{\text{Base x Height}}{2}$$

$$\frac{8' \times 4'}{2} = 16^{\text{sq ft}}$$



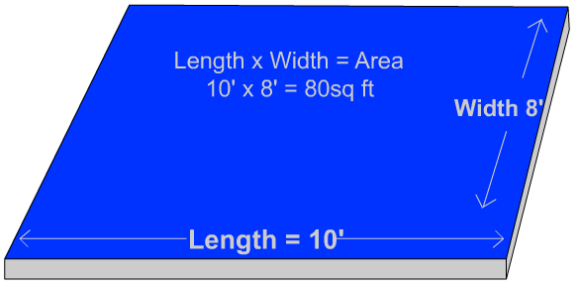
$64^{\text{sq ft}} + 16^{\text{sq ft}} = 80^{\text{sq ft}}$ Total Area

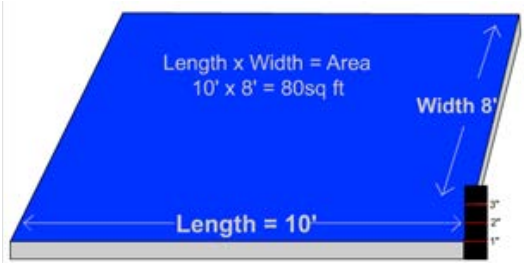
Calculating the Area of Complex Shapes

Now that we have found the area of the two sections, all we have to do is add the area of the square to the area of the triangle to find the total area of the object. 64 square feet, plus 16 square feet, equals 80 square feet. If we know what the material is and how thick it is, we can find its weight with one more calculation.

Calculating Weight Using Area - Rectangle: Step 1

To calculate the weight using area, we must find the material weight per square foot based on its thickness. Then, we simply multiply the base weight by the area of material. The area of this steel plate is 80 square feet.



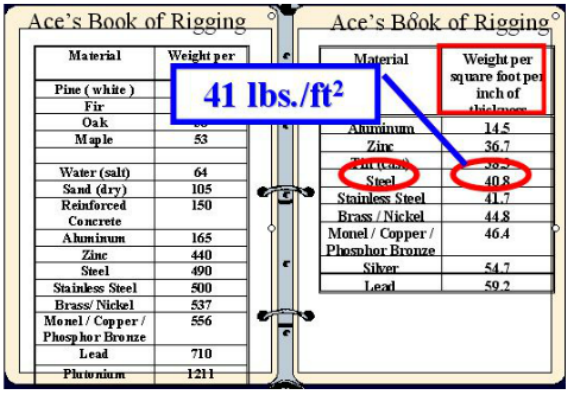


Calculating Weight Using Area - Rectangle: Step 2

Now we need to know the plate's thickness. According to the ruler, it is 1 inch thick.

Calculating Weight Using Area - Rectangle: Step 3

We can find the weight of common materials listed in several reference books available from various industry sources. Here, in "Ace's Book of Rigging", we find these tables. Material weight per cubic foot is in the left table. In the right table, unit weights are listed by weight per square foot, per inch of material thickness. We will use the table on the right since the material weights here are based on the thickness of material. We find steel listed in the "Materials" column. The unit weight is 40.8 pounds per square foot, per inch thickness of steel plate. Now let's apply the rule we learned earlier in the lesson to make the math easier and give us a safety margin in our calculations. What was the rule on rounding that we should apply to this unit of weight? Round up! So, 40.8 pounds per square foot is rounded up to 41 pounds per square foot.

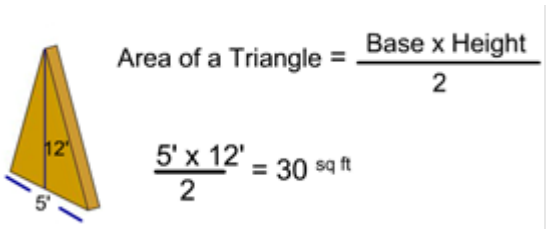


Calculating Weight Using Area - Rectangle: Step 4

To calculate the weight of the plate: Multiply the area, 80 square feet by the unit weight of 41 pounds per square foot. The weight of the plate is 3,280 pounds. If 1-inch thick steel plate weighs 41 pounds per square foot, a 2-inch thick steel plate would weigh 82 pounds per square foot. What would 1/2 inch thick steel plate weigh per square foot? It would weigh 20.5 pounds.

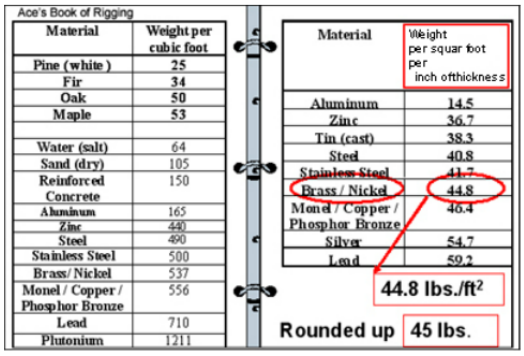
Calculating Weight Using Area - Triangle: Step 1

In this example, we have a triangular shape. How do we find the area of this plate? Multiply the base times the height and divide by 2. 12 times 5, divided by 2. The area of this plate is 30 square feet.



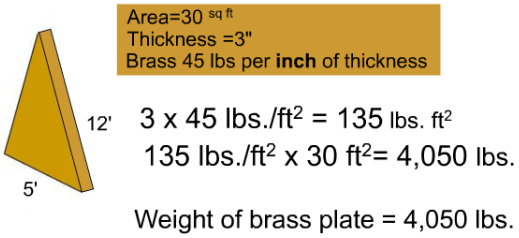
Calculating Weight Using Area - Triangle: Step 2

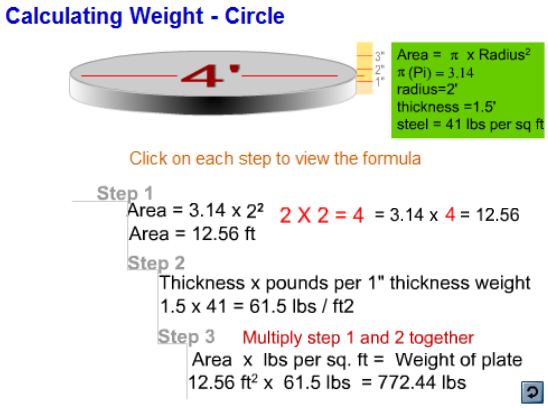
To find the weight of this plate, we have to multiply the area (30 square feet) by the unit weight of the material per inch of thickness. The material is brass, and the thickness is 3 inches. To find the total weight of the material we need to reference a table or chart to obtain the unit weight.



Calculating Weight Using Area - Triangle: Step 3

We now know that brass weighs 45 pounds per square foot, per inch of thickness. We multiply the thickness, 3 inches, by the unit weight of 45 pounds. The material weighs 135 pounds per square foot. Next, we multiply the area, 30 square feet, times the weight per square foot, 135 pounds. We find that this item weighs 4,050 pounds.



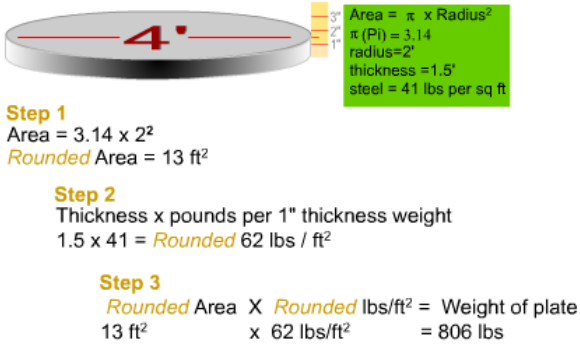


Calculating Weight Using Area - Circle

To calculate the area of a circle, multiply Pi, 3.14, by the radius squared. This steel plate is 4 feet in diameter. Therefore, the radius is 2 feet. The plate is 1 ½ inches thick. To find the area: multiply Pi, or 3.14 times the radius squared. 3.14 times 2, times 2 equals 12.56 square feet. To find the weight per square foot: multiply the plate thickness, 1 ½ inches, times the weight of 1 square foot of 1-inch thick steel. 1.5 times 41 equals 61.5 pounds. To find the weight: multiply the area, 12.56 times the unit weight of 1 ½ inch thick steel plate which is 61.5 pounds. The weight of this circular steel plate is 772.44 pounds.

Rounding Off

Rounding numbers makes calculations easier. Always round up. Rounding up give a larger area and heavier weight, therefore an added safety margin. Round up the plate area and the weight. The area, 12.56 square feet, rounded is 13 square feet. The weight, 61.5 pounds, rounded is 62 pounds. 13 times 62 equals 806 pounds.



Knowledge Check

1. Select the best answer. To find the weight of a piece of aluminum plate, you would multiply …

   A. Square feet times material weight per square foot based on a specified thickness
   B. Cubic feet times material weight per cubic foot

2. Select the best answer. A triangular shaped 1 inch thick metal plate has a base of 10 feet and a height of 15 feet. What is the area of the plate?

   A. 1,500 feet
   B. 150 feet
   C. 75 square feet
   D. 1,500 square feet

3. Select the best answer. A circular shaped ½ inch thick aluminum plate has a diameter of 7 feet. What is the area of the plate rounded up?

   A. 22 square feet
   B. 22 feet
   C. 39 square feet
   D. 7 square feet

4. Select the best answer. A complex shape of 1 inch thick aluminum plate has a rectangular area of 64 square feet and a triangular area of 16 square feet. If aluminum weighs 14 pounds per square foot, how much does the plate weigh (rounded up to the nearest hundred pounds)?

   A. 1,100 lbs.
   B. 1,300 lbs.
   C. 1,000 lbs.
   D. 1,200 lbs.

5. Select the best answer. A complex shape of 1 inch aluminum plate measures 6 feet long on the top edge, 8 feet wide on the left edge, 12 feet long on the bottom edge, ending with a 10 foot long hypotenuse connecting back to the top edge. What is the correct equation to find the area of the triangular shape?

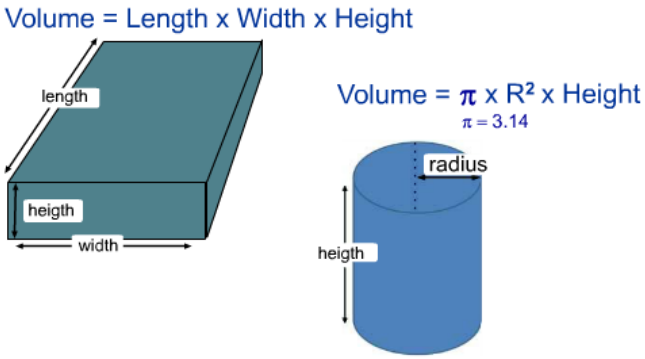
   A. 8 x 12 / 2
   B. 8 x 6 / 2
   C. 6 x 12 / 2
   D. 12 x 10 / 2

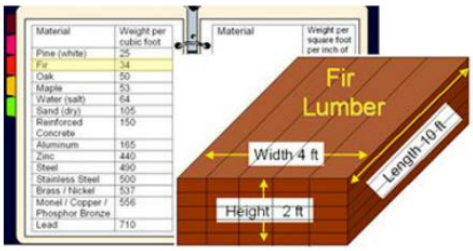
6. Select the best answer. The formula for determining the area of a triangular shaped object is:

   A. Base x Height divided by 2
   B. Base x Height x 2
   C. Length x Width x Height
   D. None of the above

Calculating Volume

The volume of a square or rectangular object is figured as length times width multiplied by the height. The volume of a cylinder is Pi times the radius squared, times the height.





80 cubic feet of fir lumber
X 34 pounds per cubic foot
2,720 pounds load weight

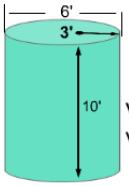
Calculating Weight Using Volume

To calculate weight by volume, we need to find the unit weight, or weight per cubic foot for the material. We go back to the tables to find the weight for a cubic foot of fir wood. This time we will use the table on the left since the material weights listed here are based on the weight per cubic foot of material. Using the standard material weight chart, we find that fir weighs 34 pounds per cubic foot. If the weight were listed in fractions or decimals, such as 33.8 pounds per cubic foot, we would simplify the math by rounding 33.8 up to 34 pounds. Multiplying 80 cubic feet by 34 pounds equals 2,720 pounds. This stack of lumber weighs 2,720 pounds.

Calculating Weight Using Area & Volume: Cylinder 1

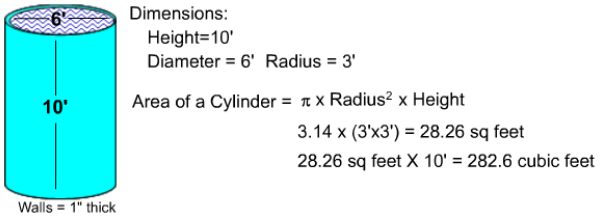
What is the formula for finding the volume of a cylinder? To calculate the volume we must first find the area of the circular end. The formula for area is Pi times radius squared. Once we know the area, we simply multiply it times the height or length. So the formula we use to find the volume of a solid cylinder is, Pi times radius squared times the height. If the cylinder were lying down you would use its length in place of the height.

Area (ft^2) of the circular end (area of a circle) = Pi x radius^2
Volume (ft^3) of a solid cylinder = Pi x radius^2 x height



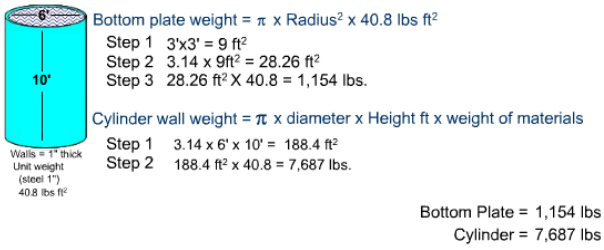
Volume of a Cylinder
Volume of a Cylinder = Pi x Radius^2 x Height

Calculating Weight Using Area & Volume: Cylinder 2



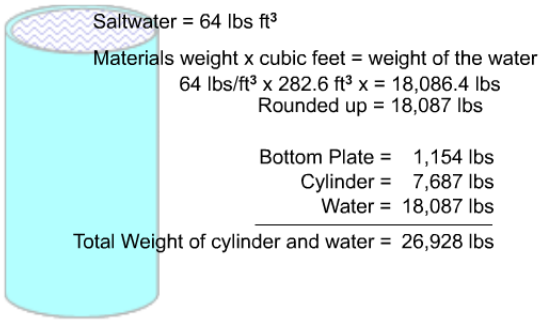
Let's calculate the volume of this cylinder. If the diameter of this object is 6 feet, what would the radius be? The radius would be 3 feet. The height is 10 feet. We multiply Pi, which is 3.14 times 3 feet times 3 feet. The result is 28.26 square feet. Now, multiply 28.26 square feet, times the height, 10 feet. The result is the volume of this cylinder, 282.6 cubic feet. If the cylinder is hollow, we will need to calculate the volume of the cylinder and the volume of the contents separately. Calculate the volume as if the cylinder is solid. Then calculate the volume of the hollow. Subtract the volume of the hollow section from the volume of the solid cylinder.

Calculating Weight Using Area & Volume: Cylinder 3



One inch steel plate weighs 40.8 pounds per square foot. The bottom plate is 6 feet in diameter, so the radius is 3 feet. 3 feet squared equals 9 square feet. We multiply 9 square feet by 3.14. This gives us the area, 28.26 square feet. We multiply this by the unit weight for steel plate (40.8 pounds per square foot). The bottom plate weighs 1,154 pounds. Calculate the cylinder wall weight as a flat plate. Multiply Pi, (3.14) by the diameter, 6 feet, and then by the height, 10 feet. Multiply the area, 188.4 square feet, by the weight of the steel plate, 40.8 pounds per square foot. The resulting weight is 7,687 pounds.

Calculating Weight Using Area & Volume: Cylinder 4



Using the volume calculation, let's find the weight of the water contained in this thin-walled cylindrical tank. Let's calculate the weight of this cylinder full of salt-water. We need to know the weight per cubic foot of salt water. Looking at our material weight chart we see saltwater weighs 64 pounds per cubic foot. We multiply the material weight times the cubic feet to find the weight of the water in the cylinder. 282.6 cubic feet times 64 pounds per cubic foot equals 18,086.4 pounds.

Now we will add up the weights: 1,154 pounds for the bottom plate, 7,687 pounds for the cylinder wall; and 18,087 pounds of water, for a total load of 26,928 pounds.

Knowledge Check

1. Select the best answer. A box has 27 cubic feet of sand in it. Sand weighs 105 lbs. per cubic foot. The box weighs 1,200 lbs. empty. The correct equation to find the total weight is:

   A. 27 x 1,200 = 32,400 + 105 = 32,505 lbs.
   B. 27 x 105 = 2,835 lbs.
   C. 27 x 105 = 2,835 + 1,200 = 4,035 lbs.

2. Select the best answer. A cylinder has a diameter of 12 feet, and a height of 17 feet. What is the volume of the cylinder rounded up?

   A. 204 cubic feet
   B. 7,687 cubic feet
   C. 204 square feet
   D. 1,922 cubic feet

3. Select the best answer. A cylinder is made of solid aluminum which has a unit weight of 165 pounds per cubic foot. What is the weight of this cylinder if the diameter is 4 feet and the height is 5 feet?

   A. 10,000 lbs.
   B. 10,362 lbs.
   C. 12,532 lbs.
   D. 10,532 lbs.

4. Select the best answer. A rectangular shaped tank has a length of 24 feet, a width of 10 feet, and a height of 12 feet. What is the volume of the tank?

   A. 2,880 cubic feet
   B. 2,900 feet
   C. 2,880 square feet
   D. 2,400 square feet

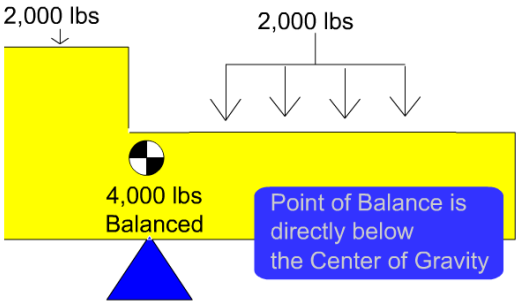
NOTES

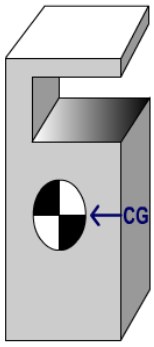
LOAD WEIGHT DISTRIBUTION

Welcome
Welcome to the Load Weight Distribution module.

Learning Objectives
Upon successful completion of this module you will be able to:
- explain the difference between the center of balance or balance point, and the center of gravity,
- understand the importance of locating an object's center of gravity,
- calculate the center of gravity of various objects,
- discuss the determining factors of weight distribution to attachment points,
- apply the "Two legs carry the load" rule,
- explain the importance of weight distribution to attachment points, and
- calculate weight distribution to attachment points.

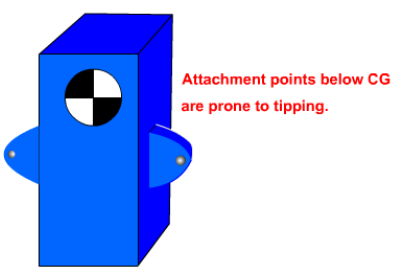
Balancing Point/Center of Balance
An object will rest in a state of balance when supported at its balance point. The balance point may not be located at the center of an object, but it is always directly below the center of gravity.

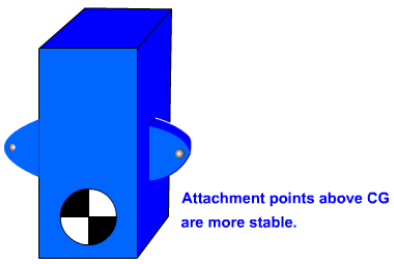




Center of Gravity
The center of gravity is the point where the entire weight of the object would balance in any direction, as if all the weight were concentrated in that one point. It is a fixed point and does not change unless the shape of the object is altered. Center of gravity is generally located in the center of symmetrical objects made of like material. For non-symmetrical objects, it must be calculated and could be located outside the object.
The hook must be centered over the center of gravity before lifting.

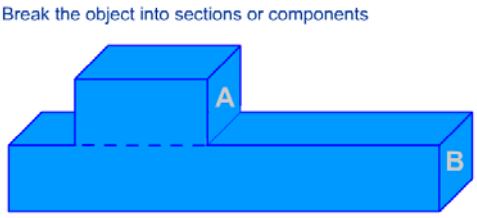
Why Find Center of Gravity
The location of the center of gravity will affect an object's reaction to movement. If the attachment points are below the center of gravity, the object will tip over more easily when moved. If the attachment points are above the center of gravity, the object is not likely to tip.





Finding the Center of Balance: Step 1

The balance point of a symmetrical object will be directly under its center. To find the balance point of a complex shape, we must first break the object into symmetrical sections or components



Finding the Center of Balance: Step 2

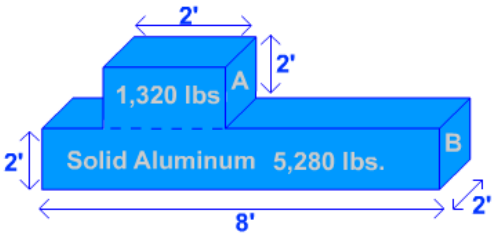
The second step is to determine the weight of each section.

Determine the weight of each section or component.
Aluminum weighs 165 lbs per cu. ft.

Part A = 2' X 2' X 2' = 8 cu. ft X 165 lbs = 1,320 lbs

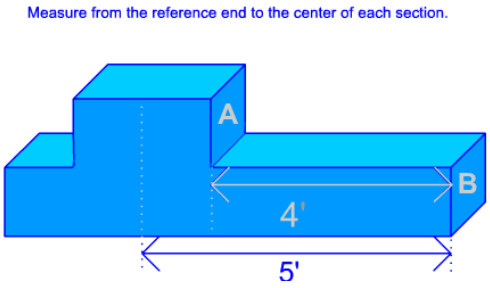
Part B = 2' X 8' X 2' = 32 cu. ft X 165 lbs = 5,280 lbs

Add the sections: 1,320 + 5,280 = 6,600 lbs



Finding the Center of Balance: Step 3

The next step is to measure from the reference end to the center of each section of the object.



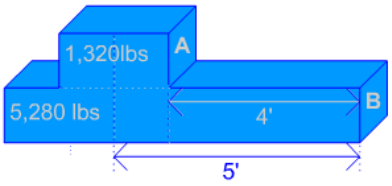
Finding the Center of Balance: Step 4

Then, multiply the weight of each section, by the distance from the reference end to the center of that section. The result is called moment. Moment is an effect produced by a force at some distance from a fixed point, such as the center of gravity. Moment, like torque, is often described in foot-pounds or pound-feet.

Multiply the weight of each section by the distance from the reference end to the center of each section.

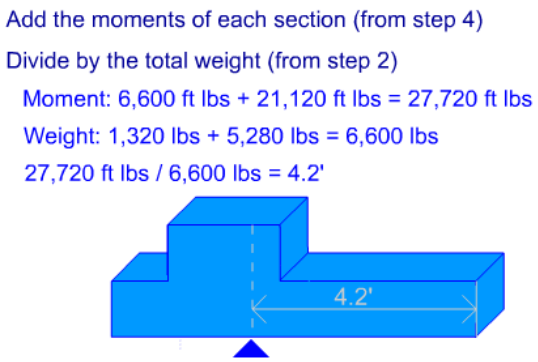
Moment of Section A = 1,320 lbs X 5' = 6,600 ft lbs

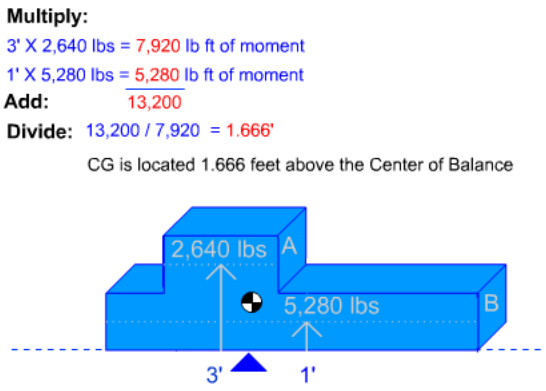
Moment of Section B = 5,280 lbs X 4' = 21,120 ft lbs



Finding the Center of Balance: Step 5

Add the moments together and divide this number by the total weight of the object. The balance point is where the moments, measured from each end, are equal.



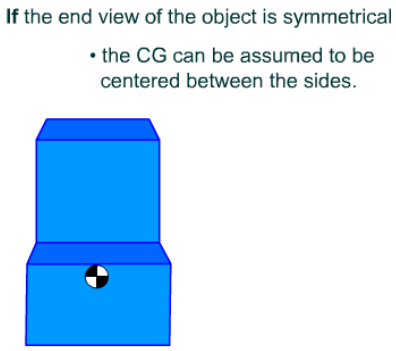


Finding the Height of the Center of Gravity

In this example the weight of section A is 2,640 pounds.
The weight of section B is 5,280 pounds.
Measure the distance from the reference end to the center of each section. Multiply the weight of each section by the distance from the reference end to the center of the section to obtain the moment.
The distance from the reference line to the center of section A is 3 feet and the distance from the reference line to the center of section B is one foot. The moment for section A is 7,920 feet. The moment for section B is 5,280 pound feet.
Add the moments together and divide by the total weight to find the height of the center of gravity.
7,920 plus 5,280 equals 13,200 pound-feet. The weight is 2,640 plus 5,280 or 7,920 pounds.
Now divide 13,200 by 7,920. The center of gravity is 1.666 feet up from the reference end.
If we convert decimal feet to inches, this equals 1 foot, 8 inches.

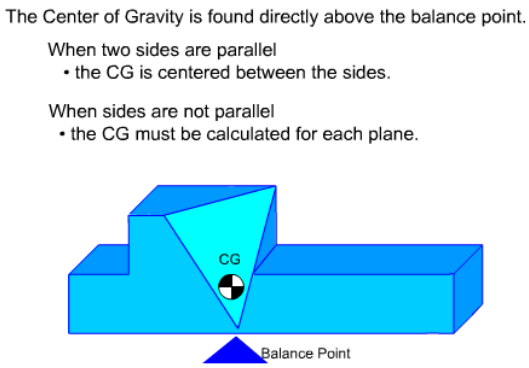
Finding CG Depth

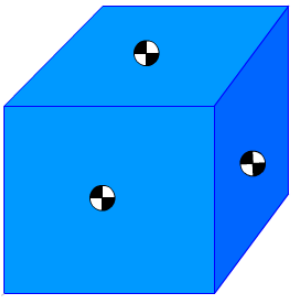
To find the depth of the center of gravity, follow the five-step process using the front of the object as the reference end for step 3. In this example, the end view shows the object is symmetrical. Therefore, we can assume the center of gravity is in the center of the object –one foot from the front.



Center of Gravity Pinpointed

The object's center of gravity is always directly above the balance point. It may be helpful to measure and temporarily mark the object's center of balance before rigging.



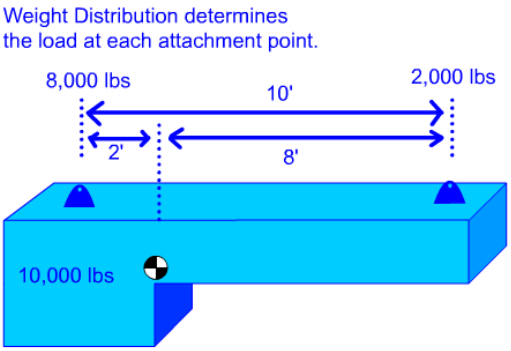


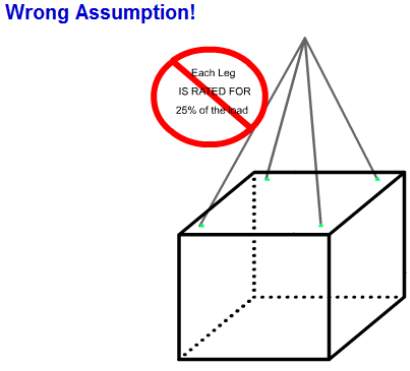
Center of Gravity Review

Remember to estimate the location of the Center of Gravity in relation to the attachment points before rigging or lifting loads. If the center of gravity is difficult to estimate, you may need engineering assistance. Loads hoisted from the bottom without restraint are susceptible to tipping. Loads should be lifted from their top, or restrained within the slings. If a load is hoisted without keeping the hook over the center of gravity, the load will shift as it clears the ground. Sometimes the rigging must be re-adjusted before making the lift.

Weight Distribution

The center of gravity provides a quick reference for how the weight is distributed throughout a load. However, before planning the lift it is necessary to refine how the load weight is distributed. Weight distribution determines what each attachment point will have to carry. This information ensures the selection of correctly rated rigging gear



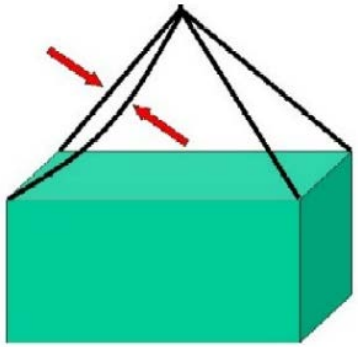


A wrong Assumption

A common assumption is that 4 legs divide the load weight into 4 equal parts. Each leg then carries 25% of the load. Most often, this is not true.

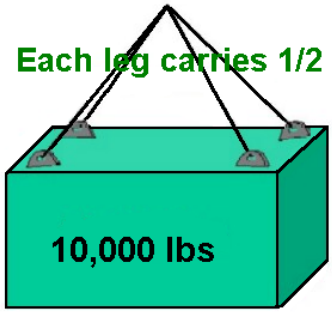
How Many Legs Really Carry the Load?

We now understand that each leg will not always carry its share of the load. In this example, one sling is longer than the others. Therefore that attachment point will not carry its share of the load. No two slings are fabricated exactly the same length. When one sling is longer than the others, when shackles or other hardware are different brands or sizes, or when one attachment point is higher than the others, one or more attachments may not carry any load at all. Don't assume that all legs will carry their share of the load.



A Safe Assumption

- Only 2 legs carry the load
- 10,000 lbs / 2 = 5,000 lbs rated load each leg

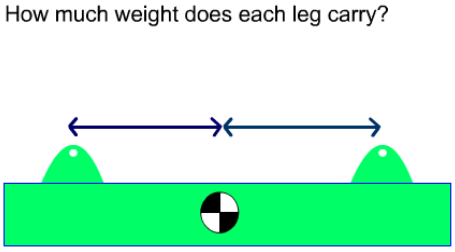


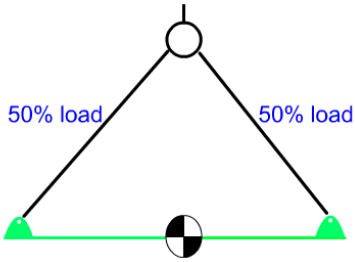
A Safe Assumption

Here is a safe assumption:
At any given time, any two legs may carry the load, even if three or more legs are used. The “two-legs-carry-the-load” rule helps us to compensate for different sling lengths, attachment points at different elevations, and load flex. Gear selections should be based on two legs being able to carry the load. For example, if an object weighs 10,000 pounds then each leg would require a rated load of at least 5,000 pounds.

Determining Leg Weight

Gear selection is dependent upon how much weight is carried by each leg - the load’s weight distribution. The distances between the Center of Gravity and the attachment points will determine how much of the weight each attachment point will carry.





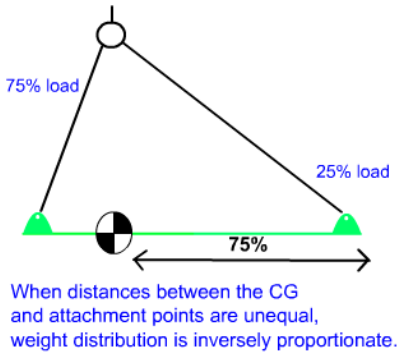
When distances between the CG and attachment points are equal, weight distribution is also equal.

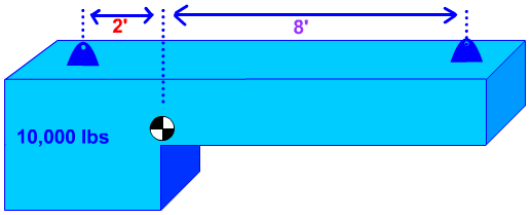
Equal Weight Distribution

This drawing represents a load. Notice the difference in weight distribution as the center of gravity changes distance from each attachment point. In this first example, each attachment carries equal weight because the center of gravity is equal distance between the attachment points. Watch the left attachment point as we move the center of gravity.

Unequal Weight Distribution

In the second example, the weight is greatest in the left attachment point because it's closest to the center of gravity. When one attachment point is closer to the center of gravity than the other attachment point, it carries more weight. It carries 75% of the weight and the opposite end carries 25%.



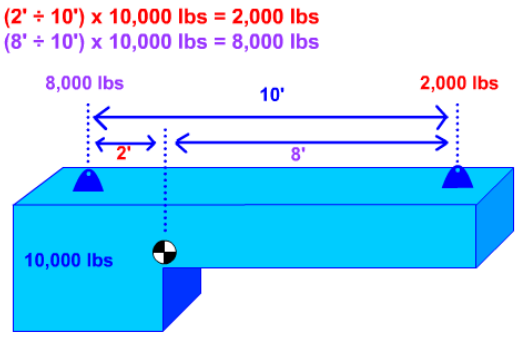


Calculating Distribution

Now, let's move beyond estimating and show how to calculate the weight distribution. In order to calculate weight distribution, you must know the object weight, the location of the center of gravity and the distance of each attachment point from the center of gravity.

Weight Distribution Example

If we want to find out how much weight is distributed to the attachment closest to the center of gravity, we divide the 8-foot distance by the overall distance between attachment points, which is 10 feet. Then we multiply this answer by the total weight of the object.
Eight divided by 10, times 10,000 equals 8,000 pounds.



Knowledge Check

1. Select the best answer. An attachment point is 2 feet from the center of gravity and the other attachment point is 6 feet from the center of gravity. What is the correct percentage of weight distribution to each attachment point with the attachment point 2 feet from the center of gravity being listed first?

   A. 33%, 66%
   B. 50%, 50%
   C. 25%, 75%
   D. 75%, 25%

2. Select the best answer. Center of Gravity is best described as:

   A. Always in the center of an object
   B. Where the item balances
   C. Where all the weight is concentrated

3. Select the best answer. The center of gravity is located below the center of balance.

   A. True
   B. False

4. Select the best answer. The center of gravity (CG) is always located within the object.

   A. True
   B. False

5. Select the best answer. Attachment point #1 is 6 feet from the center of gravity and attachment point #2 is 3 feet from the center of gravity. There is a 10,000 lb. load attached. What is the correct equation to find the weight distribution for attachment point #1?

   A. 9 divided by 3 multiplied by 10,000 (9 / 3 x 10,000)
   B. 6 divided by 3 multiplied by 10,000 (6 / 3 x 10,000)
   C. 3 divided by 6 multiplied by 10,000 (3 / 6 x 10,000)
   D. 3 divided by 9 multiplied by 10,000 (3 / 9 x 10,000)

6. Select the best answer. The center of gravity (CG) will always find its way directly under the crane hook when lifted off the ground.

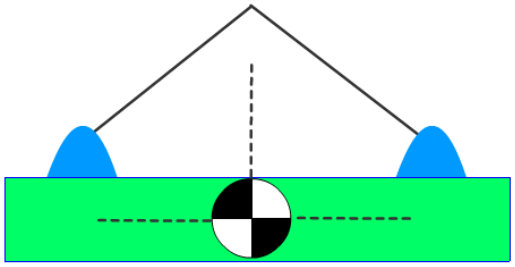
   A. True
   B. False

NOTES

SLING ANGLE STRESS

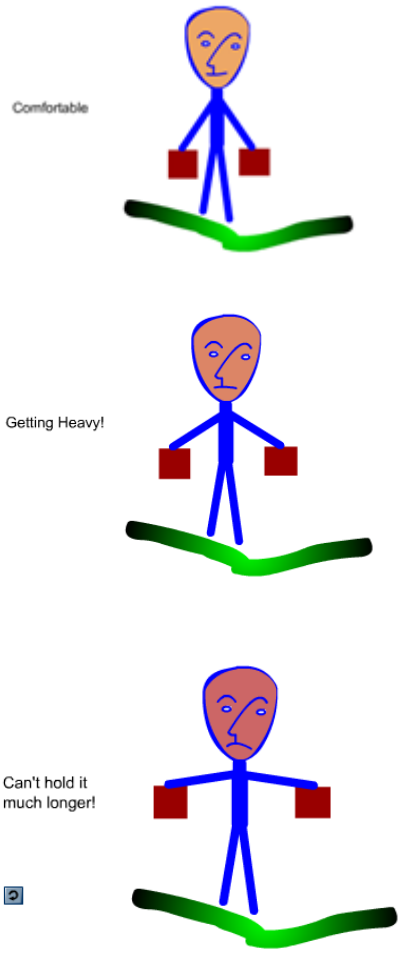
Welcome
Welcome to Sling Angle Stress.

Learning Objectives
Upon successful completion of this module you will be able to define sling angle stress and explain why it must be accounted for, calculate sling angle stress and determine the minimum sling length and rated capacity for lifts.



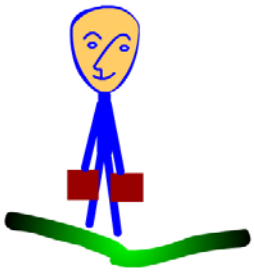
What is Sling Angle Stress?
What is sling angle stress? It is the added force or load created in the rigging when the slings are not perfectly plumb, vertical, and parallel.

Sling Angle Stress Illustration
It may be beneficial to use an illustration that we can relate to. Though this is not exactly sling angle stress, it illustrates the concept very well.



Sling Angle Stress – 90° Example

Here's Ace. He is holding a fifty-pound weight in each hand. His arms are vertical, similar to a 90° horizontal sling angle. The amount of stress in Ace's arms is equal to the amount of weight he's holding, fifty pounds. See what happens as Ace moved his arms increasingly further away from his body.

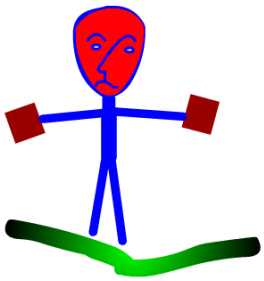


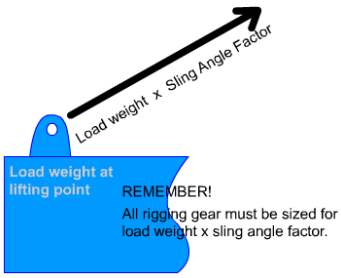
Sling Angle Stress – 45° Example

When Ace has his arms at a 45° angle the stress in his arms increases even more. The stress increase is 42% of the weight he's holding. It feels like he's holding 71 pounds in each arm.

Sling Angle Stress – 30° Example

At a 30° angle, the amount of stress in Ace's arms increases further. The stress increase at 30° is 100% of the weight he's holding. Now Ace feels like he's holding 100 pounds in each arm even though the weight is still actually 50 pounds. This same effect, called sling angle stress, occurs in rigging gear because the legs of a lift are almost always at angles. This additional stress must be considered when selecting rigging gear.





Choosing Your Gear

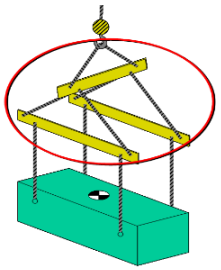
The two-leg rule is followed when choosing gear capacities for a lift. Rigging gear must have a capacity greater than the applied load. The load applied to the rigging gear includes the weight carried by the attachment points multiplied by the sling angle factor.

What Does it Affect?

Nearly every lift creates a triangle. All of the components that make up the sides of a lift triangle are affected by sling angle stress including the attachment points on the load, the crane hook, the rigging gear and the load itself. Sling angle stress can cause the load to flex and sag. Excessive sling angle stress can cause a choker hitch or basket hitch to crush a fragile item. Remember, sling angle stress does not change the weight of the load being lifted; only the load on the rigging.

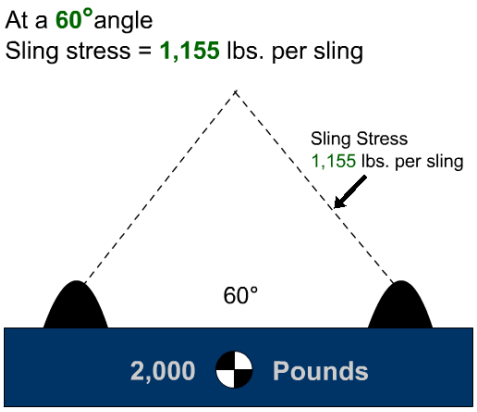
Minimizing Sling Angle Stress

Sling angle stress can be minimized by using spreaders or other below the hook lifting devices. Lifting beams or strong-backs can help ensure each sling is carrying its share of the load and that the load remains level. Sling angles may still affect the rigging gear between the hook and spreaders, even if the slings between the spreader and the load are vertical!



Sling Angle Stress Summarized

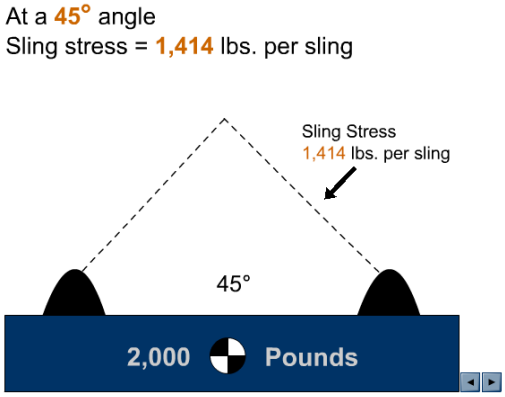
When referring to the effects of sling angle, we refer to horizontal sling angle. In other words, we are measuring the angle created between the sling and a horizontal line through the attachment points. Sling angle stress is proportional to the degree of the angle from horizontal. The more vertical the angle - the less added force. The more horizontal the angle - the greater the added force. Let's look at this principle on a load.

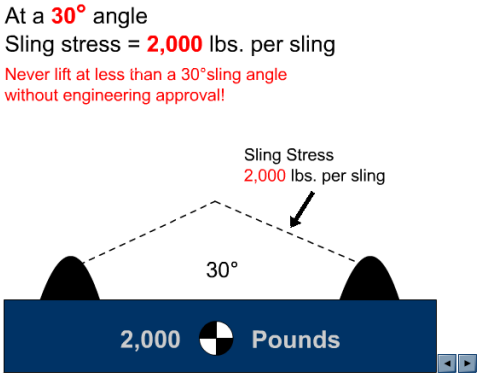


Effects of Sling Angle Stress

At a 60° angle the load on the rigging has increased to 1,155 pounds. Keep in mind each leg has 1,155 pounds of stress even though only one leg is shown. 60° is the preferred angle.

At a 45° angle the load has increased to 1,414 pounds in each sling. That's nearly a 42% increase.

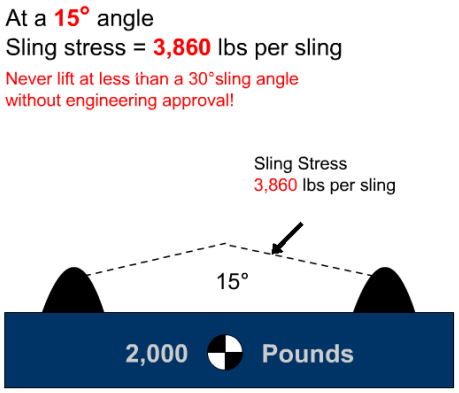




At a 30° angle the stress has increased to 2,000 pounds. Each sling now has a load equal to the weight of the object. That is a 100% increase.

Never lift with less than a 30° angle without engineering approval.

At a 15° angle the load has increased to 3,860 pounds. That's a 286% increase in each sling.



Why we Account for Sling Angle Stress

Not accounting for sling angle stress can lead to overloaded rigging gear and even catastrophic failure.

Selecting Minimum Rated Capacity

Remember, two legs must have the capacity to lift the weight of the object, plus the added force from sling angle stress. After we calculate the sling angle stress, we can determine the minimum requirements for our rigging gear.

Determine Minimum Rated Capacity

There are several ways to determine sling angle stress. We will use the angle factor chart, as it is readily available and easy to use.

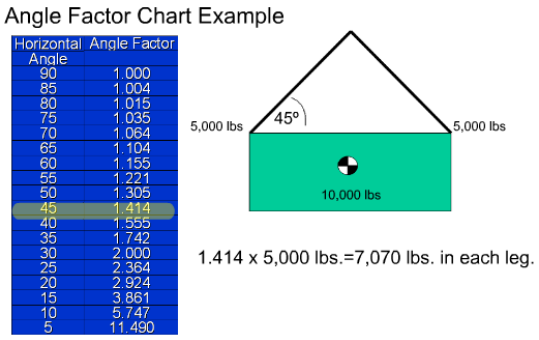
Horizontal Angle	Angle Factor
90	1.000
85	1.004
80	1.015
75	1.035
70	1.064
65	1.104
60	1.155
55	1.221
50	1.305
45	1.414
40	1.555
35	1.742
30	2.000
25	2.364
20	2.924
15	3.861
10	5.747
5	11.490

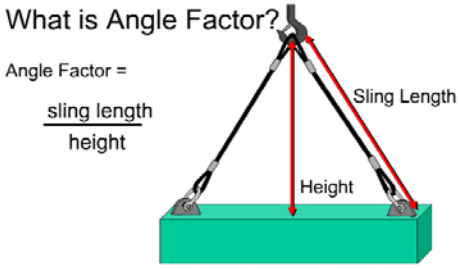
Using an Angle Factor Chart

To use an angle factor chart, you first need to determine the sling angle. Sling angle can be determined mathematically or measured. Once you have determined the sling angle, find the corresponding angle factor, and multiply that number by the weight carried in each leg. When you look at the angle factor column, you will notice a dramatic increase for angles less than 30°. That's why we do not use sling angles less than 30° unless authorized by an engineering document.

Angle Factor Chart Example

This shape represents the lift we are about to make. Let's say that the angle created by the slings we use is 45°. The angle factor for a 45° angle is 1.414. We must multiply the angle factor, 1.414 by the weight carried in the leg.
How much weight will the leg carry?
That's right, 5,000 pounds.
1.414 times 5,000 equals 7,070 pounds. This is the total stress in each leg!
This number represents the minimum gear capacity that can be used for the lift.



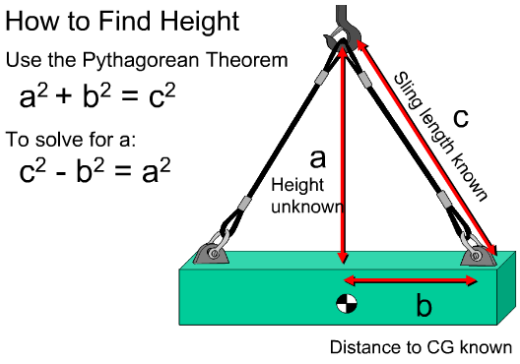


What is Angle Factor?

Remember the lift triangle? Now the whole triangle idea really comes into play. The sling angle factor is a ratio of the side of the lift triangle, which in this case is the sling, and the height of the triangle. To find it, divide the sling length by the height of the lift triangle. The height is the distance between the bearing area of the hook and an imaginary line running horizontally from the bearing area of the attachment point. If you cannot measure the height, it can be found mathematically.

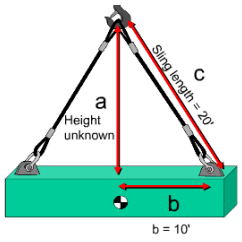
How to find Height

The Pythagorean theorem states that the length of a side of a right triangle squared, equals the length of the base squared plus the height squared.
A squared, plus B squared, equals C squared.
Here the height of the lift triangle is A, the horizontal base is B and length of the sling is C.
Only A, the height, is unknown. To find the unknown height, A, use this variation: C squared minus B squared equals A squared.



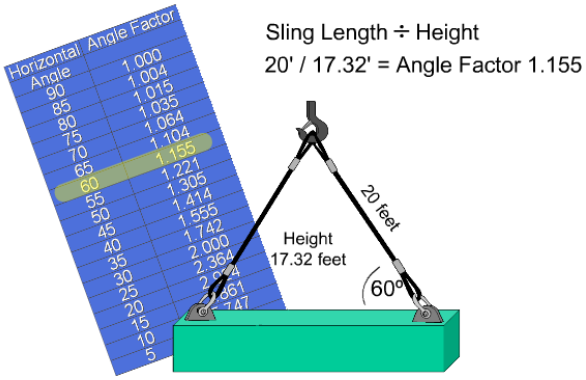
Finding Height: Example

Use C squared minus B squared equals A squared to solve for height.
The sling, C, is twenty-feet long.
Multiplying the sling length times itself gives us C squared. In this case, that is twenty times twenty or four hundred.
We measure the horizontal distance from the bearing area of the attachment to the top of the load directly above center of gravity. This dimension, B, is ten feet.
We multiply this number by itself.
10 times 10 = 100.
Subtract 100, which is B squared, from 400, which is C squared. Therefore A squared equals 300.
Now we use the square root function on our calculator to calculate the square root of 300.
The height equals the square root of 300, which is 17.32 feet.



$c^2 - b^2 = a^2$
$(20x20) - (10x10) = a^2$
$(400) - (100) = 300$
Square Root of 300 = 17.32

Height = 17.32



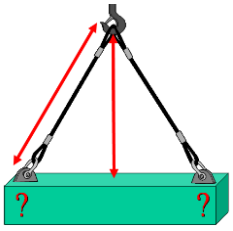
Sling Length ÷ Height
20' / 17.32' = Angle Factor 1.155

Finding Angle Factor 1

Remember the angle factor equals sling length divided by height. We just found the height of the lift triangle. Now, here's how to find the angle factor: The sling is 20 feet long and we found the height to be 17.32 feet.
20 divided by 17.32 equals 1.155. This is our angle factor.
Finally, we will multiply the angle factor by the amount of weight at the attachment point.

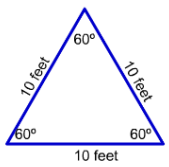
Finding Angle Factor 2

Now we can use everything we've covered thus far to solve for sling angle stress. Here's the formula: sling length **/** height **x** weight distributed to each leg
Remember, weight distribution is determined by the distance from the center of gravity to the attachment points. This works for all lifts with level attachment points.



(Sling Length ÷ Height) **x** Weight Distribution = Sling Angle Stress

60° Sling Angle - Preferred Sling Angle



- Only 16% load increase
- Easy to select slings

But...

- Best sling lengths are not always available
- Configuration may restrict
- Overhead clearance

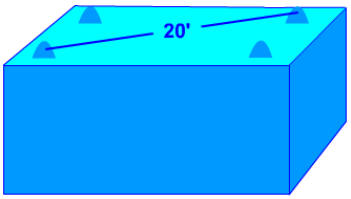
60° Sling Angle

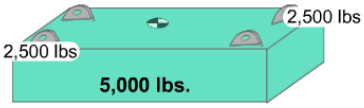
60° is the preferred sling angle. At 60°, the load in the slings increases by 16%.

Determining Sling Length for a 60° angle

To ensure your slings will have at least a 60° sling angle simply measure the distance between attachment points. Measure diagonally when there are more than two attachment points because it's the longest distance. Then select a sling that is as long, or longer than the distance measured. If you use this method to select your slings, you will never have a sling angle less than 60°.

- Measure the distance between attachment points (20')
- Select a sling as long as the distance, or longer
- In this case 20 feet.





60° angle Factor of **1.155**

1.155 x 2,500 lbs. = 2,888 lbs. Stress

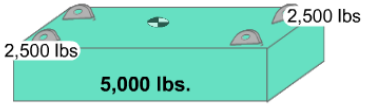
Minimum capacity sling and rigging gear require 2,888 lbs.

Determining Minimum Rated Capacity for 60° Sling Angles

Now we can easily determine the stress in the rigging before we attach the gear. Let's say the weight of the object is 5,000 pounds. How much weight would each attachment point carry? Each would carry 2,500 pounds. What is the angle factor for a 60° sling angle? The angle factor is 1.155. Multiply the angle factor, 1.155, times the weight distributed to the attachment point, 2,500 pounds. 2,888 pounds is the stress in the rigging gear and attachment points. It is also the minimum capacity for all rigging for this lift.

Determining Minimum Rated Capacity for 30° Sling Angles

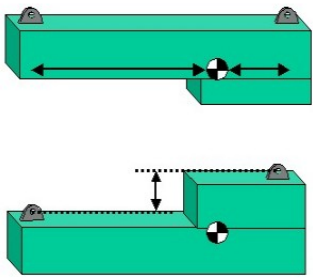
Using the same weight, let's look at the minimum rated capacities for a 30° sling angle. The angle factor for 30° is 2. At a 30° sling angle, the rigging and attachment point stress will double. Two times 2,500 pounds equals 5,000 pounds of stress. The minimum capacity sling and rigging gear required is five thousand pounds.



30° Angle Factor = **2.00**

2.00 x 2,500 lbs. = 5,000 lbs. stress

Minimum capacity sling and rigging gear require 5,000 lbs.



Unlevel / Unequal distances from CG

Where the center of balance is not equally distant between attachment points or when attachment points are on different levels, sling angle stress will not be equal between legs and extra calculations will be required. Contact your supervisor and consult the activity engineers for guidance when there is a question about sling angle stress for these types of lifts.

Knowledge Check

1. Select the best answer. A 60 degree sling angle will be formed when you match the sling length to the diagonal distance between attachment points.

   A. True
   B. False

2. Select the best answer. An object has a length of 5 feet, a width of 3 feet, and a distance of 5 feet 6 inches between attachment points. What length slings would you select to ensure the horizontal sling angle was 60 degrees or greater?

   A. 5
   B. 4
   C. 3
   D. 6

3. Select the best answer. To find sling angle stress …

   A. Multiply the weight in the attachment point with the height of the lift triangle
   B. Multiply the weight in the attachment point with the angle factor
   C. Multiply the weight of the item with the rated capacity of the gear
   D. Multiply the weight of the item with the distance between attachment points

NOTES

COMPLEX AND NON-COMPLEX LIFTS

Welcome
Welcome to the Complex and Non-Complex Lifts module.

Learning Objectives
Upon successful completion of this module you will be able to define complex and non-complex lifts, identify complex lifts, and state complex lift requirements.

Non-complex Lifts
Non-complex lifts are ordinary in nature, do not require direct supervisory oversight, and are made at the discretion of the rigger-in-charge.

Complex Lifts Overview
Complex lifts have a moderate to high level of risk. Activities are required to identify complex lifts and prepare detailed written procedures for their execution. Procedures may be in the form of standard instructions or detailed procedures specific to a lift.

Complex Lift Categories
Complex lifts include: hazardous materials; large and complex geometric shapes; lifts of personnel; lifts exceeding 80 percent of the certified capacity of the crane's hoist and lifts exceeding 50 percent of the hoist capacity for a mobile crane mounted on a barge (Excluded from this rule are lifts with jib cranes, pillar jib cranes, fixed overhead hoists, and monorails, and lifts of test weights during maintenance or testing when directed by a qualified load test director); lifts of submerged or partially submerged objects; multiple crane or multiple hook lifts on the same crane; lifts of unusually expensive or one-of-a-kind equipment or components; lifts of constrained or potentially constrained loads (a binding condition); and other lifts involving non-routine operations, difficult operations, sensitive equipment, or unusual safety risks.

Complex Lift Procedures
Activities shall identify complex lifts and prepare procedures (including rigging sketches where required) for conducting these lifts. Procedures may be standard written instructions or detailed procedures specific to a lift.
A supervisor or working leader must review on-site conditions and conduct a pre-job briefing for all complex lifts.
A rigger supervisor, operator supervisor, or a rigging or crane operator working leader shall review on-site conditions for complex lifts and shall perform a pre-job briefing before each complex lift. Any newly assigned personnel shall be briefed by the supervisor or working leader.
A rigger supervisor, operator supervisor, or working leader shall personally supervise lifts exceeding 80 percent of the certified capacity of the crane's hoist used for the lift (except for lifts of ordnance with category 3 cranes and all lifts with jib cranes, pillar jib cranes, fixed overhead hoists, and monorails), multiple-hook lifts when the weight of the object being lifted exceeds 80 percent of the certified capacity of any hoist used for the lift, and lifts of ordnance involving the use of tilt fixtures.

Subsequent identical lifts by the same crew may be done under the guidance of the rigger-in-charge.

Complex Lift Exceptions

Exceptions to the complex lift requirements include lifts over 80% of the certified capacity made with jib cranes, pillar jib cranes, fixed overhead hoists, and monorail cranes. These cranes are usually smaller capacity cranes used primarily to service only one workstation, machine or area.
Lifts of test weights during maintenance or load test are excluded from the complex lift requirements.
Ordnance lifts covered by NAVSEA OP 5 in lieu of the NAVFAC P-307 are also excluded; except for lifts using tilt fixtures, lifts where binding may occur, lifts of submerged loads, multiple crane or multiple hook lifts.

Knowledge Check

1. Select the best answer. Detailed written procedures are required for:

   A. All lifts
   B. Complex lifts
   C. Non-complex lifts
   D. Some lifts

2. Select the best answer. For all complex lifts, a rigger supervisor, operator supervisor, or rigging or crane operator working leader shall review on-site conditions and …

   A. Inspect all rigging gear
   B. Select rigging gear
   C. Conduct a pre-job briefing
   D. Define the crane operating envelope

3. Select the best answer. Lifts of test weights during maintenance or load test are …

   A. Routine lifts because they are not complex shapes
   B. Evaluated according to the complex lift requirements
   C. Excluded from the complex lift requirements
   D. Included in the complex lift requirements

4. Select the best answer. A crane with a capacity of 100,000 pounds is performing a lift of 40,000 pounds. This is a(n):

   A. Overload lift
   B. Non-complex lift
   C. Hazardous lift
   D. Complex lift

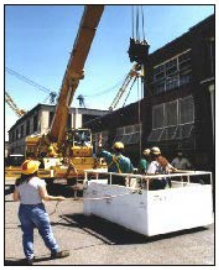
Hazardous Materials

Lifts of hazardous materials, e.g., poisons, corrosives, and highly volatile substances are complex lifts.
Materials such as oxygen, acetylene, propane or gasoline in bottles, cans or tanks that are properly secured in racks designed for lifting by a crane are excluded.

Large Complex Geometric Shapes

Complex lifts also include large and complex shapes. For example, objects with large sail area that may be affected by winds, objects with attachment points at different levels requiring different length slings, and odd shaped objects where the center of gravity is difficult to determine.

Lift Requirements for Personnel Lifts



Use cranes for lifting personnel only when no safer method is available.
Cranes, rigging gear and personnel platforms shall conform to OSHA requirements: 29 CFR Part 1926.1431 and ASME B30.23.
The total weight of the loaded personnel platform and rigging shall not exceed 50% of the rated capacity of the hoist.
A trial lift with at least the anticipated weight of all personnel and equipment to be lifted shall be performed immediately before placing personnel in the platform.
A proof test of 125% of the rated capacity of the platform must be held for 5 minutes. This may be done in conjunction with the trial lift.
A body harness and shock absorbing lanyard shall be worn and attached to a structural member within the personnel platform capable of supporting the impact from a fall. The harness and anchorage system shall conform to OSHA requirements.
Tag lines shall be used unless their use creates an unsafe condition.
Hoisting of the personnel platform shall be performed in a slow, controlled, cautious manner with no sudden movements of the crane.
Personnel shall keep all parts of the body inside the platform during raising, lowering, and positioning.
Before personnel exit or enter a hoisted platform that is not landed, the platform shall be secured to the structure where the work is to be performed, unless securing to the structure creates an unsafe situation.

Lifts Over 80% Capacity

Lifts exceeding 80 percent of the certified capacity of the crane's hoist planned for use (lifts exceeding 50 percent of the hoist capacity for a mobile crane mounted on a barge) are considered complex lifts.
Use a larger capacity hoist if possible to avoid exceeding 80% of capacity.

Submerged Lifts

Lifts of submerged or partially submerged objects are complex lifts.
The following lifts are not considered complex:
Removal of valves, rotors, pipes, etc., from dip tanks for cleaning or coating purposes.
Lifting boats of known weight from the water if the boats are of open design with bilge compartments accessible for visual inspection; the boats have label plates indicating weights; and the boats have pre-determined lifting points established by the OEM or the activity engineering organization.
Lifting submerged or partially submerged objects that meet the following criteria: the object is verified to not contain fluid in pockets and/or voids that is unaccounted for in the weight of the object; the object is verified or known to not be stuck by suction or adhesion by corrosion, marine growth, excessive surface tension, mud, etc.; and the object is verified to be clear of obstructions such as other objects in the water, or underwater cables.

Lift Requirements for Multiple Crane or Hook Lifts

Multiple-crane or multiple-hook lifts on the same crane, except for bridge or gantry cranes with hooks mechanically/structurally coupled together or control systems electrically/electronically connected, and specifically designed for simultaneous lifting such as jet engine test stand lifting cranes or synchronized antenna lifting cranes are complex lifts.
These lifts require special planning, coordination and skill.
The weight of the load and the weight carried by each crane and hook must be determined prior to the lift to avoid overloading of the cranes and/or rigging gear.
One signal person must be assigned to direct and control the entire operation.

Constrained Loads

Lifts of constrained or potentially constrained loads (binding condition) including suction caused by hydraulic conditions and loads that may be frozen to the ground are complex lifts.
Where overloading, loss of load (slack line condition) of the crane or rigging, or damage to the load is possible due to binding conditions or pre-tensioning, a portable LID with a readout readily visible to the signal person or RIC shall be used. When an LID is used, an appropriate stop point shall be estabilished and the LID shall be carefully monitored to ensure the stop point is not exceeded.
Chainfalls or other control means (e.g., procedures, micro-drives, load position/buffer) shall be used to avoid
sudden overload of the crane or rigging gear.
These lifts shall be treated as complex lifts.

Other Complex Lifts

Other complex lifts include:
Lifts of unusually expensive or one-of-a-kind equipment or components; and lifts involving non-routine operations, difficult operations, sensitive equipment, or unusual safety risks.

Crane Lift Categories Summary

There are two types of lifts, complex and non-complex. Complex lifts have a moderate to high level of risk involved. All complex lifts require preplanning, written procedures and supervisory oversight. Complex lift exceptions include: lifts by certain smaller cranes used primarily to service only one work area, cranes designed for simultaneous lifting, load tests, and ordnance lifts covered by NAVSEA OP-5; except for lifts exceeding 80 percent of the capacity of the crane's hoist, lifts using tilt fixtures, lifts where binding may occur, lifts of submerged loads, and multiple crane or multiple hook lifts..

Knowledge Check

1. Select the best answer. Which of the following identify the two basic categories of crane lifts?

   A. Usual and unusual
   B. Complex and non-complex
   C. Critical and non-critical
   D. Common and non-common
   E. None of these

2. Select the best answer. Personnel lifts are …

   A. Always considered complex lifts
   B. Not considered complex if personnel lifting devices are used
   C. Considered complex only under special conditions
   D. Not considered complex if personal protective gear is worn

3. Select the best answer. Personnel in a man-lift platform or basket must …

   A. Wear a safety belt with a shock-absorbing lanyard
   B. Stand with knees bent to absorb motion shock
   C. Wear a full body harness with a shock-absorbing lanyard
   D. Wear aircraft reflective tape on their hard hat

4. Select the best answer. For personnel lifts, the total load must not exceed …

   A. The load chart capacity
   B. 50% of the hoist's rated capacity
   C. 80% of the hoist's rated capacity
   D. The gross capacity if designated as a complex lift

NOTES

CRANE COMMUNICATIONS

Welcome
Welcome to Crane Communications.

Learning Objectives
Upon successful completion of this module you will be able to describe the communication methods used during crane operations at Navy facilities including hand signals, radio communications and direct voice.

Communication Methods
Standard hand signals provide a universal language, understood by everyone involved with weight handling. Consequently, they are the most common method used in crane operations. When presented properly, standard hand signals help prevent miscommunication and play a very important part in safe crane operations.
When making lifts where hand signals are not feasible (such as when the operator cannot see the signal person), the rigger giving the signals shall remain in continuous voice communication with the operator. The operator shall stop the crane at any time and in any situation judged to be unsafe or when communication is lost or unclear. If communication is lost, the operator shall stop operation until communication is reestablished. In addition, the operator shall immediately respond to a direction from any person to stop the crane.
Radio communications are well suited for blind and complex lifts. As a general rule, direct voice should only be used when the operator and rigger are working in close proximity and ambient noise is not a factor.

Hand Signals
Hand signals are the most widely used method of communication between signalers and crane operators. Hand signals like those found in the American Society of Mechanical Engineers, ASME B30 standards must be posted in the crane in clear view of the operator. Your activity may approve local signals in addition to these standard signals.

Hand Signal Rules
Signalers must remain in clear view of the crane operator. If the crane operator can't see you, another method of communication must be used. Only one rigger or signaler shall communicate with the crane operator at a time (except for the stop and emergency stop signals which may be given at any time by any team member).

Communication - Radio

Radios can be used to direct crane lifts while keeping crane team members informed of the lift status.
Radio guidelines: The device, or devices, used shall be tested on-site prior to crane operations. Use an isolated channel and clear the line of other traffic. Limit background noise. The operator's reception of signals shall be by a hands-free system.
Radio work practices: Voice directions given to the operator shall be given from the operator's directional perspective. Identify the crane and yourself. Each voice signal shall contain the following elements, given in the following order: function (such as hoist, boom), direction; distance and/or speed; function, stop command. Allow time between commands. Verify the command.
Note: the operator shall stop the crane at any time and in any situation judged to be unsafe or when communication is lost or unclear. In addition, the operator shall immediately respond to a direction from any person to stop the crane.

Knowledge Check

1. Select the best answer. Direct voice should only be used when:

   A. The rigger has not learned hand signals
   B. The operator and rigger are working in close proximity and ambient noise is low
   C. The operator and the rigger are working in close proximity and ambient noise is high
   D. No other form of communication is available and ambient noise is high

2. Select the best answer. In the crane cab, the crane operator must have a clear view of the …

   A. Crane lift history
   B. Crane maintenance records
   C. ASME Hand Signal Chart
   D. EOM

3. Select the best answer. How many signalers shall communicate with the crane operator at the same time?

   A. One signaler at a time
   B. Up to three signalers
   C. One signaler for each crane involved
   D. No signalers unless directed by the rigger in charge

4. Select the best answer. A universal language understood by everyone involved with weight handling is:

   A. Hand signals
   B. Signal flags
   C. Spoken word
   D. Direct voice commands

5. Select the best answer. Any additional hand signals must be …

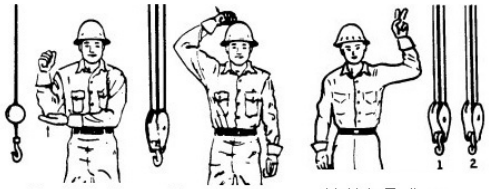
   A. Approved by the ASME
   B. Approved by OSHA
   C. Approved by the activity
   D. Approved by NOSH

6. Select the best answer. Another form of communication, other than hand signals, must be used if …

   A. The signaler is in clear view of the rigger in charge
   B. The signaler is not in clear view of the crane operator
   C. Activities designate alternative methods
   D. Ambient noise is greater than the lack of visibility

Hook and Trolley Signals

These signals indicate which hook or trolley to use and are used in conjunction with operating signals.



Auxiliary Hoist

When calling for the whip line or auxiliary hoist:

- the elbow is tapped with the opposite hand
- followed with the appropriate hook movement signal

Main Hoist

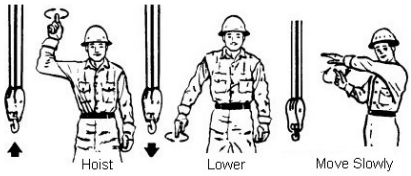
When calling for the main hoist, the signaler taps a fist on his or her hard hat and follows with the appropriate hook movement signal.

Multiple Hook & Trolleys

When working with a multiple trolley crane, these signals indicate which trolley to use. They are always followed by movement signals.

Hoist Signals

Hoist and lower signals are the same for all cranes. The distinct circular motion helps the operator see the signal clearly from greater distances and helps distinguish them from other signals.



Hoist

The hoist signal is given with the forearm vertical, the index finger pointing up, and the hand moving in small horizontal circles.

Lower

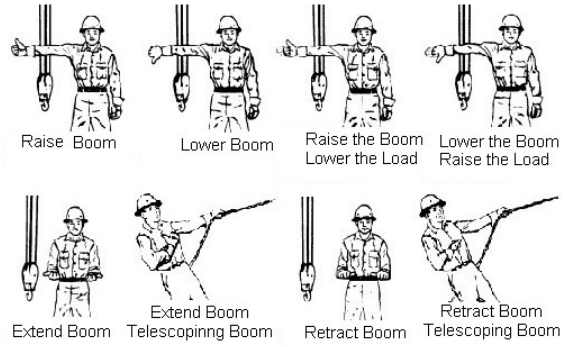
The lower signal is given with the arm extended downward, the index finger pointed down and the hand moving in small horizontal circles.

Move Slowly

A hand held motionless in front of any signal indicates to move slowly. In this clip the rigger is signaling to hoist slowly.

Boom Signals

Boom signals direct the operator to raise and lower or to extend and retract the boom. Combination boom and hoist signals allow the load to remain at the same height while booming up or down.



Raise Boom

The signal to raise the boom, or boom up, is given with an extended arm, fingers closed, and thumb pointing upward.

Lower Boom

The signal to lower the boom, or boom down, is given with an extended arm, fingers closed, and thumb pointing downward.

Raise Boom / Lower Load

The signal to raise the boom and lower the load is given with an extended arm, thumb pointing upward, and fingers flexing in and out.

Lower Boom / Raise Load

The signal to lower the boom and raise the load is given with an extended arm, thumb pointing downward and fingers flexing in and out.fingers flexing in and out

Extend Boom

The signal to extend the boom is made with both fists in front of the body and thumbs pointing outward away from each other, motioning in and out.

Extend Boom One Handed

The one handed extend signal is made with one fist in front of the chest and the thumb pointing inward with a tapping motion.

Retract Boom

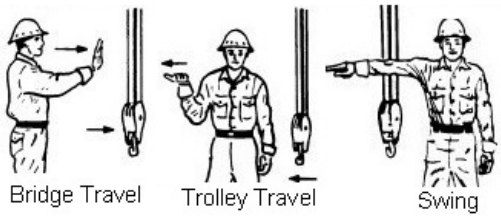
The signal to retract the boom is made with both fists in front of the body, thumbs pointing toward each other, and motioning in and out.

Retract Boom One Handed

The one handed retract signal is made with one fist in front of the chest, and the thumb pointing outward with a tapping motion.

Directional Signals Overview

Directional signals are used to guide horizontal crane movements such as bridge, trolley and swing.



Travel

The signal for crane or bridge travel is made with an extended arm, hand open with palm facing outward, and the hand moving horizontally in the desired direction of travel.

Trolley

The signal for trolley travel is made with a palm up and fingers closed, and the thumb moving in the desired direction of travel.

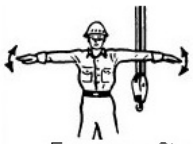
Swing

The signal for swing or rotate is an extended arm with the index finger pointed in the desired direction of rotation.

Stop Signals

Stop and emergency stop signals can be given by anyone. When these signals are given, the operator must stop operations as quickly and as safely as possible. The dog everything signal is used when all operations must be secured.


Stop


Emergency Stop


Dog Everything

Stop

The stop signal is an extended arm, palm down, moving back and forth horizontally.

Emergency Stop

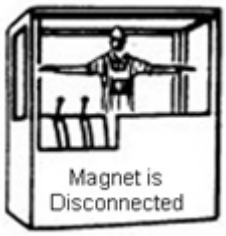
The signal for an emergency stop is both arms extended with palms down, moving them back and forth horizontally.

Dog Everything

The signal to dog everything is given to the operator when crane operations are complete, or when the crane needs to be secured. The signal to dog everything is clasped hands in front of the body.

Magnet Signals Overview

Magnet signals are used to communicate the current status of the magnet - whether it is on or off.



Magnet Disconnected

The magnet disconnect signal is used to let the person on the ground know that the electricity has been secured and it is safe to disconnect the magnet from the crane.
The magnet disconnected signal is given with both arms extended, palms up and fingers open.

Summary

In order for communications to be effective, they must be clear, concise, continuous, and understood by the crane team. Hand signals are the primary means of communication between signalers and operators. Radios are preferred for complex and blind lifts. Voice communication should only be used in close proximity and where ambient noise is not a problem.

Knowledge Check

1. Select the best answer. This signal indicates:

A. Travel
B. Use Auxiliary hoist
C. Raise Hoist
D. Use Main hoist

2. Select the best answer. When the signalers fingers are flexing in and out, this signal indicates:

A. Lower the boom
B. Stop activities
C. Lower the hoist
D. Raise the load – lower the boom

3. Select the best answer. This signal indicates to:

A. Extend the boom
B. Forward
C. Stop
D. Raise the load

4. Select the best answer. This signal indicates to:

A. Move closer
B. Retract the boom
C. Lower the load
D. Separate the load

5. Select the best answer. This signal indicates:

A. Swing
B. Travel back
C. Stop
D. Emergency Stop

6. Select the best answer. This signal indicates:

A. Stop
B. Emergency stop
C. Magnet disconnect
D. Swing

7. Select the best answer. This signal, given by the operator, indicates:

A. Magnet disconnected
B. Emergency stop

8. Select the best answer. This signal indicates:

A. Dog everything
B. Retract boom
C. Emergency stop
D. Lower load

9. Select the best answer. What is the bridge crane communications hand signal pictured, with the palms up, fingers closed, thumb pointing in the direction of motion, and jerking horizontally?

A. Swing
B. Move slowly
C. Hoist
D. Trolley travel
E. Bridge travel

10. Select the best answer. What is the crane communication hand signal pictured, with the arm extended forward, hand open and slightly raised, making a pushing motion?

A. Bridge Travel
B. Lower
C. Move slowly
D. Trolley Travel
E. Hoist

NOTES

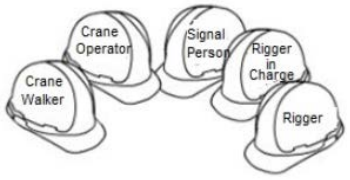
CRANE TEAM CONCEPT

Welcome
Welcome to Crane Team Concept.

Learning Objectives
Upon successful completion of this module you will be able to explain the crane team concept, define how a crane team is organized, and understand the roles and responsibilities of each team member.

Crane Team Concept
The crane team concept was developed to help ensure that crane operations are executed without injury to personnel, and without damage to property or equipment. To accomplish this goal, the crane team works together to identify and eliminate obstacles to safety.

Crane Team Members
The basic crane team consists of the crane operator and the rigger-in-charge. The supervisor may assign other personnel as required.
Additional members may include: riggers, signal persons, and crane walkers.
A rigger supervisor, operator supervisor, or a rigging or crane operator working leader may conduct team briefings.



Knowledge Check

1. Select the best answer. The Crane Team Concept was developed to ensure that all operations involving the crane are executed without:

   A. Injury to personnel
   B. Damage to property
   C. Damage to equipment
   D. All of the above

2. Select the best answer. The minimum Crane Team consists of:

   A. The Crane Operator, Crane Supervisor, and Crane Rigger
   B. The Crane Operator and Rigger-in-Charge
   C. The Crane Operator, Crane Walker, and Crane Rigger
   D. The Crane Operator, Rigger Supervisor, and Crane Rigger

3. Select the best answer. Additional Crane Team members may be assigned by …

A. The Crane Operator as required
B. The EOM designation
C. The Crane Rigger as required
D. The Supervisor as required

Crane Team Shared Responsibilities

While each member of the crane team has individual responsibilities, all team members share some common responsibility, including participation in pre-job briefings, watching for potential problems and making other team members aware of them. All team members are responsible for keeping non-essential personnel away from the crane's operating envelope during lifting evolutions.
Any crane team member shall stop the job any time unsafe conditions are found and report to supervision problems that cannot be resolved by the team.

Pre-job Briefing

A rigger supervisor, operator supervisor, or a rigging or crane operator working leader (classified as WL) shall review on-site conditions for complex lifts and shall perform a pre-job briefing before each complex lift to ensure all crane team personnel understand the required procedures for the lift.
Any newly assigned personnel shall be briefed by the supervisor or working leader.

Communications

Communications during the lift are just as important as the pre-lift brief.
All team members must be made aware of any problems that are discovered.
When making lifts where hand signals are not feasible, the rigger giving the signals shall remain in continuous voice communication with the operator. If the communication ceases, the operator shall stop operation until communication is reestablished.

Safety

Stop crane operations before personnel board the crane. Cranes should be positioned to allow safe boarding. Stop work if you're unsure about the assigned task or, if you feel safety is in jeopardy.
Have problems resolved before resuming operations.

Crane Operator Responsibilities

The crane operator must ensure that his or her license is not expired, and that the certification of the crane is not expired prior to operation. These are the two expiration dates that are of particular importance to crane operators.

The crane operator is responsible for performing the pre-use check of the crane and the operator's main concern during crane operation is operating safely. The crane operator must have a full understanding of each lift prior to execution and moves only when directed by the signal person.

Pre-Use Check

When performing the pre-use check of the crane, the operator follows and completes the Operator's Daily Checklist, the ODCL.

Full Understanding

Before making a lift, the crane operator must have a full understanding of the lift and how it is to be executed. The operator must know the exact or estimated load weight, the destination, and the capacity of the crane as it is configured.

Stop for Safety

The crane operator must immediately stop operations when the operating envelope is penetrated, if communications are lost during a blind or complex lift, and anytime a stop signal is given by anyone.

Knowledge Check

1. Select the best answer. While the members of the crane team have individual responsibilities, each have joint responsibilities as well. Each member must:

   A. Support the goal of safe operation
   B. Attend the pre-lift briefing. Any new members who replace another team member must be briefed as well
   C. Keep the Rigger-in-Charge well informed of conditions affecting personnel or the equipment during lifts.
   D. Keep non-essential personnel out of the operating area
   E. Stop operations whenever safety is in question
   F. Perform all of the listed actions above

2. Select the best answer. Securing the crane envelope is the …

   A. Sole responsibility of the crane operator
   B. Combined responsibility of all team members
   C. Sole responsibility of the rigging supervisor
   D. Combined responsibility of the crane operator and the crane supervisor

3. Select the best answer. Crane operators are responsible for all of the following except:

   A. Doing a thorough ODCL inspection
   B. Maintaining communication with the signaler
   C. Lifting and landing all loads safely
   D. Slowing down when signals are unclear

4. Select the best answer. If you feel safety is in jeopardy during the performance of your task, you should:

   A. Stop work and have the problem resolved
   B. Use the OEM manual to solve the problem
   C. Evaluate the lift plan
   D. Call your supervisor for clarification

5. Select all that apply. The crane operator must immediately stop operations when …

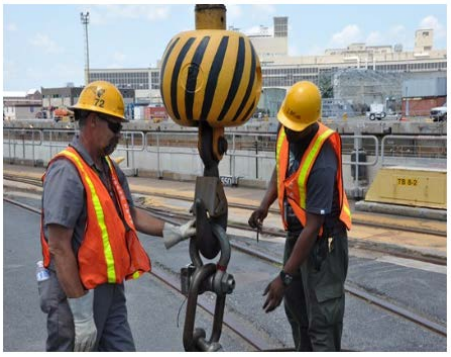
   A. Communications are lost during a blind or complex lift
   B. Any time a stop signal is given
   C. The operating envelope is penetrated
   D. Operations have exceeded allowed time
   E. The weather forecast is not good

Rigger-in-Charge Responsibilities

The rigger-in-charge (RIC) has overall control of the operation including: planning all aspects of the lift; determining the weight of the load to be lifted; establishing the appropriate method of communication with the operator; ensuring the load is properly rigged; ensuring the crane operating envelope remains clear of all obstructions; providing signals to the operator or assigning another rigger or signal person to provide the signals; and conducting the operation in a safe manner.
The RIC shall coordinate the activities of other crane team members.
The RIC shall not perform functions that would compromise their overall control of the operation.

Rigger Responsibilities

The rigger is responsible for carrying out the assignments from the rigger-in-charge and the rigger supervisor, including: assisting the crane operator in performing the pre-use check of the crane; proper gear selection and inspection prior to use; safe rigging of the load; and keeping the rigger-in-charge informed of questionable conditions associated with the operation.



Crane Walker Responsibilities

The crane walker ensures the safe travel of the crane by observing for potential obstructions, properly aligning crane rail switches, and being in a position to immediately notify the operator to stop operations should a potential problem arise.
Based on the size of the crane and congestion of the area, multiple crane walkers may be required.

Crane Walker Responsibilities – Pre-Use Check

The crane walker is responsible for assisting the rigger and operator in the pre-use check of the crane.

Signal Person

The signal person (or designated signaler) is responsible for communicating crane movements with the crane operator.
The signal person may be the rigger-in-charge, a rigger, or another qualified individual.

Supervisor Responsibilities

The supervisor is familiar with NAVFAC P-307 and supports the crane team concept. The supervisor designates crane team personnel, reviews and inspects site conditions for potential safety problems and complex lifts, reviews procedures for operations near electrical lines, investigates and reports crane accidents, and supports the team anytime they feel they need to stop a lift due to safety concerns.

Supervisor Responsibilities – Site Conditions

A rigger supervisor, operator supervisor, or a rigging or crane operator working leader shall review on-site conditions for complex lifts.

Supervisor Responsibilities – Power Lines

The supervisor assesses potential hazards and establishes procedures for safe operations around overhead electrical power lines.

Supervisor Responsibilities – Complex Lifts

A rigger supervisor, operator supervisor, or a rigging or crane operator working leader shall review on-site conditions for complex lifts and shall perform a pre-job briefing before each complex lift to ensure all crane team personnel understand the required procedures for the lift. Any newly assigned personnel shall be briefed by the supervisor or working leader.

A rigger supervisor, operator supervisor, or working leader shall personally supervisre the following lifts: lifts exceeding 80 percent of the certified capacity of the crane's hoist used for the lift (except for lifts using pillar, pillar jib, fixed overhead hoists, or monorail cranes), multiple hook lifts when the weight of the object being lifted exceeds 80 percent of the certified capacity of any hoist used for the lift, and lifts of ordnance involving the use of tilt fixtures. If the lifts are repetitive in nature, the supervisor or working leader shall be present during the first evolution of the lift with each rigging crew. Subsequent identical lifts by the same crew may be done under the guidance of the rigger-in-charge.

Supervisor Responsibilities - Accidents

The supervisor shall inspect suspected accident scenes, notify appropriate personnel, and ensure that the accident report is filed.

Knowledge Check

1. Select the best answer. If an accident is reported, the preliminary investigation will be performed by the:

   A. Rigger-in-Charge
   B. Crane operator
   C. Supervisor
   D. Crane Rigger

2. Select the best answer. Planning the lift route is the responsibility of the:

   A. Crane supervisor
   B. Rigger-in-Charge
   C. Crane operator
   D. Crane rigger

3. Select the best answer. Coordinating the activities of the crane team is the responsibility of the:

   A. Activities
   B. Rigger-in-Charge
   C. Crane operator
   D. Crane rigger
   E. Crane supervisor

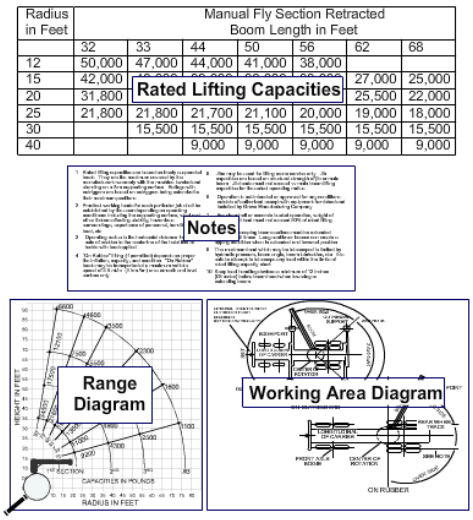
NOTES

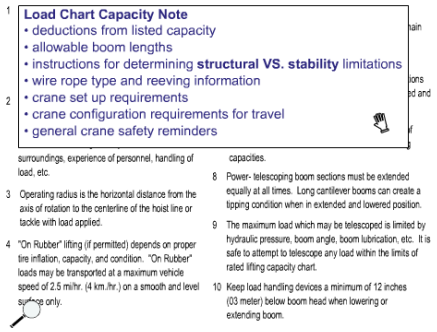
LOAD CHART REVIEW

Welcome
Welcome to Load Chart Review.

Learning Objectives
Upon successful completion of this module you will be able to: understand the parts of the load chart, understand the potential consequences of exceeding a crane's rated capacity, determine gross capacity, and calculate net capacity.

Parts of a Load Chart
The load chart usually contains the following parts: rated capacities chart, notes section, range diagram, and a working area diagram.





Notes Section
Before calculating the crane's capacity, the operator must read the general notes found on the load chart or in the load chart package.
Load chart notes contain important information such as: deductions from listed capacities, allowable boom lengths, instructions for determining structural vs. stability limitations, wire rope type and reeving information, crane set up requirements, crane configuration requirements for travel and general crane safety reminders.
Load chart notes serve as a safety refresher.

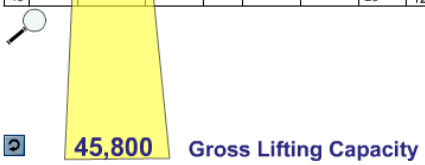
Rated Lifting Capacity Chart

The rated capacity chart is that part of the load chart that we reference to determine the crane's gross capacities. Gross capacities are listed for various boom lengths and load radii.

Rated Lifting Capacities in Pounds
40 FT. – 125FT. Boom
ON OUTRIGGERS FULLY EXTENDED -360 °
For Training Only

Radius in Feet	#0001 Main Boom Length in Feet									
	40	45	55	65	75	85	95	105	115	125
10	130,000 (70)	105,000 (72.5)								
12	111,000 (67)	105,000 (70)	94,600 (74)							
15	91,450 (61.5)	91,000 (65.5)	88,250 (70.5)	71,050 (74)						
20	69,550 (52.5)	69,050 (58)	68,400 (65)	60,400 (69)	55,250 (72.5)	48,150 (75)				
25	55,050 (41.5)	54,600 (49.5)	53,950 (58.5)	53,450 (64.5)	47,950 (68.5)	41,700 (71.5)	38,000 (73.5)	33,350 (75.5)		
30	42,950 (26)	42,450 (39.5)	41,700 (52)	41,200 (59)	41,950 (64)	36,700 (67.5)	33,300 (70.5)	30,750 (72.5)	24,550 (75)	•23,700 (76.5)
35		33,700 (26)	33,300 (44.5)	32,500 (53.5)	33,250 (59.5)	32,600 (64)	29,550 (67)	27,300 (69.5)	21,700 (72)	21,900 (74)
40	See Note 16		26,650 (35.5)	26,150 (47.5)	26,900 (54.5)	27,850 (60)	26,450 (63.5)	24,450 (66.5)	19,350 (69.5)	20,300 (71.5)
45			21,750 (23)	21,300 (40.5)	22,050 (49.5)	23,000 (55.5)	23,700 (60)	22,000 (63.5)	17,450 (66.5)	18,800 (69)
50				17,500 (32.5)	18,250 (44)	19,150 (51.5)	19,900 (56.5)	19,850 (60.5)	15,800 (64)	17,050 (66.5)
60					12,400 (30)	13,250 (41.5)	14,100 (48.5)	14,650 (53.5)	13,250 (58)	14,150 (61.5)
70						9,190 (28.5)	9,910 (39)	10,400 (46)	10,850 (51.5)	11,350 (55.5)
80							6,930 (27)	6,740 (37)	7,850 (44.5)	8,290 (49.5)
90								5,170 (25.5)	5,600 (36)	6,010 (42.5)
100									3,880 (25)	4,250 (34.5)
110										2,840 (24)
Minimum boom angle (deg.) for indicated length (no load)										0
Maximum boom length (ft.) at 0 degree boom angle (no load)										125

RADIUS	BOOM LENGTH 33'			BOOM LENGTH 45'			BOOM LENGTH 57'		
	Angle	FRONT	360°	Angle	FRONT	360°	Angle	FRONT	360°
10	67	80,000*	80,000*	74	75,000*	75,000*	74	59,600*	59,600*
12	63	76,100*	76,100*	71	73,000*	72,900*	72	55,000*	55,000*
15	57	64,200*	63,200*	67	61,700*	61,700*	66	46,300*	45,700*
20	46	45,800*	45,300*	60	46,100*	45,600*	60	35,300*	35,000*
25	31	34,700*	34,400*	52	35,100*	34,800*	54	28,800*	27,800*
30				43	27,800*	27,600*	47	22,800*	22,600*
35				32	22,500*	22,400*	40	18,900*	18,700*
40				15	17,600*	17,500*	32	15,800*	14,700*
45							20	12,700*	11,700*



Gross Capacity

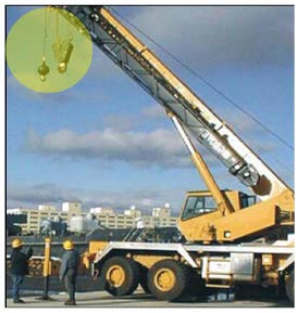
What can be safely lifted on the hook? To answer this question we must understand what gross capacity is. Gross capacity is the weight value shown on a manufacturer's load chart and the maximum amount of weight, per specific configuration, that the crane may lift, prior to deductions. In other words, the gross capacity values found on this chart are not the loads that can be suspended from the crane's hook.

What then can be safely lifted on the hook? To answer this question we must find the net capacity of the crane.

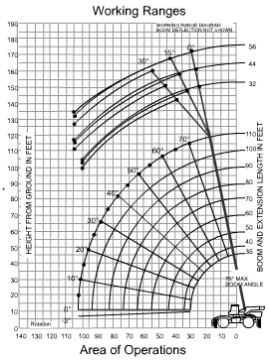
Net Capacity

Net capacity is the weight value shown on the manufacturer's load chart, minus all deductions. To calculate net capacity, subtract the effective weight of all deductions from the gross capacity. Common deductions include the weight of hook blocks, headache balls, wire rope, rigging, and attachments such as extensions, swing-away jibs, and auxiliary boom nose sections. Attachments may have different effective weights in the stowed and erected position. The effective weight of these attachments is listed in the load chart notes, in an area titled weight reductions for load handling devices.

Deductions



The weight of attachments, such as swing away jibs, stowed or erected, and the weight of auxiliary boom heads and rooster sheaves, must be deducted from gross capacity. The weight of the hooks, blocks and overhaul ball are also deducted from the gross capacity. The crane may be equipped with standard or optional hook blocks having different weights. Hook block weights and capacities should be stamped on each hook block. Be aware that some manufacturers require the weight of excess wire rope, not necessary for a lift, to be deducted.



Range Diagram

Range diagrams are used for planning lifts.

You can use them to determine the configuration of the crane needed for a particular job.

By laying out the geometry of the job on the diagram, the operator can determine the boom length, boom angle, jib length and jib offset required for the lift.

When loads must be placed above grade, the boom-tip height must allow for clearance between the boom tip and the load blocks, and the height of the load including the slings.

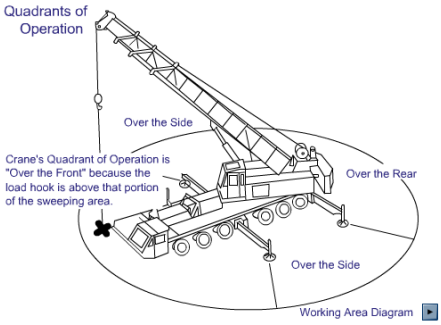
When loads must be set a certain distance in from the edge of a roof, the length of jib and necessary jib offset are easily determined by using the range diagram. It may be used to determine the boom angle of telescopic booms, when the boom is only partially extended and the radius is known.

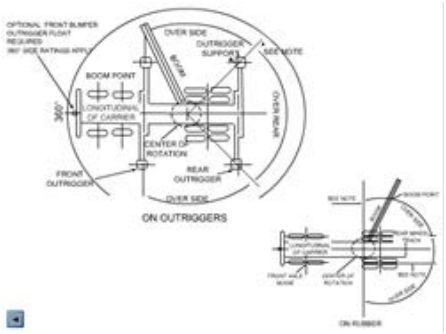
The range diagram may also be used to identify the allowable clearances between the load blocks and boom tip.

Working Area Diagram

Another important part of the load chart is the working area diagram. Crane stability and capacity will vary as the load moves from one quadrant of operation to another.

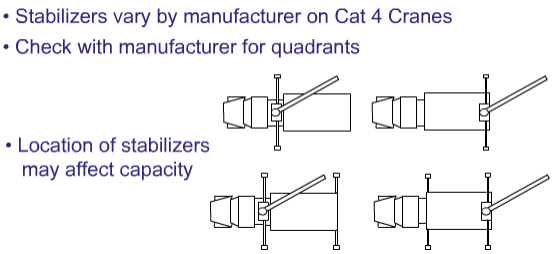
Because the crane's capacity is different in each quadrant of operation, it is important to match the load chart to the quadrant, or quadrants, the crane will be working in and through.





Category 4 Crane Quadrants of Operations

Category 4 crane stabilizers and operational quadrants vary by manufacturer. Always check OEM documentation for the location of quadrants for your machine. These diagrams provide examples of the different crane and stabilizer placements you may encounter on various category 4 cranes.

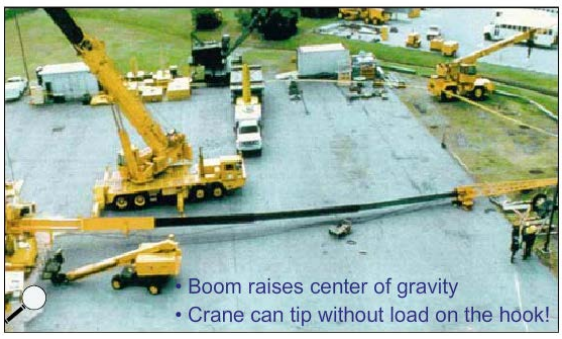


Consequences of Overloading

Exceeding the crane's rated capacity may result in one of two consequences: loss of stability or structural failure.

Loss of Stability

When a crane loses stability, the tipping force of the load overcomes the counteracting load, or counterweight of the crane. When tipping begins, especially with loads high in the air, it's very unlikely that the crane operator can do much to prevent overturning. As the crane begins to tip, the load radius increases; as the load radius increases the capacity of the crane decreases...rapidly. This happens so quickly that recovery is almost impossible.
It is therefore critical for the operator to maintain focus, situational awareness, and a thorough understanding of the crane's capability and capacity in its current configuration.



Loss of Stability – Telescopic Boom

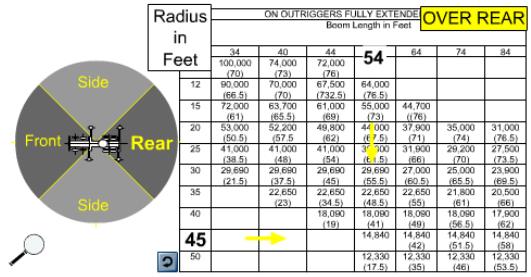
Loss of stability with telescopic boom cranes can happen more rapidly than other types of cranes because of the increased weight and higher center of gravity of the boom.
Many telescopic boom cranes will tip with no load on the hook at all, if the boom angle is too low and the boom is extended too far.

Loss of Stability - Guessing

Never rely on signs of tipping to determine whether a load can be lifted.
This is called operating by the seat-of-the-pants and may result in a catastrophe.

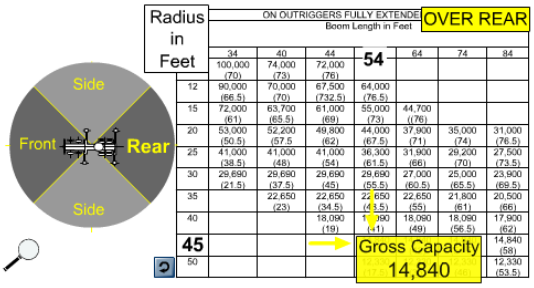
Structural Failure

If the rated capacity a crane is exceeded, the crane may fail structurally. Structural failure can result in hidden damage such as bent or twisted structural members. Structural failure can occur without warning and result in complete and catastrophic failure. Loss of stability and structural failure from overloading are avoidable if you understand and follow the crane's load chart.



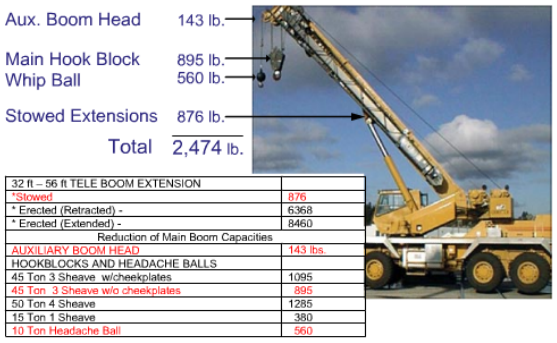
Finding Gross Capacity

Let's find the gross capacity for a particular lift. In this example, the load will be picked up over the rear quadrant. Capacity may be affected by the quadrant of operation. It's important to select the correct chart for the quadrants in which the lift will be made. In this example, the boom length is 54' and the radius is 45'. First, read down the radius column to 45'. Next, read across to the 54' boom length column to find the gross capacity: 14,840 pounds.

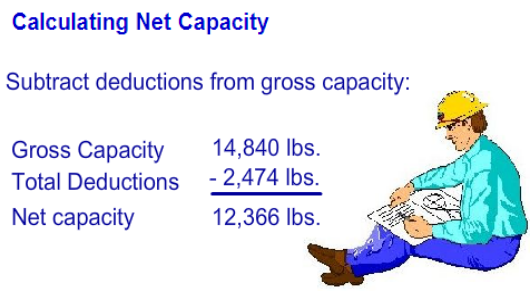


Deductions

The crane in this exercise is configured with an auxiliary boom head, weighing 143 pounds, a main hook block weighing 895 pounds, a headache ball weighing 560 pounds, and a stowed telescoping extension with an effective weight of 876 pounds.



32 ft – 56 ft TELE BOOM EXTENSION	
*Stowed	876
* Erected (Retracted) -	6368
* Erected (Extended) -	8460
Reduction of Main Boom Capacities	
AUXILIARY BOOM HEAD	143 lbs.
HOOKBLOCKS AND HEADACHE BALLS	
45 Ton 3 Sheave w/cheekplates	1095
45 Ton 3 Sheave w/o cheekplates	895
50 Ton 4 Sheave	1285
15 Ton 1 Sheave	380
10 Ton Headache Ball	560



Net Capacity

Finding the net capacity is simply a matter of subtracting the necessary deductions from the listed gross capacity. The gross capacity over-the-rear is 14,840 pounds. The deductions add up to 2,474 pounds. When the deductions are subtracted from the gross capacity we have a net capacity of 12,366 pounds over-the-rear.

Working Between Values

What should you do when the actual load radius, boom length, or boom angle is not listed on the load chart?
The following examples show how to find safe lifting capacities when the job requires working between values shown on the load chart.

Load Radius between Values

When the actual load radius falls between the values listed in the capacity chart, use the gross capacity rating for the next longer radius chart listing.
In this example the load is at a 24 foot radius.
The chart shows values in the 20 and 25 foot radius, but none at 24 foot.
To find the correct radius - use the value shown on the chart for the longer radius.
In this example the next longer radius is 25 feet.

When actual radius is between listed values, use capacity for the next longer radius.

LOAD RATING IN POUNDS
With Outriggers

Radius in Feet	Powered Boom Length in Feet							
	33 Feet		45 Feet		57 Feet		69 Feet	
	Angle	Lbs.	Angle	Lbs.	Angle	Lbs.	Angle	Lbs.
12	60	150,000	69	90,000	76	83,000		
15	54	120,000	65	86,000	71	80,000	75	74,000
20	42	90,000	58	74,000	66	67,000	71	60,000
25	25	66,000						50,000
30								43,000
35								37,000

25 Ft. = Next longer radius

When actual boom length is between listed values, **use** the **LOWER CAPACITY.**

LOAD RATING IN POUNDS
With Outriggers

Radius in Feet	Powered Boom Length in Feet							
	33 Feet		45 Feet		57 Feet		69 Feet	
	Angle	Lbs.	Angle	Lbs.	Angle	Lbs.	Angle	Lbs.
12	60							
15	54						75	74,000
20	42						71	60,000
25	25	66,000	50	62,000	60	56,000	66	50,000
30			40	48,000	54	48,000	62	43,000
35			28	37,000	47	37,000	57	37,000

45 Ft. = LOWER CAPACITY

Boom Length

When the actual boom length falls between the values listed in the capacity chart, ***use the gross capacity rating for the boom length with the lower capacity listed.***
This example shows the boom length is 36 feet. The chart shows a column for 33 and 45 foot boom lengths.
To find the correct capacity, use the column for **the boom length with the lower capacity** shown on the chart.
In this example, the correct column to use is for 45 feet of boom. So, when using a boom length anywhere between 33 and 45 feet, the gross capacity for any load radius, is obtained using the 45 foot column.
Some cranes have a slightly higher capacity at a longer boom length for the same radius in some areas of the load chart.
In this case you would choose the capacity of the shorter boom length.

Between Values for Two Variables

Sometimes you must determine gross capacity for values between those listed for both boom length and radius.
For a 24-foot radius, choose the row for the 25 foot radius,
For a 36-foot boom length, read down the column for the 45-foot boom length.
Following this procedure, the gross capacity for both radius and boom length is 62,000 pounds.
Remember, when working between values shown on a capacity chart, ***always choose the lower values listed on the load chart to determine safe capacity.***

- 24 foot radius — Read *25 feet*
- 36 foot boom length — Read *45 feet*

LOAD RATING IN POUNDS With Outriggers								
Radius in Feet	Powered Boom Length in Feet							
	33 Feet		**45 Feet**		57 Feet		69 Feet	
	Angle	Lbs.	Angle	Lbs.	Angle	Lbs.	Angle	Lbs.
12	60	150,000	69	90,000	76	83,000		
15	54	120,000	65	86,000	71	80,000	75	74,000
20	42	90,000	58	74,000	66	67,000	71	60,000
25	25	66,000	50	**62,000**	60	56,000	66	50,000
30			40	48,000	54	48,000	62	43,000
35			28	37,000	47	37,000	57	37,000

Gross Capacity = 62,000 lbs.

ALWAYS Choose the Lower Values Shown

Boom Angle Between Values

When actual BOOM ANGLE is between listed values,

...use the LOWER ANGLE

LOAD RATING IN POUNDS MAIN BOOM WITH OUTRIGGER FULLY EXTENDED AND SET				
Radius in Feet	Angle in Degrees	Over Front in Pound	Over Rear and Side	Boom Point Elevation (Feet)
25	78		87,970	106
30	75	69,670		
35	72	53,970		
40	69	43,670		
45	66	36,270		
50	63	30,770		
60	56	23,070	23,070	92
70	49	17,970	17,979	84
80	41	14,270	14,270	74

55° is between 56° and 49° Choose the angle that shows the lower capacity (49°)

When the boom angle falls between the values listed in the capacity chart, choose the boom angle with the lower capacity.
In this example the load will be lifted at a 55 degree boom angle. As you can see on the capacity chart, 55° falls between the listed angles of 49° and 56°.
To find the correct capacity, choose the row with **the lower capacity** shown on the chart.
In this example the correct reference boom angle is 49º.

Knowledge Check

1. Select the best answer. The definition of gross capacity is: the crane's lifting capacity …

   A. Plus the weight of everything carried by the outriggers
   B. Before taking any deductions
   C. After all deductions
   D. Less the weight of everything carried by the outriggers

2. Select the best answer. The capacity shown on the manufacturer's load chart is the …

   A. Minimum lifting capacity
   B. Overall lifting capacity
   C. Net lifting capacity
   D. Total lifting capacity
   E. Gross lifting capacity

3. Select the best answer. The two most likely consequences of exceeding the crane's capacity are loss of stability and …

   A. Bent and damaged rigging gear
   B. Motor burn out and failure
   C. Disciplinary action
   D. Structural failure

4. True or False. A telescopic boom crane cannot tip unless there is a load on the hook.

   A. True
   B. False

5. Select the best answer. A definition of net capacity is …

   A. The gross capacity less all applicable deductions
   B. The total of the load to be lifted
   C. The gross capacity plus all applicable deductions
   D. The total capacity of all applicable deductions

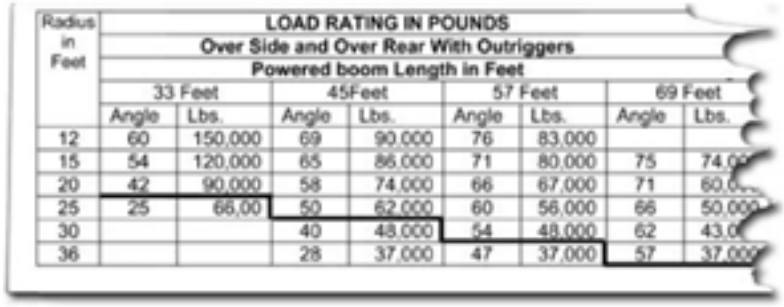
6. Select the best answer. If the gross capacity of the crane is 15,000 pounds and the combined weight of all deductions is 2,800 pounds, the net lifting capacity of this crane is …

   A. 18,000 pounds
   B. 12,200 pounds
   C. 2,800 pounds
   D. 15,000 pounds as found on the manufacturer's load chart

7. Select the best answer. When the actual radius, boom angle or boom length falls between those listed on the load chart …

   A. Use the lower capacity listed
   B. Calculate the correct percentage of the difference
   C. Use the higher capacity listed
   D. Stop and ask your supervisor

8. Select the best answer. When pre-planning a mobile crane lift, the crane operator performs a “dry run” and finds that the radius is 17 feet and the boom length is 52 feet. Using the sample load chart below, the gross capacity for this scenario is …



Radius in Feet	LOAD RATING IN POUNDS Over Side and Over Rear With Outriggers Powered boom Length in Feet							
	33 Feet		45Feet		57 Feet		69 Feet	
	Angle	Lbs.	Angle	Lbs.	Angle	Lbs.	Angle	Lbs.
12	60	150,000	69	90,000	76	83,000		
15	54	120,000	65	86,000	71	80,000	75	74,0
20	42	90,000	58	74,000	66	67,000	71	60,0
25	25	66,00	50	62,000	60	56,000	66	50,000
30			40	48,000	54	48,000	62	43,0
36			28	37,000	47	37,000	57	37,000

A. 48,000 lbs.
B. 56,000 lbs.
C. 67,000 lbs.
D. 74,000 lbs.
E. 80,000 lbs.
F. None of the above

NOTES

RIGGING GEAR TEST, INSPECTION, AND MARKING REQUIREMENTS

Welcome
Welcome to the Rigging Gear Test, Inspection, and Marking Requirements module.

Learning Objectives
Upon successful completion of this module you will be able to explain the primary goal of the test and inspection program, identify the section of NAVFAC P-307 that addresses rigging gear requirements, list the required equipment markings, identify what records must be kept, and identify the equipment covered in Section 14.

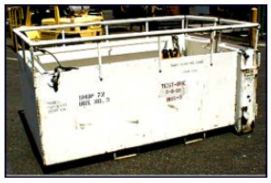
NAVFAC P-307 Section 14
Let’s look at the section of NAVFAC P-307 that deals with rigging, Section 14.
Section 14 provides selection, maintenance, inspection, test, and use requirements for rigging gear and miscellaneous lifting equipment. These requirements help ensure the rigging gear you use is safe. When followed, these requirements help ensure optimum service life of the gear.
These requirements apply to covered equipment used, with or without cranes, in weight handling operations, and to covered equipment used with multi-purpose machines, material handling equipment or "MHE" (e.g., forklifts), and equipment covered by NAVFAC P-300. These requirements also apply to contractor-owned rigging equipment used with Navy and BOS contractor-owned WHE, multi-purpose machines, MHE, and equipment covered by NAVFAC P-300 used in weight handling operations.
Except for BOS contracts, these requirements do not apply to contractor-owned equipment used with contractor-owned cranes, multi-purpose machines, MHE, backhoes, excavators, and front-end loaders.

Test and Inspection Program
NAVFAC P-307 requires each activity to establish a program that includes initial visual inspection and load test of equipment, marking, pre-use inspections before equipment is used, documented periodic inspections of equipment, and documented periodic load tests of certain equipment.
Except for hooks, rigging hardware and load indicating devices do not require load tests or documentation of inspections.

Why Test and Inspect
Why do we need a test and inspection program? The primary goal is to prevent personnel injury!
The test and inspection program is designed to identify sub-standard, defective, damaged, or worn equipment, and remove unsafe equipment from service.
Unsatisfactory equipment and gear shall be removed from service and disposed of or repaired. Equipment shall be stored before and after use in such a way and location so as to prevent damage and not be a hazard to employees. Occasionally, equipment and gear is unsatisfactory as a result of a crane or rigging accident. The activity shall determine if damage was due to a crane or rigging accident and, if so, ensure that the accident is investigated and reported in accordance with NAVFAC P-307 section 12.

Covered Equipment

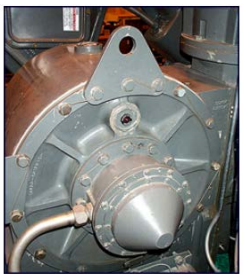
NAVFAC P-307 section 14 applies to the following equipment used in weight handling operations: rigging gear (slings, including chain, wire rope, metal mesh, synthetic rope, synthetic webbing, and synthetic roundslings; shackles; eye bolts; swivel hoist rings; links and rings; turnbuckles; insulated links; hooks; etc.); portable LIDs (dynamometers, load cells, crane scales, etc.); crane structures; and portable manual and powered hoists/winches.



Additional Covered Equipment

Also covered are below-the-hook lifting devices identified in ASME B30.20 (e.g., spreader beams, container spreaders, plate clamps, magnets, vacuum lifters); personnel platforms; portable gantry/A-frames, and portable floor cranes used for general lifting; and cranes and hoists procured with, integral to, and used solely in support of larger machine systems (milling machines, press brakes, etc.).

Equipment Not Covered



Equipment not covered includes: ordnance equipment, which falls under NAVSEA OP-5, original equipment manufacturer or OEM installed welded lift lugs, threaded holes and bolt-on pads, OEM provided rigging gear used for limited lifts such as off-loading, re-loading, initial storage, and shipment, and equipment in an approved test and inspection program (NAVAIR, NAVSEA, Strategic Systems Program, Army, or Air Force approved program).
Where OEM provided specialized rigging equipment is used, the activity shall ensure that the equipment is in good condition and that personnel using the equipment know how it is to be used.

Knowledge Check

1. Select all that apply. The reason test and inspection is required is to …

   A. Prevent personnel injury
   B. Identify sub-standard equipment
   C. Remove unsafe equipment

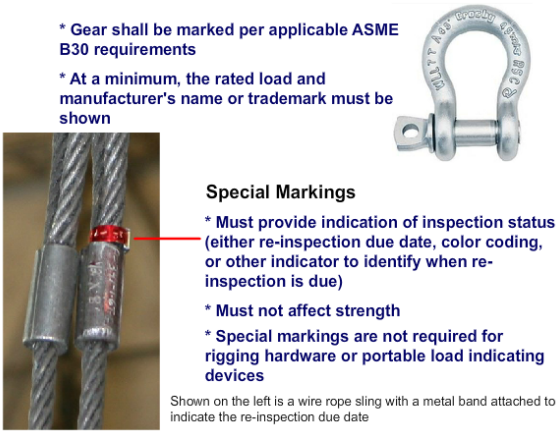
2. Select the best answer. Rigging gear identification markings applied by the activity usually indicate that the equipment is …

   A. Not damaged
   B. New to the activity
   C. In an inspection program
   D. Authorized for use

3. Select the best answer. Equipment test and inspection requirements in section 14 of NAVFAC P-307 do not apply to …

   A. OEM installed bolt-on pads
   B. Cranes and hoists integral to larger machines
   C. Container spreaders
   D. Personnel platforms

Equipment Markings



Markings on each piece of equipment are the most apparent way for you, the user, to know the requirements of NAVFAC P-307 have been met.
Equipment must be marked per the applicable ASME B30 volume (B30.9 for slings, B30.10 for hooks, B30.16 for portable hoists, B30.20 for below-the-hook lifting devices, B30.21 for lever hoists, and B30.26 for rigging hardware).
In addition to the identification and marking requirements of the applicable ASME volume, except as noted in NAVFAC P-307 paragraphs 14.8 and 14.11, each piece of equipment must be clearly marked, tagged or engraved with an indication of the re-inspection due date and a unique serial number that will allow it to be traced to its test and inspection documentation.
Below the hook lifting devices weighing more than 100 pounds shall be marked with the weight of the device.
Markings must be done in a manner that will not affect the strength of the component.
Vibra-etch methods and low stress dot faced stamps are acceptable methods for marking equipment.
Contact the OEM for guidance on where and how to mark equipment.
Load tests, documented inspections, and special equipment markings (other than the manufacturer's markings required by B30.26) are not required for equipment covered by ASME B30.26 (shackles, adjustable hardware, compression hardware, links, rings, swivels, rigging blocks, and portable load indicating devices.)

Wire Rope Endless Slings

Endless slings shall have a marked rated load based on a D/d efficiency of 50 percent and may be used over various size pins at loads not exceeding the marked rated load.
Where endless wire rope slings are designed for a particular use, they shall be marked to indicate the pin diameter used to determine the rated load.

Chain Slings

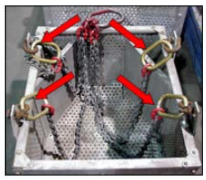
In accordance with 29 CFR 1915.112 and 29 CFR 1917.42, chain slings used in ship repair, shipbreaking, or cargo transfer require quarterly periodic inspections and must be marked to indicate the date of the next required inspection.

Lashing

Lashing must be marked to identify it to the spool or reel from which it came.
The rated load must be marked on each piece as well as the re-inspection due date.

Multi-Part Equipment

For multiple part equipment that can be separated (e.g., load indicators with custom shackles), the subordinate part (the shackle) shall be identified to the primary part (load indicator). This is not intended for standard shackles or turnbuckles, equipment that is not field disassembled such as swivel hoist rings, or for equipment for which the activity engineering organization is allowed to designate fasteners by grade only, such as portable padeye/lifting lug fasteners and eyebolt nuts. If space limitations do not permit legible marking, a tag containing required markings shall be attached and engineering guidance shall be obtained.



Multi-Leg Slings

Multi-leg slings assemblies shall be marked with the rated load of each leg, the rated load of the entire assembly, and the sling angle upon which the rated load is based.

Braided Wire Rope Slings

NAVFAC P-307 requires that braided slings shall have the OEM's marking re-marked at 70% of the OEM's rated load unless destructive tests are conducted on sample slings. The documentation is reviewed by the Navy Crane Center.
So, there are many additional markings that may be required for different equipment. Not only do these markings have to be present, they must be legible.

Illegible or Missing Markings

Sometimes markings become hard to read due to wear or they may even be removed during a repair process.
Replace markings that are hard to read or have been removed.
Remember, all rigging equipment must be marked.

Required Records

Equipment markings should link the piece of equipment to its test and inspection records.
NAVFAC P-307 requires documentation of tests and inspections.
Records are the auditable proof that equipment has been tested and inspected and provide a basis for ongoing evaluation of the equipment.
The latest test and inspection record will be retained on file at the activity.
Computer generated files are acceptable if they identify the individual components and inspection results.

MASTER HISTORY RECORD CARD	EQUIPMENT TYPE / DWG NO	EQUIPMENT ID
		CF 127D

SPS CAPACITY	MANUF. RECOMMENDED PERIODIC TEST VALUE	MAX. MATERIAL REMOVAL AUTHORIZED	PROOF TEST VALUE

RECORD OF INSPECTION / TESTING					MAINTENANCE REPAIR AND MODIFICATION RECORD		
CYCLE	PURPOSE / DESCRIPTION	S	U	** C/740 VSR/DATE	CYCLE	DESCRIPTION	**C740/VS/DATE
Annual	Load Test Chainhoist	X		J.W. Inspector 1/27/20XX			

Record Information

NAVFAC P-307 requires that the records include identification of individual components, latest test and inspection results, and dates of inspections and tests.
There are many ways to identify the equipment to the records.

Matching Gear to Record

A unique identification number may be used to identify the equipment to its record.
The ID number can be as simple or complex as you need it to be.
A simple method might be to use a letter designator that represents a particular type of gear followed by a serialized number.
Mark the equipment ID number on the gear. Write the ID number on the record.
Now the gear has identifiable records!

Gear Marking Example

This is an example of how the gear is marked at one Naval Shipyard. This is just one example of how an activity could choose to identify individual components to their records. This example reflects a fairly complex system that may be useful for activities who own multiple groups of equipment that need to be segregated.

In this example, the unique identification number is used to identify three different things.

The first number “98” identifies which shop, group, or code owns the equipment.

Secondly, “P28” identifies the specific piece of gear with a serialized number.

This particular number indicates that it was the 28th sling manufactured or certified on a specific day. The number 94-350 identifies the day it was manufactured or certified, 94 being the year 1994, 350 being the day of the year.

No matter what method you use, there is important information that should be included in the gears records.

Identifies the owener of the equipment:
- shop
- group
- code

Identifies the specific piece of gear with a serialized number.

(P28) indicates that this was the 28th sling manufactured or certified on a specific day.

The number *94350* identifies the day it was manufactured or certified.

- 94: the year -1994
- 350: the day of the year

Knowledge Check

1. Select all that apply. Which of the following markings are required on lashing?

   A. Serial number
   B. Rated load
   C. The re-inspection due date
   D. Size

2. Select the best answer. Rigging gear test and inspection records must include…

   A. Identification of individual components
   B. Dates of tests and inspections
   C. Latest test inspection results
   D. All of the data listed above

3. Select the best answer. Matching ID marks on rigging gear are required for …

   A. All rigging equipment
   B. End fittings on slings
   C. Components that can be separated
   D. Chain slings with permanent attachments
   E. Rope or chain sling bridle assemblies

4. Select the best answer. Rigging gear test and inspection records are required to be kept on file …

   A. For 1 year
   B. Until replaced by a more current record
   C. For 3 years
   D. For 6 months

NOTES

RIGGING GEAR GENERAL USE

Welcome
Welcome to the Rigging Gear General Use module.

Learning Objectives
Upon successful completion of this module you will be able to describe safe work practices when using rigging gear, list selection criteria, identify possible hazards to rigging gear, and explain how to protect your rigging gear from damage during use.

Section 14 of NAVFAC P-307
NAVFAC P-307 section 14, Rigging Gear and Miscellaneous Equipment, provides selection, maintenance, inspection, test, and use requirements for rigging gear and miscellaneous lifting equipment.

SECTION 14
RIGGING GEAR
AND MISCELLANEOUS EQUIPMENT

14.1 Introduction. This section provides selection, maintenance, inspection, test, and use requirements for rigging gear and miscellaneous lifting equipment. These requirements apply to covered equipment used, with or without cranes, in weight handling operations, and to covered equipment used with multi-purpose machines, MHE (e.g., forklifts), and equipment covered by NAVFAC P-300. These requirements also apply to contractor-owned rigging equipment used with Navy and BOS contractor-owned WHE, multi-purpose machines, MHE, and equipment covered by NAVFAC P-300 used in weight handling operations. Except for BOS contracts, these requirements do not apply to contractor-owned equipment used with contractor-owned cranes, multi-purpose machines, MHE, backhoes, excavators, and front-end loaders (refer to paragraph 11.1).

This section and the applicable portions of section 10 provide the minimum requirements for developing and maintaining a program for covered equipment, i.e., maintenance, inspection, and use of applicable gear, operational responsibilities and requirements, operational risk management, critical non-crane rigging operations, etc. Knowledge factors for riggers involved in weight handling operations are provided in appendix N. This publication does not provide information on rigging principles or techniques; however, based on repeated accidents and monitor program observations, a few notable rigging practices are provided. Such information can be found in rigging handbooks, rigging gear users association manuals, OEM publications, textbooks, consensus standards, etc. (see appendices Q and R) and shall be used to provide guidance to rigging personnel. Activities have the option to establish local rigging procedures based upon established rigging references and the activity engineering organization may develop design and use criteria for locally designed and engineered rigging gear used in non-standard applications.

For Government-furnished equipment under the cognizance of NAVSEA 08, this section applies when the applicable technical manual invokes the NAVSEA Lifting Standard. For all equipment governed by the Lifting Standard, where requirements differ from this section, the Lifting Standard shall be followed.

These requirements also apply to rigging gear and miscellaneous equipment used by other military services on Navy maintained and certified cranes at joint bases.

14.1.1 Covered Equipment. This section applies to the following equipment used in weight handling operations: rigging gear (slings, including chain, wire rope, metal mesh, synthetic rope, synthetic webbing, and synthetic roundslings; shackles; eye bolts; swivel hoist rings; links and rings; turnbuckles; insulated links; hooks; etc.); portable LIDs (dynamometers, load cells, crane scales, etc.); crane structures; and portable manual and powered hoists/winches. Also covered are below-the-hook lifting devices as identified in ASME B30.20 (e.g., spreader beams, container spreaders, plate clamps, magnets, vacuum lifters); personnel platforms (see paragraph 10.9 through 10.9.2.3 for additional personnel platform requirements); portable gantry/A-frames, and portable floor cranes used for general lifting; and cranes and hoists procured with, integral to, and used solely in support of larger machine systems (milling machines, press brakes,

14-1

Rigging Manuals
Information on rigging techniques can be found in rigging handbooks, rigging manuals, OEM publications, textbooks, and consensus standards.
Let's cover some of the safety precautions that apply to all types of rigging equipment or operations.

General Safety Rules
Remain alert when performing crane rigging operations.
Hazards are always present.
Two common danger areas are between the rigging gear and the load; and between the load and other objects.
These areas are sometimes referred to as "the bight".
Be sure to your keep hands, feet, and head, out of the bight!

Homemade Gear
Never use shop made equipment unless it has been approved by engineering and certified for use in weight handling operations!

Selecting Rigging Gear

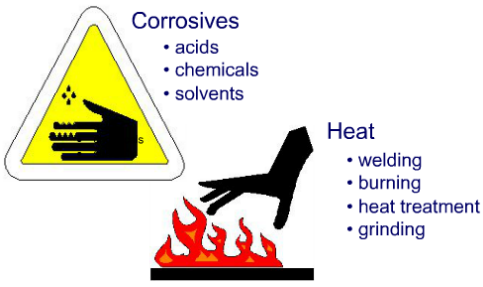
Use rigging gear only for the purpose it is designed for.
Rigging gear is a tool like a hammer or wrench. We've all heard the phrase…
"use the right tool for the job."
It's the same for rigging gear. If you don't have the right rigging gear to safely do the job, stop and get it!
Never use damaged gear.
Never use gear past its inspection due date!
Your safety and the safety of the rest of the crane team depend on the gear you use, and how you use it.
Take the time to do it right!

Selecting Rigging Gear

Keep the following in mind when selecting rigging equipment.
Rigging equipment must be selected based on the total force that will be applied to the gear, not just the weight of the load. Remember, in some cases, the force in one leg of a multiple sling leg could exceed the weight of the load.
Keep the overhead height restrictions or clearances in mind when selecting sling length. Sling lengths that are too long may cause the hook to reach the limit switch before the load reaches the desired height.
You must also think about the hazards the gear may be subjected to so you can choose the appropriate equipment.

Rigging Gear Hazards

The first major hazard we must talk about is abuse.
Here the biggest hazard is you, the user!
Don't drag your slings on the ground. Cement or paved surfaces will quickly abrade slings and gear. Contact with the ground can embed grit and abrasives into the sling, which will cause damage.
Don't pull slings from under a load while the load is resting on them. Set the load down on blocking to keep from crushing the sling.



Hazards (Corrosives and Heat)

Keep gear away from corrosives, acids, paint thinners, and any other harmful chemicals.
Chemicals that may have a corrosive effect on one type of gear may not affect another.
For example, acids would quickly destroy a nylon sling but might not harm another synthetic material.
Protect your gear from all heat sources such as welding, burning, grinding, or heat-treating.

Hazards (Sharp Edges)

Another common hazard is sharp edges.
No matter what type of gear you use, sharp edges will leave their mark if the gear is not protected.
Never use slings against sharp edges without adequate protection.

Hazards (Electrical)

You must be aware of the danger electricity presents when working around energized components or electrical lines.
Watch out for welding leads, light strings, shore power and other common hazards when looking for lay down areas.
Wire rope, chain, and metal mesh slings should never be used if they could increase the possibility of electrical shock.
Protect yourself and the gear by ensuring all power is secured prior to installing your gear on or around electrical components.

Protective Materials

Slings can be easily cut at sharp corners or edges, or otherwise damaged by abrasion or excessive bearing stress. Cutting of synthetic slings is the most common type of sling failure, leading to dropped loads.
Sling protection material shall be of sufficient thickness and strength to prevent sling damage.
When wrapped around corners and sharp edges, synthetic slings shall be completely blocked from contacting the edge with hard material such as split piping, blocks, or special rounded shoes, not soft material such as canvas, fire hose or leather gloves.
Sling manufacturers also provide products that protect slings from sharp corners or edges. Activities should contact the manufacturer for availability of such products.

Sling Protection

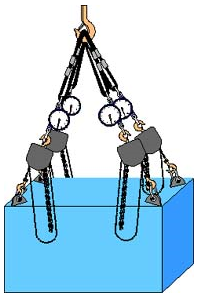
Ensure the rigging configuration is stable and slings cannot slide off the sling protection.
The level of protection required is based on potential damage at the contact interface.
Damage potential levels are classified as abrasion, bearing, and cutting. The level of protection chosen shall be commensurate with the type of damage potential.
The person responsible for rigging the load shall be trained in recognizing the different damage types and determining what protection methods, material, and components are required to adequately protect the slings.

Hoist and Crane References

Portable manual and powered hoists/winches shall meet the criteria of ASME B30.16 and OEM recommendations.
Portable floor cranes/shop cranes (including attachments used solely on portable floor cranes/shop cranes) shall meet the criteria of ASME PASE and OEM recommendations.
Lever hoists shall meet the criteria of ASME B30.21 and OEM recommendations.
Other equipment shall meet the criteria of applicable ASME B30 (e.g., trolleys maintained and inspected in accordance with ASME B30.17) and/or OEM recommendations.

Hoists and Crane Usage

When using chain hoists and portable floor cranes, ensure hoist capacities meet or exceed the expected load.
Load indicating devices may be used in conjunction with hoists to help prevent overload of the hoist and related gear when leveling, rotating, or tilting objects.

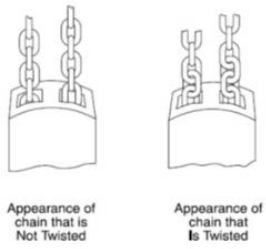


Using Hoists and Cranes

Do not move the load (travel, hoist with a crane, etc.) when it is suspended from a manual chain hoist unless the hand chain is tied off or otherwise secured. This prevents inadvertent operation.
A bag can be attached to the hoist body to hold excess chain.
Never use more than one person to pull the hand chain of a manual chain hoist. Do not use excessive force to operate a hoist. Never use extension bars on lever-operated hoists.

Usage Don’ts

Never use the load chain to choke around an object and never “tip load” the hook!



Additional Chain Hoist Requirements

Do not run the load chain all the way out (bitter end) on a chain hoist as this puts extra pressure on the holding pin and doesn't allow for any payout adjustment once it is hooked into the load. When using chainfalls, ensure the chain is not twisted due to the lower block being "capsized", or twisted.

Additional Rigging Practices

Loads shall be rigged so that the load cannot fall out of the rigging.
Frapping shall be used where necessary to ensure the load does not fall out of the rigging. When using slings in a sweeping or basket configuration under a load, the load should be balanced and the slings should be secured with frapping to prevent inadvertent shifting or movement of the load.
Ends of unused slings/sling legs shall be secured against inadvertent contact when lifting a load.
Items susceptible to falling or dislodgement from the lifted load shall be secured or removed prior to the lift.
Pallets shall be of such material and construction and so maintained as to safely support and carry the loads being handled on them.
When handling taglines, always face the load, keep hands and feet clear, and do not wrap the tagline around the hands, arms, or any other part of the body.
In a choker hitch, a shackle is recommended to be used in the choke point with the shackle pin located in the eye of the sling.

Below the Hook Lifting Devices

Below the hook lifting devices and container spreaders must be operated in accordance with ASME B30.20 and OEM recommendations.
Never use below the hook lifting devices if you do not thoroughly understand the operating characteristics and limitations.
Ensure the lifting device has sufficient capacity for the expected load.

Knowledge Check

1. Select the best answer. Which section of the NAVFAC P-307 is the rigging gear section?

   A. Section 10
   B. Section 12
   C. Section 14
   D. Section 8

2. True or False. It is okay to use home-made rigging gear as long as you are lifting light loads.

   A. True
   B. False

3. Select the best answer. When selecting rigging gear for a job, which of the statements below should be followed?

   A. Never use damaged gear
   B. Consider height restrictions when selecting sling lengths
   C. Never use gear past its inspection due date
   D. Base rigging gear on the total stress, not just the weight of the load
   E. Follow all of the above

4. Select the best answer. What should be used between the rigging gear and the load to prevent damage to the load and rigging?

   A. Metal Spacers
   B. Appropriate Sling Protection
   C. Your hand

5. True or False. Two people can operate a chain fall if the pull chain is too hard for one person to pull while hoisting a load.

   A. True
   B. False

NOTES

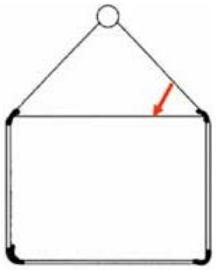
SLING USE

Welcome
Welcome to the Sling Use Module.

Learning Objectives
Upon successful completion of this module you will be able to list sling limitations, explain proper sling attachment and identify the three different hitches and the rated capacities for each.

Wire Rope
A common metal sling is the wire rope sling. Wire rope slings have some limitations even though they are generally strong and durable.
D-to-d is the term for the ratio between the diameter of the object around which the sling is bent and the diameter of the sling body.
The capitol D represents the diameter of the object and the small d represents the diameter of the sling.
When using wire rope slings always maintain a minimum D-to-d ratio of one to one in the body of the sling.
In other words, Never bend a wire rope around a diameter smaller than itself!
Bending a wire rope around a diameter smaller than its minimum D-to-d ratio will damage the wires and weaken the sling.

Wire Rope Sling Use
For loads with a non-circular cross section the bend diameter is derived from the minimum bend diameter of the wire rope around the corner of the load.
For slings bent around corners, the corners must be rounded to provide the minimum D/d efficiency.
Chafing protection is used to protect the load and sling from damage.
Except for braided slings, wire rope slings shall not be used in single leg vertical hitches, unless a method is used to prevent unlaying of the rope.



Wire Rope Temperature Restrictions
Wire rope must also be protected from extreme temperatures, which can seriously affect the wire's strength.
Do not use wire rope slings below minus 40 degrees or above 400° Fahrenheit.
Fiber core rope wire should not be used above 180° Fahrenheit.

Wire Rope Restrictions
Wire rope clips should not be used to fabricate slings.
And wire rope slings should never be knotted.

Chain Sling Use

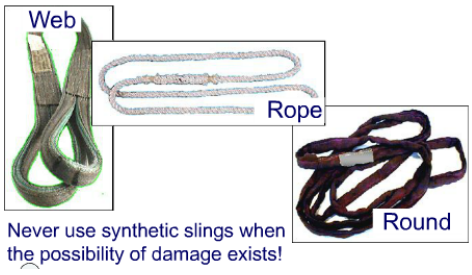
Chain slings are a good choice when the job demands abrasion and damage resistant slings. However, if used improperly, they too can be damaged.
Chain slings should not be used on loads that are damaged easily.
Never use knots or bolts to shorten or extend the sling.
Use sling protection materials on sharp corners and edges to prevent damage to slings and the load.
Chain slings shall be used in accordance with ASME B30.9 and OEM recommendations.
When a chain sling is used in a choker hitch, the straight-line rated load shall be reduced to reflect the efficiency percentages shown in table 14-3 of NAVFAC P-307.
For chain slings with an angle of choke less than 121 degrees, the percent of rated capacity shall be determined by the sling OEM or the activity engineering organization.

Chain Sling Temperature Restrictions

The sling manufacturer should be consulted when the slings are to be used in temperatures of minus or negative 40 degrees Fahrenheit (F).
For slings exposed to temperatures of 400 degrees Fahrenheit or above, follow ASME B30.9 requirements for rated load reduction.

Metal Mesh Sling Temperature Restrictions

Metal mesh slings are often used in abrasive or high temperature environments that would damage slings.
Do not use bare metal mesh slings when temperatures are below -20° or above 550° Fahrenheit.
Do not use elastomer coated slings when temperatures are below 0° or above 200° Fahrenheit.
Metal mesh slings shall be used in accordance with ASME B30.9 and OEM recommendations.



Synthetic Sling Types

There are three types of synthetic slings, synthetic rope slings, synthetic webbing slings, and synthetic roundslings.
Synthetic slings should be used only when they can be protected from damage!
Natural fiber rope slings are not to be used for overhead lifting.

Using Synthetic Slings

Avoid chemical exposure to synthetic slings and always use sling protection material! Synthetic slings can be easily cut at sharp corners or edges or otherwise damaged by abrasion or excessive bearing stress. Sling protection shall be used where there is a possibility of the sling being cut or otherwise damaged by abrasion or bearing. Sling protection material shall be of sufficient thickness and strength to prevent sling damage. With high stresses on slings, soft chafing protection material may not maintain the minimum required radius or provide the required protection. In these cases, harder materials, such as split piping sections or special rounded shoes shall be used. Ensure the rigging configuration is stable and slings cannot slide off the sling protection. The level of protection required is based on potential damage at the contact interface. The level of protection chosen shall be commensurate with the type of damage potential. The person responsible for rigging the load shall be trained in recognizing the different damage types and determining what protection methods, material, and components are required to adequately protect the slings.

Minimize exposure to sunlight and other sources of ultraviolet light. Store all synthetic slings indoors in a cool dry place.

Use of synthetic slings shall be in accordance with ASME B30.9 and OEM recommendations.

Web Sling Use

Synthetic webbing slings shall be used in accordance with ASME B30.9 and OEM recommendations.

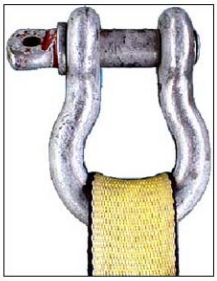
Where a synthetic webbing sling is used in a choker hitch, the straight-line rated load shall be reduced to reflect the efficiency percentages shown in table 14-3 of NAVFAC P-307.

Web slings must be installed flat around the load without kinks or twists. Kinks and twists reduce friction on the load and can cause the sling to roll or slide out of position.

These slings are not affected by D-to-d ratio.

Eye length in relation to the diameter of the hook is critical.

The eyes of webbing slings are stitched and the stitching can be damaged if the eye is spread excessively.



Web Slings and Shackles

Ensure slings are not excessively bunched in the bowl of the hook or in shackles, which can cause uneven loading on the fibers.

Shackles used with synthetic web slings must allow the sling to lay relatively flat without excessive curling of the edges.

Curling causes uneven loading of the sling. Slight curling, however, is acceptable.

Stacking of synthetic slings is not considered bunching if allowed by the sling OEM, the bearing stress calculations showing allowable stresses are performed and documented by the activity engineering organization, and the resulting bearing stress is within the sling OEM allowable levels.

Synthetic Web Sling Temperature Restrictions

Polyester and nylon webbing slings shall not be used in contact with an object or at temperatures in excess of 194 degrees or below negative 40 degrees Fahrenheit.

Synthetic Rope Sling Use

Synthetic rope slings shall be used in accordance with ASME B30.9 and OEM recommendations.
Stranded synthetic rope slings shall not be used in a single part vertical hitch, unless a method is used to prevent unlaying of the rope.
When making single point lifts with eye and eye synthetic rope slings, use two slings or double up a single sling. If they are allowed to spin, the splice could come undone and drop the load!
The minimum D-to-d ratio is 1 to 1.
This means a one half-inch diameter synthetic rope sling cannot bend around any object that is smaller than one half-inch.
Synthetic rope slings shall not be substituted for other types of slings shown on rigging sketches without prior engineering approval.

Synthetic Rope Sling Temperature Restrictions

Polyester and nylon rope slings shall not be used in contact with an object or at temperatures in excess of 194 degrees or below negative 40 degrees Fahrenheit.

Roundsling Use

Synthetic roundslings shall be used in accordance with ASME B30.9 and OEM recommendations.
Roundslings shall be used only in the lifting application for which they were designed by the OEM, and in strict compliance with the OEM's instructions.
For new roundslings, a certificate of proof test shall be retained in the history file for the life of the sling.
Where a synthetic roundsling is used in a choker hitch, the straight-line rated load shall be reduced to reflect the efficiency percentages shown in NAVFAC P-307 table 14-3. They shall not be used in a choker hitch if the sling OEM recommends against this practice.

Other Roundslings

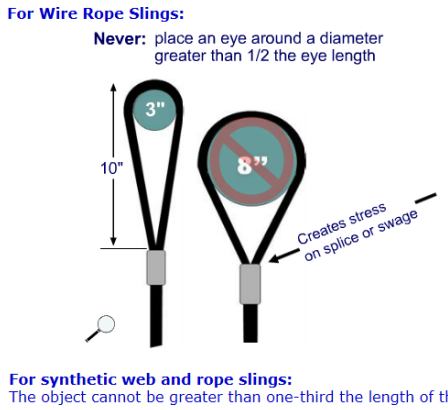
Roundslings constructed of yarns other than nylon or polyester, (e.g., Kevlar, Spectra, Dyneema, Vectran, Technora) (referred to here as “high performance fiber roundslings”) shall be used in accordance with WSTDA- RS-1-HP in addition to ASME B30.9, OEM recommendations, and the additional requirements of NAVFAC P-307.

Roundsling Temperature Restrictions

Polyester roundslings shall not be used in contact with objects or at temperatures above 194 degrees or below negative 40 degrees Fahrenheit.

Sling Use Considerations

Slings must not be used at angles less than 30° from horizontal unless specifically authorized by an engineering work document.
Never use a sling that has been knotted.
Use sling protection as needed.
Rigging gear including slings, shackles, turnbuckles, and eyebolts, must be sized such that two legs can carry the load to allow for variations in sling length and load flex.



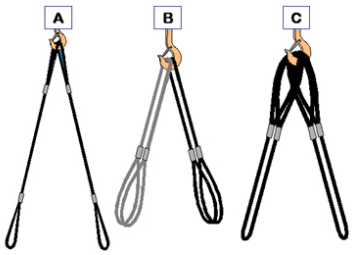
Eye and Hook Considerations

The size of the hook or shackle relative to the size of the sling eye can be critical.
If we place a ten-inch long sling eye on a load which is 3 inches in diameter, the eye opens slightly and causes very little added stress to the eye or the splice.
However, if we place that sling on a hook with a diameter of 8 inches, this can stress the eye and can cause the swage or stitches to fail.
Never place the eye of a wire rope sling around an object which has a diameter greater than 1/2 the length of the eye.
Never place the eye of a synthetic web or rope sling around an object which has a diameter greater than 1/3 the length of the eye.
If the hook diameter is too large, a shackle can be used to connect the slings to the hook, thereby reducing the diameter over which the sling eyes are placed.

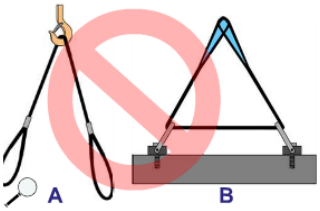
Attaching Gear to Hooks

When attaching rigging gear to hooks be sure the safety latch is working properly and closes the throat opening without obstruction.
Failure to do so can allow the gear to come off the hook.
All gear attached to the hook must seat properly in the bowl. Do not stack slings or allow slings to cross each other in the hook. That can lead to crushing of the slings!

Correct use of Slings on Hooks



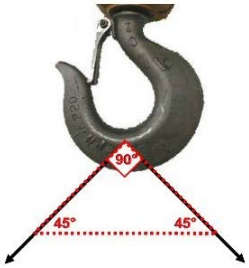
These graphics illustrate correct ways to attach slings to a hook.
Graphic “A” shows a vertical application with two sling eyes seated in the bowl of the hook.
Graphic “B” shows two slings doubled over the hook and sling eyes pointing down to attachment points.
Graphic “C” shows two slings doubled with sling eyes on the hook and the bight pointing down to attachment points.
When wire rope slings are used as in graphics “B” and “C”, and a heavy load is applied, individual wires may become permanently deformed or bent.
If a sling is doubled to the point where it is permanently set, it should not be used in a vertical or straightened out configuration because straightening the sling could cause the wires to break in the strands.



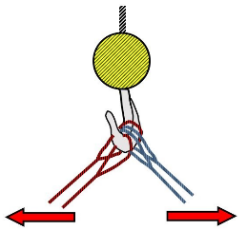
Incorrect Use of Slings on Hooks

These graphics illustrate some incorrect ways of attaching slings to a hook.
Incorrect sling applications can be extremely dangerous and can result in loss of load control and personnel injury!
Graphic “A” shows a single sling with the “bight” riding the hook and the eyes attached to two separate attachment points.
Slings applied in this manner could slip on the hook causing the load to shift.
Graphic “B” shows a sling through two attachment points.
Installing a sling through more than one attachment point will create excess stress on the sling, the attachment points, and the gear.

Included Angle



Included angle is the angle measured between two slings sharing a common attachment point.
Where slings are supported in a hook, the included angle of the slings shall not exceed 90 degrees, unless otherwise approved by the activity engineering organization.
Hooks shall not be loaded at the point or tip, or be side loaded.



Inside and Outside Slings

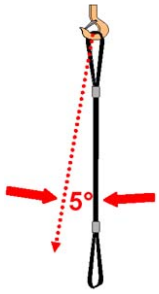
When rigging four slings to a hook, separate the slings into two pairs, inside and outside so they do not pull in the plane of the hook.
Attach the inside slings to one end of the object and the outside slings to the other end, being careful that they are not crossed.

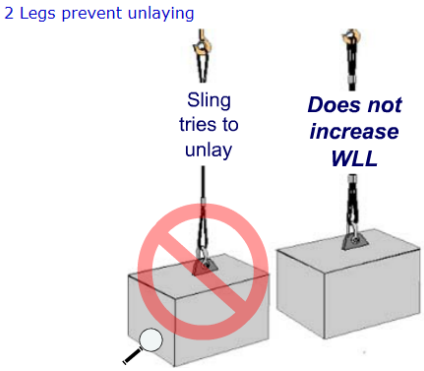
3 Types of Hitches

Slings are used in straight-line, choker, and basket hitches.
A straight-line hitch is commonly referred to as a vertical hitch.
The rated load for the same sling with each hitch will be different.

Rated Loads of Straight-Line Hitches

The rated load for a straight-line hitch is 100% of the sling's capacity.
Sling angle stress is encountered any time the straight line angle exceeds 5° and must be taken into account.



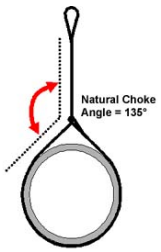


Straight-Line Hitch and 2 Legs

To prevent unlaying of wire rope (except for braided slings) or stranded synthetic rope slings, the slings shall not be used in a single part straight-line (vertical hitch) or choker hitch, unless a method is used to prevent unlaying of the rope.
Use two legs for single point lifts. The second leg prevents the sling from spinning.
It is important to note that the configuration shown here does not increase the rated load because slings are rarely the exact same length.
The shorter of the two will carry the load.

Choker Hitches

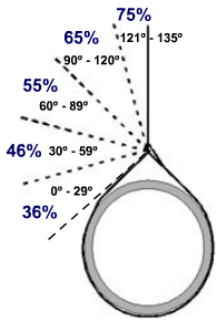
Using a shackle to set a choker hitch will prolong the life of the sling.
Whenever a shackle is used to set a choker hitch set the eye of the sling on the pin of the shackle.
This will prevent the "running" part of sling from rotating the pin of the shackle as it passes over it.
Never set the choker so the running part of the sling passes against the shackle pin.



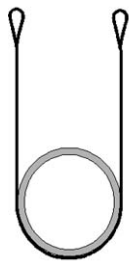
Rated Loads of Choker Hitches

Whenever a choker hitch is used the sling's rated load is reduced.
The natural choke angle is 135°, if a choker hitch is allowed to tighten itself as the load is lifted.
When choke angles are less than 121° the rated load must be reduced further.

Wire and Synthetic Rope Sling Choker Hitch Efficiencies



This chart shows the efficiency of the sling's capacity when choking with a wire rope or synthetic rope sling. Refer to NAVFAC P-307 Table 14-3 for choker efficiencies of other slings.
For angles 121° to 135°, the rated load is reduced to 75% of the vertical capacity (Synthetic Web Slings, Roundslings, and Chain Slings are rated at 80%).
Check with the OEM or activity engineering organization for ratings of chain slings at angles of choke less than 121 degrees.
This does not apply to braided multi-part wire rope slings.



Basket Hitches

Basket hitches are the strongest of the three hitches.
Slings in a basket hitch can carry 200% of the sling's single rated load when the sling angle is less than 5° from vertical, and the required D-to-d ratio is maintained.
Wire rope requires a D-to-d ratio of greater than 40 to 1.
Synthetic rope requires a D-to-d ratio of at least 8 to 1.

Knowledge Check

1. Select the best answer. The minimum D/d ratio in the body of a synthetic rope sling is …

   A. 1:1
   B. 2:1
   C. 3:1
   D. 4:1

2. True or False. D/d ratio does not affect synthetic web slings.

   A. True
   B. False

3. True or False. It is acceptable to bend a 1 inch wire rope sling around a ¾ inch shackle.

   A. True
   B. False

4. Select the best answer. The minimum D/d ratio allowed for wire rope slings is …

   A. 1:1
   B. 2:1
   C. 3:1
   D. 4:1

5. Select the best answer. With the proper D/d ratio a sling in a basket hitch can lift _____ of the rated load of the sling.

   A. 75%
   B. 100%
   C. 150%
   D. 200%

NOTES

SAFE OPERATIONS MODULE 1

Welcome
Welcome to the Safe Operations module.

Learning Objectives
Upon successful completion of this module you will be able to explain operator responsibilities, describe proper methods to lift and land loads, understand the requirements when working near overhead power lines, identify safe operating procedures, and state securing procedures for cranes.

Understanding the Crane

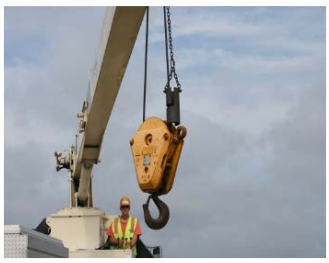

The vast majority of crane accidents are the result of personnel error and are therefore avoidable. Where team personnel are at fault, it is typically due to inattention, poor judgment, overconfidence, or haste to get the job done.
Crane operators at naval activities may be required to operate various types, makes, and models of cranes. Operators must be trained, licensed, and thoroughly familiar with the operating characteristics, including posted operational restrictions or limitations, of each type, make, and model of crane that may be operated.
Note: A license is not required for operators of category 3 non-cab operated cranes.

Operator Training
Prior to being licensed, operator trainees must be thoroughly trained on the operation of the type of crane for which a license is to be issued.
The operator trainee shall operate the crane only under the direct observation of a licensed operator. The licensed operator shall retain full responsibility for the safe operation of the crane.
The supervisor shall approve lifting of loads based upon the candidate's demonstration of knowledge of the equipment and operation without loads.
The trainee shall not perform complex lifts.
Note: A license is not required for operators of category 3 non-cab operated cranes.

Operations Manual
Operators must read and follow the manufacturer’s requirements, written procedures, safety instructions, and precautions.

Posted Information
The operator must heed posted warnings and instructions on the crane such as hand signal placards, controller function labels, and warning labels. Certification information should be posted in plain sight.

Pre-Operational Check



To make sure the crane and work area are safe, a complete check of the crane shall be performed by the operator prior to the first use of the crane each day.
When performing the operational check in cold weather or icy conditions, the operator should raise the blocks and boom before lowering them to avoid damage when sheaves may be frozen.
Operators should inform rigging personnel to stand clear of the area below the blocks and boom prior to operation.
The operator should hoist up slowly, in small increments, to break any ice and/or snow free, and monitor the sheaves to ensure proper movement and operation of the sheaves and wire rope.
This should also be performed periodically throughout the day to ensure proper operation during cold weather or icy conditions.

Knowledge Check

1. Select the best answer. When operating cranes, the operator's primary responsibility is to:

   A. Keep the crane clean
   B. Use the shortest boom length possible
   C. Do pre-use checks
   D. Operate safely

2. Select the best answer. Crane operators at naval activities may operate various types, makes, and models of cranes for which they are licensed. How must safety and operator proficiency be assured under these circumstances?

   A. Operators must receive written and performance tests by a crane license examiner as outlined in the NAVFAC P-307 manual
   B. Operators must operate at reduced speeds until confident and capable
   C. Operators must be familiarized (as directed by a supervisor) before operating

3. Select the best answer. What information should be posted, clearly understandable, and readily available to the operator?

   A. Travel speed through congested areas
   B. Crane Operator's license number
   C. Certification information

4. Select the best answer. Which of the following operator responsibilities is considered the basis for ensuring a safe and reliable crane?

   A. Periodic lubrication and servicing
   B. Firm and level supporting surface
   C. The Pre-Use Check or Operator's Daily Checklist (ODCL)
   D. Proper set-up on outriggers

5. Select the best answer. What information should be posted, clearly understandable, and readily available to the operator?

   A. Labels for each control function
   B. Operator's License Number
   C. ODCL Checks

6. Select the best answer. When can an unlicensed crane operator trainee operate a crane?

   A. When he or she needs to operate a crane to get the job done
   B. Only under the direct observation of a licensed operator
   C. When their supervisor tells them to operate a crane
   D. In an emergency

Operator Awareness

When operating a crane, the operator must be aware of everything in the operating envelope including hazards, obstructions, and personnel. At the same time the operator must be aware of the sound, feel, and behavior of the crane.

Unsafe Conditions

Whenever an unsafe condition exists, operators must immediately stop operation and the condition must be resolved before continuing. If you cannot resolve a safety issue with the team members, contact the supervisor for assistance. Remember, operators have the authority and responsibility to stop and refuse to operate the crane until safety is assured.

Lifts near Personnel

Loads must never be moved or suspended over personnel. Choose an alternate load path or evacuate personnel from the area.

Riding Loads

Personnel must never ride loads. Use only approved personnel lifting devices if personnel must be lifted.

Minimum clearance distances for operation near electric power lines and for transit with no load and boom or mast lowered.

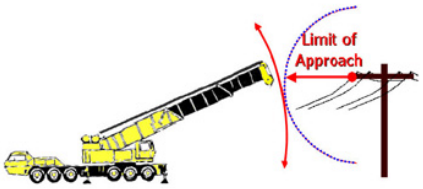
VOLTAGE, KV (PHASE TO PHASE)	MINIMUM REQUIRED CLEARANCE, FT (M)
Operation Near High Voltage Power Lines	
0 to 50	20 (6.10)
Over 50 to 200	20 (6.10)
Over 200 to 350	20 (6.10)
Over 350 to 500	50 (15.24)
Over 500 to 750	50 (15.24)
Over 750 to 1000	50 (15.24)
In Transit with No Load and Boom or Mast Lowered	
0 to 0.75	4 (1.22)
Over 0.75 to 50	6 (1.83)
Over 50 to 345	10 (3.05)
Over 345 to 750	16 (4.87)
Over 750 to 1000	20 (6.10)

Figure 10-3

Overhead Lines

Whenever working near overhead power transmission lines, have the power de-energized and visibly grounded. When the power cannot be de-energized, the minimum required clearances described in figure 10-3 of NAVAC P-307 must be maintained. If any part of the crane or load could approach the distances noted in figure 10-3 of NAVAC P-307, a designated spotter shall be assigned. In addition a supervisor shall visit the site, assess potential hazards, and establish procedures to safely complete the operation.
Follow the requirements of NAVFAC P-307 paragraphs 10.13.1 through 10.13.6 for crane operations near or below overhead electrical transmission lines, operation near communication towers, and travelling below power lines.

Limit of Approach

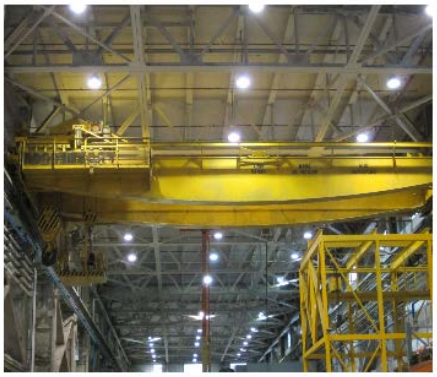


When operating a crane in the vicinity of overhead electrical transmission lines, for voltages less than 350 kV, the minimum required clearance is 20 feet. Where the voltage is known to be 350 kV or more, the minimum required clearance is 50 feet.
A designated spotter shall be assigned by the supervisor and be positioned to effectively gauge and monitor the clearance distance and communicate directly with the operator.
When operating in the vicinity of overhead transmission lines, the best crane set up is one in which no part of the crane or load can enter the clearance limit.
Even boom failure should not allow the crane, load line, or load to enter the limit.

Operating Practices

The crane operator must operate the crane in a safe manner, moving loads slowly and smoothly. Avoid rapid starts and sudden stops to help reduce load swing. Anticipate stopping points, and slow down before bringing loads to a stop. Crane swing should be relatively slow to prevent outward swing of the load due to centrifugal force.

The operator shall remain at the controls at all times while a load is suspended from the crane. This does not include slings and other gear used to rig the load and does not include a load attached to the crane with slack in the rigging gear. This also does not apply to under-running bridge cranes, jib cranes, pillar cranes, pillar jib cranes, monorails, and fixed overhead hoists used in industrial processes that require a suspended load such as cleaning, degreasing, painting, testing, and similar processes. For such cases, the suspended load shall be less than 80 percent of the crane's rated capacity, the area shall be secured to prevent unauthorized personnel from entering, the crane shall be tagged to indicate this condition, and the load shall not be suspended longer than required.



Crane Operating Characteristics

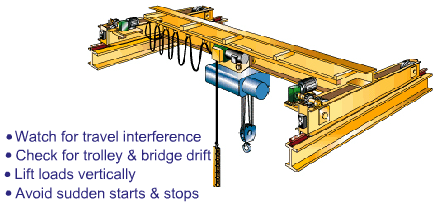
There are a variety of operating characteristics and issues that the users of Category 2 and 3 cranes must consider. Listed below are just a few.

Operating of Category 2 and 3 cranes may be from the cab or from the ground using a pendant controller or remote controls. A disadvantage of operating a very high mounted overhead traveling crane from the cab is that the operator may have difficulty in judging position and in seeing signals.

Some cranes are equipped with dynamic lowering controls. A dynamic lowering control is an automatic device that speeds the lowering of an empty hook or light load, and slows a heavy load.

On some cranes a heavy load may lower when the hoist control is initially moved from the neutral position to the hoist position. The load may not lift until the hoist speed is high enough to support and raise the load. This characteristic is called hoist roll back. When positioning heavy loads, the final vertical adjustment should be made by lowering the load because of hoist roll back.

Operating OET and Gantry Cranes



Overhead electric traveling cranes are generally operated indoors so congestion is often an issue. Watch for changes in the work area that may cause interference. Storage racks with material stacked too high are a common problem.
Operators should always check for trolley and bridge drift before operating the crane.
Lift loads vertically. Side pulls can cause uneven or overlapped spooling of the hoist wire and may cause the wire rope to be cut or severely damaged. In addition, ensure the hook and block are not swinging prior to hoisting. Improper or overlapped spooling of the wire rope on the drum can occur with or without a load on the hook when hoisting.
Avoid sudden starts and stops with the bridge. This can result in skidding and uneven wear on the wheels.
A sudden start with a heavy load on one end of the bridge or a slippery track may cause a crane to skew. Skewing is a condition where one end of the bridge gets ahead of the other end, frequently causing binding on the rails. Excessive skew may be straightened by slowly bumping the bridge into the end stops.

Operating Techniques

When slowly taking the slack out of rigging gear, and when starting to move a light load or empty hook smoothly, the first hoisting point or slowest possible speed should be used.
A technique called "Inching", or performing a motion very slowly, a little at a time, can be used when a crane operation or function requires small movement.
Another technique, "Plugging", is the use of reverse power instead of a brake to slow or stop the bridge or trolley travel. This method of braking or stopping movement is not used for hoisting or lowering motions. As a precaution, the operator should be ready to use the foot brake to stop movement if the power or operation should fail.

Lifting Loads

Prior to lifting, position the freely suspended hook directly over the loads c gravity when attaching the load. This prevents side loading the boom or c prevents dragging or shifting of the load as it is picked up.
Sufficient tag lines shall be used to minimize load swing and rotation unles creates a hazard.
Take the slack out of rigging gradually and watch for hook movement that need to reposition the crane before lifting.
When lifting a load, stop hoisting when the load lifts a few inches off the ground and check to ensure there is no slippage of the hoist brake. This must be performed for every load.
Accelerate smoothly to reduce dynamic loading.
Extreme caution shall be used when making lifts out of water. When the load comes out of the water, buoyancy is lost and the load on the crane may increase. Also, just as the load

leaves the water, the surface tension (suction) can increase the load on the crane momentarily. Water held inside the object may also increase the load weight.

Landing Loads

Prior to lowering loads, be sure the surface that you plan to land the load on will support the load.
When landing loads: slowly lower the load as you approach the landing surface, stop the load a few inches off the ground or landing surface, then slowly lower the rest of the way.
Ensure the load is stable and secure before slacking and removing the rigging gear.

Securing the Crane

When securing cranes remove gear from the hook, stow hooks near, but not in, the upper limit switches, place all controls in the neutral or off position, engage all brakes, rotate locking devices and drum pawls, and secure power.
Operators shall ensure local safety requirements are followed.
For mobile cranes, set the carrier brake and chock wheels if the crane is on an incline.

Traveling

When traveling cranes with loads, stow unused hooks, follow OEM requirements and keep loads close to the ground while avoiding obstructions.
When initiating travel movements and when the load or crane is approaching personnel, the warning horn or signal, if so equipped, shall be sounded.
Maintain communication with and operate under the direction of a signaler.
Use slow speeds for better load control.
Be aware of travel restrictions, and other cranes working in the area.
Remember to check clearances and watch for obstructions.

Summary

In this module we discussed:

- Operator responsibilities, including: taking the time to get familiar with the crane's operating characteristics, reading and following the operations manual, having the required information on the crane, and performing the ODCL.
- Safe operating practices, situational awareness, and proper methods for lifting and landing loads.
- The rules and requirements, including limits of approach, for operating cranes in the vicinity of overhead power lines; and
- How effective teamwork and safe operating practices reduce accidents.

Knowledge Check

1. Select the best answer. When lifting loads with a crane, which of the following is the first thing an operator should do?

   A. Lift the load slightly to check the brake
   B. Center the hook over the center of gravity of the load
   C. Take the slack out of the rigging
   D. Change speeds smoothly

2. Select the best answer. The second step in the procedure for lifting loads is to:

   A. Hoist slowly and remove slack from the rigging gear
   B. Hoist slowly until the load lifts
   C. Hoist at one speed until the load lifts

3. Select the best answer. The third step for lifting loads is to:

   A. Lift the load until completely suspended and stop
   B. Lift the load until a desired height and stop
   C. Lift until the load clears all obstacles and stop

4. Select the best answer. While operating, the crane operator becomes concerned over the safety of the lift. The Rigger-in-Charge sees no problem and tells the operator to continue. The operator should:

   A. Tell his or her supervisor at the end of the shift
   B. Proceed slowly with caution
   C. Refuse to continue until safety is assured
   D. Note the incident on the back of the ODCL card

5. Select the best answer. Side loading a crane boom by dragging loads or lifting a load with a non-vertical hoist may result in:

   A. Destructive stresses placed on the boom and sheaves
   B. Possible overload due to swinging of the load after lifting
   C. Uncontrolled movement of the load due to shifting
   D. Any of the listed factors above

6. Select the best answer. In general, which of the following things should an operator do when traveling cranes with loads?

   A. Keep loads just high enough to clear obstacles
   B. Start slowly and increase speeds gradually
   C. Avoid sudden stops
   D. Stow or secure unused hooks
   E. Perform all of the listed actions above

7. Select the best answer. If a heavy load shall be inched into an exact vertical position, should the final adjustment be made by raising or lowering? Why?

   A. By lowering. When hoisting, the load may inadvertently lower while the controls are moved from neutral to a hoist speed high enough to support and raise the load.
   B. By hoisting. When lowering, the speed may not be controllable.
   C. By hoisting. When hoisting, the load may lower before the speed is high enough to lift the load.

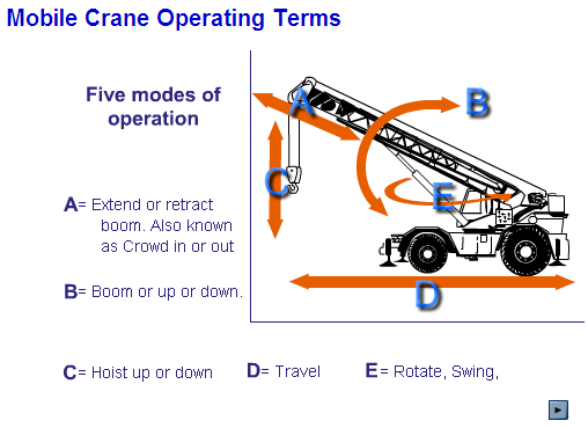
NOTES

SAFE OPERATIONS MODULE 2

Welcome
Welcome to Safe Operations Module 2.

Learning Objectives
Upon successful completion of this module you will be able to explain specific crane operating principles and securing procedures for mobile hydraulic cranes, mobile lattice boom cranes, floating cranes, portal cranes, locomotive cranes, and OET & gantry cranes.

Mobile Crane Operating Terms
There are five common modes of operation for a typical mobile crane: booming up or down, rotating, traveling, hoisting up or down, and extending and retracting the boom. Raising or lowering the boom is also known as booming or luffing. Rotate sometimes called swing or slew, causes the upper-works of the crane to revolve on the carrier. Travel mode allows the operator to move the entire crane on wheels, tires or crawler tracks. Hoist mode is used to raise and lower the hooks. For extendible boom cranes, like the one shown, the extend or retract boom mode sometimes referred to as crowding is used to lengthen or shorten the boom.

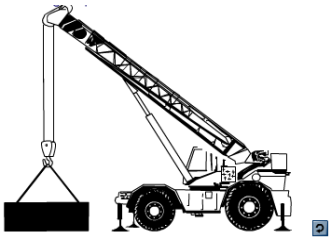


Mobile Cranes - Traveling
Follow all OEM directions for transiting the crane.
When transiting a truck, rough-terrain, all-terrain, or crawler crane to and from job sites, secure the hook and block to the carrier frame to prevent them from swinging into the boom.
When securing the hook block, raise it just enough to take up the slack. Do not over tighten.

A weak link connection shall be used to secure the hook block to the crane. The breaking strength of the connecting piece shall be less than the rated load of the hook block's wire rope as reeved.
When securing the hook blocks for highway travel, add a back-up (stronger) tie-back to prevent free swinging in the event of weak link failure.
Ensure there are adequate clearances.
Unless otherwise allowed by the OEM, the boom shall be carried in line with the direction of transit.
Additionally, the superstructure shall be secured against rotation.

Operating

When lifting and landing heavy loads with mobile cranes, adjust the boom position as necessary to compensate for deflection. The signal person should assist in keeping the boom tip directly over the load. Use the shortest boom length practical for maximum stability and strength. Use power lowering for positive load control.

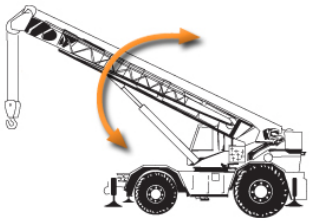


Engaging the Rotate Locking Device

The rotate locking device should be engaged: whenever the operator leaves the cab or controls; while the crane is traveling with a load in “pick and carry” mode (if required by the OEM); and any other time required by the crane OEM.

Knowledge Check

1. Select the best answer. There are five common modes of operation for a mobile crane. The arrow in this image depicts which operational mode?



   A. Hoist up or down
   B. Rotate
   C. Extend or Retract Boom
   D. Booming up or down

2. Select the best answer. There are five common modes of operation for a mobile crane. The arrow in this image depicts which operational mode?

   A. Extend or Retract boom
   B. Booming up or down
   C. Rotate
   D. Hoist up or down

3. Select the best answer. There are five common modes of operation for a mobile crane. The arrow in this image depicts which operational mode?

   A. Booming up or down
   B. Hoist up or down
   C. Extend or Retract boom
   D. Rotate

4. Select the best answer. When moving a truck, cruiser, or crawler crane to and from job sites, always secure the _____ to the carrier frame.

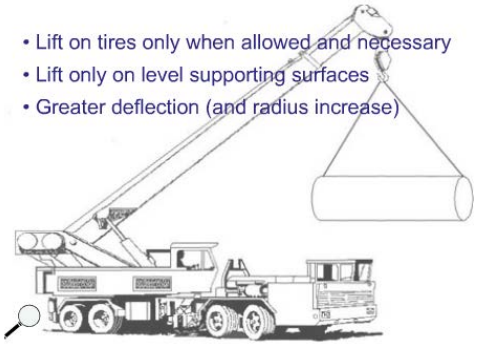
   A. Hooks
   B. Jacks
   C. Rigging gear
   D. Oiler
   E. Jib

5. Select the best answer. When lifting heavy loads with mobile cranes, operators must keep in mind what specific precaution?

   A. Use both hooks for added capacity
   B. Adjust as necessary for boom deflection before lifting the load
   C. Remove stowed jib to lighten boom

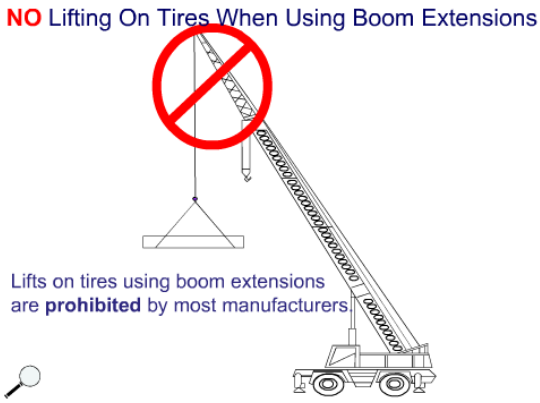
Lifting on Tires

Lift on rubber only when necessary and allowed. Cranes are much less stable on rubber than when on outriggers. Lift only on level surfaces. Remember, greater deflection and radius increase can be expected when making lifts on tires.



Issues

Check all tires for condition and inflation to OEM specifications. Axle lockouts must be tested according to OEM instructions to ensure proper operation.

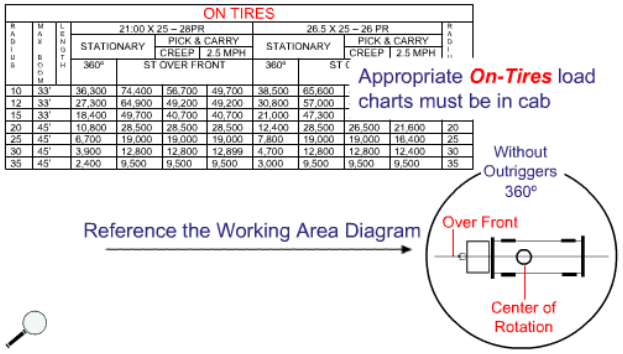


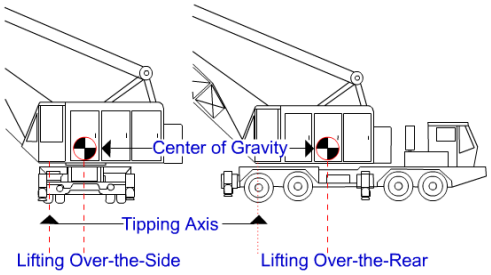
Boom Extensions

Check the crane's manual and load chart information before using a jib or extension. Lifting from jibs or boom extensions while on rubber is prohibited by most manufacturers.

On-Rubber Load Chart

When lifting on rubber is permitted at your activity, you must use the appropriate on-rubber load charts. This chart shows gross capacities when working on tires. The OEM may provide on rubber charts for stationary 360 degrees, locked over-the-front, defined arc over-the-front and pick & carry. Check the working area diagram before lifting on tires.





Crane Center of Gravity

It is important for operators to understand how the center of gravity affects the capacity of the crane when moving from one quadrant to another. The illustration shows a crane on-rubber positioned for lifting over the side and over the rear. The symbol on each crane represents the center of gravity of the entire crane including the carrier. The tipping axis for the crane in each position is the centerline of the outer tires. A crane becomes less stable with the same load applied, whenever the center of gravity of the crane moves closer to the tipping axis. This is why most mobile cranes have a higher over-the-rear capacity than over-the-side.

Traveling with Loads

Travel with suspended loads only when permitted by the OEM and the local activity. Cranes must have appropriate Pick and Carry Load Charts in the operator's cab. Set the rotate lock and travel with the load directly over the end in-line with the carrier as required by the OEM. Generally this means carrying over the front with RT cranes and over the rear with truck cranes. Rotate brakes are normally used for holding operating position when the crane is not in line with the crane carrier. When practical, and as permitted by the OEM, extend the outriggers and keep the outrigger pads a few inches off the ground. Always check that the automatic or manual axle lock-outs, when equipped, are released. Be sure the ground which the crane will travel over can support the machine.

Extendible Boom Cranes - Operating

Lower the hoist block when extending the boom to prevent the block from raising into the limit as the boom is extended. This could result in two-blocking and break the hoist wire rope, dropping the load. Remember that anti two-block devices are operational aids that can fail and must not be relied upon to stop the movement of the hoist. Extend counterweights as required on cranes so equipped. On hydraulic truck cranes, set the front stabilizer float, when equipped. Check the operator's manual and load chart notes for instructions on setting the stabilizer float. In many cases, it must be set regardless of the quadrants of operation.

Extendible Boom Cranes - Securing

When securing a truck crane with a hydraulic boom retract the boom fully and place it in the cradle. For rough terrain cranes place the boom in a nearly horizontal position. Requirements for mobile extendible boom cranes may vary from manufacturer to manufacturer. Always consult OEM instructions for securing requirements for each crane.

Mobile Lattice-boom Cranes - Operating

When operating a mobile lattice-boom crane, lower the hoist blocks to allow boom tip clearance before lowering the boom. Lowering a fixed boom with the load block close to the boom-tip sheaves may result in two-blocking. On many lattice-boom truck cranes, you must also set the front float when equipped for on-outrigger operation. For friction machines, set hoist-drum pawls when the hoist is not in use. When the crane is equipped with automatic hoist-drum pawls, they should be checked regularly.

Mobile Lattice-boom Cranes – Securing

When securing lattice-boom cranes, place the boom at approximately 45 degrees, and engage hoist drum and boom pawls. Lock down all foot brakes and then disengage the master clutch. Shut down the engine and secure the crane.

Knowledge Check

1. Select the best answer. Extending the boom on a typical hydraulic crane will cause the hook(s) to _____.

   A. Spin
   B. Raise
   C. Lower

2. True or False. On hydraulic truck cranes, set the front float, or 5th outrigger, when equipped.

   A. True
   B. False

3. Select the best answer. Hydraulic booms can fail with little or no warning when subjected to:

   A. Side loads
   B. Over loads
   C. Both A and B are correct

4. Select the best answer. When securing rough terrain cranes, the boom should be in a near _____ position.

   A. Vertical
   B. Horizontal
   C. Safe

5. Select the best answer. All of the following steps apply to securing lattice-boom cranes except:

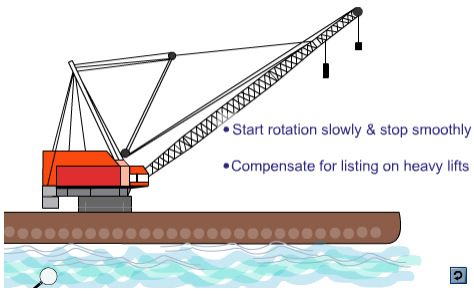
   A. Disengage master clutch
   B. Engage all drum pawls
   C. Place the boom at approximately 45 degrees
   D. Lock down all foot brakes
   E. Retract boom

6. True or False. Lowering a fixed boom with the load block close to the boom tip sheaves may result in two-blocking.

   A. True
   B. False

Floating Cranes – Operating

When swinging or rotating floating cranes you must start slowly and stop smoothly. Abrupt starts and stops cause barge rotation, putting unnecessary strain on mooring lines.
To compensate for the list of the floating crane when lifting heavy loads from the pier, position the hook directly over the load, take a strain on the rigging, and then boom up.



Floating Cranes – Securing

When securing floating cranes, follow OEM and local instructions and set the boom at the recommended angle or so the hooks are over the deck anchor point. Secure the hooks to the barge using tie-down pendants with a weak link.

Floating Crane Barge – Securing

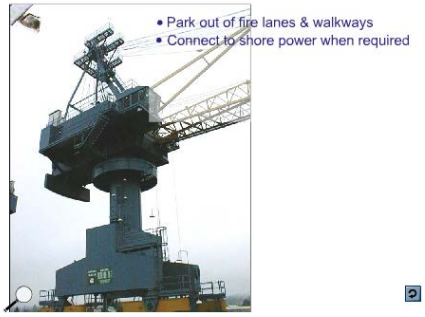
Secure the floating crane barge as required. Set the gangway when the crane is moored pier-side. Clean and secure the deck. Store or secure loose cargo. Stow unused rigging gear, mooring lines, & ropes. Check mooring line tension to allow for tidal changes. At high tide, ensure that lines are slack enough to avoid over-stressing or parting as the tide recedes. At low tide, snug up mooring lines to minimize barge movement as the tide rises and lines slacken. Energize exterior lighting such as anchor lights and aircraft warning lights as required. Secure personnel access areas, ladders, auxiliary machinery and close all watertight doors and hatches.

Portal Cranes - Operating

Travel with caution, especially in congested work areas and when approaching curves, intersections, building entrances, and access to ladders leading into dry docks. It is a good practice to stop before crossing rail switches to verify correct alignment. When possible, the operator should position the boom in the direction of travel. If the crane rigger gives a signal to travel back and disappears from sight, the crane operator must stop traveling until communication is re-established. Clearance lines painted along crane tracks are a guide to keep all materials and vehicles away from crane travel trucks. Operators shall stop crane travel when materials or vehicles are inside crane clearance lines, until they are moved.

Portal Cranes - Securing

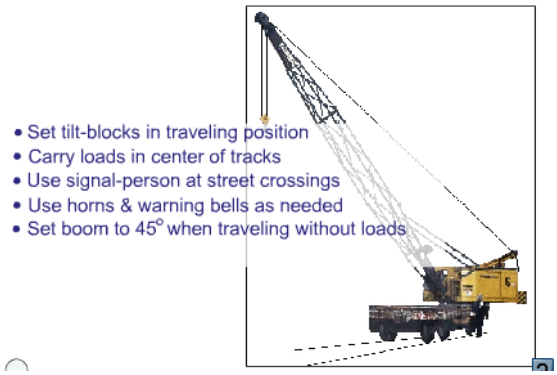
When securing portal cranes, follow OEM recommendations. Park away from fire-lanes, gangways, and pedestrian walkways. When required, connect to shore using the proper electrical safety procedures.



Locomotive Cranes - Operating

When operating a locomotive crane, use tilt-blocks or bed-stabilizing wedges, according to OEM instructions, to provide over-the-side stability for heavy lifts. Use outriggers when making lifts exceeding the free-rated capacity of locomotive cranes.

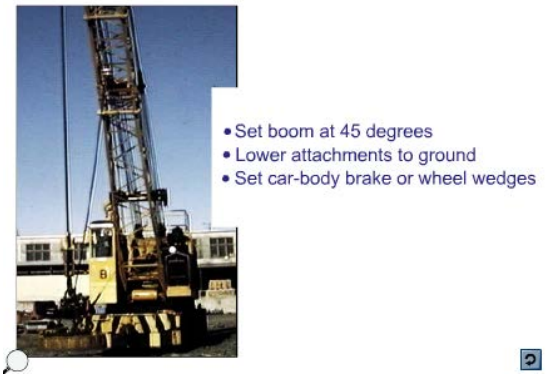
Locomotive Cranes - Traveling



Disengage tilt-blocks or bed-wedges when traveling and lifting over the side at the same time. Failure to do so may result in derailing the crane because of the decreased ability for the axle assemblies to pivot on the carrier when rounding corners. When traveling around corners, carry loads in the center of the tracks. When this is not possible, carry the load or counterweight, whichever is heavier, to the outside of the curved track. This will prevent the tapered travel wheels from climbing the rail and derailing the crane. Have the signal person flag traffic at street crossings. Sound the horn when approaching intersections or blind corners and use warning bells while backing up. When traveling without loads, set the boom to approximately 45 degrees.

Locomotive Cranes – Moving Cars

If you need to move rail cars using a locomotive crane, use caution when coupling or disconnecting cars. The crane crew shall make sure that no one is working in, on, or under the car, and that nothing will prevent its safe movement. Crews shall uncouple cars only when brakes are set and wheels are properly chocked. Limit the number of cars moved at one time, loaded or unloaded, to the number recommended by the crane manufacturer or by local policy. Locomotive cranes are not usually designed to charge the braking systems of additional cars or to move several cars at a time.



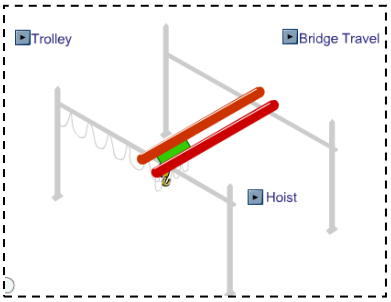
Locomotive Cranes – Securing

When securing locomotive cranes, set the boom at about a 45 degree angle. If equipped with a magnet, clam-shell, or other lifting attachment, lower it to the ground. Set the car-body brake or place wheel wedges against the inner set of travel wheels.

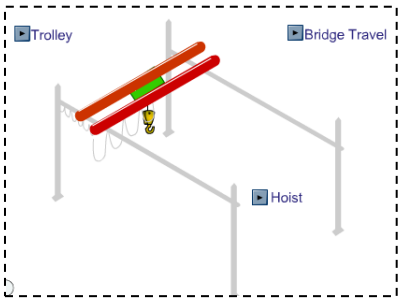
Overhead Electric Traveling (OET) and Gantry Cranes - Operations

The bridge travel function is used to travel the crane in the selected direction along the length of the runway rails. This allows the operator to move the entire crane along its supporting rail structure, in the selected direction. The trolley function is used to move the hoisting machinery in the selected direction along the trolley rails. The hoist function is used to raise and lower the hooks.

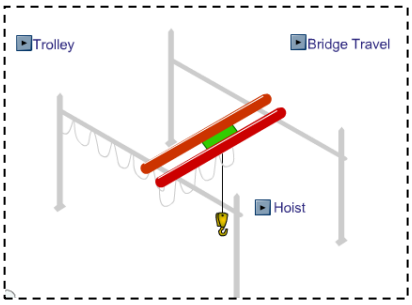
Trolley



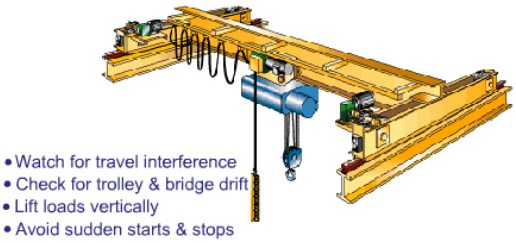
Bridge



Hoist



OET and Gantry Cranes - Operating



Overhead electric traveling cranes are generally operated indoors so congestion is often an issue. Watch for changes in the work area that may cause interference. Storage racks with material stacked too high are a common problem. Operators should always check for trolley and bridge drift before operating the crane. Lift loads vertically. Side pulls can cause uneven or overlapped spooling of the hoist wire and may cause the wire rope to be cut or severely damaged. In addition, ensure the hook and block are not swinging prior to hoisting. Improper or overlapped spooling of the wire rope on the drum can occur with or without a load on the hook when hoisting. Avoid sudden starts and stops with the bridge. This can result in skidding and uneven wear on the wheels. A sudden start with a heavy load on one end of the bridge may cause a crane to skew. Skewing means that the bridge and trucks are out of alignment with the rails, often resulting in wheel chatter from flange contact with the sides of the rail head.

OET and Gantry Cranes - Operating

Always board cab-operated cranes at designated places. Access the crane cab or bridge walkway using fixed ladders, stairs, or platforms. Remain aware of other cranes working on the same rail system. For gantry cranes, watch travel truck clearances. For cab-operated gantry cranes, this may require additional personnel to ensure a clear travel path. Use radio controls according to the manufacturer's instructions. Turn off power to the radio controller and properly store when finished operating.

OET and Gantry Cranes - Securing

Move cab-operated cranes to a boarding platform or ladder. Never attempt to walk the rails to enter or exit an OET crane.

Ensure that crane power is turned off and the lower block is not an obstruction. Do not store the hook block in the upper limit unless allowed by the OEM or activity instruction; additionally, provide sufficient clearance below the upper sheave assembly or trolley so that the subsequent operator performing a pre-use check will be able to stop the hoist motion before a two-block event occurs in case the hoist does not operate in the correct direction upon initiation.

When necessary for OET or gantry cranes located outside, secure the crane against movement by the wind. Chock the travel trucks or wheels as necessary.

Activities are required to develop instructions for securing WHE in adverse weather conditions. Operators shall be aware of these requirements.

Knowledge Check

1. True or False. When operating floating cranes you must start swinging or rotating quickly and stop abruptly.

   A. True
   B. False

2. Select the best answer. Lifting heavy loads with floating cranes will cause the barge to _____.

   A. Rotate
   B. List
   C. Sink
   D. Drift
   E. Skew

3. True or False. Portal crane operator shall stop crane travel if materials or vehicles are inside crane clearance lines.

   A. True
   B. False

4. Select the best answer. When making heavy lifts with locomotive cranes, the use of tilt-blocks or bed-wedges will increase _____ stability.

   A. Over the end
   B. On outriggers
   C. On rubber
   D. Over the side

5. Select the best answer. Failure to disengage tilt-blocks or bed-wedges for locomotive crane travel may result in _____.

   A. Overheating brakes
   B. Derailing the crane
   C. Loss of stability
   D. Overloading the crane

6. Select the best answer. Which of the following is a mode of operation for a typical OET or gantry crane?

   A. Skew
   B. Hoist
   C. Luff

7. Select the best answer. Which of the following is a mode of operation for a typical OET or gantry crane?

   A. Luff
   B. Trolley
   C. Swing

8. Select the best answer. Which of the following is a mode of operation for a typical OET or gantry crane?

   A. Rotate
   B. Extend
   C. Bridge

NOTES

CRANE AND RIGGING ACCIDENTS

Welcome

Welcome to Crane and Rigging Accidents.

Learning Objectives

Upon successful completion of this module you will be able to identify the elements in the crane and rigging operating envelopes, define a crane accident, define a rigging accident, near miss, and unplanned occurrence, identify the primary causes of accidents, and explain the procedures to follow when an accident occurs.

Accident Categories

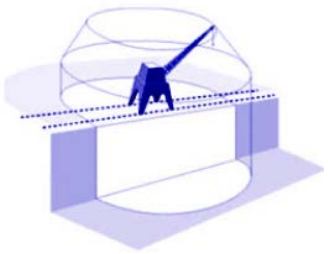
There are two general categories of accidents: crane accidents and rigging accidents.
Crane accidents are those that occur during operation of a category 1, 2, 3, or 4 crane.
Rigging accidents are those that occur when gear and equipment identified in section 14 is used by itself in a weight handling operation, i.e., without category 1 through 4 cranes, or when covered gear is used with multi-purpose machines, MHE (e.g., forklifts), and equipment covered by NAVFAC P-300 in a weight handling operation.
In addition, accidents that occur during the operation of entertainment hoists shall be classified as rigging accidents.

Significant Accidents

A significant accident is an accident that typically has a greater potential to result in serious injury or substantial property damage.
The following accident types are considered significant accidents: injuries (regardless of severity), overloads, dropped loads, two-blocks, crane derailments, or contact with overhead electrical power lines.
Other types of accidents that result in OPNAV Class A, B, C, or D reporting thresholds for material property damage are also considered significant accidents.

Crane Operating Envelope

In order to define a crane accident, you must first understand the crane operating envelope.
The operating envelope consists of any of the following elements: the crane (except a crane being operated in transit as defined in NAVFAC P-307 appendix A), the operator, the riggers, signal persons, and crane walker, other personnel involved in the operation, the rigging gear between the hook and the load, the load, the crane's supporting structure (ground, rail, etc.), and the lift procedure.



Rigging Operating Envelope

The operating envelope around any rigging or other section 14 equipment operation includes the rigging gear or miscellaneous equipment identified in section 14, the user of the gear or equipment (including operators of multi-purpose machines, MHE, and construction equipment), other personnel involved in the operation, the load, the gear or equipment's supporting structure (padeyes, ship's structure, building structure, etc.), the load's rigging path, and the rigging or lift procedure.

Knowledge Check

1. Select all that apply. The crane operating envelope includes the crane, the operator, the riggers, the crane walkers, and …

   A. Rigging gear between the hook and the load
   B. The area where the load will be landed
   C. Any supporting structures
   D. The load

2. Select all that apply. The rigging operating envelope contains the rigging gear and miscellaneous equipment covered by P-307 section 14, the load itself and…

   A. The load rigging path
   B. The crane removal procedure
   C. The rigging procedure
   D. The user of the gear or equipment
   E. The gear or equipment’s supporting structure
   F. Other personnel involved in the operation

Near Miss

A near miss is an unplanned event during a weight handling operation that did not result in a definable accident but easily had the potential to do so. Only a break in the chain of events prevented an accident. Simply put, a near miss is an accident that almost took place. The difference between a near miss and an accident (serious or otherwise) is often a fraction of an inch or a split second of time. A near miss report is used to learn from situations where an accident "almost" happened so that the real event can be averted.

Unplanned Occurrence

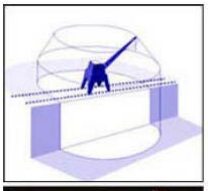
An "unplanned occurrence" describes an event that does not meet the definition of a crane or rigging accident but results in injury or damage to a crane, crane component, or related equipment due to an event not directly related to a weight handling operation. Examples include, but are not limited to, injury or damage caused by weather, damage to a parked or stationary crane caused by another moving object (e.g. vehicle, forklift), and flooding or fire damage.

Reporting

Near Misses and unplanned occurrences that do not fall under the crane and rigging accident definitions shall be reported using figure 12-2 (available on the Navy Crane Center website).
These reports shall be submitted in accordance with NAVFAC P-307 section 12 within 30 days of the event.

Crane Accident

A crane accident occurs when any of the elements in the crane operating envelope fails to perform correctly during a crane operation including operation during maintenance or testing, resulting in any of the following: personnel injury or death, material or equipment damage, dropped load (including any part of the load or rigging gear and any item lifted with the load or rigging gear), derailment, two-blocking, overload (including load tests when the nominal test load is exceeded), or collision (avoidable contact between the load, crane, and/or other objects).



Rigging Accidents

A rigging accident occurs when any of the elements in the operating envelope fails to perform correctly during a rigging operation resulting in any of the following: personnel injury or death, material or equipment damage that requires the damaged item to be repaired because it can no longer perform its intended function, dropped load (including any part of the load or rigging gear and any item lifted with the load or rigging gear), two-blocking of cranes and powered hoists identified in section 14, or overload (including load tests when the test load tolerance is exceeded).
Note: A dropped load, two-blocking, and overload are considered accidents even though no material damage or injury occurs.

Damaged Rigging Gear

When damage to rigging gear is discovered during an inspection or when damaged rigging gear is returned to the gear room, and an accident is suspected, the gear shall be immediately removed from service and a comprehensive investigation initiated.
For a suspected accident, the activity shall follow the investigation and reporting requirements of NAVFAC P-307, section 12, promptly perform a comprehensive investigation, and prepare a Crane and Rigging Accident Report and forward a copy to the Navy Crane Center (Code 06) within 30 days of the accident.
Local Weight Handling Equipment accident reporting procedures shall also be followed.

Accident Examples

Some common examples of accidents are: dropped loads, injuries from a shifting load, failure of rigging gear resulting in a dropped load, overloads, and improperly secured loads falling from pallets.

Accident Exception

A component failure (e.g., motor burnout, gear tooth failure, bearing failure) shall be considered an accident only if damage to the load or another component occurs as a result of the failure.

Accident Causes

In most cases, crane accidents result from personnel error and can be avoided.
Most crane accidents are caused by: inattention to the task, poor judgment, bad communication, team members having too much confidence in their abilities, or operating the crane too fast.

Operator Responsibilities

The operator can play a significant role in eliminating human error and accidents. Drugs and alcohol can affect a person's capability to think, reason, or react in normal situations and can certainly lead to serious accidents. Operators must always consult their physicians regarding effects of prescription drugs before operating equipment, and recognize that medications often affect people differently. An operator is responsible for evaluating his or her physical and emotional fitness.

Accident Actions

Upon having an accident or having seen evidence of damage, the crane team, riggers, equipment users, etc., shall stop all operations and notify immediate supervisor(s).
If there is impending danger to the equipment or personnel, place the crane and/or load in a safe position prior to notifying supervision.
Ensure the accident scene is secured and undisturbed so as to facilitate the investigation.
The supervisor shall review the situation and take any further emergency action.
The supervisor shall notify management personnel as well as the activity safety office.

Crane Accident Actions

If a crane accident occurs, personnel must take the following actions:
Stop operations as soon as possible, however don't stop at the expense of safety.
In some circumstances, for example, if a crane is involved in a collision as a load is being lowered, the operator should first land the load, then, follow the accident response procedure.
Don't try to correct the problem unless life or limb is in danger.
Call, or have someone call 911 if an injury occurs.
Secure the crane.
Secure power as required.
If danger exists to the crane or personnel, place the crane and load in a safe position.
Notify supervision as soon as safely possible.
Ensure that the accident scene is preserved to aid the investigation.

Notification and Reporting

For accidents involving a fatality, inpatient hospitalization, overturned crane, collapsed boom, or any other major damage to the crane, load, or adjacent property, notify the Navy Crane Center by e-mail as soon as practical, but not later than eight hours following the accident. Notification for all other accidents shall be made as soon as practical but no later than three working days after the accident.
For each suspected accident, activities shall promptly perform an investigation, prepare a crane and rigging accident report using figure 12-1 (available on the Navy Crane Center web site), and forward a copy to the Navy Crane Center (Code 06) within 30 days of the accident.

Accident Reporting Procedures - Contractor

The contractor shall: notify the contracting officer as soon as practical, but not later than four hours, after any WHE accident, secure the accident site and protect evidence until released by the contracting officer, and conduct an investigation to establish the root cause(s) of any WHE accident, near miss, or unplanned occurrence.
Crane operations shall not proceed until the cause is determined and corrective actions have been implemented to the satisfaction of the contracting officer.
The contractor shall provide the contracting officer a report for an accident or near miss within 30 days using the appropriate form provided in NAVFAC P-307 section 12 consisting of a summary of circumstances, an explanation of causes, photographs (if available), and corrective actions taken.

Accident Reporting Procedures - Contracting Officer

The contracting officer shall notify the host activity of any WHE accident upon notification by the contractor. Additionally, the contracting officer shall notify the Navy Crane Center, by e-mail (nfsh_ncc_accident@navy.mil), of an accident involving a fatality, in-patient hospitalization, overturned crane, collapsed boom, or any other major damage to the crane or adjacent property as soon as possible, preferably within 8 hours of notification by the contractor. For all other accidents, notify the Navy Crane Center as soon as practical but no later than three working days after the accident.
The contracting officer shall provide the Navy Crane Center and host activity a copy of every accident and near miss report, regardless of severity, upon receipt from the contractor.
The contracting officer or designated weight handling representative shall sign all crane and rigging accident and near miss reports to indicate that they are satisfied that the contractor's investigation and corrective action are sufficient.

Knowledge Check

1. Select the best answer. During maintenance the rigging gear between the crane hook and the load fails and results in equipment damage. This is reported as a:

   A. Rigger error
   B. Rigging gear deficiency
   C. Operator error
   D. Crane accident

2. Select the best answer. During crane operations the load shifts. The operator reacts quickly and saves the load but causes the crane to derail. This is reported as a:

   A. Load configuration error
   B. Crane walker’s error
   C. Crane accident
   D. Operator error

3. Select the best answer. When rigging gear covered by P-307 Section 14 fails while suspended from a structure and drops the load it is a:

   A. Rigging accident
   B. Load configuration error
   C. Crane accident
   D. Rigging error

4. Select the best answer. If component failure occurs, such as motor burnout, and does not result in damage, the component failure is considered:

   A. A crane accident
   B. A rigging accident
   C. Crane maintenance's responsibility
   D. A non-accident

5. Select the best answer. To whom or to what are the majority of crane accidents attributed?

   A. Weather conditions
   B. Crane operators
   C. Equipment failure
   D. Riggers or signalmen
   E. Personnel error

6. Select all that apply. Over-confidence and poor judgment among team members can contribute to crane and rigging gear accidents. Select additional factors that can contribute to accidents:

   A. Engineering lift specifications
   B. The crane operating envelope
   C. Operating the crane too fast
   D. Inattention to the task

7. Select the best answer. If you have an accident with a crane or you find damage and suspect an accident has happened, your first step is to:

   A. Stop operations as soon as safely possible
   B. Call emergency services if anyone is injured
   C. Notify your supervisor immediately
   D. Secure the crane and power as required

NOTES

Naval Facilities Engineering Command
NAVY CRANE CENTER

GENERAL CRANE SAFETY REFRESHER EVALUATION SHEET

Student Name:_____

Command/Activity/Organization: _____

Instructor: _____ Date: _____

Directions: To assist in evaluating the effectiveness of this course, we would like your reaction to this class. Do not rate questions you consider not applicable.

Please rate the following items:	Excellent	Very Good	Good	Fair	Poor
Content of the course met your needs and expectations.					
Content was well organized.					
Materials/handouts were useful.					
Exercises/skill practices were helpful.					
Training aids (slides, videos, etc) were used effectively.					
Instructor presented the material in a manner, which was easy to understand.					
Instructor was knowledgeable and comfortable with the material.					
Instructor handled questions effectively.					
Instructor covered all topics completely.					
Probability that you will use ideas from the course in your work.					
Your opinion of the course.					
Your overall opinion of the training facilities.					

What were the key strengths of the training? How could the training be improved? Other comments?

_____

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_____

List other training topics in which you are interested:_____

_____

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Note: If you would like a staff member to follow up and discuss this training, please provide your phone number:_____