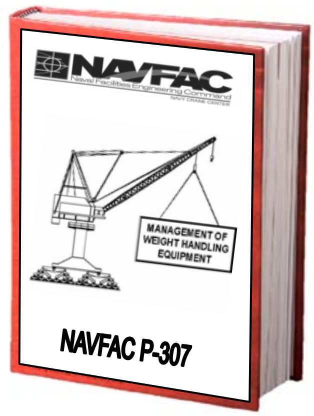
Navy Crane Center



NAVFAC P-307 Training

RIGGING PRACTICES

WEB BASED TRAINING STUDENT GUIDE

NCC-RP-05.2

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INTRODUCTION

Welcome

Welcome to the Rigging Practices course.

Rigging Practices is designed to acquaint personnel (professional riggers) with Navy requirements for safe weight handling operations and provide a knowledge base upon which to build with on-the-job experience.

Introduction

The following topics will be discussed during this training: Crane Types and Components; Determining Load Weight and Load Weight Distribution; Sling Angle Stress and D/d Ratio; Rigging Gear Marking and Record Requirements; Rigging Gear Inspection, and Test Requirements; Rigging Gear Use; Complex and Non-Complex Lifts; Crane Communications, and Crane Team Concept; Attachment Points; Planning and Executing Crane Lifts; Safe Operations; and Crane and Rigging Accidents.

Course Objectives

Upon successful completion of this course you will be able to: identify crane types and components; determine load weights and load weight distribution; determine sling angle stress; explain proper selection, use, marking, inspection, testing, and record requirements for rigging gear; identify and understand complex and non-complex lift requirements; explain the crane team concept; identify proper crane communication methods; identify attachment point requirements; plan and execute crane lifts; understand safe operating requirements; and identify crane and rigging accidents, near misses, unplanned occurrences, and reporting requirements.

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 the 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 navigation buttons (top right) look like arrow heads and allow you to move forward to the next screen or back to the previous screen by clicking on the arrowhead pointing to the right or left, respectively. The ‘pause’ and ‘continue’ buttons (top right) allow you to pause and continue (or start) the course or module. The ‘exit’ button (top right) closes the module and returns you to the main module menu. The 'view and hide narration' links (lower right on the content screen) allow you to view and/or hide a text version of the audible narration.

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, and trends (with narratives and pictures); Content changes, additions, deletions; Other topics; Clarifications and corrections; and 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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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.

Category 1 Crane Examples

Floating Cranes

These types of cranes include barge, pontoon, or hull mounted with an integral base.

The luffing booms are capable of continuous 360 degrees rotation.

They are powered by diesel-electric generators, diesel-drivin hydraulic pumps, and may be self-propelled and/or tug assisted.

Category 1 Crane Examples

Hammerhead Cranes

Hammerheads have a rotating counterbalanced cantilevered boom equipped with one or more trolleys that move along the length of the boom.

Most are supported by a pintle or turntable mounted ato a traveling or fixed tower assembly.

Category 1 Crane Examples

Container Cranes

Container cranes have hinged booms and main beams with traveling trolleys mounted on rails, which in turn is mounted on a traveling gantry structure.

These cranes are used at several military port activities to quickly transfer containers on and off ships.

Category 1 Crane Examples

Derricks

This crane has a boom that is hinged near the base of a fixed mast.

Typically, the boom rotates left and right between the mast support legs or "stiff legs". These stiff legs are capable of handling tensile and compressive forces.

The pictured crane is referred to as a stiff-leg derrick and can rotate 180 degrees.

Category 1 Crane Examples

Portal Cranes

Portal cranes consist of a rotating superstructure ounted on a gantry structure. The gantry style structure allows for the free movement of traffic and materials when the crane is located on the pier.

There is an operator's cab, machinery house, and a luffing boom.

The primary source of power is a diesel engine that drives generators or hydraulic pumps.

They are supported by wide gauge rail allowing the portal crane to move about the facility.

Category 1 Crane Examples

Mobile Cranes

The most common type of mobile crane is the truck mounted hydraulic crane.

These cranes consist of a rotating superstructure mounted on a specialized truck chassis equipped with a power plant, driver's cab, and operator's cab.

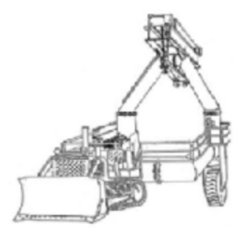
The primary source of power for these types of cranes are diesel engines that drive hydraulic pumps and provide electric power.

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 Tired 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

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.

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.

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.

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 Crane 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. Use the forward and backward arrows to scroll through and review the various examples and their descriptions.

Category 2 and 3 Crane Examples

Bridge or OET Cranes

These types of cranes may be cab, pendant, or radio controlled.

Principal parts include the bridge, girders, end trucks, trolley, hoist, and controls.

Mobility is limited to the height of the bay, length of the runway, and the span of the bridge.

Category 2 and 3 Crane Examples

Pillar Jib Cranes

This is a fixed crane consisting of a rotating vertical member with a horizontal arm supporting a trolley and hoist.

Pillar-jib cranes normally rotate 360 degrees.

Category 2 and 3 Crane Examples

Jib Cranes

Jib cranes are normally category 3 cranes, but can be category 2 cranes.

They consist of a horizontal boom that is either cantilevered or supported by tie rods and is capable of rotating left and right. They're equipped with either powered or manual hoists and may have trolleys.

Usually mounted on a wall or column.

Category 2 and 3 Crane Examples

Trolley Mounted Overhead Hoists

These cranes consist of an under-hung trolley with one or more drums and sheaves for wire rope or chain.

They are powered manually, electrically, hydraulically, or pneumatically.

Mobility is limited to the height and length of the supporting beam.

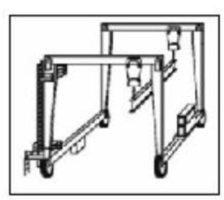
Knowledge Check

1. Select the best answer to fill in the blank. 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 to fill in the blank. 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 to fill in the blank. 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

Power Types

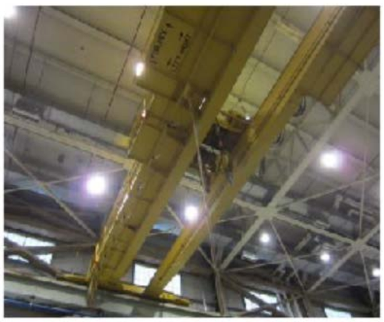
Category 1 and 4 cranes generally use electric or hydraulic power that is supplied by a diesel engine. A collector ring system conveys electrical current from the revolving portion of the crane to the lower crane structure.

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.

Boom Dog

Examples

Examples of load-bearing parts are wire rope, sheaves, hooks, hook blocks, hoist drum pawls, and a boom dog, used to prevent unwanted rotation of a boom or hoist drum.

Carrier Frame Structure

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.

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.

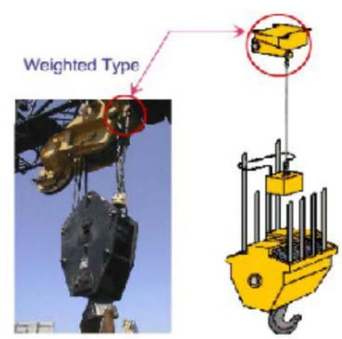
Load Moment Indicators

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 overtravel 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

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

   a. Electric or hydraulic power supplied by a diesel engine
   b. Pneumatic and electric power supplied by a backup generator
   c. Hydraulic and water power supplied by a compressor
   d. Pneumatic and hydraulic power supplied by a compressor

7. Select the best answer to fill in the blank. Load - _______ parts are those that restrain, position, or control the movement of the load.

   a. Bearing
   b. Controlling
   c. Lifting
   d. Handling
   e. Operation

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

   a. Operational Safety Device
   b. General Safety Device
   c. Load-Bearing Part
   d. Load-Controlling Part

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

   a. Operational Safety Device
   b. General Safety Device
   c. Load-Controlling Parts
   d. Load-Bearing Parts

10. Select the best answer to fill in the blank. Load-________ parts are those that support the load.

    a. Bearing
    b. Controlling
    c. Lifting
    d. Handling
    e. Operational

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

    a. Through the collector ring system
    b. Through the electrical panels
    c. Through the main circuit board
    d. Through transistors

12. Select the best answer to fill in the blank. Safety devices that provide protection for personnel and equipment are considered ________ safety devices.

    a. Load-bearing
    b. Universal
    c. General
    d. Operational

13. Select the best answer to fill in the blank. Safety devices that affect the safe load lifting and handling capabilities of equipment are considered ________ safety devices.

    a. Load-bearing
    b. Universal
    c. General
    d. Operational

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

    a. Operational Safety Devices
    b. Load-Controlling Parts
    c. Load-Bearing Parts
    d. General Safety Devices

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

    a. Operational Safety Device
    b. Load-Controlling Part
    c. Load-Bearing Part
    d. General Safety Device

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 Determines

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, a Load Indicating Device (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

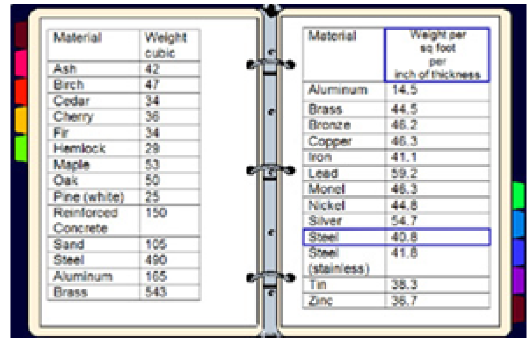
Never take word of mouth to establish load weight! Word of mouth may be used as a starting point for sizing the crane and rigging gear so the component can be weighed with a load indicating device, but never shall it be used as the final determination of load weight. To avoid overloading any equipment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

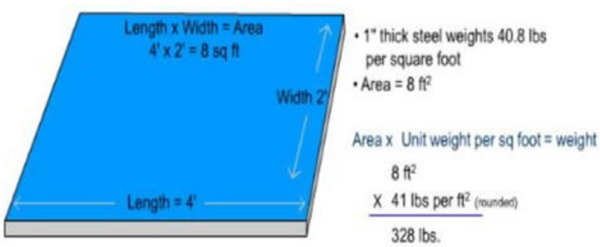
Standard Material Weight

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.

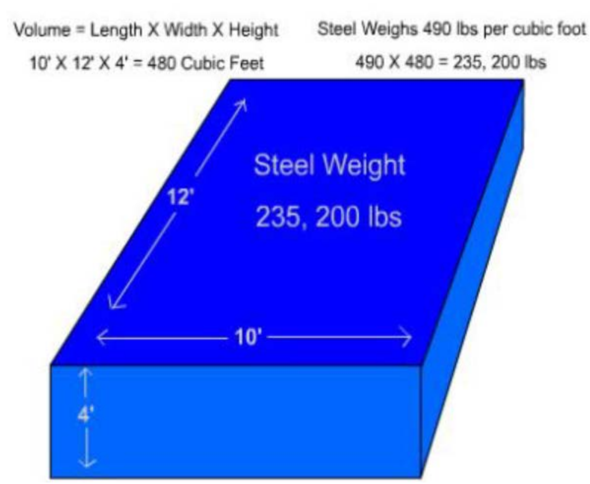


Calculating Weight by Area

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.

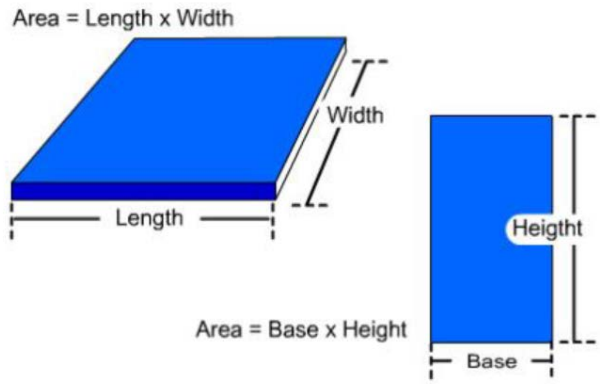
Calculating Weight by Volume

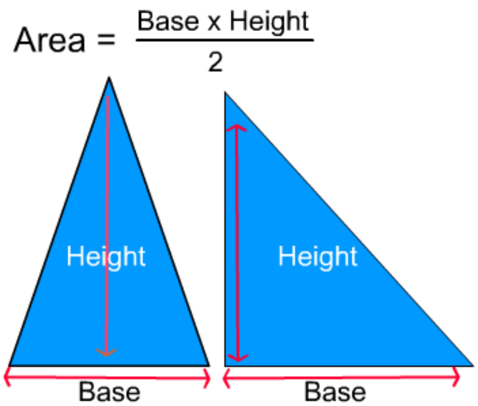
Volume is always expressed in cubic units, such as cubic inches, cubic feet, and cubic yards. Let's calculate the volume of this box. The formula is length, times width, times height. The length is 12 feet. The width is 10 feet. The height is 4 feet. When we multiply 12 times 10, times 4, the volume 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 units of square feet or square inches.



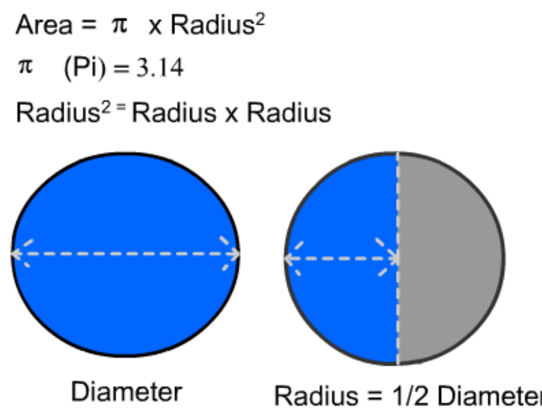


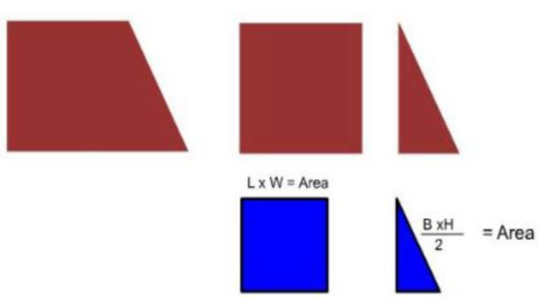
Calculating the Area of a Triangle

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.



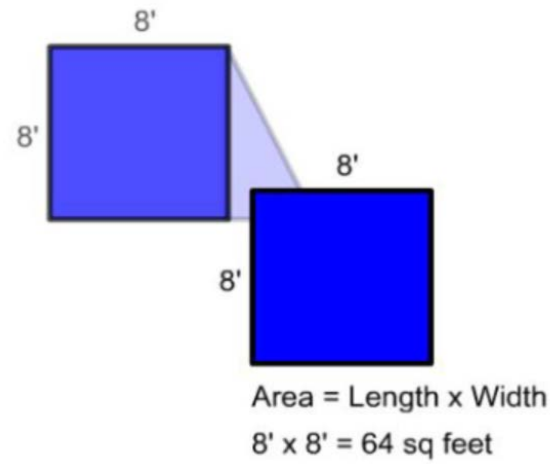


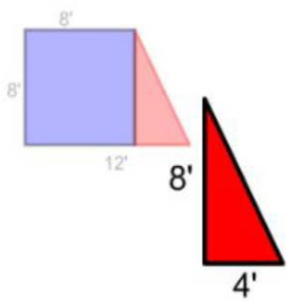
Calculating the Weight of Complex Shapes 1

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.

Calculating the Area of the First Part

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.





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

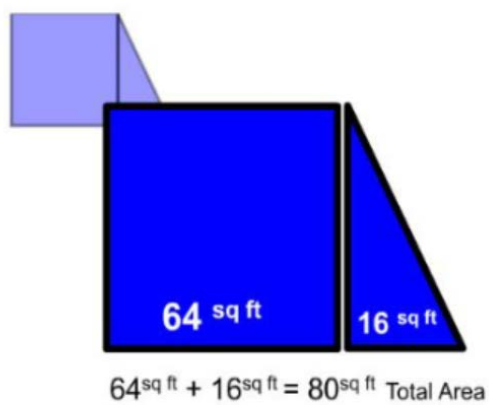
$$\frac{8' \times 4'}{2} = 16 \text{ sq ft}$$

Calculating the Area of the Second Part

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 square feet. 32 square feet divided by 2 equals 16 square feet.

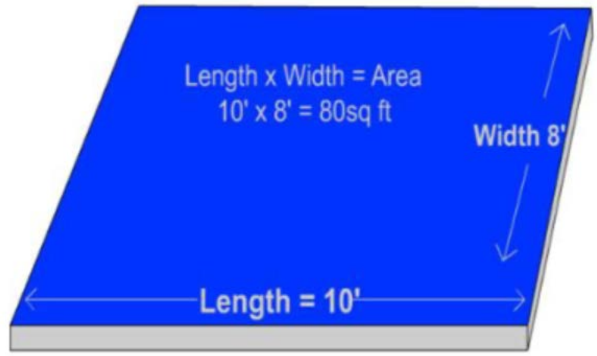
Adding Areas

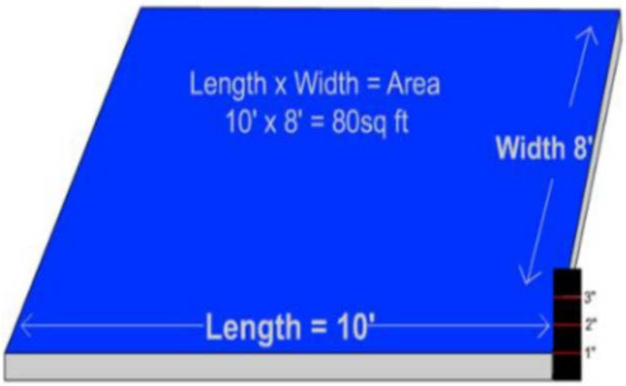
Now that we have found the area of the two sections, all we have to do is add the area of the square to the area of the triangle to find the total area of the object. 64 square feet, plus 16 square feet, equals 80 square feet. If we know what the material is and how thick it is, we can find its weight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



Calculating Weight 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.



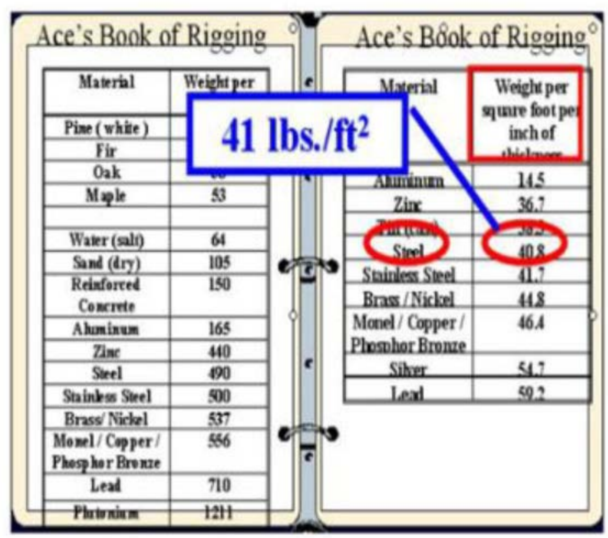


Calculating Weight Step 2

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

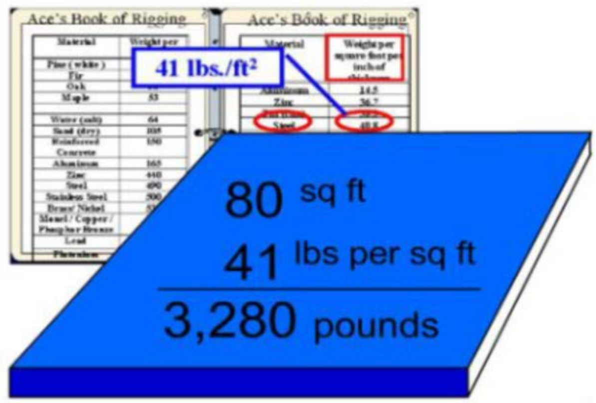
Calculating Weight Step 3

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 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.



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

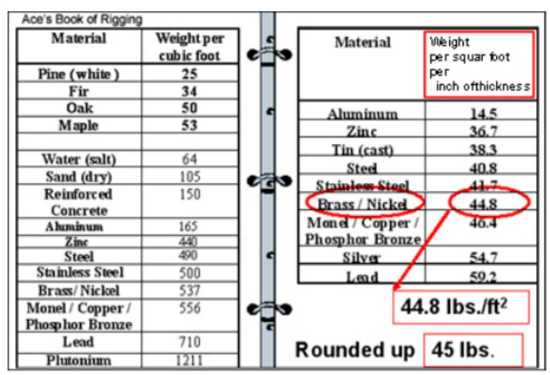
$$\frac{5' \times 12'}{2} = 30 \text{ sq ft}$$

Calculating Triangle Area

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.



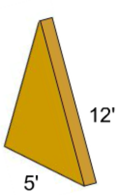
Ace's Book of Rigging

Material	Weight per cubic foot
Pine (white)	25
Fir	34
Oak	50
Maple	53
Water (salt)	64
Sand (dry)	105
Reinforced Concrete	150
Aluminum	165
Zinc	440
Steel	490
Stainless Steel	500
Brass/ Nickel	537
Monel / Copper / Phosphor Bronze	556
Lead	710
Plutonium	1211

Material	Weight per squar foot per inch ofthickness
Aluminum	14.5
Zinc	36.7
Tin (cast)	38.3
Steel	40.8
Stainless Steel	41.7
Brass / Nickel	44.8
Monel / Copper / Phosphor Bronze	46.4
Silver	54.7
Lead	59.2

44.8 lbs./ft²

Rounded up 45 lbs.



Area=30 sq ft
Thickness =3"
Brass 45 lbs per **inch** of thickness

$3 \times 45 \text{ lbs./ft}^2 = 135 \text{ lbs. ft}^2$

$135 \text{ lbs./ft}^2 \times 30 \text{ ft}^2 = 4{,}050 \text{ lbs.}$

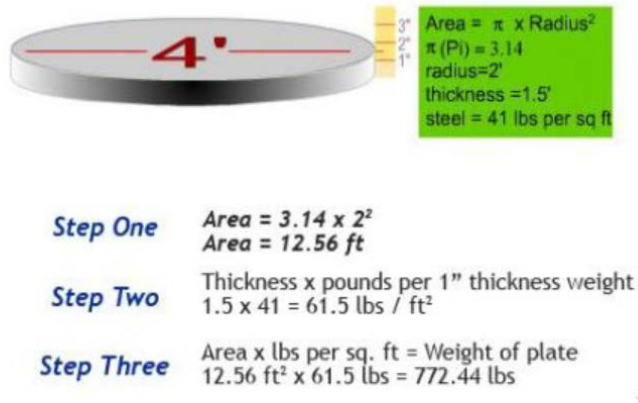
Weight of brass plate = 4,050 lbs.

Calculating Triangle Weight 2

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 Circle Weight

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 Numbers

Rounding numbers make 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 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. 1,200 pounds
    b. 1,100 pounds
    c. 1,300 pounds
    d. 1,000 pounds

5. Select the best answer. A complex shape of 1 inch thick 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?

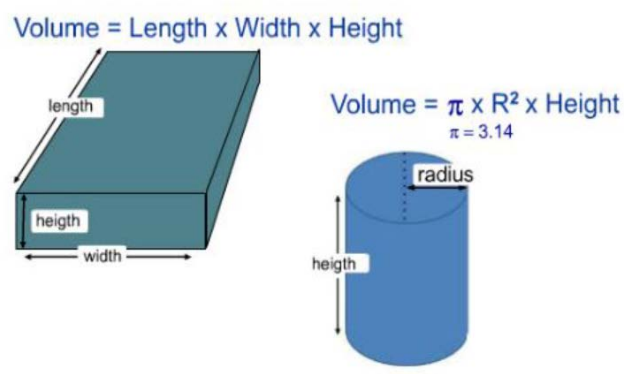
    a. 8 x 12 / 2
    b. 8 x 6 / 2
    c. 6 x 12 / 2
    d. 12 x 10 / 2

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

    a. Base x Height / 2
    b. Base x Height x 2
    c. Length x Width x Height
    d. None of the above

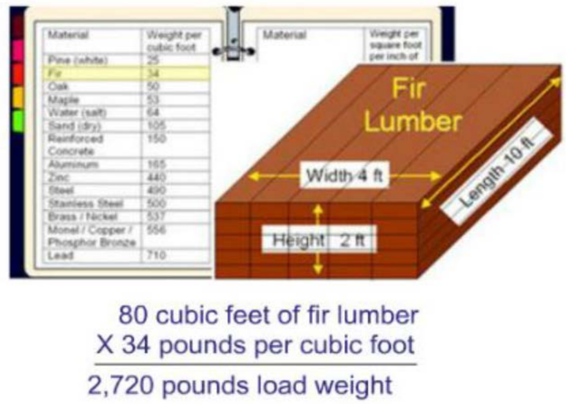
Calculating Volume

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.



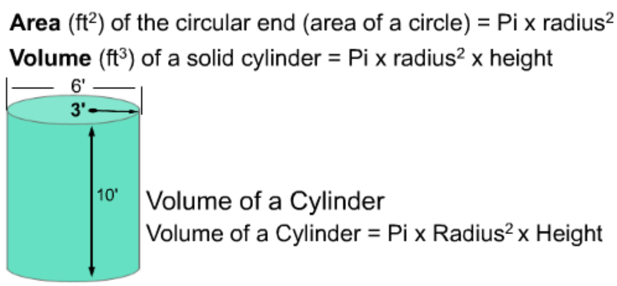
Load Weight by Volume Example

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.



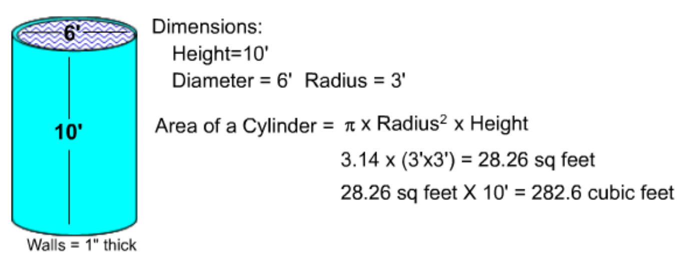
Cylinder Volume Calculation

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.



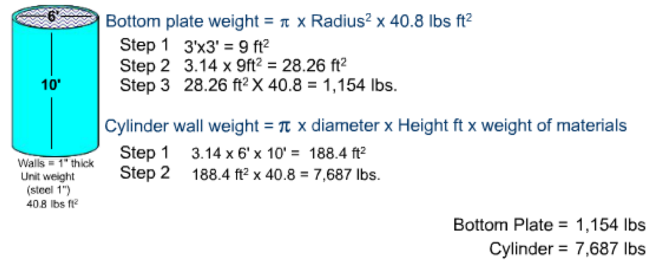
Cylinder Volume Calculation 2

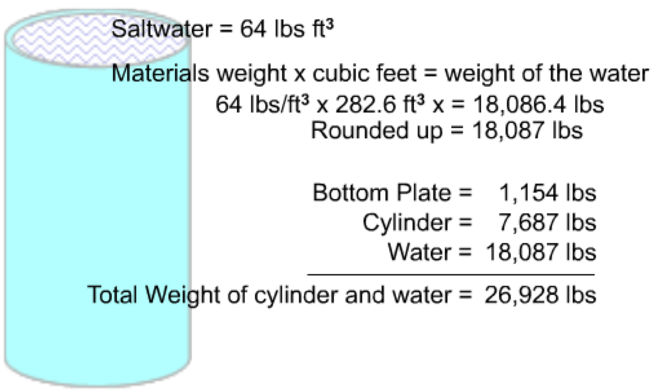
Let's calculate the volume of this cylinder. If the diameter of this object is 6 feet, what would the radius be? The radius would be 3 feet. The height is 10 feet. We multiply Pi, which is 3.14 times 3 feet times 3 feet. The result is 28.26 square feet. Now, multiply 28.26 square feet, times the height, 10 feet. The result is the volume of this cylinder, 282.6 cubic feet. If the cylinder is hollow, we 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 Cylinder Weight

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 Cylinder Weight 2

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

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

    a. 27 x 105 = 2,835 pounds
    b. 27 x 1,200 = 32,400 + 105 = 32,505 pounds
    c. 27 x 105 = 2,835 + 1,200 = 4,035 pounds

8. 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

9. Select the best answer. A cylinder is made of solid aluminum which has a 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 pounds
   b. 10,362 pounds
   c. 12,532 pounds
   d. 10,532 pounds

10. 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

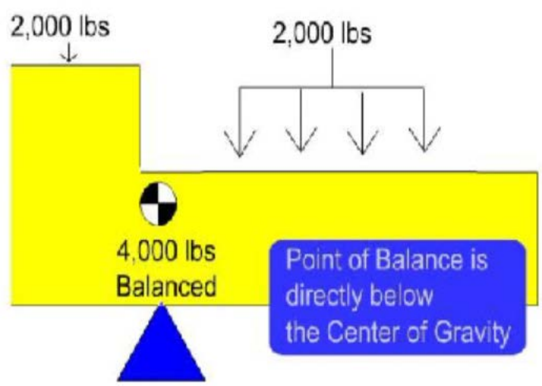
NOTES

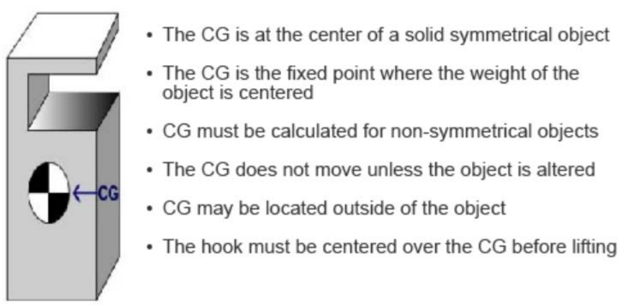
Load Weight Distribution

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
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.

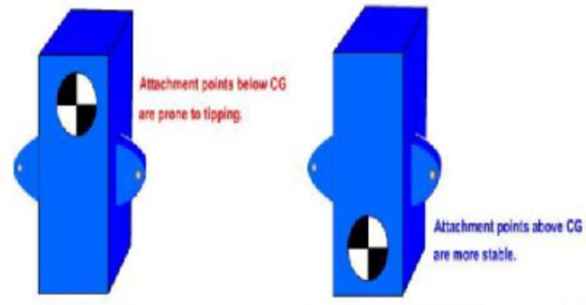




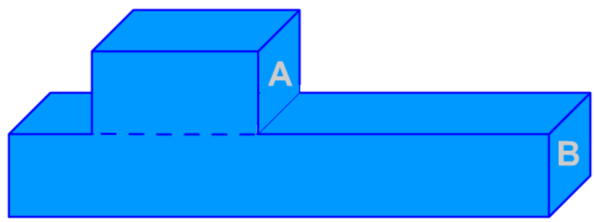
Center of Gravity
The center of gravity is the point where the entire weight of the object would balance in any direction, as if all the weight were concentrated in that one point. It is a fixed point and does not change unless the shape of the object is altered. Center of gravity is generally located 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 the 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.



Break the object into sections or components



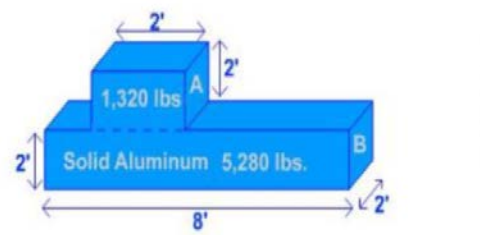
Finding the Balance Point: Step 1

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 Balance Point: Step 2

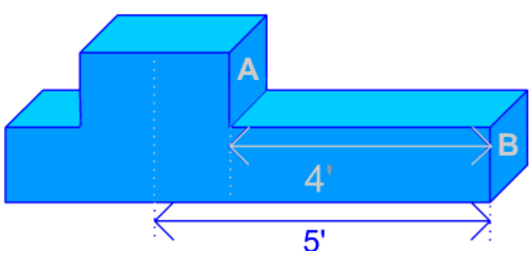
The second step is to determine the weight of each section.

- Determine the weight of each section or component.
- Aluminum weighs 165 pounds per cubic foot



Part A = 2' x 2' x 2' = 8 ft^3 x 165 lbs/ft^3 = 1,320 lbs.
Part B = 2' x 8' x 2' = 32 ft^3 x 165 lbs/ft^3 = 5,280 lbs.
Add the sections: 1,320 + 5,280 = 6,600 lbs.

Measure from the reference end to the center of each section.



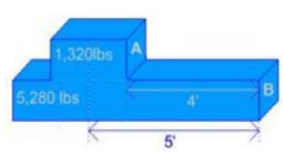
Finding the Balance Point: Step 3

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

Finding the Balance Point: Step 4

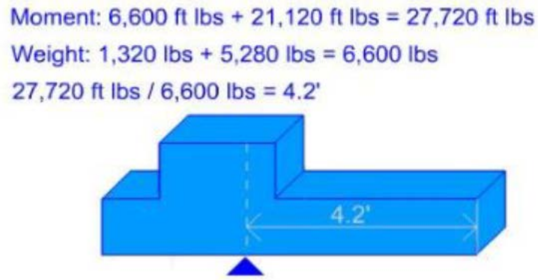
Then, multiply the weight of each section, by the distance from the reference end to the center of that section. The result is called moment. Moment is an effect produced by a force at some distance from a fixed point, such as the center of gravity. Moment, like torque, is often described in foot-pounds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

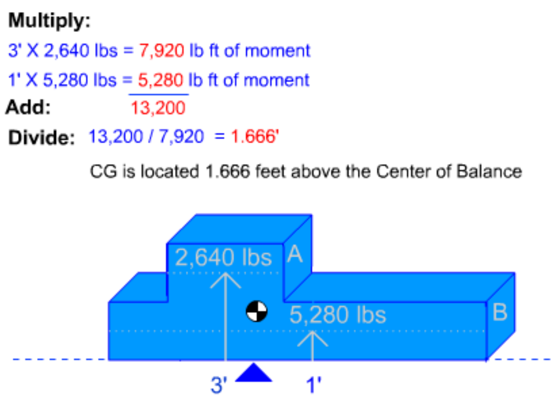
Moment of Section A = 1,320 lbs. x 5 ft. = 6,600 ft lbs
Moment of Section B = 5,280 lbs. x 4 ft. = 21,120 ft lbs



Finding the Balance Point: 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.



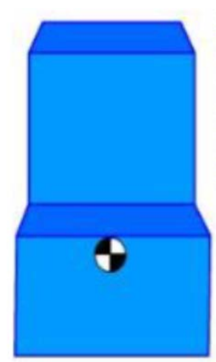


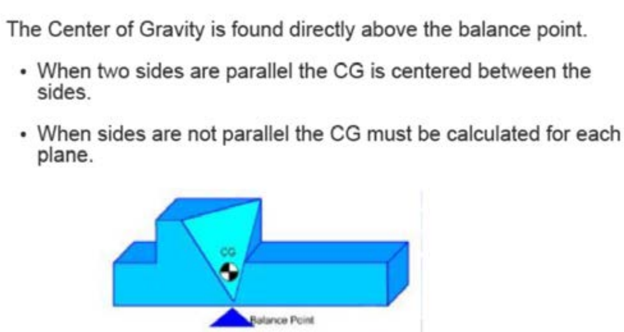
Finding the Height of the Center of Gravity

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 pound-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.

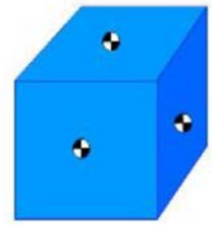




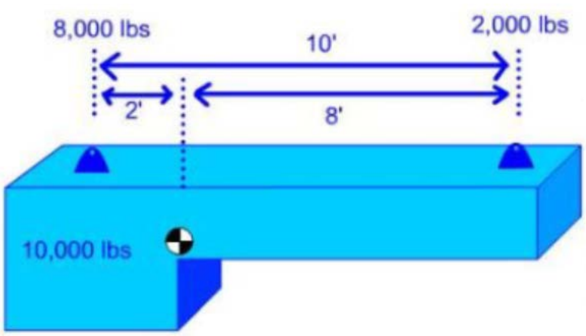
Center of Gravity Pinpointed

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.

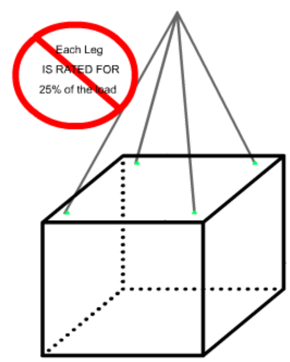


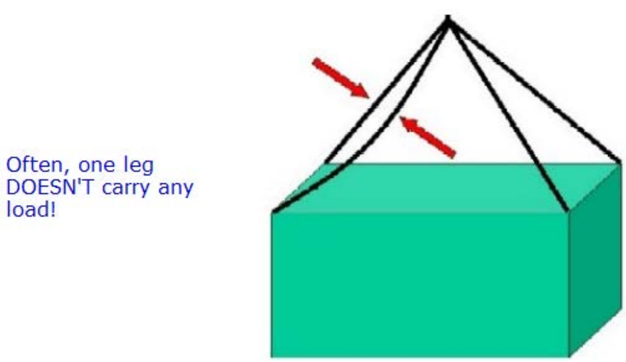
Weight Distribution

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.

Wrong Assumption

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



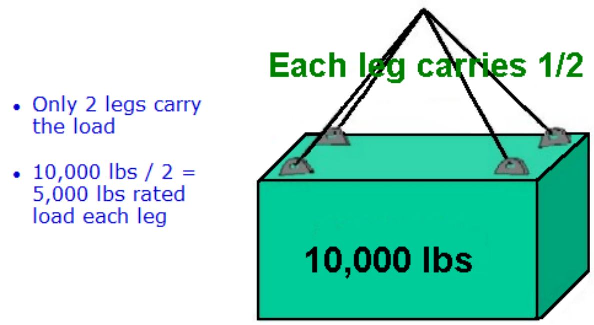


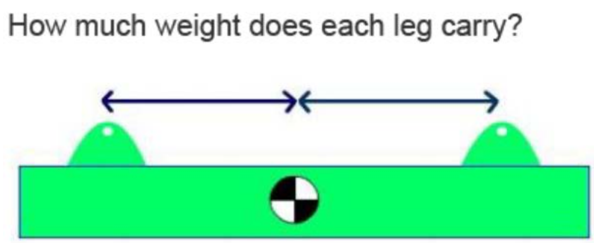
How Many Legs Really Carry the Load?

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

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.



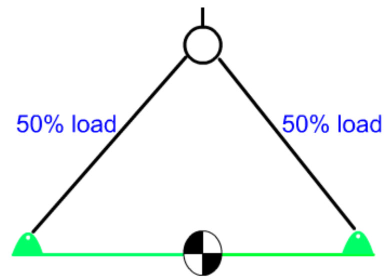


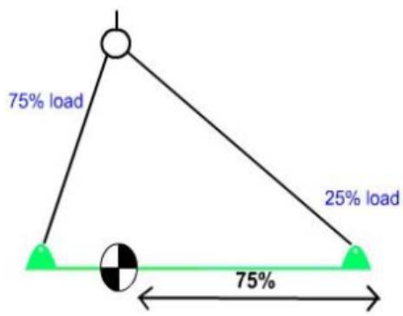
Determining Leg Weight

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.

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.



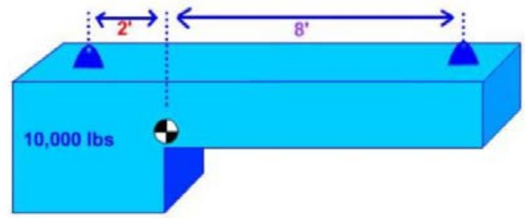


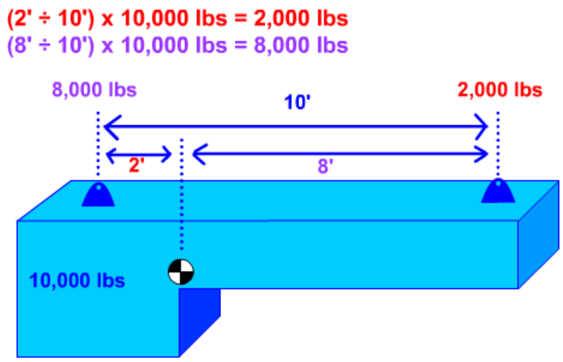
Unequal Weight Distribution

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 percent of the weight and the opposite end carries 25 percent.

Calculating Weight 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. 50%, 50%
   b. 75%, 25%
   c. 25%, 75%
   d. 33%, 66%

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 (CG) and attachment point #2 is 3 feet from the center of gravity. There is a 10,000 pound 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. 3 divided by 6 multiplied by 10,000 (3 / 6 x 10,000)
    c. 3 divided by 9 multiplied by 10,000 (3 / 9 x 10,000)
    d. 6 divided by 3 multiplied by 10,000 (6 / 3 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

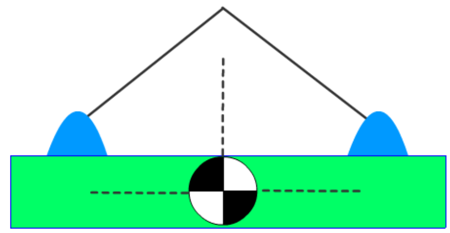
NOTES

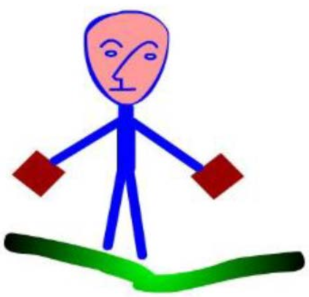
SLING ANGLE STRESS

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.

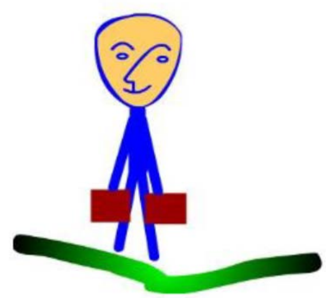
What is Sling Angle Stress?
What is sling angle stress? It is the added force or load created in the rigging when the slings are not perfectly plumb, vertical, and parallel.

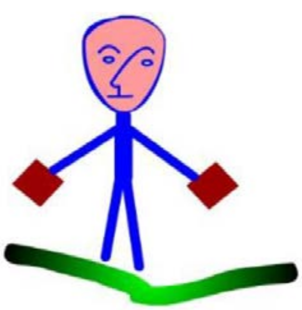




Sling Angle Stress Illustration
It may be beneficial to use an illustration that we can relate to. Though this is not exactly sling angle stress, it illustrates the concept very well.

90 Degree Sling Angle Stress 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.

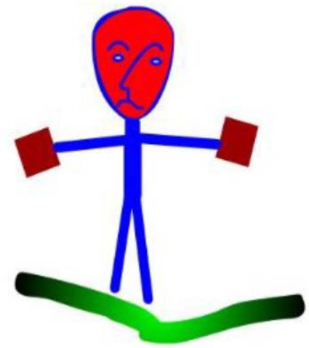


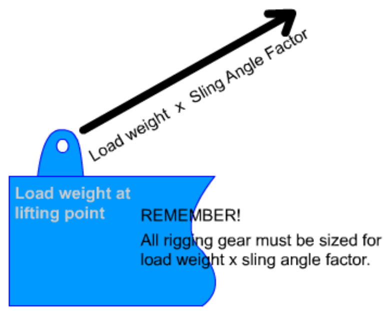


45 Degree Sling Angle Stress Example
When Ace has his arms at a 45 degree angle the stress in his arms increases even more. The stress increase is 42 percent of the weight he's holding. It feels like he's holding 71 pounds in each arm.

30 Degree Sling Angle Stress Example

At a 30 degree angle, the amount of stress in Ace's arms increases further. The stress increase at 30 degrees is 100 percent 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.



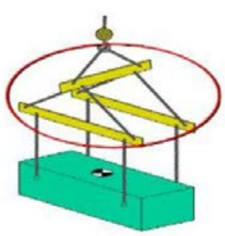


Choosing Your Gear

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 Sling Angle 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

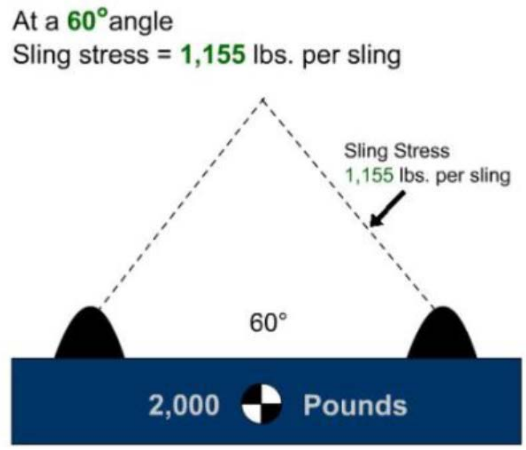
Sling angle stress can be minimized by using spreaders or other below the hook lifting devices. Lifting beams or strong-backs can help ensure each sling is carrying its share of the load and that the load remains level. Sling angles may still affect the rigging gear between the hook and spreaders, even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

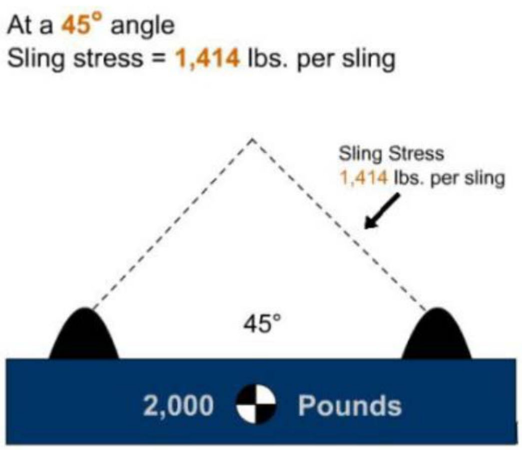
Sling Angle Stress Summarized

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.

60 Degree Sling Angle Example

At a 60 degree 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 degrees is the preferred angle!



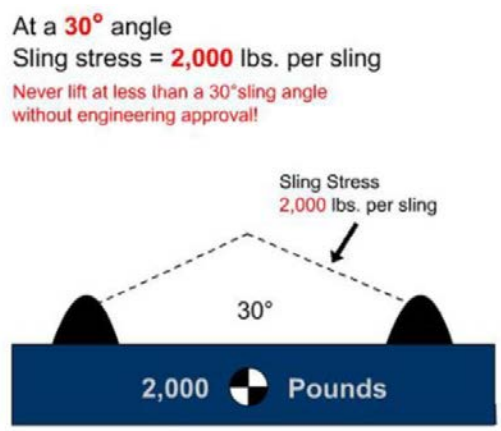


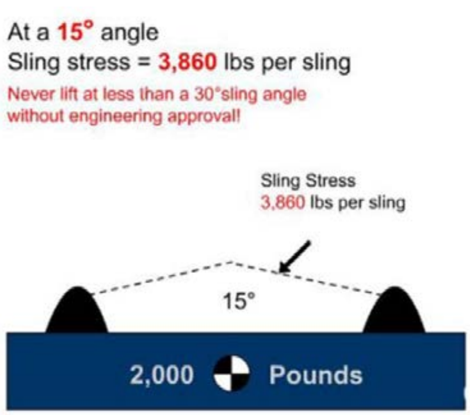
45 Degree Sling Angle Example

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

30 Degree Sling Angle Example

At a 30 degree 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 percent increase! Never lift with less than a 30 degree angle without engineering approval!



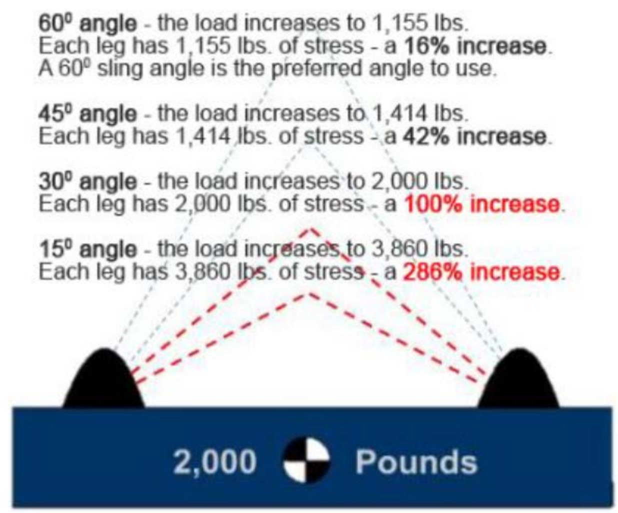


15 Degree Sling Angle Example

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

Effects of Sling Angle Stress Summary

At a 60 degree 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 degrees is the preferred angle! At a 45 degree angle the load has increased to 1,414 pounds in each sling. That's nearly a 42 percent increase! At a 30 degree 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 percent increase! Never lift with less than a 30 degree angle without engineering approval! At a 15 degree angle the load has increased to 3,860 pounds. That's a 286 percent increase in each sling!



Accounting for Sling Angle Stress

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

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.

Determining Sling Angle Stress

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.

Angle Factor Chart

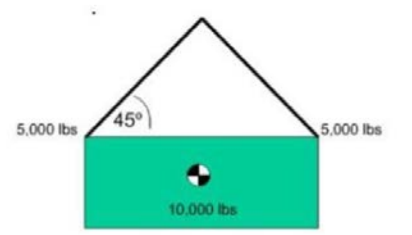
To use an angle factor chart, you first need to determine the sling angle. Sling angle can be determined mathematically or measured. Once you have determined the sling angle, find the corresponding angle factor, and multiply that number by the weight carried in each leg. When you look at the angle factor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

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

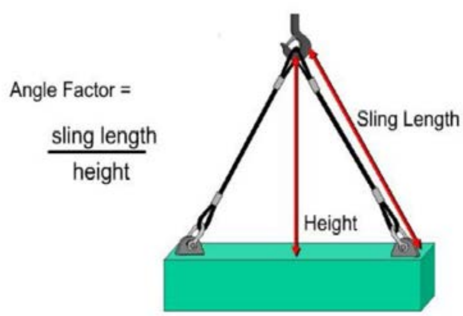
Angle Factor Chart Example

This shape represents the lift we are about to make. Let's say that the angle created by the slings we use is 45 degrees. The angle factor for a 45 degree 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.

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



1.414 x 5,000 lbs.=7,070 lbs. in each leg.

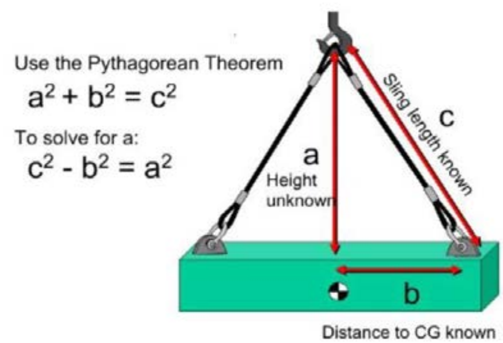


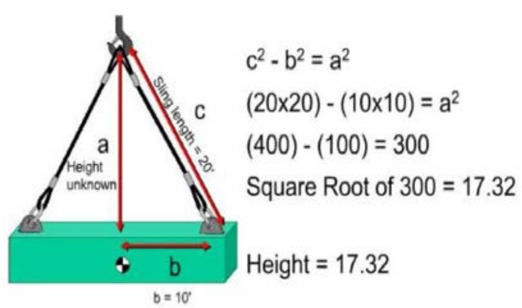
Angle Factor

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.



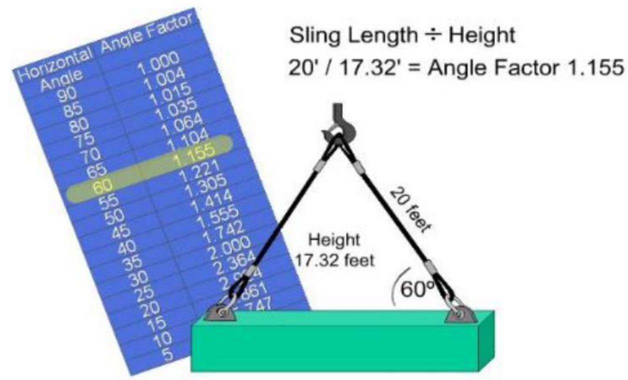


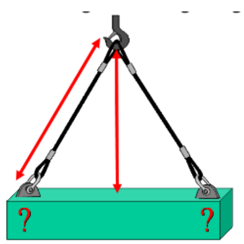
Finding Height Continued

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. Ten times 10 equals 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.

Finding Angle Factor

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.





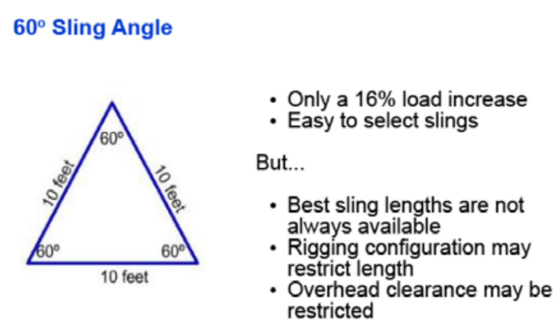
(Sling Length ÷ Height) X Weight Distribution = Sling Angle Stress

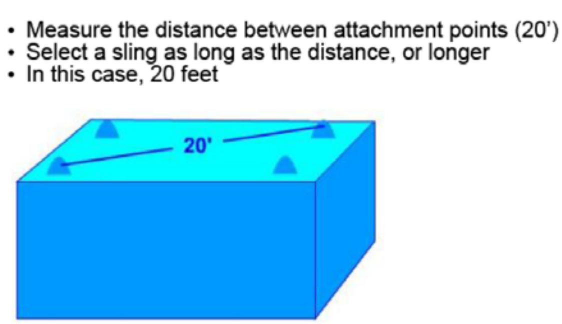
Solving Sling Angle Stress

Now we can use everything we've covered thus far to solve for sling angle stress. Here's the formula: Sling length divided by height, times the 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.

60 Degree Sling Angle

60 degrees is the preferred sling angle. At 60 degrees, the load in the slings increases by 16 percent.





60 Degree Sling Length

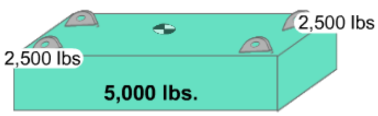
To ensure your slings will have at least a 60 degree sling angle, simply measure the distance between attachment points. Measure diagonally when there are more than two attachment points, because it's the longest distance. Then select a sling that is as long, or longer than the distance measured. If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

60 Degree Sling Angle Minimum Capacity

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 degree 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!

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.

30 Degree Minimum Capacity



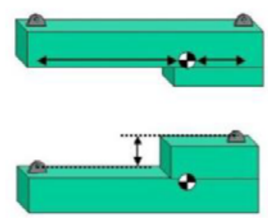
30° Angle Factor = **2.00**
2.00 x 2,500 lbs. = 5,000 lbs. stress
Minimum capacity sling and rigging gear require 5,000 lbs.

Using the same weight, let's look at the minimum rated capacities for a 30 degree sling angle. The angle factor for 30 degrees is 2. At a 30 degree 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.

Unequal distance from Center of Gravity

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.

- Never assume sling angle stress is equal between legs
- Calculations are required to find sling angle stress



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. 3
   b. 4
   c. 5
   d. 6

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

   a. Multiply the weight in the attachment point with the angle factor
   b. Multiply the weight of the item with the distance between attachment points
   c. Multiply the weight of the item with the rated capacity of the gear
   d. Multiply the weight in the attachment point with the height of the lift triangle

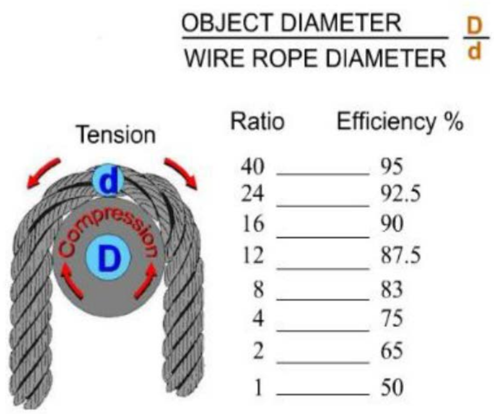
NOTES

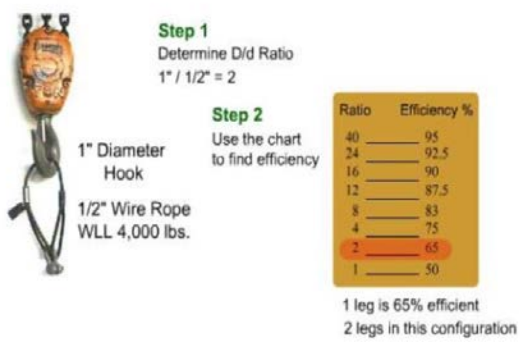
D/d RATIO

Welcome
Welcome to the D to d Ratio module.

Learning Objectives
Upon successful completion of this module you will be able to explain the concept of "D" to "d" ratio (D/d), determine a sling's D/d ratio in a given application, determine sling efficiency, and determine the sling's rated load.

D/d Ratio
D/d ratio is the relationship between diameter of an object that a sling is bent around to the diameter of the sling. D/d ratio is generally applied to wire rope slings. The tighter the bend, the greater the loss of strength. The sling can be weakened and severely damaged if it's bent around a diameter smaller than its own diameter. To determine how the bending will affect the sling: divide "D", the object diameter by "d", the sling diameter. The result is the D/d ratio. Use table fourteen-two in the P-307 to determine sling efficiencies at various D/d ratios.





Understanding Efficiency
Here we have a 1/2-inch wire rope sling with a rated load of 4,000 pounds, bent around a 1-inch hook. The first thing we must do is determine the D/d ratio. The hook diameter is 1 inch and the sling diameter is 1/2 inch. 1 divided by 1/2 equals 2. The D/d ratio is 2. Looking at the chart, we see that a D/d ratio of 2, provides 65% efficiency. One leg is 65% efficient. There are two legs in this configuration.

Using Efficiency
Now that we know the efficiency, let's figure out the maximum weight that could be lifted in this configuration. First, we must determine the rated load of each leg. We multiply the rated load by the efficiency; 4,000 times .65 or 65%, equals 2,600. 2,600 pounds is the rated load for one leg. When we double a sling over an object, we effectively create two legs. Since two legs are carrying the load, we multiply the rated load by 2. 2,600 times 2 equals 5,200. This is the rated load of the doubled sling. Whenever we bend a

wire rope around an object, or double our wire rope slings, this D/d ratio must be calculated. For D/d ratios that fall between the values shown, use the lower efficiency.

D/d Calculations

The D/d principle also applies to slings bent around corners. In this case, the diameter of the curvature of the sling as it bends around the corner of the object to be lifted must be determined. For many applications, special fittings such as pipe sections are placed on the corners of the object to ensure a large enough diameter of curvature for the sling so as not to reduce the sling efficiency too greatly.

Knowledge Check

1. Select the best answer. D to d ratio is the relationship between the diameter of two slings.

   a. True
   b. False

2. Select the best answer. You have a rigging configuration with a 1 inch diameter sling doubled over a 6 inch diameter hook and attached to the load using a single attachment point. What is the efficiency of one leg of the sling?

Ratio	Efficiency %
40	95
24	92.5
16	90
12	87.5
8	83
4	75
2	65
1	50

   a. 83%
   b. 65%
   c. 75%

3. Select the best answer. In the previous question, the sling's rated capacity is 12,400 pounds. What equation below would be used to determine the capacity of one leg or sling in the rigging configuration?

   a. 12,400 x .65 = 8,060 pounds
   b. 12,400 x .83 = 10,292 pounds
   c. 12,400 x .75 = 9,300 pounds
   d. 6,200 x .75 = 4,650 pounds

4. Select the best answer. Given the same rigging configuration and capacity as provided in the previous questions, what would the total rigging configuration capacity be?

   a. 9,300 pounds
   b. 24,800 pounds
   c. 12,400 pounds
   d. 18,600 pounds

5. Select the best answer. You have a rigging configuration with a ½ inch diameter sling with a 6,200 pound rated load doubled over a 8 inch diameter hook with a 10 ton capacity, and attached to the load using a single attachment point or shackle with a 15,000 pound rated load. What is the capacity of the rigging or sling configuration?

Ratio	Efficiency %
40	95
24	92.5
16	90
12	87.5
8	83
4	75
2	65
1	50

   a. 18,600 pounds
   b. 11,160 pounds
   c. 6,200 pounds
   d. 12,400 pounds

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
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 Inspection?
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 Equipment Covered

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.

Equipment Markings

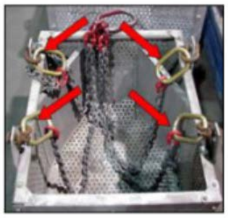
Markings on each piece of equipment are the most apparent way for you, the user, to know the requirements of NAVFAC P-307 have been met. Equipment must be marked per the applicable ASME B30 volume (B30.9 for slings, B30.10 for hooks, B30.16 for portable hoists, B30.20 for below-the-hook lifting devices, 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).

Multiple 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 Sling Markings

Multi-leg sling 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.

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 Sling Markings

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 Markings

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.

Illegible or Missing Markings

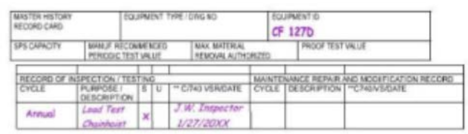
Sometimes markings become hard to read due to wear, or they may even be removed during a repair process. Replace markings that are hard to read, or have been removed. Remember, all rigging equipment must be marked.

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.

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.



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	** C740 VS/DATE	CYCLE	DESCRIPTION	**C740/VS/DATE
Annual	Load Test Chainhoist	X		J.W. Inspector 1/27/20XX			

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!

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. In an inspection program
    c. Authorized for use
    d. New to the activity

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. Container spreaders
    c. Personnel platforms

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

    a. Rated load
    b. Serial number
    c. Re-inspection due date
    d. Size

5. 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 and inspection results
    d. All of the data listed above

6. Select the best answer. Matching ID markings on rigging gear are required for …

    a. End fittings on slings
    b. Chain slings with permanent attachments
    c. Rope or chain sling bridle assemblies
    d. Components that can be separated

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

    a. For 3 years
    b. For 6 months
    c. For 1 year
    d. Until replaced by a more current record

NOTES

RIGGING GEAR TEST REQUIREMENTS

Welcome
Welcome to Rigging Gear Test Requirements.

Learning Objectives
Upon successful completion of this module, you will be able to describe required tests, determine test load percentages, and determine the testing frequency for rigging gear and miscellaneous equipment.

Load Test Overview
Load tests ensure that the equipment will operate safely within its rated load and design function. Except as noted in NAVFAC P-307 paragraphs 14.8 and 14.11, each piece of applicable equipment shall be given an initial load test. Equipment that does not require an initial load test includes: shackles, links, rings, swivels, eye bolts, eye nuts, turnbuckles, blocks, swivel hoist rings, and portable load indicating devices (LIDs).

Load Tests
For each test, the equipment shall withstand the load test for a minimum of two minutes (ten minutes for hoists or winches, cranes, and crane structures) with no permanent deformation.

Dynamic Tests
Equipment with moving parts requires an additional test. Hoists, winches, trolleys, and other moving machinery must lift, or travel, the test load through at least one revolution of all moving parts.

Certificate of Load Test
A certificate of load (proof) test from the supplier of purchased equipment (stating the actual test load and test duration) will satisfy testing requirements, provided the proof loads and test duration meet or exceed the requirements of NAVFAC P-307 paragraph 14.4.1.

Determining Test Loads
To determine the correct test load, you will need to know the rated load of the equipment and the required test percentage. Nominal test loads or test load percentages for rigging gear and related equipment can be found in Table 14-1 of NAVFAC P-307. Be sure to check the test load percentage for the type of gear you are testing, because test load percentages vary for different types of gear.

Test Load Tolerance
The actual test load, or test load tolerance, is plus 5 minus 0 (+5/0) percent of the nominal test load. The plus 5% provides a range to ensure the full test load is achieved without excessive overloading. For cranes, crane structures, hoists, winches, portable

floor cranes, portable gantry/A-frames, and trolleys, the test load shall be plus 0 minus 5 (+0/-5) percent of the nominal test load.

Determining Test Load Example

To determine the minimum test load for a plate clamp with a rated load of 2,000 lbs. we must first find the required test load percentage in Table 14-1 of NAVFAC P-307. We see that plate clamps are tested at 125%, plus 5%, minus 0%. Multiply 2,000 pounds by 1.25. This equals 2,500 lbs. The test load must not be less than 2,500 lbs.

Test Load Example Step 2

Once the minimum test load is established we need to determine the load tolerance. Multiply the 2,500 lbs. minimum test load by 1.05. This equals 2,625 lbs, the maximum test load for this piece of equipment. The maximum test load can also be determined by multiplying 2,500 lbs. by .05 (or 5%), which gives us 125 lbs. Then add 125 lbs. to 2,500 lbs. This provides the maximum test load of 2,625 lbs.

Reduction of Rated Load

For equipment where the OEM does not permit testing at the percentages shown in table 14-1, the rated load shall be reduced such that the OEM's allowed test load will serve as the load test value.

Rated Load Reduction Example

For example, if we need to load test a plate clamp that has a rated load of 2,000 pounds and the OEM does not allow overload testing, the OEM’s allowed test load will serve as the maximum load test value. To find the reduced rated load, we would divide 2,000 pounds by 131.25 percent. This gives us 1,523 pounds. The rated load should be rounded to 1,500 pounds, and the item must be marked to show the new rated load.

Conducting Load Tests

When conducting load tests, wear the appropriate personal protective equipment and secure the area to keep personnel out of harm's way in case the equipment fails. Remember, you are exceeding the rated load of the gear. Be safe!

Rigging Gear

When testing wire rope and synthetic rope slings, ensure the slings are prevented from unlaying. For slings and NAVFAC P-307 paragraph 14.8 equipment used in cargo transfer, a certificate of proof load test from the OEM is required. Proof load test percentages shall be obtained from the applicable ASME volume if not specified in table 14-1. Where test weights are used to test rigging gear and other equipment covered by section 14, the requirements of NAVFAC P-307 paragraph 4.7.1.1 shall apply for the test weights.

Rigging Assemblies

A rigging assembly made up of component parts (i.e., slings, shackles, rings, etc.) that are reserved for that particular assembly may be tested as a complete assembly. A rigging component tested as part of an assembly shall not be removed and used independently, unless it can be proven that the component was tested at the applicable percentage shown in table 14-1.

Load Testing with Machines

Load testing of rigging gear and miscellaneous equipment utilizing machines specifically designed for that purpose (e.g., pull test machine) is not considered a weight handling operation. Deficiencies that occur during these evolutions shall be reported in accordance with NAVFAC P-307 paragraph 14.5. Overloads that occur during these evolutions should be investigated and reported as unplanned occurrences in accordance with section 12.

Lashing

Lashing materials such as synthetic rope, wire rope, and webbing do not need to be individually tested if a sample has been tested and each piece is marked. A sample from each spool or reel must be tested and determined to have satisfactory breaking strength. OEM certification is acceptable. Each piece used for lashing must be inspected and marked.

Annual Load Test

A periodic load test must be conducted annually, or within 12 months prior to use on cranes integral to larger machine systems, hoists and winches, magnetic lifters, personnel platforms, plate clamps, and vacuum lifters.

Biennial Load Test

Crane structures without permanently mounted hoists, as well as portable A-frames, portable gantries, portable floor cranes, and trolleys are required to be load tested every two years.

Controlled Storage Exception

The requirement for periodic load test within 12 months prior to use does not apply to manually operated portable hoists placed into an extended controlled storage condition. The hoist must be inspected, repaired if necessary, and initially load tested. It may then be placed in controlled storage and given a tracking number. A numbered locking security seal (metal or plastic) must be applied to the pull chain or operating lever to ensure the hoist cannot be operated. When the hoist is needed for use, it must be visually inspected for apparent damage or significant deterioration and operated prior to being issued. The re-inspection due date must then be marked on the hoist. This new re-inspection due date cannot exceed one year from the date the hoist was put back into service. The maximum storage period is 10 years.

Exception to Periodic Load Testing

Crane structures and portable gantry or A-frames with rated loads of 100 pounds or less, or that have a minimum design factor, based on the yield strength of the material, of 10 or greater do not require periodic load testing. A periodic inspection is required every two years.

Knowledge Check

1. Select the best answer to fill in the blank. For applicable rigging equipment (not including hoists, winches, cranes, and crane structures), a load test is held for a minimum of _____ minutes.

   a. 8
   b. 2
   c. 6
   d. 4

2. Select the best answer to fill in the blank. For each load test of hoists, winches, cranes, and crane structures, the test load must be held for a minimum of _______ minutes.

   a. 10
   b. 5
   c. 2
   d. 20

3. Select the best answer to fill in the blank. Hoists, winches, trolleys, and other moving machinery must lift, or travel, the test load through at least _____ revolution(s) of all moving parts.

   a. 2
   b. 1
   c. 3
   d. 4

4. Select the best answer. What must be done if the OEM does not permit testing in excess of the rated load?

   a. The equipment’s rated load must be reduced
   b. OEM must re-mark the equipment
   c. Use the rated load marked on the equipment

5. Select the best answer. Individual components tested as a lifting assembly must …

    a. Show individual load ratings
    b. Be lock-wired to prevent disassembly
    c. Be tested first independently
    d. Not be used independently

6. Select the best answer. The actual test load, or test load tolerance, is plus 0 minus 5 (+0/-5) percent of the nominal test load for rigging gear (not including cranes, crane structures, hoists, winches, portable floor cranes, and portable gantry/A-Frames).

    a. True
    b. False

7. Select the best answer. How often do cranes integral to larger machine systems, hoists, winches, magnetic lifters, personnel platforms, plate clamps, and vacuum lifters require a periodic load test?

    a. Every 2 years
    b. Every 3 years
    c. Every year
    d. Quarterly

NOTES

RIGGING GEAR INSPECTION

Welcome
Welcome to the Rigging Gear Inspection module.

Learning Objectives

Upon successful completion of this module, you will be able to list the required inspections, determine inspection frequency, describe inspection and rejection criteria, and identify repair requirements.

Inspection Types

There are two types of required inspections, pre-use and periodic. The pre-use inspection is performed prior to use. No documentation is required for pre-use inspections. The periodic inspection is a comprehensive, documented inspection, performed on a schedule. Note: Documentation is not required for inspections of rigging hardware covered by ASME B30.26 (shackles, adjustable hardware, compression hardware, links, rings, swivels, rigging blocks, and portable load indicating devices). Post-use inspections are recommended to ensure no damage has occurred during the weight handling operation.

Pre-Use Inspection

All equipment must be inspected prior to each use. The pre-use inspection ensures the equipment is not damaged or worn beyond allowable limits. The inspector must verify the rated load of the equipment and ensure the markings are legible. If the inspection due date has passed, the equipment must not be used. Remove any gear from service that fails inspection.

Periodic Inspection

Periodic inspections must be done by a qualified person. If inspection reveals that the equipment has accumulated damage or is worn beyond the allowable limits it must be removed from service. Records must be kept on file for all periodic inspections. Note: Documentation is not required for inspections of rigging hardware covered by ASME B30.26 (shackles, adjustable hardware, compression hardware, links, rings, swivels, rigging blocks, and portable load indicating devices). Inspection records provide a basis for evaluation, and provide the audit trail proving the equipment is in a test and inspection program. The inspection frequency varies depending on the type of equipment. See table 14-1 of NAVFAC P-307.

Annual Inspections

Annual Inspections are required for beam clamps, below the hook lifting devices, blocks, slings, container spreaders, cranes integral to larger machine systems, equalizer beams and flounder plates, eye bolts, eye nuts, hoists/winches, hooks, insulated links, lashing, lifting beams, links and rings, magnetic lifters, personnel platforms, plate clamps, portable load indicating devices, portable padeyes/lugs, shackles, swivels, swivel hoist rings, turnbuckles, vacuum lifters, and welded links and rings.

Biennial Inspection

Periodic inspections are required every 2 years for crane structures that do not have permanently mounted hoists, portable gantry/A-frames and portable floor cranes, and trolleys.

Inspection Every 3 Months

In addition to the annual inspection noted previously, OSHA requires a periodic inspection every three months for chain slings used in ship repair and cargo transfer.

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.

Deficiencies

Deficiencies include failure or malfunction of equipment and major or unsafe discrepancies between design drawings and equipment configuration. This does not include normal wear on the equipment. In those instances where a deficiency is detected that has applicability at other Navy activities, the Navy Crane Center shall be notified as soon as practical, but in no case later than five days of the discovery. A summary report of the deficiency, including corrective actions taken or recommended, shall be forwarded to the Navy Crane Center within 21 days.

Knowledge Check

1. Select the best answer. Documented records are required for periodic inspections of all rigging equipment.

   a. True
   b. False

2. Select the best answer. What are the two types of rigging gear inspections?

   a. Frequent and Annual
   b. Periodic and Pre-Use
   c. Annual and Biannual
   d. Periodic and Random

3. Select the best answer. Who is required to perform an inspection prior to using rigging gear, and what is this inspection called?

   a. The User, Periodic Inspection
   b. Gear Room Personnel, Pre-Operational Inspection
   c. The User, Pre-Use Inspection
   d. Gear Room Qualified Personnel, Pre-Use Inspection
   e. Rigging gear room personnel, Prior to Use Inspection

Sling Rejection Criteria: Knots
A knot in any part of a sling is cause for rejection.

Chain Sling Inspection
Chain slings used for overhead lifting must be fabricated from chain that is grade 80 or 100. Links are randomly marked by the manufacturer with 8, 80, or 800 for grade 80 chain, and 10, 100, or 1000 for grade 100 chain.

Chain Sling Inspection 2
Chain slings are generally very tough and durable and consequently they tend to get a lot of hard use. Carefully inspect each link and end attachment; including master links and coupling links. Nicks and cracks may be removed by grinding. Measure the link or component after grinding. Rejection is required if the defect can not be removed or if any part of the link diameter is below the required minimum. Look for deformation such as twisted, bent, stretched links, or broken welds.

Chain Sling Stretch
Chain links stretch when they are overloaded. Worn chain links will also cause the sling length to inscrease. Measure the length of each sling leg and look for increased chain length that may indicate overloading or link wear.

Chain Sling Rejection Criteria
In addition to the removal criteria of ASME B30.9, the sling shall be removed from service if inspection reveals any of the following: an increase in length of a measured section due to stretch exceeding five percent, and a link with a raised scarf or defective weld.

Coupling Link Inspection

Inspect coupling links carefully. Make sure the keeper pin is not loose or protruding.

Wire Rope Sling Rejection Criteria

Inspect wire rope slings along the entire length of the sling, including splices, end attachments, and fittings. Look for permanent distortion, such as kinked, crushed, or birdcaged areas.

Rejection Criteria II – Core Protrusion

Look for core protrusion in-between the strands of the wire rope. Core protrusion is indicative of structural failure within the wire rope. The core should not be visible in straight runs. However, when a wire rope is bent, you will be able to see the core; this is not core protrusion. Fiber core wire rope slings may sometimes protrude between the strands in the end of an eye, opposite the bearing point; this too is not core protrusion.

Rejection Criteria III – Heat Damage

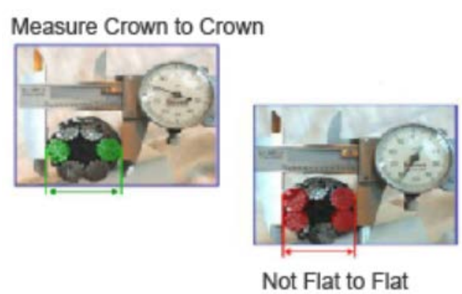
Look for signs of heat damage, such as discoloration, and other more obvious signs as shown here.

Rejection Criteria IV - Corrosion

Look for severe corrosion or pitting of the wires, or any condition that would cause loss of wire rope strength. Pay close attention to the outside area on each eye of the sling. This area wears more due to dragging the sling on concrete/paved surfaces.

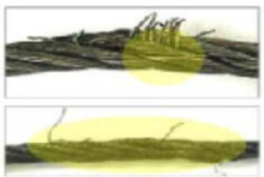
Measuring Wire Rope

When measuring wire rope sling diameter with calipers, make sure you place the caliper on the crowns of the wire strands. Do not place the caliper across the flats or valleys of the strands.



Rejection Criteria VI - Broken Wires

Do not run your bare hand along the wire rope to detect broken wires! Bend the sling while watching for broken inside wires. Bending will open the area between the two ends and expose a broken wire, making it easy to detect. Broken wire rejection criteria is based on a section of the wire determined by its “lay length”. Lay length is the linear distance along the wire rope in which a strand makes one complete turn around the rope's center.



Rejection Criteria VII - Strand Laid Wire Rope Slings

Single part and strand laid wire rope slings must be removed from service if inspection reveals any of the following criteria: ten randomly distributed broken wires in one lay length, or five broken wires in one strand in one lay length.

Rejection Criteria VIII - Braided Slings

For braided wire rope slings with less than eight parts, reject slings with 20 randomly distributed broken wires in one rope braid length, or one completely broken strand. For braided wire rope slings with eight parts or more, reject slings with 40 randomly distributed broken wires in one rope braid length or one completely broken strand.

Rejection Criteria IX - Cable Laid Slings

Cable laid wire rope slings must be removed from service if inspection reveals 20 randomly distributed broken wires in one rope lay length, or one completely broken strand.

Rejection Criteria X - End Fittings

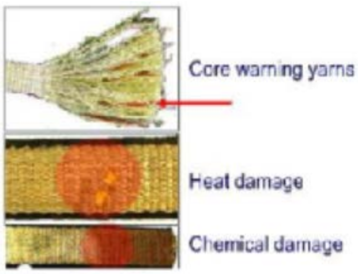
When inspecting slings with end fittings, ensure the fitting is not cracked, deformed or loose. Make sure the wire rope in the fitting is not corroded. Inspect the end attachment for wear that exceeds 10% of the OEM's nominal socket dimension or 5% of the socket pin diameter. When inspecting slings with speltered sockets, the wire should not have any axial or lateral movement.

Metal Mesh Sling Rejection Criteria

Inspect the entire length of metal mesh slings including welds, end attachments, and fittings. Remove the sling from service if inspection reveals any of the following: missing or illegible sling identification, a broken weld or a broken brazed joint along the sling edge, a broken wire in any part of the mesh, a reduction in wire diameter of 25% due to abrasion or 15% due to corrosion, a lack of flexibility due to distortion of the mesh, a cracked end fitting, visible distortion of either end fitting out of its plane, slings in which the spirals are locked or without free articulation, fittings that are pitted, corroded, cracked, bent, twisted, gouged, or broken, or other conditions, including visible damage, that cause doubt as to the continued use of the sling.

Metal Mesh Sling Rejection Criteria II

Remove the sling from service if the eye openings in the end fitting are inscreased by more than 10%, or if there is a reduction of 15% of the original cross sectional area at any point around the hook opening of the end fitting.

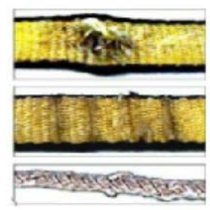


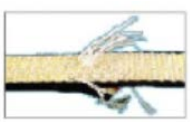
Synthetic Sling Rejection Criteria

Remove the sling from service if the sling identification is missing or illegible. Never use synthetic slings with exposed core warning yarns. Do not rely on core warning yarns to indicate damage, as not all manufacturers use them and damage can reach rejection limits without exposing core yarns.

Synthetic Sling Rejection Criteria II

Other damage that would require a synthetic sling to be removed from service includes heat or chemical damage, melting or charring of any part of the sling, punctures, cuts, or snags, indications of rotting, variations in size, crushed webbing, excessive abrasive wear, and embedded abrasive particles.



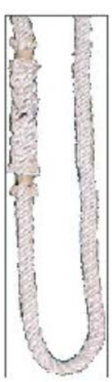


Synthetic Sling Rejection Criteria III

Look for broken or damaged stitches or splices. The stitching holds the sling together. Check it carefully.

Synthetic Sling Rejection Criteria IV

Look for damage caused by prolonged exposure to sunlight, which can result in discoloration, fading or roughness. Look for cracked, distorted, broken, or excessively worn, pitted, or corroded end fittings. Also, look for knots or indications the sling has been knotted. If you find evidence that a sling has been knotted, remove it from service.



Synthetic Rope Sling Rejection

Remove the sling from service if any of the following conditions are present: Missing or illegible sling identification; cuts, gouges, areas of extensive or considerable fiber or filament breakage (fuzzing), and abraded areas on the rope; inspect inside the rope for fiber breakage, fused or melted fiber; damage that is estimated to have reduced the effective diameter of the rope by more than 10%; foreign matter that has permeated the rope and may attract and hold grit; kinks or distortion in the rope structure; melted, hard, or charred areas; poor condition of thimbles or end fittings; for hooks, removal criteria as stated in ASME B30.10; for rigging hardware, removal criteria as stated in ASME B30.26; and other conditions including visible damage that cause doubt as to the continued use of the sling. In addition to the above, the sling shall be removed from service if inspection reveals any of the following: indications of rotting, backturns, variations in the size or roundness of the strands, or severance of one-third of the cover (outer) yarns.

Synthetic Round Sling Rejection

Remove the sling from service if inspection reveals any of the following: melting, burn marks, charring, or other evidence of heat damage; snags, punctures, tears, or cuts that expose any part of the core yarns; broken or worn stitches in load bearing splices; excessive wear, abrasion, or embedded abrasive particles; internal knots, bumps, bulges, or irregularities that can be felt by massaging the sling manually along its length. Note: A knot in the yarn where the cover is joined may be a termination made by the OEM, which is acceptable.) Cracked, distorted, broken, or excessively worn, pitted, or corroded end fittings; and any other condition that causes doubt as to the strength of the sling are also signs for removing a sling from service. Synthetic roundslings have two covers. If the outer cover is torn, cut, or damaged, the sling should be removed from service and sent to the OEM for inspection and repair. If the inside cover is also torn or damaged and exposing the core yarns, the sling must be removed from service.

Knowledge Check

4. Select the best answer. What is the minimum grade of chain required for chain slings?

   a. Grade 60
   b. Grade 80
   c. Grade 100
   d. Grade 70

5. Select the best answer. A knot in a synthetic sling is allowed as long as it does not cause permanent damage to the sling.

   a. True
   b. False

6. Select the best answer. Chain slings used in cargo transfer should be inspected annually.

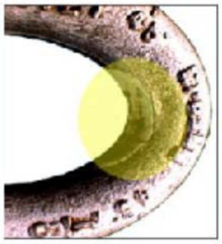
   a. True
   b. False

7. Select the best answer. A metal mesh sling can remain in service if only one wire is broken in the mesh.

   a. True
   b. False

Types of Hardware Damage

When inspecting rigging hardware, look for corrosion or severe pitting that would leave an orange peel effect when cleaned. Slight surface rust is okay. Inspect for wear, cracks, nicks, gouges, deformation, or distortion. Distortion may include elongation, peening, or heat damage.



Areas to Inspect - Bearing Surfaces

Inspect the whole body of the hardware, but be particularly vigilant when inspecting the bearing surfaces for wear and distortion. Pay particular attention to the bearing surfaces since this is where the load is applied and will often show tell-tale signs of overload or abuse; just as the flattened area indicates on this picture.

10% Wear

Remove shackle bows and welded links, from service when wear exceeds 10% of the nominal diameter shown in federal specification RR-C-271. For shackle sizes not shown in federal specification RR-C-271, the OEM's listed nominal dimensions will be used. Remove hooks from service when wear exceeds 10% of OEM's nominal dimensions.

Inspection of Threaded Shanks

Threaded shanks must be inspected carefully before use or load testing. When using gear with threaded shanks, such as eyebolts, hoist rings, etc., inspect the shank carefully for bends, twists, or damaged threads.

Inspection of Moving Parts

Some hardware has moving parts, such as hoist rings and turnbuckles. Ensure that all moving parts move freely. Hoist ring bases should swivel 360 degrees, and the bail should pivot at least 180 degrees.

Tackle Block Inspection

Tackle blocks shall be removed from service if inspection reveals distortion, cracks in the housing or sheaves, damaged sheaves, binding, abnormal sheave play, or any damage that may cause doubt as to the strength of the unit.

Below-The-Hook Lifting Devices

Below the hook lifting devices and container spreaders shall be inspected in accordance with ASME B30.20 and OEM recommendations. Always read and follow the information provided by the OEM.

Hoists, Cranes, A-Frames, and Gantries

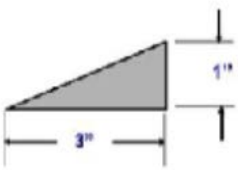
Chain hoists and portable hoists shall be inspected in accordance with: ASME B30.16 and OEM recommendations. Lever operated hoists shall be inspected in accordance with ASME B30.21 and OEM recommendations. Other equipment shall be inspected in accordance with applicable ASME B30 criteria and/or OEM recommendations.

Load Indicating Devices

Follow the inspection and removal criteria of ASME B30.26. Attachment of these devices shall be in accordance with OEM recommendations. Portable load indicating devices shall be calibrated in accordance with the activity's calibration program and the OEM's recommendations. Initial and periodic load testing are not required.

Overview of Repairs

When minor damage, such as nicks or cracks are found, it may be possible, and more economical, to remove the defect rather than replace the gear. Repairs must be performed in accordance with OEM or engineering instructions. Alterations must be approved by the activity engineering organization. Re-inspection and load test of the repaired or altered equipment shall be performed prior to returning to service. Repair documentation for load bearing, load controlling, or operational safety devices must be retained for 7 years, all other repairs 1 year. Alteration documentation must be retained for the life of equipment.



Authorized Repair

Grinding to remove defects is the only method authorized to repair rigging gear. Heat or welding is not permitted to correct defects. And, no attempt shall be made to straighten bent or twisted rigging gear. Grinding shall follow the contour of the piece. Blending with a maximum 1 to 3 taper. The component dimensions after grinding must be within the wear limits for the piece being repaired. If the after-grinding dimensions exceed the wear limits specified by the OEM or NAVFAC P-307, the component must be removed from service. Removal of defects as specified will not require a load test.

Non-Destructive Test

Removal of cracks must be verified by non-destructive testing before the hardware can be returned to service.

Knowledge Check

8. Select the best answer. Rigging hardware that is bent can be repaired by straightening it back to original shape.

   a. True
   b. False

9. Select the best answer. Rigging hardware such as eyebolts, links, rings, and shackles are required to have a periodic inspection every 2 years.

   a. True
   b. False

10. Select the best answer. Distorted rigging hardware must be …

   a. Heat treated and returned to service
   b. Re-marked for a reduced capacity
   c. Evaluated for repairs
   d. Removed from service and destroyed

11. Select the best answer. Documentation for alteration of rigging equipment is required to be retained for …

   a. 1 year
   b. Until replaced by another record
   c. The life of the equipment
   d. 2 years

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.

NAVFAC P-307 Section 14

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 10.3 through 10.3.2.1 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 and 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!

Shop-made 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!

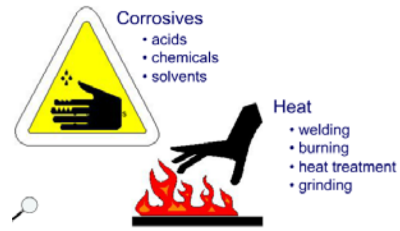
Selecting Rigging Equipment Continued

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.

Electrical Shock Hazards

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.

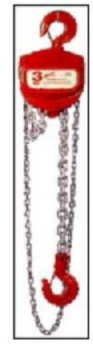
Protective Materials

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.

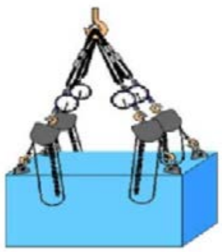
Sling Protection

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 & 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.



Using Hoists & Cranes

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.

Chain Hoist Use

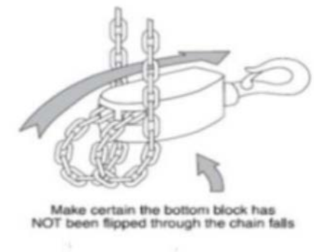
Do not move the load (travel, hoist with a crane, etc.) when it is suspended from a manual chain hoist unless the hand chain is tied off or otherwise secured. This prevents inadvertent operation. A bag can be attached to the hoist body to hold excess chain. Never use more than one person to pull the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

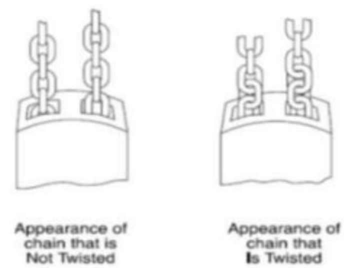
Usage Don'ts

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 (to the 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 NAVFAC P-307 is the rigging gear section?

   a. Section 10
   b. Section 14
   c. Section 8
   d. Section 12

2. Select the best answer. 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. Appropriate sling protection
   b. Your hand
   c. Metal spacers

5. Select the best answer. 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

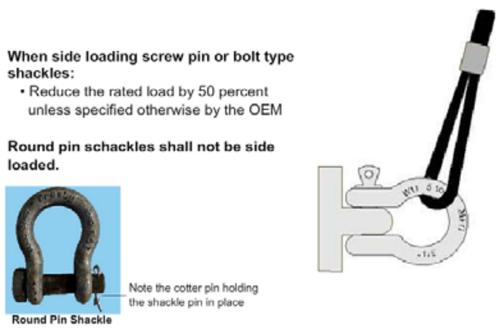
NOTES

RIGGING HARDWARE

Welcome
Welcome to the Rigging Hardware module.

Learning Objectives
Upon successful completion of this module you will be able to identify use limitations for shackles, eyebolts, swivel hoist rings, and other types of rigging hardware. You will also be able to identify correct installation procedures and identify rated loads of rigging hardware in various configurations.

Hardware Usage
Use the same size and type of shackle on each leg in multiple leg applications. Different types, sizes, or brands of shackles may vary significantly in physical size. This in turn will affect the overall length of the leg and the tension created in each leg. When installing the pin into the bail, be sure the pin is fully seated into the bail.

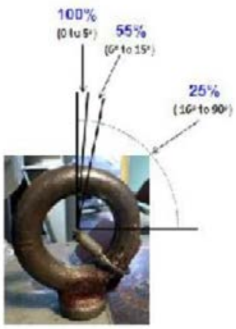


Side Loading Shackles
It may be sometimes necessary to apply a side load to a shackle. When side loading a screw pin or bolt type shackle reduce the rated load by 50% or as specified by the OEM. Round pin shackles shall not be side loaded. Shackles should be loaded bow-to-bow, whenever possible. For pin-to-pin or pin-to-bow loading, and for all other attachments to a shackle pin, the shackle is considered to be side loaded with the restrictions noted above unless the attachment is centered on the pin.

Eyebolt Types
There are two types of eyebolts you may find at your work site, shouldered eyebolts and non-shouldered eyebolts. Non-shouldered eyebolts are sometimes referred to as plain pattern or regular nut eyebolts. All eyebolts shall be selected and used in accordance with ASME B30.26 and OEM recommendations.

Non-shouldered Eyebolts

Non-shouldered eyebolts may be used in vertical applications only. Angled pulls greater than five degrees, even in the plane of the eye are not permitted.

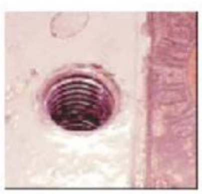


Shouldered Eyebolts

Shouldered eyebolts may be loaded at an angle as long as they are loaded in the plane of the eye. When loading a shouldered eyebolt at an angle, the capacity of the eyebolt is reduced. The rated load of the eyebolt shall be reduced in accordance with NAVFAC P-307 table 14-4 or OEM recommendations, whichever is more restrictive.

Installing Shouldered Eyebolts

When loading shouldered eyebolts at an angle in the plane of the eye, the eyebolts must be installed with the shoulder seated flush against the mounting surface.



Engaging Hole

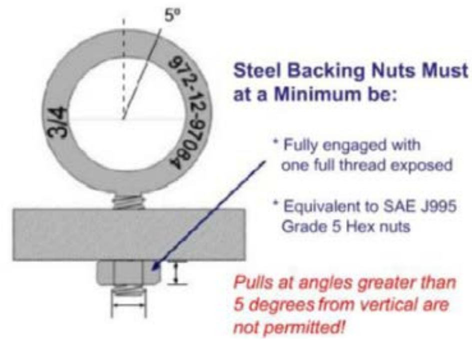
When checking the engaging hole in the item you are going to lift: Make sure the threads are not damaged, and the hole is free of debris.

Minimum Thread Engagement

The minimum thread engagement depends on the material into which you are installing the piece of rigging equipment. When installing eyebolts into steel the minimum required thread engagement is one and one half times the diameter. When installing eyebolts into aluminum, the minimum thread engagement is two times the diameter. For other materials contact your activity's engineering organization or the OEM.

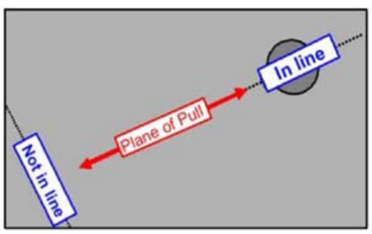
Backing Nuts

When eyebolts are used with backing nuts, the backing nut must be at least SAE J995 grade five and fully engaged with at least one full thread exposed. Note: With engineering approval, nut type eyebolts can be used without the shoulder being flush.



Threaded Attachment Point Use

Remember to use extreme caution when using a threaded item such as an eyebolt or a hoist ring as a single attachment point! Never rotate or spin an object being lifted with a single threaded attachment point. The lifting attachment may unthread and the object may fall.

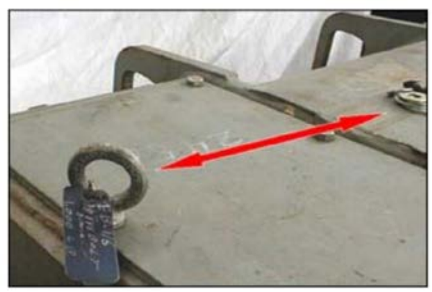


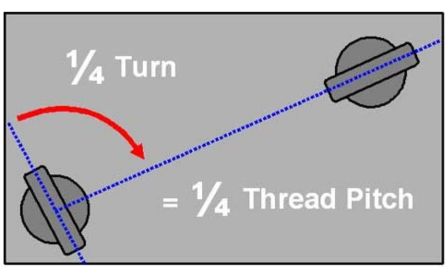
Eye Alignment

To use eyebolts with an angular load, the loading must be in line with the plane of the eye. This may not always happen when installing eyebolts. Look at this shape and imagine two slings connected to each eyebolt shown from the top. You can see that the top eyebolt would be in line with the plane if two slings were attached. The bottom eyebolt ended up out of plane when tightened against the seating surface.

Shim Use Overview

If the shoulder seats flush and the eyebolt is not in the plane of pull shims may be used to align the eye with the plane of pull. When using shims, use the minimum thickness that will orient the eye in the plane of the pull. The total thickness of shims must never exceed one thread pitch. The thread pitch represents one full revolution or rotation of the shank. If there are 16 threads per inch, then the thread pitch is 1/16th inch.





Determining Thickness

In order to determine shim thickness we must determine how much rotation is required. How far would this eyebolt have to rotate in order to line up in the plane of pull? It must rotate 1/4 of a turn. How much shim would that require? One quarter of the thread pitch would orient the eyebolt in line to the plane of pull. For the eyebolt noted previously with a thread pitch of 1/16th inch, total shim thickness would be 1/64th inch.

Incorrect Use of Shims

This is an example of shims being used incorrectly. Do you see the problem with this eyebolt installation? The total shim thickness is more than the thread pitch.

Side Pulls

Side pulls on eyebolts are very dangerous and may cause the eyebolt to fail. Side pulls result from loading out of the plane of the eye. Never pull an eyebolt at an angle to the plane of the eye. The loading must be in line with the plane of the eye. Never install a sling through two separate eyebolts. The result will be side pulls on both eyebolts and damage to the sling.

Eye Nuts

Eye nuts must be used in accordance with ASME B30.26 and OEM requirements. Eye nuts should have full thread engagement and should be secured against rotation during lifting or load handling activities. The eye nut may be secured against rotation by installing a locknut, lockwire, or rope attached or secured to the component or object being lifted. Eye nuts shall only be used for in-line loads. The plane of the eye may be positioned with a flat washer(s) or locknut. Components shall be in good working condition prior to use and shock loading should be avoided.

Swivel Hoist Rings

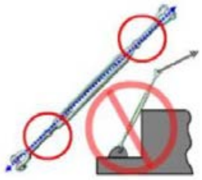
Angular pulls do not reduce the rated load of a swivel hoist ring. When using swivel hoist rings, they shall be installed with the shoulder flush to the face of the mounting surface, unless prior approval is obtained from the OEM to install a spacer. If prior approval is obtained to install a spacer, the approval shall be in writing (or e-mail) and all OEM recommendations shall be followed. The minimum thread engagement shall be 1 and 1/2 times the diameter of the bolt for steel (or threads fully engaged for swivel hoist rings with thread projections less than 1 and 1/2 times the diameter of the bolt). They must be tightened with a calibrated torque wrench in accordance with OEM requirements.

Swivel Hoist Rings Continued

Swivel hoist rings shall be selected and used in accordance with ASME B30.26 and OEM recommendations. They must be tightened to the OEM specified torque. The torque value is normally marked on the top washer of the hoist ring. Before using backing nuts on hoist rings, check the OEM requirements to see if it is allowed.

Turnbuckles

Turnbuckles are commonly used for tensioning lines and securing loads. They shall be selected and used in accordance with ASME B30.26 and OEM recommendations. Turnbuckles require an annual periodic inspection.



Turnbuckles Continued

Turnbuckles are used only for in-line pulls. Jam nuts, when used, must be tightened in accordance with OEM instructions to prevent rotation. If the possibility of rotation still exists, the turnbuckle must be secured by safety wire or other suitable means in addition to jam nuts.

Knowledge Check

1. Select the best answer. Pulls outside the plane of the eye are allowed on eyebolts as long as the rated load has been decreased.

   a. True
   b. False

2. Select the best answer. The minimum depth of thread engagement for a ¾ inch eyebolt into a steel object is:

   a. 1 1/8 inch
   b. 1 ½ inch
   c. 1 inch
   d. ½ inch

3. Select the best answer. An angular pull of 45 degrees is allowed on non-shouldered type eyebolts.

   a. True
   b. False

4. Select the best answer. The rated load of swivel hoist rings must be reduced when they are used for angular pulls.

   a. True
   b. False

NOTES

HOISTS

Welcome
Welcome to the Hoists module.

Learning Objectives
Upon successful completion of this module, you will be familiar with hoist types, hoist operation and use requirements, improper use, and securing methods.

Hoist Types
There are a variety of hoist types used in the rigging trade. Some common hoist types include: Electric-Powered Chain or Wire rope Hoists, Hand Chain Operated Chain Hoists, Lever Hoists, and Air-Powered Chain or Wire Rope Hoists.

Hoist Use
Chain hoists are used in many different applications to assist in performing rigging operations. They work on the principal of mechanical advantage, so in reality very little effort is expended. They are normally used to lift, lower, and drift loads.

Marking, Use, and Inspection
Hoists shall be marked with the name of the manufacturer, the model or serial number, the rated load, and the re-inspection due date. Prior to use hoists must be visually and operationally inspected for damage and proper operation. Inspections required include a daily pre-use (or frequent) inspection that is required to be performed by the user, and a documented periodic inspection (required annually for hoists). Pre-use inspections are not required to be documented. Post-use inspections are recommended to ensure no damage has occurred during the weight handling operation. Operation, maintenance, and inspection of hoists shall be in accordance with applicable ASME B30 and OEM requirements.

Visual Inspection
When inspecting hoists, personnel shall perform a visual inspection, checking for evidence of loose, missing, or damaged bolts, nuts, rivets, retaining pins, guards, covers, guides, sheaves, sprockets, hooks, latches, chain, wire rope, and stops. Load chain or wire rope shall be checked for damage and proper reeving.

Operational Inspection

Hoist functions, including hoisting and lowering, the braking system, and hook latch operation shall be operationally tested to inspect for proper operation and unusual sounds. Lifting and lowering functions shall be tested under no-load conditions. Testing through the complete lift length or entire length of load chain or rope is not required. Electric and Air-Powered hoist inspection shall also include a visual inspection of air lines, valves, and other parts for leakage, and an operational inspection of upper limit devices. When checking upper limit devices care shall be exercised. The load block shall be inched into its limit device or run in at the slowest possible speed. Note: If a deficiency or problem is discovered during the visual or operational inspection personnel shall discontinue operation and remove the hoist from service or use.

Operation Method and Potential Binding

Here are some general requirements when working with hoists and cranes. Only one person may operate a hoist at one time, unless multiple pull chains are on the chain hoist. If it takes more than one person to pull the chain or ratchet, the hoist is possibly being overloaded. Do not use extension bars on lever operated hoists. Chain hoists should be operated slowly, hand-over-hand, one link at a time if necessary for slow controlled movement. Use chain hoists in rigging configurations when lifting loads in potential binding situations. This provides more control than a crane.

Hook Attachment and Drifting

Properly seat the shackle, sling, or other device in the bowl of the hook, not on the tip. Ensure the upper and lower hooks are secured with safety latches or mousing prior to handling a load. Do not allow the attachment to rest on the safety latch. The safety latch will not support the load. Keep loads as low as possible when drifting or moving the load. Drifting is defined as the lateral movement of a load from one location to another using one or more hoists, cranes, and/or rigging equipment.

Installation and Brake Check

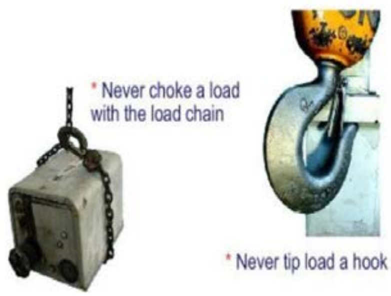
Install and use hoists in a manner which will not cause binding against area obstacles or components during use. A hoist may be hung from a wire rope sling without a shackle only if the hook has a diameter equal to or greater than the diameter of the wire rope. (The hook bowl cross section measurement is the hook diameter) When a load is approaching the rated capacity of the hoist check the hoist brake action by lifting the load just clear of its supports, stop operation, and continue operation only after verifying that the brake system is operating properly (the load does not lower).

Inching and Direction Change

Electric or Pneumatic-Powered hoists should be inched slowly into engagement with a load, but unnecessary inching and quick reversals of direction should be avoided. It is best to stop the motor completely when changing from lifting to lowering, or vice versa.

Improper Operation

Do not run the load chain or wire rope over sharp objects. If the load chain or wire rope does come into contact with other components, ensure adequate chafing material is placed between the chain or wire rope and the component to prevent damage. On wire rope hoists, do not lower the load below the point where less than two wraps of rope remain on each anchorage of the hoist drum, unless a lower limit device is provided, in which case no less than one wrap may remain on each anchorage of the hoist drum. Do not use the limit switch to stop movement of the hoist during load movement. Do not drag loads with hoists. Dragging the load may cause damage to the load, the surface (i.e., the deck, or floor), and/or other components.



Improper Operation Continued

Never use the load chain to choke around an object or component. In addition, never "tip load" the hook.

Chain Position and Scaffolding

Do not use a hoist or chain ratchet that has twisted, kinked, or otherwise damaged chain links. Do not use scaffolding as a point of attachment for lifting devices, unless authorized by the cognizant technical code or engineering. Do not operate the hoist if the rope or chain is not seated properly on the drum, sheaves, or sprockets.

Padeyes and Two-blocking

Do not hang a hoist or chain ratchet directly into a padeye without a shackle unless authorized by the cognizant code or engineering. The sharp edges of a padeye may cause damage to the hook of the hoist. Do not two-block the hoist. Two-blocking occurs when the hook makes contact with the sheave or body of the hoist. Leave a minimum of 6 links on chain falls or a minimum of 1 link exposed below the chain stopper on ratchets (the link that the stop ring is attached to) to avoid two-blocking the hoist.

Securing Hoists

Always secure the hand chain or hoist when not in use. This prevents inadvertent operation of the hoist if a load remains attached or suspended. A chain bag can be attached to the hoist body to hold excess load chain. One or two half-hitches may be used to secure the hand chain around the load chain. Locks may also be used to prevent operation.

Knowledge Check

1. Select the best answer. What markings are required on hoists?

   a. The name of the manufacturer, model number, rated load, and re-inspection due date
   b. The rated load and re-inspection due date
   c. The serial number and re-inspection due date
   d. The name of the manufacturer, model number, and capacity

2. Select all that apply. What are the two types of inspections performed on hoists and rigging equipment?

   a. Pre-Use Inspection
   b. Test Inspection
   c. Periodic Inspection
   d. Operation Inspection

3. Select the best answer to fill in the blank. When securing a chain hoist, _________ may be used by securing the hand chain around the load chain.

   a. Knots
   b. Bends
   c. Half-hitches
   d. Rope

4. Select the best answer. Two people may operate a hoist at the same time if the pull chain is too hard for one person to pull.

   a. True
   b. False

5. Select the best answer. A hoist can be hung from a wire rope sling without a shackle installed if the diameter of the hook is equal to or greater than the diameter of the sling.

    a. True
    b. False

6. Select the best answer. When lifting a load that is near the rated capacity of the hoist, the hoist brake should be checked by:

    a. Lifting the load just clear of its supports, stopping movement, then checking to ensure the load is not lowering
    b. Watching the load for lowering as the load is being raised
    c. Lifting the load approximately 4 feet and checking to make sure it does not lower
    d. Lifting the load as high as possible and checking for lowering

7. Select the best answer. Why should hoists not be used in tie-down applications?

    a. Because the manufacturer does not allow it
    b. Because they do not have adequate capacity
    c. Because they may be subjected to shock loading
    d. Because the load brakes may fail

8. Select the best answer. Hoist hooks must have latches or be moused during lifting operations.

    a. True
    b. False

9. Select all that apply. Prior to use, load chains should be inspected for:

    a. Proper size
    b. Proper reeving
    c. Damage
    d. Adequate capacity

NOTES

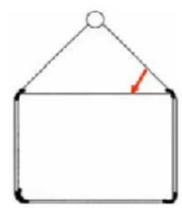
SLING USE

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 Slings
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 Continued
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 degrees Fahrenheit. Fiber core rope wire should not be used above 180 degrees Fahrenheit.

Wire Rope Clips
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 degrees or above 550 degrees Fahrenheit. Do not use elastomer coated slings when temperatures are below 0 degrees or above 200 degrees Fahrenheit. Metal mesh slings shall be used in accordance with ASME B30.9 and OEM recommendations.

Synthetic Sling Types

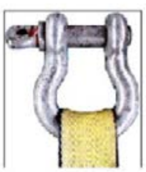
There are three types of synthetic slings, synthetic rope slings, synthetic webbing slings, and synthetic roundslings. Synthetic slings should be used only when they can be protected from damage! Natural fiber rope slings are not to be used for overhead lifting.

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 to 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.

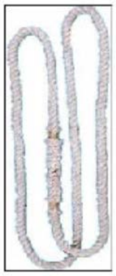
Synthetic Web Sling Temperature Restrictions

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.

Round Sling 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.

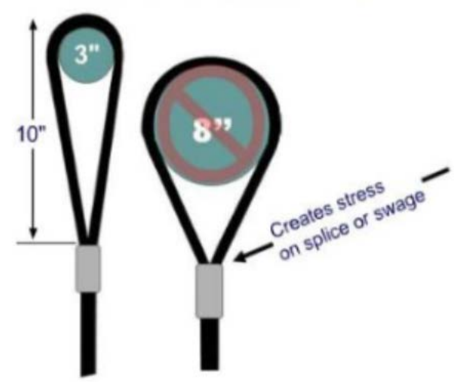
Round Sling Temperature Restrictions

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 degrees 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

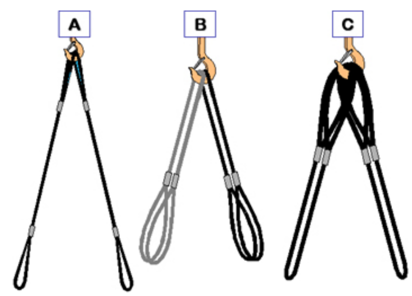


The size of the hook or shackle relative to the size of the sling eye can be critical. If we place a ten-inch long sling eye on a load which is 3 inches in diameter, the eye opens slightly and causes very little added stress to the eye or the splice. However, if we place that sling on a hook with a diameter 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.

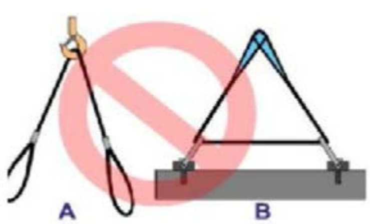
Attaching to Hook

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 Sling Attachment



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 strands to break.

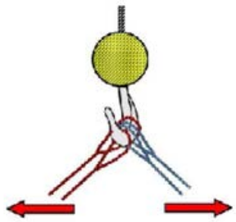


Incorrect Sling Attachment

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.

Hitch Types

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.

Straight-Line Hitch

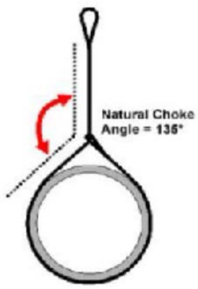
The rated load for a straight-line hitch is 100 percent of the sling's capacity. Sling angle stress is encountered any time the straight line angle exceeds 5 degrees and must be taken into account.

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

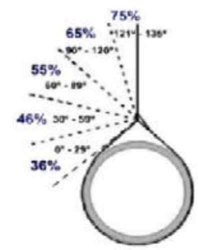
Using a shackle to set a choker hitch will prolong the life of the sling. Whenever a shackle is used to set a choker hitch set the eye of the sling on the pin of the shackle. This will prevent the running part of sling from rotating the pin of the shackle as it passes over it. Never set the choker so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



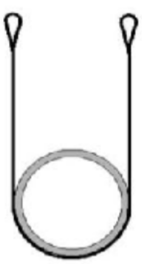
Choker Hitch Rated Loads

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

Choker Hitch Efficiency



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 degrees to 135 degrees, the rated load is reduced to 75 percent of the vertical capacity (Synthetic Web Slings, Roundslings, and Chain Slings are rated at 80 percent). 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 percent of the sling's single rated load when the sling angle is less than 5 degrees 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. Select the best answer. D/d ratio does not affect synthetic web slings.

   a. True
   b. False

3. Select the best answer. It is acceptable to bend a 1 inch wire rope sling around a ¾ inch shackle.

   a. True
   b. False

4. 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 to fill in the blank. 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

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 (RIC).

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. Non-complex lifts
    b. Complex lifts
    c. Some lifts
    d. All lifts

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

    a. Define the crane operating envelope
    b. Select rigging gear
    c. Inspect all rigging gear
    d. Conduct a pre-job briefing

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

    a. Excluded from the complex lift requirements
    b. Routine lifts because they are not complex shapes
    c. Evaluated according to 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. Non-complex lift
    b. Overload lift
    c. Complex lift
    d. Hazardous 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 Shape

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.

Personnel Lift Requirements

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%

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.

Multiple Crane 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 established 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.

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

5. 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

6. Select the best answer. Personnel lifts are …

    a. Not considered complex if personal protective gear is worn
    b. Not considered complex if personnel lifting devices are used
    c. Always considered complex lifts
    d. Considered complex only under special conditions

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

    a. Wear a full body harness with a shock-absorbing lanyard
    b. Stand with knees bent to absorb motion shock
    c. Wear a safety belt with a shock-absorbing lanyard
    d. Wear aircraft reflective tape on their hard hat

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

    a. The gross capacity if designated as a complex lift
    b. 80% of the hoist's rated capacity
    c. 50% of the hoist's rated capacity
    d. The load chart capacity

NOTES

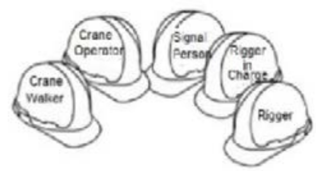
CRANE TEAM CONCEPT

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 Walker, and Crane Rigger
    b. The Crane Operator, Rigger Supervisor, and Crane Rigger
    c. The Crane Operator, Crane Supervisor, and Crane Rigger
    d. The Crane Operator and Rigger-In-Charge

3. Select the best answer. Additional crane team members may be assigned by …

   a. The EOM designation
   b. The crane operator as required
   c. The crane rigger as required
   d. The supervisor as required

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.

Crane Team 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 Responsibility

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

4. 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 crane 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

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

   a. Combined responsibility of the crane operator and the crane supervisor
   b. Sole responsibility of the rigging supervisor
   c. Sole responsibility of the crane operator
   d. Combined responsibility of all team members

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

    a. Maintaining communication with the signaler
    b. Lifting and landing all loads safely
    c. Slowing down when signals are unclear
    d. Doing a thorough ODCL inspection

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

    a. Evaluate the lift plan
    b. Call your supervisor for clarification
    c. Use the OEM manual to solve the problem
    d. Stop work and have the problem resolved

8. Select the best answer. The crane operator must immediately stop operations when …

    a. Communications are lost during a blind or complex lift
    b. The weather forecast is not good
    c. The operating envelope is penetrated
    d. Any time a stop signal is given
    e. Operations have exceeded allowed time

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.

Assists with the Pre-Use Check

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

Signal Person Responsibility

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.

Site Conditions

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

Power Lines

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

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 rigging supervisor, operator supervisor, or working leader shall personally supervise 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.

Accidents

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

Knowledge Check

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

    a. Crane Operator
    b. Crane Rigger
    c. Supervisor
    d. Rigger-In-Charge

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

    a. Rigger-In-Charge
    b. Crane Supervisor
    c. Crane Rigger
    d. Crane Operator

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

    a. Crane Rigger
    b. Crane Operator
    c. Activities
    d. Crane Supervisor
    e. Rigger-In-Charge

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 can not 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 re-established. 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, A.S.M.E. 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).

Radio Communications
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. 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. No other form of communication is available and ambient noise is high
   b. The operator and the Rigger are working in close proximity and ambient noise is high
   c. The operator and Rigger are working in close proximity and ambient noise is low
   d. The Rigger has not learned hand signals

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

   a. EOM
   b. ASME Hand Signal Chart
   c. Crane lift history
   d. Crane maintenance records

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

   a. One signaler for each crane involved
   b. One signaler at a time
   c. Up to three signalers
   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. Signal flags
   b. Hand signals
   c. Spoken word
   d. Direct voice commands

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

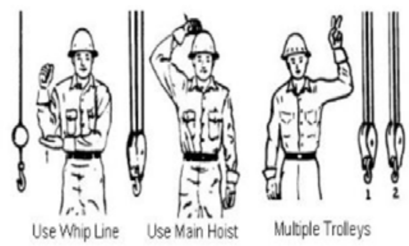
    a. Approved by ASME
    b. Approved by OSHA
    c. Approved by NOSH
    d. Approved by the activity

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

    a. Activities designate alternative methods
    b. The signaler is not in clear view of the crane operator
    c. Ambient noise is greater than the lack of visibility
    d. The signaler is in clear view of the Rigger-In-Charge

Hook and Trolley Signals

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

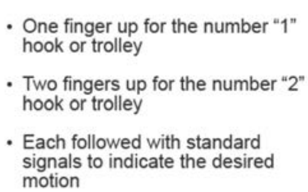


Auxiliary Hoist

When calling for the whip line or auxiliary hoist: the elbow is tapped with the opposite hand, and 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.

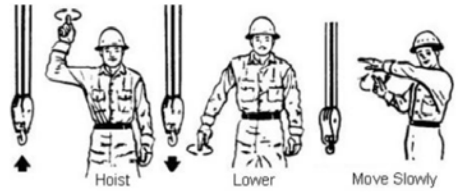


Multiple Hooks and Trolleys

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

Hoist and Lower 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.

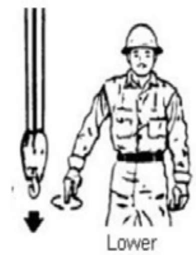


Hoist

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.

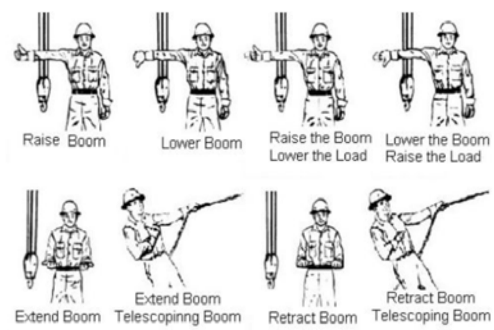


Move Slowly

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 (Boom Up)

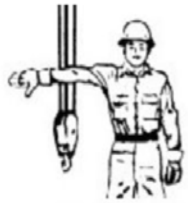
The signal to raise the boom, or boom up, is given with an extended arm, fingers closed, and thumb pointing upward.

Lower Boom (Boom Down)

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

Raise Boom and 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 and 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.

Extend the 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 Hand

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

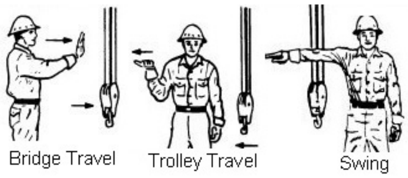
The signal to retract the boom is made with both fists in front of the body, thumbs pointing toward each other, and motioning in and out.

Retract Boom - One Hand

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

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



Travel or Bridge

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 pointing 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

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

Emergency Stop

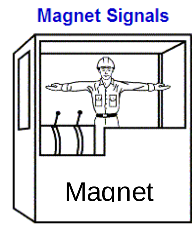
The signal for an emergency stop is both arms extended with palms down, moving them back and forth horizontally.

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

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

7. Select the best answer. This signal indicates:

   a. Use Main Hoist
   b. Raise hoist
   c. Use Auxiliary Hoist
   d. Travel

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

   a. Lower the boom
   b. Stop activities
   c. Raise the load – lower the boom
   d. Lower the hoist

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

   a. Extend the boom
   b. Raise the load
   c. Stop
   d. Forward

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

   a. Separate the load
   b. Lower the load
   c. Move closer
   d. Retract the boom

11. Select the best answer. This signal indicates:

   a. Stop
   b. Emergency Stop
   c. Travel back
   d. Swing

12. Select the best answer. This signal indicates:

   a. Stop
   b. Magnet disconnect
   c. Swing
   d. Emergency Stop

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

   a. Emergency stop
   b. Magnet disconnected

14. Select the best answer. This signal indicates:

   a. Retract boom
   b. Lower load
   c. Dog everything
   d. Emergency stop

15. 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. Hoist
   c. Trolley travel
   d. Move slowly
   e. Bridge travel

16. 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. Lower
    b. Hoist
    c. Trolley travel
    d. Move slowly
    e. Bridge travel

NOTES

ATTACHMENT POINTS

Welcome

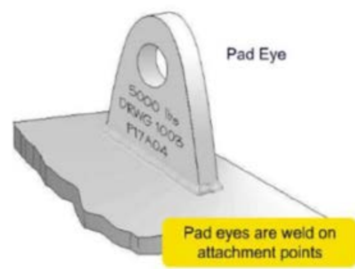
Welcome to Attachment Points.

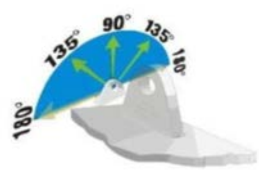
Learning Objectives

Upon successful completion of this module, you will be able to identify attachment point types, requirements, and placement criteria, identify lashing material types, and understand lashing requirements.

Weld-on Attachments

Attachment points are where the rigging gear is connected to the load. There are many types of attachment points. Weld-on pad eyes are durable attachment-points designed specifically for lifting. Normally, weld-on pad eyes are installed by the manufacturer. When rigging to these attachment points, shackles should always be used.





Capacity and Load Application

Pad-eye capacities vary depending on design and material. Most pad-eyes, if properly designed and installed, can be used up to 100 percent of rated capacity through a full 180 degree range, provided they are tensioned within the plane of the eye. Side loading is generally limited to 5 degrees or less. When in doubt, check with your activity's engineering department for specific guidance.

Inspection of Welds and Structure

Visually inspect pad-eyes, welds and the structure they are welded to before and after each use. Look for: cracks, corrosion, deformation, or other signs of damage or overload. If you have any doubt as to the strength or integrity of the pad-eye or the attached structure, DON'T USE IT. Stop work and contact your supervisor. A properly filled out danger tag should be attached to the pad-eye in question.

Can't Load 'In-plane'

There may be times when pad-eye orientation will not allow in-plane loading. Lifting beams can be used to orient the rigging for in-plane loading.

Knowledge Check

1. Select the best answer. Padeye and lifting lug capacities depend on:

    a. Personal preference
    b. Material and design
    c. Crane capacity
    d. Climate

2. Select the best answer. Padeye side pulls should be restricted to:

    a. Use only as directed
    b. 5 degrees
    c. Loads over 20,000 pounds
    d. 60 degrees

3. Select all that apply. Visual inspections of attachment points include looking for:

    a. Cracks
    b. Date tags
    c. Manufacturing information
    d. Corrosion
    e. Deformation

4. Select the best answer. What should be applied to an attachment point when it is found to be unfit for use?

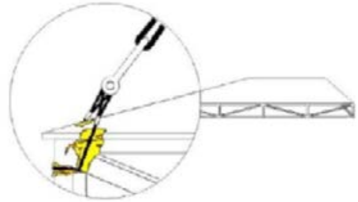
    a. Engineering evaluation request
    b. A Do Not Use or Danger tag
    c. 150 percent proof test
    d. 125 percent proof test

5. Select the best answer. What may be used to align rigging gear in the plane of attachment points?

    a. Spreader beams
    b. Shorter slings
    c. Bending attachments
    d. None of the above

Using Structural Components

If welded pad-eyes are not available, a load's structural component can be used as an attachment point. Be sure the structure can support the load weight and the added tension from sling angle stress.



User Installed Attachment Points

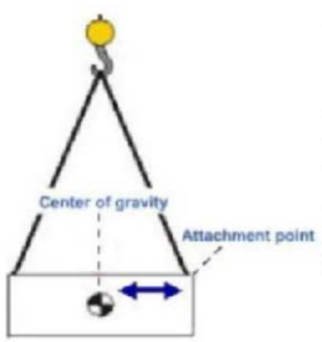
Sometimes, an attachment point needs to be added to the load. Beam clamps, plate clamps, swivel hoist rings, eye-bolts, or portable padeyes, may be attached to the load for lifting.

Attachment Points and OEM

Remember, all rigging gear, including portable user-applied attachment points must be used in accordance with OEM instructions. Be sure to perform a pre-use visual inspection.

Attachment Point Placement

Choosing the right location for attachment points is very important to maintaining load control. Your choices may be limited due to the weight of the load, how the weight is distributed, the material the load is made of, or how the load is constructed. Is it fragile? Does it have machined surfaces? Consider the size and shape of the load, where the load is going, whether it needs to be rotated or flipped, and the load's center of gravity.



Attachment Point Placement Continued

The load's center of gravity should be considered when deciding the placement of attachment points. The farther the attachment points are from the load's center of gravity, the more stable the load will be and the less susceptible it is to tipping. The load's center of gravity must remain within the stability triangle formed by the slings, otherwise the load can flip or tip over. When choosing attachment points, ask yourself, which method will provide the best control.

Lashing

Lashing is defined as: wire rope, synthetic rope, or synthetic webbing (without permanent end fittings) that is used for wrapping around and securing an object to provide a point or points from which to lift the object, or attaching to an approved structure to serve as a point from which to rig. Lashing shall not be used to substitute for standard rigging components (slings, shackles, etc.) where the use of such rigging is practical.

Lashing vs. Slings

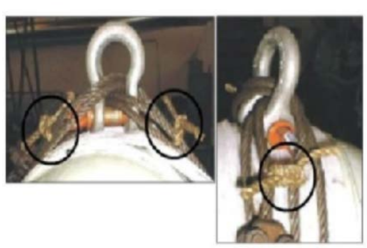
Why is lashing treated differently than slings? Lashing requires the use of knots or clamping devices, with appropriate reductions in rated capacity. Knots and clamping devices are not permitted for slings. Proper lashing methods and techniques are essential for safe weight handling.

Lashing Requirements

Use of lashing shall, as a minimum, comply with the following: Lashing shall be visually inspected annually and immediately prior to each use. In addition, lashing shall be inspected after each use and damaged portions removed prior to reuse. Lashing shall be attached tightly enough to prevent the object to be lifted from slipping out, and shall be installed so as not to damage or crush the object. Lashing shall be provided with adequate protection from abrasion, cutting, and extreme bearing damage, as applicable. The lashing configuration shall be such that at least two parts of lashing support the load, and the lashing shall be marked with its rated load and re-inspection due date.

Additional Lashing Requirements

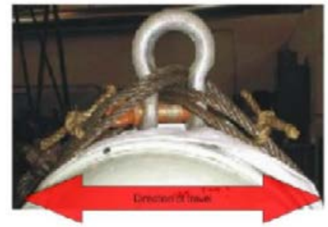
Additional lashing requirements include: forged steel wire rope clips shall be used to secure the ends of wire rope lashing; the rated load of the lashing shall be reduced by 20 percent or by the reduction due to D/d efficiency, whichever is the greater reduction; properly tied standard knots or hitches (square knots backed up with half hitches, bowlines, clove hitches, etc.) may be used to secure synthetic rope and webbing lashing; when knots are used, the rated load of the lashing shall be reduced by 50 percent or by the reduction due to D/d efficiency, whichever is the greater reduction; and the additional force due to lift angles in the lashing configuration shall be taken into consideration to ensure the rated load (or reduced load) of the lashing is not exceeded.



Secure Shackles from Rendering

When using hardware such as rings or shackles with lashing, secure the rigging gear to the lashing to prevent rendering.

Drifting a Lashed Load



If a planned lift will involve drifting or load transfer, the shackle, ring, or other rigging gear, should be positioned "in-line" with the intended direction of travel. Rigging gear attached to the load should be large enough to accommodate two additional shackles for load transfer.

Knowledge Check

6. Select the best answer. When welding, bolting, or clamping isn't practical for attachment points, which of the following could be used?

   a. Lashing
   b. Magnetic lifting devices
   c. Vacuum lifting devices
   d. Any of the listed items above

7. Select the best answer. Which of the following best defines lashing?

   a. Wire rope slings wrapped around an object and knotted
   b. Wire rope, synthetic rope, or synthetic webbing (without permanent end fittings) that is used for wrapping around and securing an object to provide a point or points from which to lift the object
   c. Any type of rope that's wrapped around an object to provide a lift point
   d. Wire, webbing, or rope which does not require certification

8. Select the best answer. When using wire rope clips to secure the ends of wire rope lashing, the rated load of the lashing is reduced by 20%, or by the reduction due to D/d efficiency, whichever is the greater deduction.

   a. True
   b. False

9. Select the best answer. When tying knots in synthetic rope lashing, the rated load is increased by 50%.

   a. True
   b. False

10. Select the best answer. Knots may never be used to secure synthetic lashing.

    a. True
    b. False

11. Select the best answer. The hardware attachment point on a lashed load should be positioned:

    a. In-line with the direction of travel
    b. Opposite from the direction of travel
    c. 60 degrees from the direction of travel
    d. Perpendicular to the direction of travel

NOTES

PLANNING CRANE LIFTS

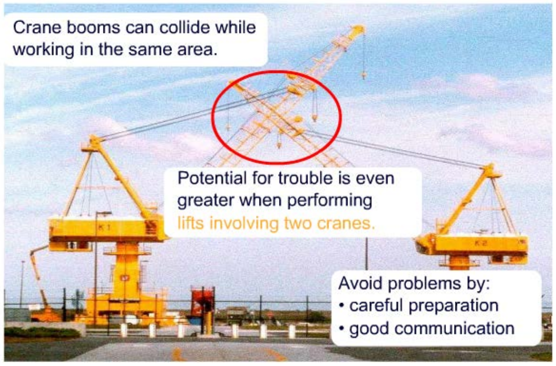
Welcome
Welcome to Planning Crane Lifts.

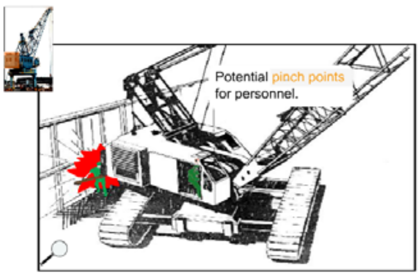
Learning Objectives
Upon successful completion of this module, you will be able to identify potential crane clearance issues and how to avoid potential obstructions, identify the uses of each part of the load chart, explain "gross" and "net" capacity, and discuss pre-lift preparations and crane team briefing topics.

Crane Clearance Overview
Working safely with cranes involves identifying potential problems prior to and during crane operations. Regardless of the crane used, certain components of the crane require constant attention.

Crane Boom
Often the crane's boom will be the largest single component on the crane.
The potential for collision with buildings, cranes, and other structures may exist.

Boom Collision
When two cranes work in the same area, extra precautions must be taken to avoid collisions, especially boom collisions. This potential increases when conducting lifts using two cranes because of the close proximity of the equipment. Careful preparation and good communications are essential.





Crane Counterweights
Crane counterweights, especially on mobile cranes, pose a potential hazard to personnel. Serious injury or death can occur if someone gets trapped in the pinch point between the counterweight and an obstruction. Even though portal crane counterweights are not normally a personnel concern, they can cause serious damage to anything they come in contact with.

Barricading

The crane shall be so positioned at the job site as to provide adequate clearance from all obstructions to any part of the crane in any position that it will operate. Particular attention to counterweight clearance is required. Accessible areas within the swing radius of the rotating superstructure of a crane shall be barricaded to prevent personnel from being struck or crushed by the crane.

Counterweight Clearance

The crane may pass by structures without collision while the boom is parallel to the track. But when traveling with the boom perpendicular to the track the counterweight may overhang the track by ten, twenty, thirty feet or more.

Gantry Clearance

Gantry clearance should be closely monitored during crane travel. Vehicles attempting to drive under the crane without regard for clearance can jeopardize crane safety.

Travel Trucks

Items left in the path of travel trucks are usually no match for the power and weight of the crane. Injury to personnel and damage to materials and equipment, including the crane itself, can be avoided if we monitor the crane's travel path and keep it clear at all times.

Avoiding Problems

Inspect the crane area work site prior to starting any crane movement. Monitor the area for changing conditions during the work shift. Potential obstacles in the crane's operating envelope should be identified and removed if possible. A plan for working safely around immovable items should be discussed.

Develop a Plan

Develop well thought out lift plans to avoid problems. Use additional personnel as crane walkers or spotters. Move the crane to another area or change the pick-up and lay-down areas.

Construction Areas

Areas where construction is underway may present some special problems for the crane team. Work site conditions may not be controlled by your facility. Materials and equipment may be left in the area. Portable barriers or fencing may extend into the cranes' travel or swing path. Contractors may not be aware of your crane safety procedures and requirements. Regardless of the circumstances, take the time to ensure crane safety by addressing these issues prior to beginning the operation.

Restricted Travel Areas

You may encounter restricted areas that involve ground loading or crane interference, which can limit crane travel or swing maneuvering. Check with your supervisor or safety officer for load restriction information.

Mobile Crane Load Weight

For mobile crane lifts that exceed fifty percent of the crane's capacity at the maximum planned radius, the radius must either be verified by actual measurement or by operating the crane with an empty hook through the lift evolution and verifying the radii from the radius indicator. For mobile crane lifts that exceed eighty percent of the crane's capacity at maximum planned radius, the radius must be verified by measurement when possible. Do not rely solely on the radius indicator.

Complex Lifts

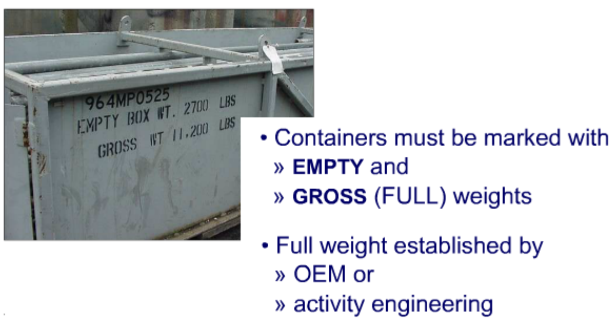
Complex lifts have a moderate to high level of risk. Activities are required to identify complex lifts and prepare detailed written procedures for their execution. Procedures may be in the form of standard instructions or detailed procedures specific to a lift.

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.

Equipment Weights and Markings

Man lifts, aerial platform vehicles, forklifts, mobile cranes, and similar equipment that may be lifted by crane shall be weighed and stenciled with the weight in pounds. For activities in foreign countries, additional marking of the weights in kilograms is acceptable. OEM marked weights are acceptable. Lifting points and/or lifting configurations shall also be identified.



Container Weights

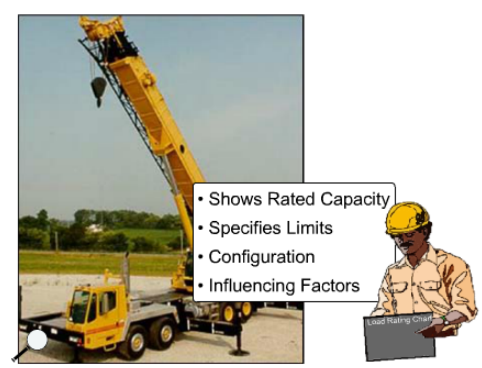
Sand hoppers, tubs, and other containers that may carry material must be marked with empty and full weights. Full weight must be established by the OEM or the activity engineering organization. If the weight is not marked, it must be verified using a load indicating device. Always check to see what the contents are. A container designed to hold a relatively light material may be significantly heavier if it is filled up with water.

Unmarked Weight

If the container's weight is not marked, its weight must be verified by the use of a load indicating device (or LID). The LID, rigging gear, and crane shall be sized to pick up the maximum possible weight of the unmarked load. If a marked container cannot be physically verified as empty, or the container is only marked with a full weight, the container shall be considered full or an LID shall be used. Pallets, boxes, and other storage containers shall be inspected for damage and structural integrity prior to loading or lifting.

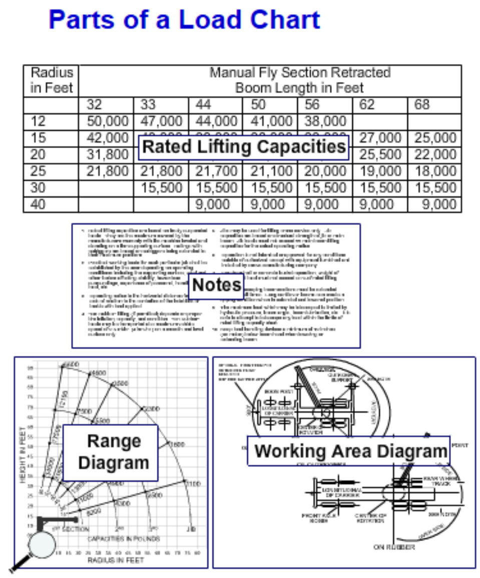
Understanding Load Charts

A load chart specifies the rated capacity for each permissible configuration, operational limits, and set-up requirements for the various configurations. The load chart identifies principal factors influencing the crane's capacity, such as boom angle, boom length, load radius, deductions from gross capacity, crane configuration, and quadrants of operation.

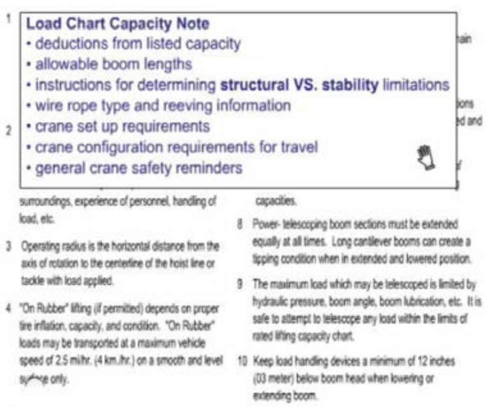


Parts of a Load Chart

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.

Capacity Chart

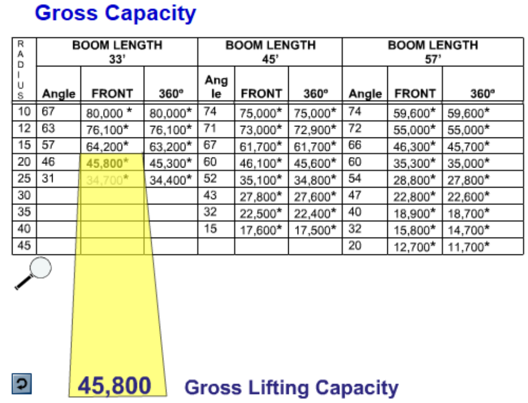
The rated capacity chart is that part of the load chart that we reference to determine the crane's gross capacities. Gross capacities are listed for various boom lengths and load radii.

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

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.



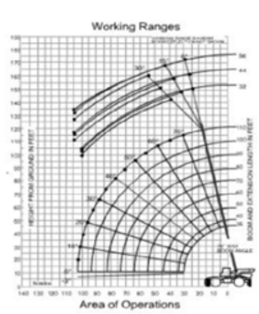
RADIUS	BOOM LENGTH 33'			BOOM LENGTH 45'			BOOM LENGTH 57'		
	Angle	FRONT	360º	Angle	FRONT	360º	Angle	FRONT	360º
10	67	80,000 *	80,000*	74	75,000*	75,000*	74	59,600*	59,600*
12	63	76,100*	76,100*	71	73,000*	72,900*	72	55,000*	55,000*
15	57	64,200*	63,200*	67	61,700*	61,700*	66	46,300*	45,700*
20	46	45,800*	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*

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.

Common 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.

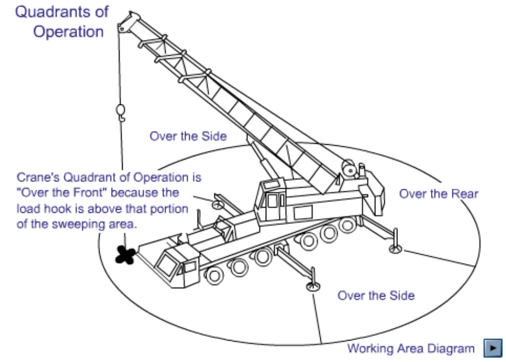


Range Diagram

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



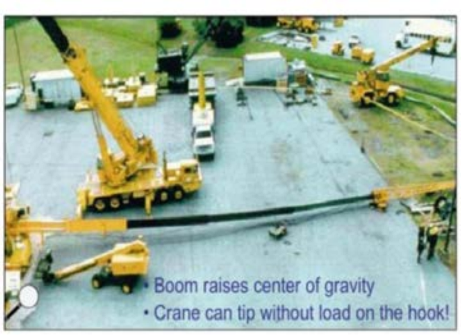
Another important part of the load chart is the working area diagram. Crane stability and capacity will vary as the load moves from one quadrant of operation to another. Because the crane's capacity is different in each quadrant of operation, it is important to match the load chart to the quadrant, or quadrants, the crane will be working in and through.

Overloading Cranes

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.



Telescopic Boom Cranes

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.

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 of 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.

Pre-job Briefings

Pre-job briefings are a decision making tool used by the crane team to anticipate hazards, minimize risks associated with the job, and reduce the potential for accidents. Pre-job briefings ensure all team members understand specific assigned responsibilities, rules and procedures for making the lift, and potential dangers and how to avoid them.

Briefing Topics

Topics discussed at a pre-job briefing should include: activity safety policies, the lift procedure, assignment of duties and individual responsibilities (who is responsible to do what, and when), communication methods, crane characteristics, ground conditions and cribbing requirements, hazards in the crane work area including crane clearances, load travel paths, and load weight. Additional topics include rigging requirements such as: required rigging gear, the load's center of gravity, and load controlling methods such as chain hoists, hold backs, and tag lines as appropriate. If a load indicating device is required, who will be assigned to monitor the LID, and pre-determined stop points should be discussed. Topics such as tracks and switch alignment, traffic control and weather concerns should also be addressed.

Knowledge Check

1. Select the best answer to fill in the blank. The _______ on mobile cranes is particularly hazardous to personnel.

    a. Counterweight
    b. Machinery house
    c. T-lines
    d. Alarms and horns

2. Select the best answer. Load charts contain rated capacities, a notes section, range diagrams, and a working area diagram.

    a. True
    b. False

3. Select the best answer. What section of the load chart would help someone identify the maximum hook height in a give configuration?

    a. Rated capacities
    b. Working area diagram
    c. Notes section
    d. Range diagram

4. Select the best answer to fill in the blank. Taking all necessary deductions from the capacities listed in the load chart provides the operator with ___________.

    a. Reduced capacity
    b. Safety margin
    c. Gross capacity
    d. Net capacity

5. Select the best answer. The gross capacity found on the load chart is the total rated load of the crane before deductions are taken.

    a. True
    b. False

6. Select the best answer. Gross weight stenciled on sand hoppers, tubs, or other containers is the weight of the empty container.

    a. True
    b. False

7. Select the best answer. Because of the weight of a telescopic boom, a telescopic boom crane:

    a. Is secured into position by its weight
    b. May tip more rapidly
    c. Will never tip without a load
    d. Is more stable

NOTES

EXECUTING CRANE LIFTS

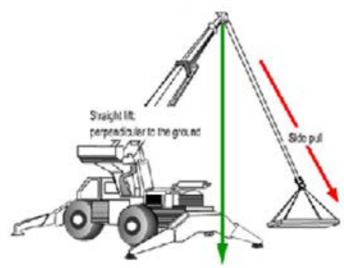
Welcome
Welcome to Executing Crane Lifts.

Learning Objectives
Upon successfully completing this module, you will be able to identify procedures and requirements for safely lifting, moving, landing, and securing loads.

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 are not permitted to ride loads being moved by cranes. If rigging or loading orientation requires adjusting, use another type of access whenever possible. Choose a personnel lift, scaffolding or ladders. Do not use the load as a means of transportation!

Side Pulls
Loads shall be lifted vertically. The practice of side-loading the crane is dangerous and prohibited.



Load Carry Height
When moving a load from one point to another, the load should be as low to the ground as possible. If the load must be carried higher to clear obstacles, tag lines of sufficient length should be used to maintain load control.

Waterborne Lifts
When lifting loads from water, you may encounter suction from the sediment at the bottom. Flat bottom loads may experience a suction effect just prior to clearing the water. Loads with pockets, voids, or tanks may hold water that can increase anticipated load weight when the load is lifted above the water. Always use a load-indicating device. Without a load-indicating device, it would be difficult to accurately calculate the

increased load on the crane and rigging gear. Tide changes and wave action can cause overloads, shock loads and loss of control. A plan should be developed to account for these.

Crane Stability

Avoid lower than necessary boom angles. As always, be sure to talk with the crane operator whenever crane stability issues come up.

Residual Radius Increase

The load radius is equal to the horizontal distance measured from the center of rotation of the crane center pin to the center of the hook. Load radius can be established by centering the hook over the load and referring to the crane's radius indicator. For fixed boom lengths, radius can be calculated using boom angle and a load chart. Boom deflection or residual radius increase is an unwanted increase in the crane's operating radius when a heavy load is applied to the hook and must be taken into account. Several factors can cause it, including: boom deflection, flexing in the crane's structure, wire rope stretch, and for floating cranes - vessel listing. It can cause the load to shift, swing, or lunge as it lifts. If you're not prepared, personnel or nearby equipment could be jeopardized!

Residual Radius Increase Example

If we do not compensate for the movement, personnel injury and/or material damage can occur. Select the forward or play button to view an example.

Preventing Increase

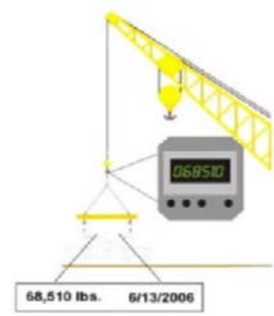
So how do we control this movement? First, talk to the crane operator whenever you think a lift might be susceptible to load radius increase. Communicate to the crane operator to place the rigging over the load's center of gravity using a boom angle which will minimize radius increase. Connect the rigging gear to the load and signal the operator to hoist slowly to remove slack. When the slack in the lifting gear has been removed, signal the operator to boom up slowly while you watch that the hoist wires remain plumb. It may be necessary for the crane operator to raise the hoist and boom alternately in small increments to ensure the hook stays centered until the load is completely suspended.

Floating Crane Increase

Floating cranes have a unique characteristic that can increase the radius significantly. In addition to boom deflection, floating cranes can list, as their barge leans deeper into the water in the direction of lift. This listing movement can adversely affect load control. Allow additional space around the load as a buffer zone.

Lifting Guidelines

As soon as the load is completely suspended, signal the operator to stop hoisting. At this time, the crane operator can check the hoist brakes. If a load indicating device is being used, the load weight can be verified if necessary. It's a good idea to record the weight for future reference.



Inspect Rigging

Maybe a shackle has turned or a sling is pinched or hung-up on an obstruction. Now is a good time to re-check the load for any loose material that could fall off during movement. This is the last chance you'll get to correct any of these problems before sending the load off. Take the time to make these corrections. Don't rush and don't send an unsafe load aloft.

Barricading

The crane shall be so positioned at the job site as to provide adequate clearance from all obstructions to any part of the crane in any position that it will operate. Particular attention to counterweight clearance is required. Accessible areas within the swing radius of the rotating superstructure of a crane shall be barricaded to prevent personnel from being struck or crushed by the crane.

Traveling with a Load

Traveling a crane with a suspended load is a hazardous operation. When traveling, always have the boom in the position providing adequate stability in case the load should swing out of radius. Only when permitted by the OEM shall a mobile crane be permitted to travel with a suspended load.

Mobile Crane Travel Requirements

When traveling a mobile crane with a load, operators and riggers should follow these requirements: Whenever possible, travel with the boom and load over the rear and parallel with the axis of the crane carrier and with the direction of travel either forward or reverse, with the swing lock or brake engaged. Whenever practical, and as permitted by the OEM, extend the outriggers and maintain minimal clearance (3 to 4 inches) above the ground. Do not travel truck, rough-terrain, or all-terrain cranes with the load over the side unless specifically permitted by the OEM and authorized by the certifying official. When traveling, keep loads close to the ground. Avoid sudden starts and stops. Always travel at the slowest possible speed. Avoid raising the boom to the maximum boom angle in order to prevent it from engaging the backstops or bouncing into the cab (loaded or unloaded). And, be sure the ground over which the crane shall travel can support the machine.

Landing Loads

Avoid landing loads in congested areas. Whenever possible, land the load in an uncluttered area visible to both you and the operator.

Emergency Access Routes

It's extremely important to leave emergency access routes open. Avoid landing loads in fire lanes and emergency access routes.

Personnel Access

Remember - do not lift loads over personnel! Avoid landing loads in front of access ladders, platforms and doorways. Secure the area before attempting to land the load.

Ground Loading

Be sure the landing surface can support the weight of the load.

Blocking and Stability

Use adequate blocking or support material to prevent damage to the load and the landing surface. Be sure that the load is stable before unhooking it from the crane.

Securing Loads

Tie down materials must be strong enough to control unwanted load movement. Inspect tie down points for defects, such as cracks, broken welds, and distortion.

Knowledge Check

1. Select the best answer. When are personnel allowed to ride loads suspended from a crane?

   a. Only when rigging needs adjusting
   b. When the load needs to remain in view of the crane operator
   c. Never
   d. When loads need to be stabilized

2. Select the best answer. When are loads allowed to be moved over personnel?

   a. As directed by supervision
   b. When other travel routes are too congested
   c. Never
   d. When personnel are wearing appropriate safety gear

3. Select the best answer. What should be included in the rigging for all waterborne lifts?

   a. Tag lines
   b. A load indicating device
   c. Spreader bars to minimize sling angles
   d. None of the above

4. Select the best answer to fill in the blank. To ensure wire rope alignment in the crane sheaves and to maintain stability, loads are to be lifted __________.

   a. Quickly
   b. With side pulls
   c. Below the center of gravity
   d. Straight up and down

5. Select the best answer to fill in the blank. So the crane operator can check the brakes when initially hoisting loads, hoisting should be _____________.

   a. Stopped a few inches off the ground
   b. Monitored for radius increase
   c. Continued to the highest position

6. Select the best answer. One method to overcome unwanted radius increase is to:

   a. Hoist down
   b. Boom down
   c. Hoist up
   d. Boom up

7. Select the best answer. While traveling with a load, loads should be kept:

   a. As low to the ground as safely possible
   b. As high as the boom will allow for total clearance
   c. Always perpendicular to the crane cab

8. Select the best answer. What should be avoided when landing loads with cranes?

   a. Congested areas
   b. Personnel accesses
   c. Fire lanes and emergency accesses
   d. Avoid all of the listed situations above

9. Select the best answer. When crane operators stop hoisting to check the brakes, the riggers should …

    a. Verify load stability
    b. Ensure rigging is properly set
    c. Both of the above answers are correct

10. Select the best answer. If a mobile crane is permitted (by the OEM) to travel with a suspended load, what precautions should be observed?

    a. Avoid sudden starts and stops
    b. Travel at the slowest possible speed
    c. Outriggers should remain extended and elevated 3 to 4 inches above the ground
    d. Observe all listed precautions above

NOTES

SAFE OPERATIONS

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 on the candidate's demonstration of knowledge, skill, and ability with the crane and safe 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. Operate safely
   d. Do pre-use checks

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

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. The pre-use check or Operators Daily Checklist (ODCL)
   c. Proper set-up on outriggers
   d. Firm and level supporting surface

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

   a. ODCL Checks
   b. Operator's license number
   c. Labels for each control function

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

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

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

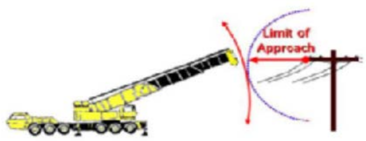
Personnel are not permitted to ride loads being moved by cranes. If rigging or loading orientation requires adjusting, use another type of access whenever possible. Choose a personnel lift, scaffolding or ladders. Do not use the load as a means of transportation!

Overhead Power 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.

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



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 should 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.

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 center of gravity when attaching the load. This prevents side loading the boom or crane and prevents dragging or shifting of the load as it is picked up. Sufficient tag lines shall be used to minimize load swing and rotation unless their use creates a hazard. Take the slack out of rigging gradually and watch for hook movement that indicates the 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 Cranes with Loads

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 the 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

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

    a. Change speeds smoothly
    b. Center the hook over the center of gravity of the load
    c. Lift the load slightly to check the brake
    d. Take the slack out of the rigging

8. 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 at one speed until the load lifts
    c. Hoist slowly until the load lifts

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

    a. Lift until the load clears all obstacles and stop
    b. Lift the load until a desired height and stop
    c. Lift the load until completely suspended and stop

10. 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. Note the incident on the back of the ODCL card
    b. Proceed slowly with caution
    c. Refuse to continue until safety is assured
    d. Tell his/her supervisor at the end of the shift

11. 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

12. 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

13. 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.

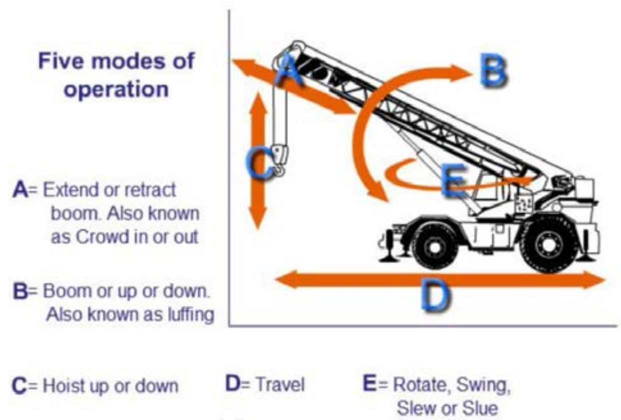
NOTES

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 overhead electric traveling (OET) and gantry cranes.

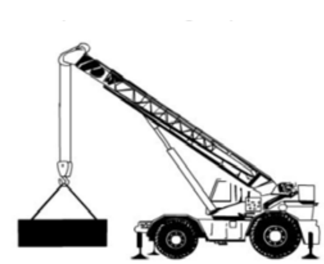
Mobile Crane Operating Terms
There are five common modes of operation for a typical mobile crane: booming up or down, rotating, traveling, hoisting up or down, and extending and retracting the boom. Raising or lowering the boom is also known as booming or luffing. Rotate, sometimes called swing or slew, 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.

Mobile Cranes - 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 Lock

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. Extend or Retract Boom
   b. Hoist up or down
   c. Rotate
   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. Rotate
   b. Extend or Retract Boom
   c. Booming up or down
   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. Extend or Retract Boom
   b. Rotate
   c. Hoist up or down
   d. Booming up or down

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

   a. Jib
   b. Oiler
   c. Rigging gear
   d. Jacks
   e. Hooks

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

   a. Remove stowed jib to lighten the boom
   b. Adjust as necessary for boom deflection before lifting the load
   c. Use both hooks for added capacity

Lifting on Tires

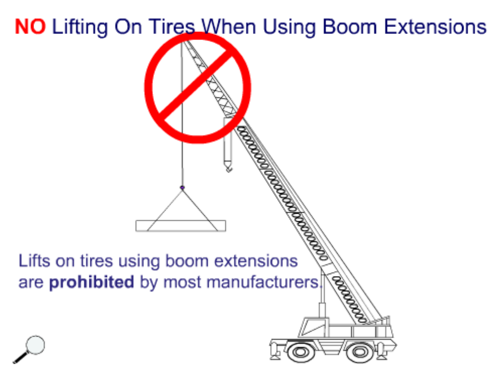
Lift on rubber only when necessary and allowed. Cranes are much less stable on rubber than when on outriggers. Lift only on level surfaces. Remember, greater deflection and radius increase can be expected when making lifts on tires.

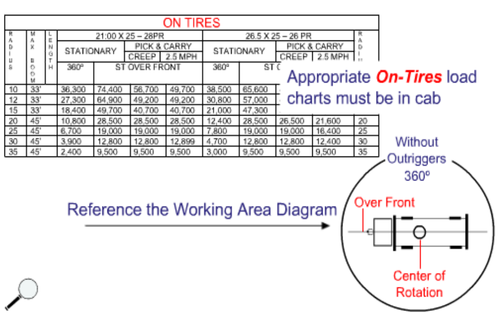
Lifting on Tires: Issues

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.



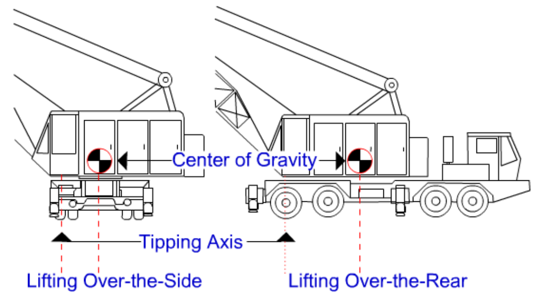


RADIUS	MAX BOOM LENGTH	21:00 X 25 – 28PR STATIONARY 360°	21:00 X 25 – 28PR STATIONARY ST OVER FRONT	21:00 X 25 – 28PR PICK & CARRY CREEP	21:00 X 25 – 28PR PICK & CARRY 2.5 MPH	26.5 X 25 – 26 PR STATIONARY 360°	26.5 X 25 – 26 PR STATIONARY ST [illegible]	26.5 X 25 – 26 PR PICK & CARRY CREEP	26.5 X 25 – 26 PR PICK & CARRY 2.5 MPH	RADIUS
10	33'	36,300	74,400	56,700	49,700	38,500	65,600	[illegible]	[illegible]	[illegible]
12	33'	27,300	64,900	49,200	49,200	30,800	57,000	[illegible]	[illegible]	[illegible]
15	33'	18,400	49,700	40,700	40,700	21,000	47,300	[illegible]	[illegible]	[illegible]
20	45'	10,800	28,500	28,500	28,500	12,400	28,500	26,500	21,600	20
25	45'	6,700	19,000	19,000	19,000	7,800	19,000	19,000	16,400	25
30	45'	3,900	12,800	12,800	12,899	4,700	12,800	12,800	12,400	30
35	45'	2,400	9,500	9,500	9,500	3,000	9,500	9,500	9,500	35

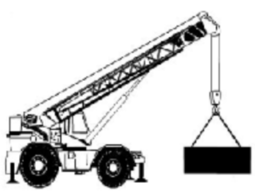
On-Tires Load Chart

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 inline 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.

Operating Extendable Boom Cranes

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.

Securing Extendable Boom Cranes

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.

Operating Lattice Boom Cranes

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.

Securing Mobile Lattice Boom Cranes

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

6. Select the best answer to fill in the blank. Extending the boom on a typical hydraulic crane will cause the hook(s) to _________.

    a. Lower
    b. Spin
    c. Raise

7. Select the best answer. On hydraulic truck cranes, set the front float or 5th outrigger, when equipped.

    a. True
    b. False

8. 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

9. Select the best answer to fill in the blank. When securing rough terrain cranes, the boom should be in a near _______ position.

    a. Safe
    b. Vertical
    c. Horizontal

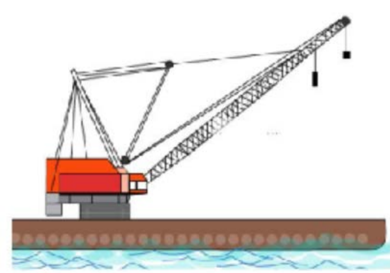
10. Select the best answer. All of the following steps apply to securing lattice boom cranes except:

    a. Engage all drum pawls
    b. Retract the boom
    c. Lock down all foot brakes
    d. Place the boom at approximately 45 degrees
    e. Disengage the master clutch

11. Select the best answer. 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.

Securing Floating Cranes

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.

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 power 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.

Moving Railcars

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.

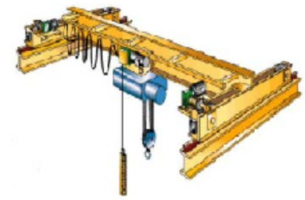
Locomotive Cranes - Securing

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.

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.

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 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.

Operating OET and Gantry Cranes 2

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.

Securing the Crane

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

12. Select the best answer. When operating floating cranes, you must start swinging or rotating quickly and stop abruptly.

    a. True
    b. False

13. Select the best answer to fill in the blank. Lifting heavy loads with floating cranes will cause the barge to ________.

    a. Skew
    b. Drift
    c. Sink
    d. List
    e. Rotate

14. Select the best answer. Portal crane operators shall stop crane travel if materials or vehicles are inside crane clearance lines.

    a. True
    b. False

15. Select the best answer to fill in the blank. When making heavy lifts with locomotive cranes, the use of tilt-blocks or bed-wedges will increase _________ stability.

    a. On-rubber
    b. Over the end
    c. On outriggers
    d. Over the side

16. Select the best answer to fill in the blank. Failure to disengage tilt-blocks or bed-wedges for locomotive crane travel may result in ____________.

    a. Overloading the crane
    b. Overheating brakes
    c. Derailing the crane
    d. Loss of stability

17. 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

18. Select the best answer. Which of the following is a mode of operation for a typical OET or gantry crane?

    a. Swing
    b. Trolley
    c. Luff

19. Select the best answer. Which of the following is a mode of operation for a typical OET or gantry crane?

    a. Bridge
    b. Rotate
    c. Extend

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. The load
    b. The area where the load will be landed
    c. Any supporting structures
    d. Rigging gear between the hook and 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 user of the gear or equipment
    c. The rigging procedure
    d. The gear or equipment's supporting structure
    e. Other personnel involved in the operation
    f. The crane removal procedure

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.

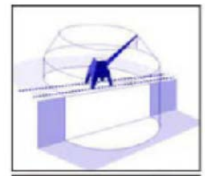
Unplanned Occurrence

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 Definition



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 judgement, 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.

WHE Accident Response

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.

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.

Contractor Accident Reporting Procedures

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.

Contracting Officer Reporting

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

3. 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. Crane accident
    d. Operator error

4. 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. Operator error
    b. Crane accident
    c. Crane walker’s error
    d. Load configuration error

5. 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. Rigging error
    c. Load configuration error
    d. Crane accident

6. 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 non-accident
    c. A rigging accident
    d. Crane maintenance's responsibility

7. Select the best answer. To whom or to what are the majority of crane accidents attributed?

    a. Personnel error
    b. Crane operators
    c. Riggers or signalmen
    d. Weather conditions
    e. Equipment failure

8. Select all that apply. Over-confidence and poor judgement among team members can contribute to crane and rigging accidents. Select additional factors that can contribute to accidents:

    a. Engineering lift specifications
    b. Inattention to the task
    c. The crane operating envelope
    d. Operating the crane too fast

9. 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. Notify your supervisor immediately
    b. Stop operations as soon as safely possible
    c. Secure the crane and power as required
    d. Call emergency services if anyone is injured

NOTES