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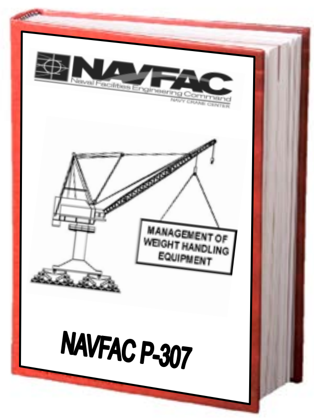
Naval Facilities Engineering Command
NAVY CRANE CENTER

Navy Crane Center



NAVFAC P-307 Training

CATEGORY 4 CRANE SAFETY

WEB BASED TRAINING STUDENT GUIDE

NCC-C4CS-03

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INTRODUCTION

Welcome

Welcome to Category 4 Crane Safety.
Category 4 Crane Safety is designed to acquaint crane operators with Navy requirements for the safe operation of category 4 cranes and provide a knowledge base on which to build upon with on-the-job experience.

Topics covered include: Crane Types and Components, Operator's Daily Checklist (ODCL), Complex and Non-Complex Lifts, Determining Load Weight and Load Weight Distribution, Sling Angle Stress and D/d Ratio, Rigging Gear Test, Inspection, Marking, and Record Requirements, Rigging Gear Use, Load Charts, Crane Communications, Crane Team Concept, 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, complete an Operator's Daily Checklist (ODCL), identify crane set-up requirements and lift types, determine load weights and load weight distribution, identify proper inspection, marking requirements, and use of rigging gear, understand proper sling use and sling angle stress, identify and properly use load charts, understand crane communication methods and the crane team concept, perform safe crane operations, and identify crane and rigging accidents.

Getting the Most Out of the Course

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

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

The Reference Area

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

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

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

Knowledge Checks

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

The knowledge checks will help you prepare for the module quizzes and final exam. Question types include: Fill in the Blank, Drag and Drop, Multiple Choice - Single Answer, Multiple Choice - Multiple Answer, and True/False.

Exam Directions

When taking exams, keep the following in mind…

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

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

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

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

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

Feedback

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

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nfsh_ncc_training@navy.mil (email)

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

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

Ready to Begin

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

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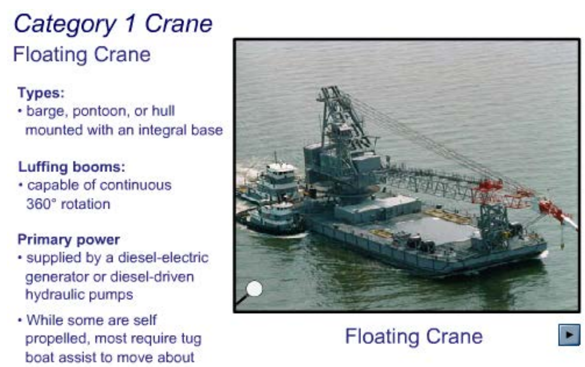
CRANE TYPES AND COMPONENTS

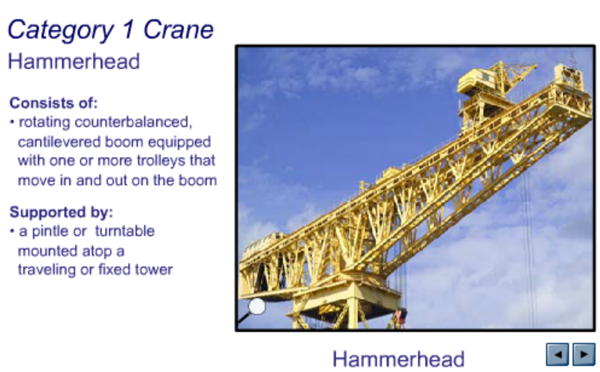
Welcome
Welcome to Crane Types and Components.

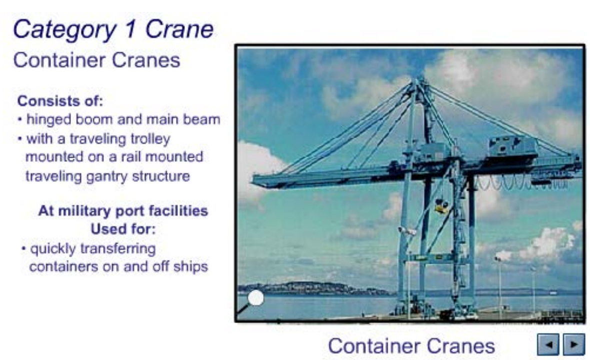
Learning Objectives
Upon successful completion of this module you will be able to define and identify crane types, critical crane components, load bearing parts, load controlling parts, and operational safety devices.

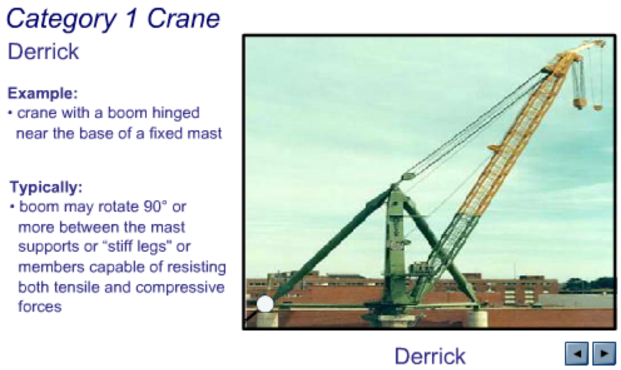
Category 1 Cranes
This is a list of some of the more common types of category 1 cranes. Category 1 cranes come in a wide variety of sizes and configurations and include: portal cranes, hammerhead cranes, locomotive cranes, derricks, YD floating cranes*, tower cranes, container cranes, mobile cranes, 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.

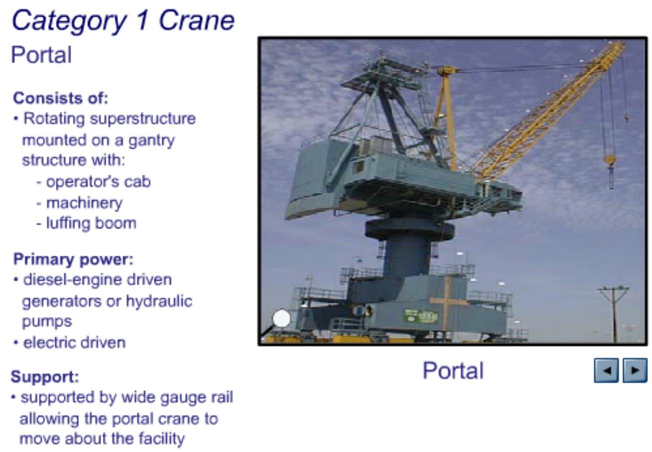
Category 1 Crane Examples
Here, and on the next few slides, are some un-narrated pictures and descriptions of different types of category 1 cranes. Use the forward and backward arrows to scroll through and review the various examples and their descriptions.

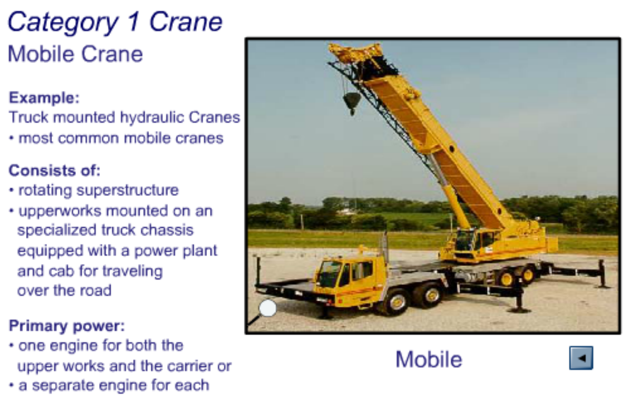






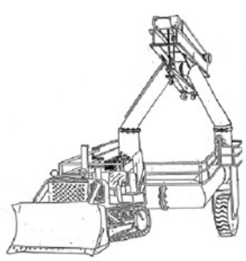






Mobile Boat Hoist

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



Landing Craft Retrieval Unit

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

Rubber Tire Gantry Crane

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

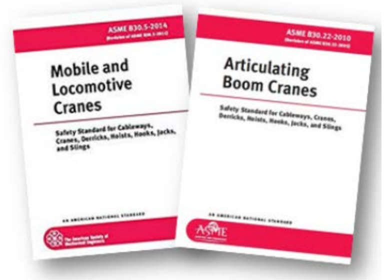
Category 4 Crane Examples

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

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

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

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



Category 2 and 3 Cranes

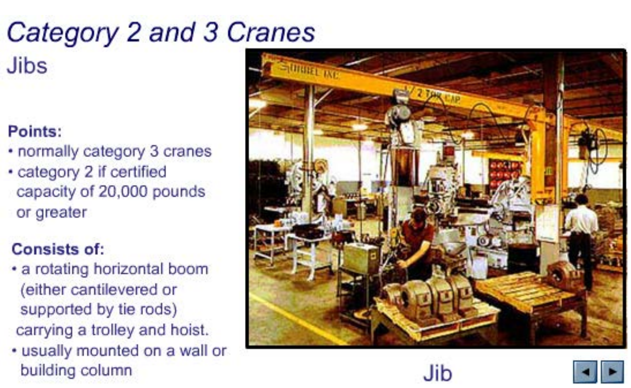
Category 2 and Category 3 cranes include: overhead traveling cranes; gantry cranes; wall cranes; jib cranes; davits; pillar cranes; pillar jib cranes; monorails and associated hoists; fixed overhead hoists, including fixed manual and powered hoists; portable hoists used continuously in a single location,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

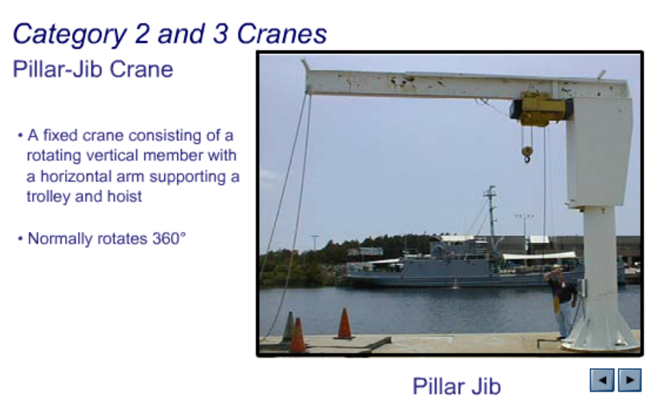
Category 2 and 3 Crane Capacity

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.



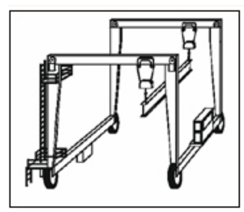


Knowledge Check

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

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

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



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

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

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

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

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

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

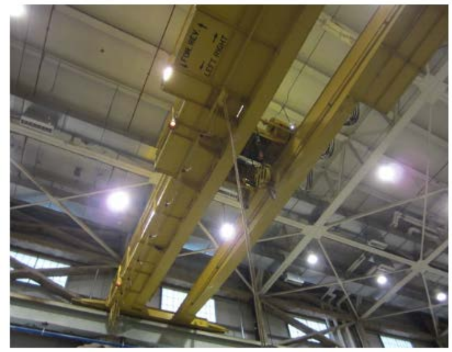
Category 2 and 3 cranes may be manually-operated or power-operated.
A manually-operated crane hoist mechanism is driven by pulling an endless chain. The crane travel mechanism is driven in the same manner or by manually moving the load or hook.
A power-operated crane is driven by electric, pneumatic, 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 Cranes

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 Cranes

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.

Load-bearing Parts - Examples

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

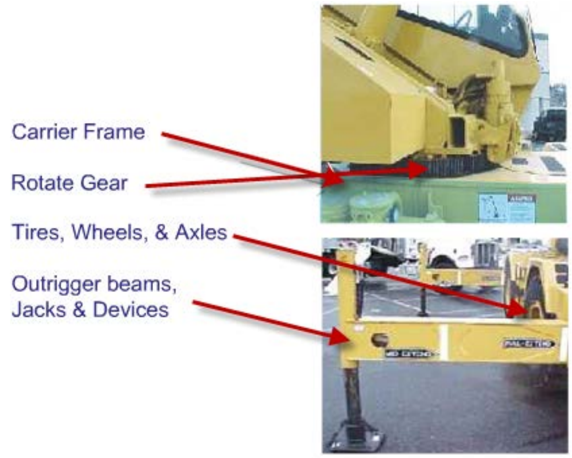
Wire rope,
Hooks, & Blocks

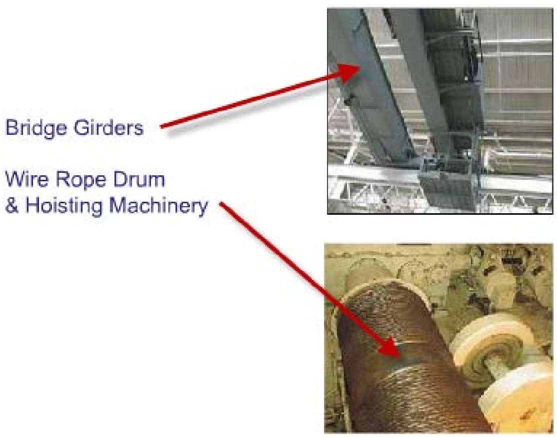
Sheaves

Dogs or Pawls

Load-bearing Parts – Carrier Frame Structures

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



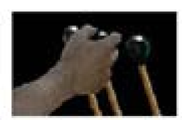


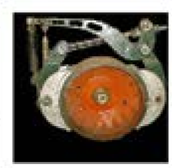
Load-bearing Parts – On Bridge Cranes

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.

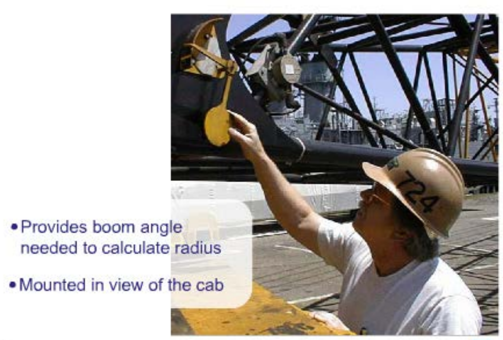
Some general safety devices used to warn personnel working on or around the crane are horns, bells, whistles, travel alarms, and travel warning lights.

Operational Safety Devices – 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.

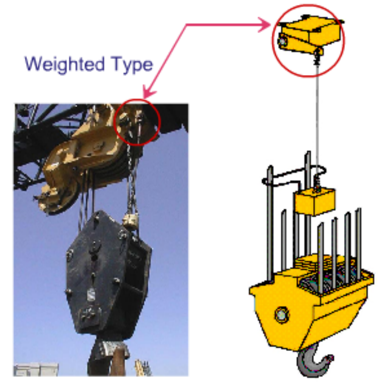


Operational Safety Devices – Angle Indicators

Mechanical boom angle indicators are operational safety devices. These devices provide the operator with the boom angle needed to calculate the radius of the crane.

Mechanical boom angle indicators are usually mounted on the boom where they can easily be read from the cab.

Operational Safety Devices – Limit Switches



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

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

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

These images are examples of weighted-type hoist upper-limit switches. A spring-loaded switch opens the circuit when the hook block raises the weight. Interruption of power to the hoist function stops the upward movement of the hoist block to prevent two-blocking.

Operational Safety Devices – Over-speed

Over-speed, pressure, and temperature devices on crane-mounted engines are operational safety devices. When the engine provides the power to move loads, the devices provide shutdown ability to protect the engine from damage. Appendix F of NAVFAC P-307 provides additional examples of operational safety devices.

Knowledge Check

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

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

2. Select the best answer. Load - _______________ parts are those that restrain, position, or control the movement of the load.

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

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

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

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

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

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

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

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

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

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

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

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

   A. Universal
   B. Load-Bearing
   C. General
   D. Operational

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

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

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

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

NOTES

OPERATOR'S DAILY CHECKLIST (ODCL)

Welcome
Welcome to the Operator's Daily Checklist Module.

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

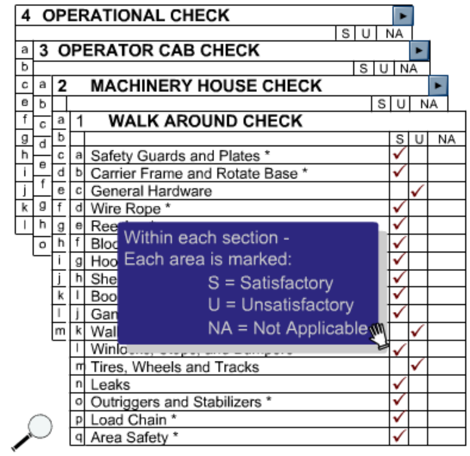
Introduction
An Operators Daily Checklist or ODCL is a safety checklist.
The ODCL aids the operator in doing a complete check and provides a record of inspections.

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

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

ODCL Sections

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



Knowledge Check

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

   A. Complex lifts only
   B. Moving the crane to a new location
   C. The first use of the crane each day
   D. Securing the crane each day

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

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

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

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

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

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

Warning Tags

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

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

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

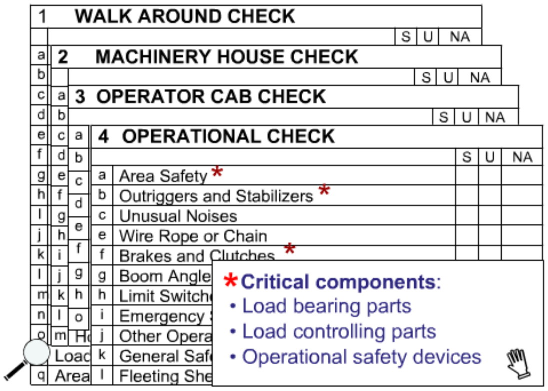
A Lockout Tag is installed to inform you that the energy has been locked out, and is used to protect the person or persons who hung the tag while they are working on the affected system or component. It is intended for one shift use and is usually accompanied by a physical locking device to prevent operation.

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

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

Who Can Remove These Tags?

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

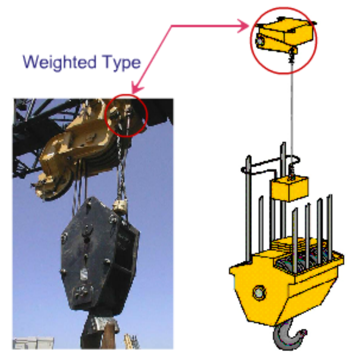


Critical Components

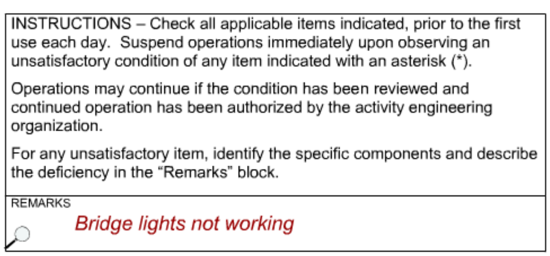
The ODCL identifies components that are critical to the safe operation of the crane.
Critical components are load-bearing parts, load-controlling parts, and operational safety devices. They are identified by an asterisk (*) next to the item.
Any deficiency to a critical component or safety hazard must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

Limit Switches

Limit switches are operational safety devices that prevent damage to the crane if a loss of control occurs. Most cranes are equipped with limit switches.
The purpose of a hoist limit switch is to prevent over-travel of the hook block and the possibility of two-blocking.
Two-blocking occurs when the hook block comes in contact with the upper sheave block during hoisting of the hook (or lowering the boom). Two-blocking is dangerous because it could result in damage to the crane, parting of the hoist lines, and dropping the load.
These images are examples of weighted-type hoist upper-limit switches.



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



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

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

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

REMARKS

Bridge lights not working

Unsatisfactory Conditions

You must give a detailed description of unsatisfactory conditions in the remarks block of the ODCL form.
If you discover a load bearing part, load controlling part or operational safety device that is unsatisfactory, you must stop, secure the crane and notify your supervisor. The supervisor shall immediately report the crane deficiency to the crane inspection organization. The item shall be marked by the operator as unsatisfactory on the ODCL and the deficiency shall be described in the remarks block.
Minor deficiencies must be marked as unsatisfactory on the ODCL and the operator shall describe the deficiency in the remarks block.
The supervisor shall provide the ODCL to the organization responsible for corrective action.

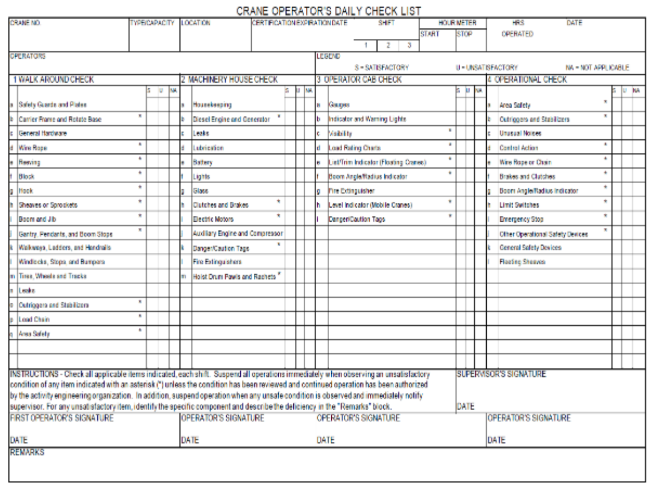
Recording

Results of the inspection must be noted on the ODCL.

Each item shall be marked “S” for satisfactory, “U” for unsatisfactory, or “N/A” for not applicable.

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

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



CRANE OPERATOR'S DAILY CHECK LIST

CRANE NO. | TYPE/CAPACITY | LOCATION | CERTIFICATION EXPIRATION DATE | SHIFT 1 2 3 | HOUR METER START STOP | HRS OPERATED | DATE

OPERATORS

LEGEND S = SATISFACTORY U = UNSATISFACTORY NA = NOT APPLICABLE

1 WALK AROUND CHECK	S	U	NA	2 MACHINERY HOUSE CHECK	S	U	NA	3 OPERATOR CAB CHECK	S	U	NA	4 OPERATIONAL CHECK	S	U	NA
a Safety Guards and Plates				a Housekeeping				a Gauges				a Area Safety *			
b Carrier Frame and Rotate Base *				b Diesel Engine and Generator *				b Indicator and Warning Lights				b Outriggers and Stabilizers *			
c General Hardware				c Leaks				c Visibility *				c Unusual Noises			
d Wire Rope *				d Lubrication				d Load Rating Charts *				d Control Action *			
e Reeving *				e Battery				e List/Trim Indicator (Floating Cranes) *				e Wire Rope or Chain *			
f Block *				f Lights				f Boom Angle/Radius Indicator *				f Brakes and Clutches *			
g Hook *				g Glass				g Fire Extinguisher				g Boom Angle/Radius Indicator *			
h Sheaves or Sprockets *				h Clutches and Brakes *				h Level Indicator (Mobile Cranes) *				h Limit Switches *			
i Boom and Jib *				i Electric Motors *				i Danger/Caution Tags *				i Emergency Stop *			
j Gantry, Pendants, and Boom Stops *				j Auxiliary Engine and Compressor								j Other Operational Safety Devices *			
k Walkways, Ladders, and Handrails				k Danger/Caution Tags *								k General Safety Devices			
l Windlocks, Stops, and Bumpers				l Fire Extinguishers								l Floating Sheaves			
m Tires, Wheels and Tracks				m Hoist Drum Pawls and Rachets *											
n Leaks															
o Outriggers and Stabilizers *															
p Load Chain *															
q Area Safety *															

INSTRUCTIONS - Check all applicable items indicated, each shift. Suspend all operations immediately when observing an unsatisfactory condition of any item indicated with an asterisk (*) unless the condition has been reviewed and continued operation has been authorized by the activity engineering organization. In addition, suspend operation when any unsafe condition is observed and immediately notify supervisor. For any unsatisfactory item, identify the specific component and describe the deficiency in the "Remarks" block.

SUPERVISOR'S SIGNATURE DATE

FIRST OPERATOR'S SIGNATURE DATE | OPERATOR'S SIGNATURE DATE | OPERATOR'S SIGNATURE DATE | OPERATOR'S SIGNATURE DATE

REMARKS

Knowledge Check

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

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

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

   A. Emergency Stop Button
   B. Batteries
   C. Windlocks, stops and bumpers

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

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

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

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

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

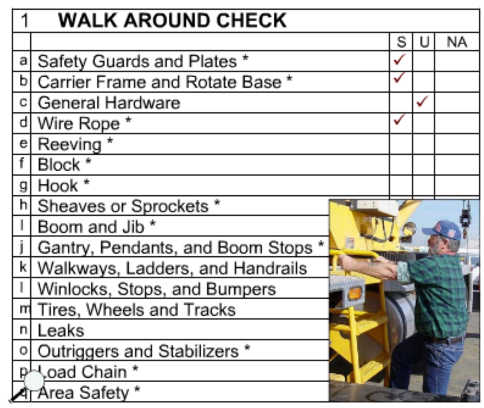
   A. Correct, incorrect, not applicable
   B. Stable, unstable, or not applicable
   C. Serviceable, unserviceable, or not applicable
   D. Satisfactory, unsatisfactory, or not applicable

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

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

Walk Around Check

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



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

Safety Guards and Plates

Check for missing safety guards and plates.

Carrier Frame and Rotate Base

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

General Hardware

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

Wire Rope and Reeving

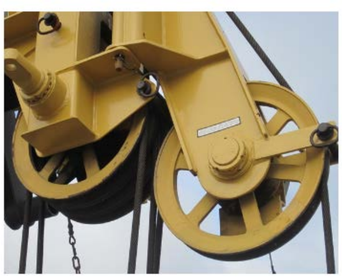
Visually check wire rope for unusual wear, fraying, birdcaging, corrosion, and kinking. Check end connections, where visible, for proper configuration, seating, and condition of wire rope.

Visually check the condition of wire rope or load chain reeving. Ensure wire rope or load chain is running true in the hook block and boom point sheaves, and laying correctly on the drum or sprockets

Block and Hook

Visually check the condition of the block and ensure all swivels rotate freely.

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



Walk Around Check 2

Sheaves or Sprockets

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

Boom and Jib

Check the condition of the boom and jib for straightness and any evidence of physical damage, such as cracking, bending, or other deformation of the steel elements or welds.

When checking lattice booms, be especially watchful for bent lattices and dents in the main chords. It is important to have bent or dented crane boom members inspected and evaluated because they can greatly reduce the strength of a boom, possibly resulting in sudden collapse of the boom.

Walkways, Ladders, and Handrails

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

Walk Around Check 3
Tires, Wheels, and Tracks

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

Leaks

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

Outriggers and Stabilizers

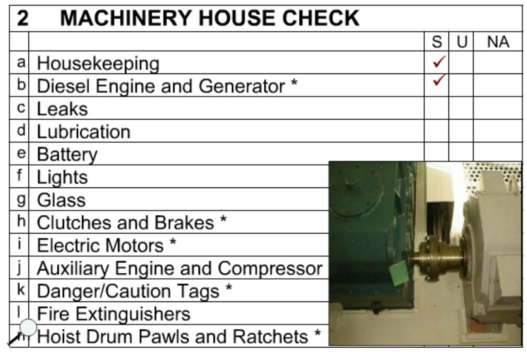
Check outriggers and stabilizers for damage.
If floats or pads are not permanently installed on the outriggers, ensure they are on the carrier and that they are not damaged.

Load Chain

Check for damaged or deteriorated links.

Area Safety

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



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

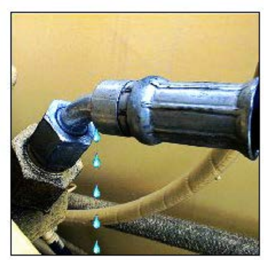
Machinery House / Machinery Area Check

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

Machinery House Check - Housekeeping

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

Machinery House Check - Leaks



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

Machinery House Check - Lubrication

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

Battery and Lights

Check batteries for excessive corrosion and leakage.
Check to ensure lights are working.

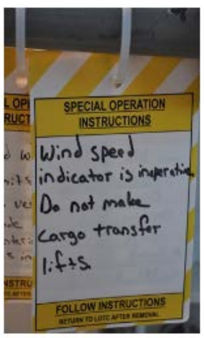
Clutches and Brakes

Check accessible portions of clutches and brakes for evidence of excessive heat, wear, or grease and oil on the linings. Check for evidence of loose fasteners and for missing or broken parts.

If a brake is equipped with a manual release mechanism, check to ensure the mechanism is not in the released position.

Machinery House Check – Electric Motors

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



Danger/Caution Tags

If danger or caution tags are posted, read, understand, and follow the directions on the tags.

Check the appropriate ODCL column as follows: "S" - all tags are properly hung: "U" - tags improperly hung or otherwise deficient: "NA" - no tags.

Fire Extinguishers

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

Knowledge Check

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

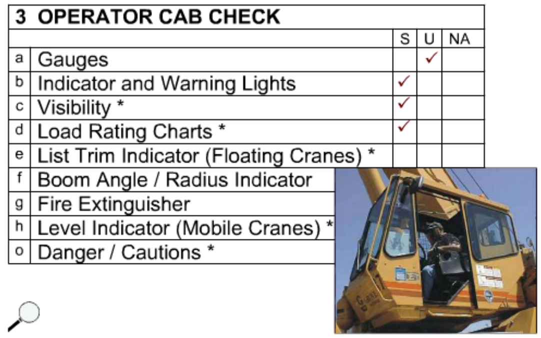
    A. Overloading the crane
    B. Lubrication
    C. Normal operations
    D. Overheating

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

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

Operator’s Cab Check

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



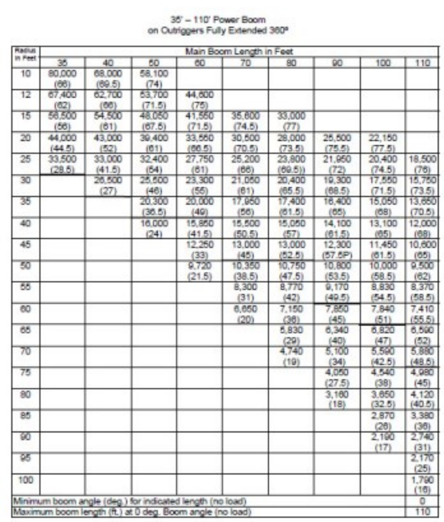
3	OPERATOR CAB CHECK	S	U	NA
a	Gauges		✓	
b	Indicator and Warning Lights	✓		
c	Visibility *	✓		
d	Load Rating Charts *	✓		
e	List Trim Indicator (Floating Cranes) *			
f	Boom Angle / Radius Indicator			
g	Fire Extinguisher			
h	Level Indicator (Mobile Cranes) *			
o	Danger / Cautions *			

Gauges, Indicator and Warning Lights

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

Load Rating Charts

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



35' – 110' Power Boom
on Outriggers Fully Extended 360°

Radius in Feet	Main Boom Length in Feet								
	35	40	50	60	70	80	90	100	110
10	80,000 (66)	68,000 (69.5)	58,100 (74)						
12	67,400 (62)	62,700 (66)	53,700 (71.5)	44,600 (75)					
15	56,500 (56)	54,500 (61)	48,050 (67.5)	41,550 (71.5)	35,600 (74.5)	33,000 (77)			
20	44,000 (44.5)	43,000 (52)	39,400 (61)	33,550 (66.5)	30,500 (70.5)	28,000 (73.5)	25,500 (75.5)	22,150 (77.5)	
25	33,500 (28.5)	33,000 (41.5)	32,400 (54)	27,750 (61)	25,200 (66)	23,800 (69.5))	21,950 (72)	20,400 (74.5)	18,500 (76)
30		26,500 (27)	25,500 (46)	23,300 (55)	21,050 (61)	20,400 (65.5)	19,300 (68.5)	17,550 (71.5)	15,750 (73.5)
35			20,300 (36.5)	20,000 (49)	17,950 (56)	17,400 (61.5)	16,400 (65)	15,050 (68)	13,650 (70.5)
40			16,000 (24)	15,850 (41.5)	15,500 (50.5)	15,050 (57)	14,100 (61.5)	13,100 (65)	12,000 (68)
45				12,250 (33)	13,000 (45)	13,000 (52.5)	12,300 (57.5P)	11,450 (61.5)	10,600 (65)
50				9,720 (21.5)	10,350 (38.5)	10,750 (47.5)	10,800 (53.5)	10,000 (58.5)	9,500 (62)
55					8,300 (31)	8,770 (42)	9,170 (49.5)	8,830 (54.5)	8,370 (58.5)
60					6,650 (20)	7,150 (36)	7,850 (45)	7,840 (51)	7,410 (55.5)
65						5,830 (29)	6,340 (40)	6,820 (47)	6,590 (52)
70						4,740 (19)	5,100 (34)	5,590 (42.5)	5,880 (48.5)
75							4,050 (27.5)	4,540 (38)	4,980 (45)
80							3,160 (18)	3,650 (32.5)	4,120 (40.5)
85								2,870 (26)	3,380 (36)
90								2,190 (17)	2,740 (31)
95									2,170 (25)
100									1,790 (16)
Minimum boom angle (deg.) for indicated length (no load)									0
Maximum boom length (ft.) at 0 deg. Boom angle (no load)									110

Boom Angle/Radius Indicator

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

Fire Extinguishers

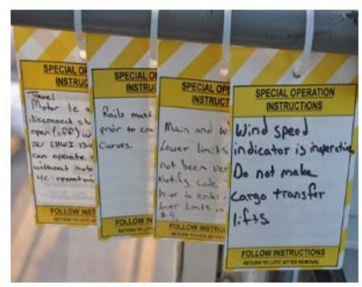
Ensure fire extinguishers are in place, seals are unbroken, and inspection tags are up to date.
Operators shall be familiar with the location, operation, and care of fire extinguishers provided.

Level Indicator

On mobile cranes, check the level indicator for damage.

Danger/Caution Tags

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



Instructions

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

Housekeeping

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

Operational Check

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

The final check before placing the crane in service is the operational check. The operational check shall include operating the machine without load through all motions; using all controls through a range sufficient to ensure their proper operation; and verifying the proper operation of safety devices, gauges, meters, warning signals, limit switches, and other devices.

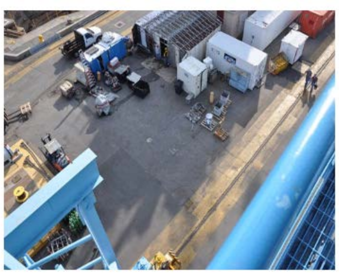
When possible, the operational check shall be conducted away from personnel and any hazardous surroundings.

A qualified rigger, if present during the operational check, should control access, observe crane operation, and report any unusual noises or other indications of unsafe conditions to the crane operator.

When performing the operational check portion of the ODCL in cold weather or icy conditions, the operator should raise the blocks and boom before lowering them to avoid damage when sheaves may be frozen.

Operators should inform rigging personnel to stand clear of the area below the blocks and boom prior to operation.

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



Area Safety

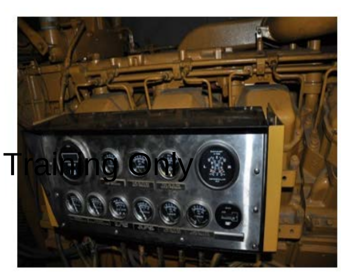
Check the work area and ensure that the exact locations of obstacles or hazards are known.

Ensure ground conditions are sufficiently firm to support a loaded crane.

It is not expected that all possible areas of travel be checked during the pre-use check. However, before any area of travel is utilized that has not been checked during the pre-use check additional attention should be focused on obstacles and potential hazards.

Outriggers and Stabilizers

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



Unusual Noises

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

Controls and Control Action

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

Wire Rope or Chain

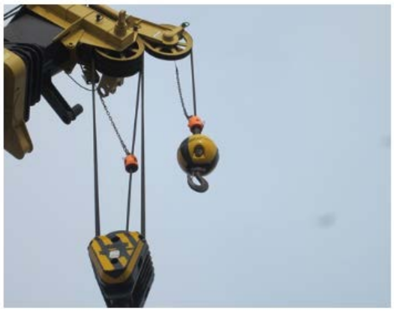
Check for proper paying-out of the wire rope or chain, that the wire rope or chain and hook blocks do not twist/spin, and that the wire rope or chain is running freely through the sheaves or sprockets and blocks.
If the boom and hoist drums or load sprocket are visible from the operator's station, check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

Brakes and Clutches

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

Boom Angle/Radius Indicator

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



Limit Switches

Checking of limit switches shall be performed at slow speed and include each upper hook hoist primary limit switch and the upper and lower boom hoist primary limit switches. (Except for cranes used in construction, verifying the operation of the upper and lower boom hoist limit switches is required only during the initial check of the crane each day.)
Checking of hook hoist lower limit switches is not required if the hook can be lowered to its lowest possible position (e.g., bottom of drydock being worked at minimum radius, floor level for a typical building crane) while still maintaining a minimum of two wraps of rope on the hoist drum (three wraps for ungrooved drums) or extra chain for a chain hoist.
For cranes that do not have the requisite number of wraps or sufficient chain, the hook hoist lower limit switch shall be checked where operationally possible, i.e., if the crane is at a location where the limit switch can be checked (where the lower limit switch is not checked during the pre-use check, it shall be checked if the crane is subsequently relocated to a position where it can be checked).
When lower limit switch checks are not required, this shall be noted on the crane operators pendant, master switch, or operating instructions.
For cranes that have hoist overload clutches or two-block damage prevention features, do not check the overload clutches or damage prevention features. The ODCL shall be annotated to ensure that these features are not checked.
Checking of secondary limit switches is not required unless a specific operation is planned where the primary limit switch will be bypassed.

Emergency Stop

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

Other Operational Safety Devices

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

General Safety Devices

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

Summary

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

Knowledge Check

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

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

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

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

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

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

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

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

NOTES

CRANE SET-UP

Welcome
Welcome to Crane Set-Up.

Learning Objectives
Upon successful completion of this module you will be able to: list key considerations for traveling mobile cranes to job sites, identify job site considerations, and explain outrigger and stabilizer setup.

Overview
At the end of this module you will understand the importance of proper crane set-up. Understanding proper crane set-up and a well prepared working area for the crane is critical for the safety of every lift.

Traveling to the jobsite
For safe travel to the job site, the driver or operator of the crane must be trained and qualified for the specific type of machine to be moved.
Prior to travel, the operator must perform a pre-use check of the machine or crane, check the travel route, disengage the power take-off unit (if applicable), and check for adequate air pressure in tires.
Power take-off (PTO) means a secondary engine shaft (or equivalent) that provides substantial auxiliary power for purposes unrelated to vehicle propulsion or normal vehicle accessories such as air conditioning, power steering, and basic electrical accessories. A typical PTO uses a secondary shaft on the engine to transmit power to a hydraulic pump that powers auxiliary equipment, such as a boom.

Pre-Use Check (ODCL)


A complete check of the crane shall be performed by the operator prior to the first use of the crane each day (whether the crane is used in production, maintenance, testing, or being relocated). A Crane Operator's Daily Checklist (ODCL) shall be used for this purpose.
For operations not involving a lift (e.g., moving the crane to a new location), the operator shall check those functions applicable to the operation to be performed.
If the crane will be operated for production, maintenance, or testing after relocation, a complete check of the crane shall be performed prior to operation.

Pre-Use Check Prior to Movement
For operations not involving a lift (e.g., moving the crane to a new location), the operator shall perform the walk around check, machinery house/machinery area check, operator's cab check, and an operational check of those functions applicable to the operation to be performed.

Checking the Route

If traveling over public roads the driver must also meet all federal and state requirements.

When possible, the route should be checked for hazards, such as low overpasses, power lines, or questionable ground conditions.

Knowledge Check

1. Select the best answer. Which of the following should be considered before traveling a crane?

   A. Number of riggers required
   B. Trained and qualified driver
   C. Engineering documentation

2. Select the best answer. Which of the following should be considered before traveling a crane?

   A. Pre-use checks performed
   B. Union requirements for drivers
   C. Security clearance

3. Select the best answer. Which of the following should be considered before traveling a crane?

   A. Number of riggers required
   B. Check the route
   C. Tire sizes

4. Select the best answer. When traveling, the rotate lock should be ______________.

   A. Engaged
   B. Rotated
   C. Disengaged
   D. Optimized for travel

Site Conditions

The success of the lift may depend on how the crane operator deals with varying job site conditions such as crane clearances, underground hazards, and proximity to overhead power lines.

Clearance

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. No part of the crane rotate structure may be closer than 2 feet from an obstruction.

Live Mast Clearance

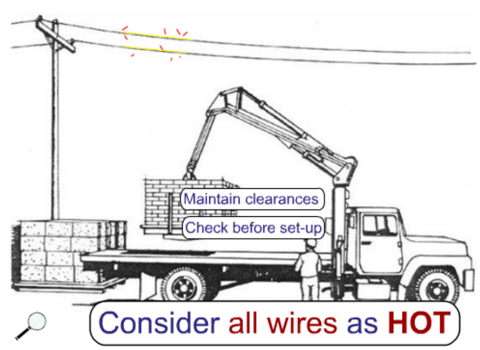
Clearances between the live mast and obstructions may be reduced after initial setup.

This illustration shows how raising the boom to a high angle on some cranes may cause the live mast to project beyond the counterweight. Setting up too close to buildings or tall structures with this crane could lead to a crane accident.

Underground Hazards

Underground hazards at the worksite must be considered when setting up mobile cranes. The crane will support the load only if the ground will support the loaded crane.
Avoid areas known to have buried utilities, tunnels or pipelines as machine weight and vibration can cause them to collapse. If the bearing capacity of the ground is questionable, use additional blocking or cribbing to increase ground support and crane stability.

Proximity to Power Lines



Power line contact is the largest single cause of fatalities associated with cranes.
Check for power lines before setting up or operating cranes. If any part of the crane or load could approach the distances noted in NAVFAC P-307, figure 10-3, during a proposed operation, subparagraphs 10.13.1 through 10.13.6 shall be followed.
Where the voltage is known to be less than 350 kV, the minimum required clearance shall be 20 feet. Where the voltage is known to be greater than 350 kV, the minimum clearance shall be 50 feet. Figure 10-3 also provides required clearance distances for operation in transit, or when traveling below a power line. Paragraph 10.13.6 gives additional requirements.
Treat all wires and electrical equipment as if they are hot even when they are de-energized.

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.

Knowledge Check

1. Select the best answer. When setting up a mobile crane, what is the minimum clearance between the rotating upper works and fixed objects?

   A. 18 inches
   B. 6 feet
   C. Whatever the crane operator feels is safe
   D. 12 inches
   E. 2 feet

2. Select the best answer. If the minimum clearance cannot be achieved the crane team must ____________________.

   A. Turn on headlights
   B. Sound the horn to warn personnel in the area
   C. Erect barricades
   D. Rotate slowly and cautiously
   E. Designate a team member to guard the area when rotating

Crane Set-Up

Many mobile cranes rely on outriggers to support the entire crane. Some use stabilizers which add stability to a crane while relying on tires for support. Stabilizers are also used on certain truck cranes with front stabilizers in addition to four outriggers.

When lifting on outriggers/stabilizers, the operator shall ensure the outriggers/stabilizers are properly extended, set in accordance with the OEM's requirements and recommendations, and the crane is leveled in accordance with the OEM's requirements. Improper deployment may lead to inaccurate or inconsistent crane levelness readings.

Outrigger/stabilizer floats shall be securely attached to the outriggers.

Manufacturer's load charts should contain all of the information necessary for proper crane set-up.

Firm Surface

The supporting surface must be able to support the pressure generated by a crane.
A high percentage of the weight of the crane and load can be transmitted to one float especially when rotating a heavy load directly over it.
Since the area of the outrigger or stabilizer float is relatively small it generates high pressures.
On soft ground or questionable surfaces, always use blocking beneath floats. This distributes the crane's load over a larger area, decreasing the pressure.
Any blocking used to support outrigger/stabilizers shall be strong enough to prevent crushing, be of sufficient width and length to prevent shifting or toppling under load, and shall be inspected before use to ensure it is free from defects.

Outriggers Properly Extended

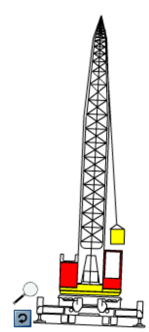
Outriggers with extendable beams should be fully extended except where they have OEM designed mid-point extension and zero extension positions for outriggers.
You must use the corresponding load charts that match these outrigger positions.

Tires Off the Ground

When a crane is set up on outriggers, the weight of the crane must be off the carrier tires in order for the crane to pick its full rated capacity. Tires should be just clear of the ground. On some cranes with pivoting axels, one of the tires may touch the ground.
In either case, the weight of the raised tires is part of crane's counteracting weight that offsets the moment of the load. Keeping the tires as close the supporting surface as possible provides a safeguard if an outrigger jack or beam fails. Some cranes use stabilizers in conjunction with the tires to help stabilize the crane for lifting.

A Level Crane

A level crane is critical to the safety of every lift. The importance of this cannot be over-emphasized! Operating in an out of level condition is not allowed.

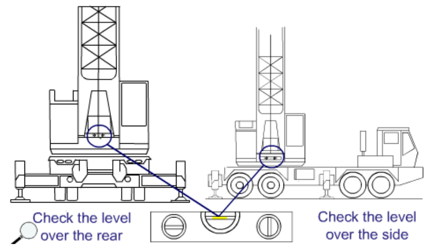


Using a Bubble Level

In-the-cab level indicators should be used for initial setup only. Bubble type levels like this one in the crane cab, should be confirmed if any doubt exists. For lifts approaching rated capacity, or for load testing, it is best to confirm with a calibrated level.

Using a Machinist Level

A level can be placed on the machined surface of the rotate base on the carrier. Normally an area near the boom heel pins provides access. Do not place the level on a deck plate. They are often not smooth enough.



Using a Plumb Bob

The crane's whip hoist line can be used as a quick check for level. Check for level by sighting the hoist line along the centerline of the boom while positioned over the front or over the rear. Repeat this check over the side. If the whip hoist does not line up with the boom the crane is out of level.

Pads Pinned

Outrigger floats or pads must be secured to the outriggers and stabilizers. If it is not secured, the cylinder may disengage the pad if the outrigger becomes light.
They are usually secured with pins or quick release locking devices.

Locking Beams

When operating a crane with mechanical outrigger locks, be sure they are locked.
The type shown here is usually found on scissor-type outrigger beams that hinge at the carrier frame and are raised and lowered with a hydraulic cylinder between the frame and the beam. Some cranes use a threaded rod screwed down onto the top of a hydraulic jack cylinder to prevent bleed-off and movement. Others use cam locks.

Knowledge Check

1. Select the best answer. When setting up a crane you must have ____________.

   A. Jack stands
   B. A firm supporting surface
   C. A crane walker
   D. A valid driver's license

2. Select the best answer. When on outriggers, outrigger beams must always be _____________.

   A. Locked
   B. Rotated

3. Select the best answer. When setting up a crane on outriggers, the tires must be ____________________.

   A. Just clear of the ground
   B. Firmly set for stability
   C. Depressurized
   D. Rotated for flexibility

4. Select the best answer. When setting up a crane on outriggers the outriggers will be _______________________.

   A. Placed according to engineering specifications
   B. Properly extended
   C. Retracted on the down side
   D. Extended as far as possible

5. True or False. When lifting on tires, ensuring the crane is level is still necessary.

   A. True
   B. False

NOTES

COMPLEX AND NON-COMPLEX LIFTS

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

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

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

Complex Lifts
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 capacity of the crane's hoist and lifts exceeding 50 percent of the hoist certified 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. Some lifts
    C. Complex 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 must review on-site conditions and …

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

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

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

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

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

Hazardous Materials

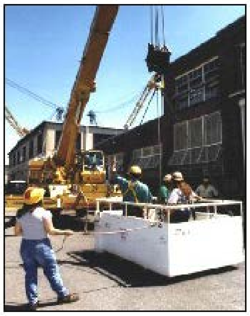
Lifts of hazardous materials, e.g., poisons, corrosives, and highly volatile substances are complex lifts.
Materials such as oxygen, acetylene, propane or gasoline in bottles, cans or tanks that are properly secured in racks designed for lifting by a crane are excluded.

Large and Complex Geometrical Shapes

Complex lifts also include large and complex shapes.
For example: objects with a 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 Lifts

Use cranes for lifting personnel only when no safer method is available.
Cranes, rigging gear and personnel platforms shall conform to OSHA requirements: 29 CFR Part 1926.1431 and ASME B30.23.
The total weight of the loaded personnel platform and rigging shall not exceed 50% of the rated capacity of the hoist.
A trial lift with at least the anticipated weight of all personnel and equipment to be lifted shall be performed immediately before placing personnel in the platform.
A proof test of 125% of the rated capacity of the platform must be held for 5 minutes. This may be done in conjunction with the trial lift.



A body harness and shock absorbing lanyard shall be worn and attached to a structural member within the personnel platform capable of supporting the impact from a fall. The harness and anchorage system shall conform to OSHA requirements.
Tag lines shall be used unless their use creates an unsafe condition.
Hoisting of the personnel platform shall be performed in a slow, controlled, cautious manner with no sudden movements of the crane.
Personnel shall keep all parts of the body inside the platform during raising, lowering, and positioning.
Before personnel exit or enter a hoisted platform that is not landed, the platform shall be secured to the structure where the work is to be performed, unless securing to the structure creates an unsafe situation.

Lifts Over 80% Capacity

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

More Complex Lift Examples

Submerged Lifts

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

Lift Requirements for Multiple Crane or Hook Lifts

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

Constrained Loads

Lifts of constrained or potentially constrained loads (binding condition) including suction caused by hydraulic conditions and loads that may be frozen to the ground are complex lifts.

Where overloading, loss of load (slack line condition) of the crane or rigging, or damage to the load is possible due to binding conditions or pre-tensioning, a portable LID with a readout readily visible to the signal person or RIC shall be used. When an LID is used, an appropriate stop point shall be estabilished and the LID shall be carefully monitored to ensure the stop point is not exceeded.

Chainfalls or other control means (e.g., procedures, micro-drives, load position/buffer) shall be used to avoid sudden overload of the crane or rigging gear. These lifts shall be treated as complex lifts.

Other 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

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

   A. Usual and unusual
   B. Complex and Non-Complex
   C. Critical and Non-Critical
   D. Common and Non-Common
   E. None of these

2. Select the best answer. Personnel lifts are …

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

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

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

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

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

NOTES

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Determining Load Weight

Welcome

Welcome to Determining Load Weight.

Learning Objectives

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

Load Weight

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

Determining Load Weight Acceptable Methods

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.

Determining Load Weight Unacceptable Methods

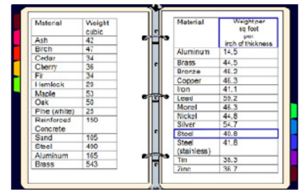
Never take word of mouth to establish load weight! Word of mouth may be used as a starting point for sizing the crane and rigging gear so the component can be weighed with a load indicating device, but never shall it be used as the final determination of load weight.
To avoid overloading any equipment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

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 Weights of Materials

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.

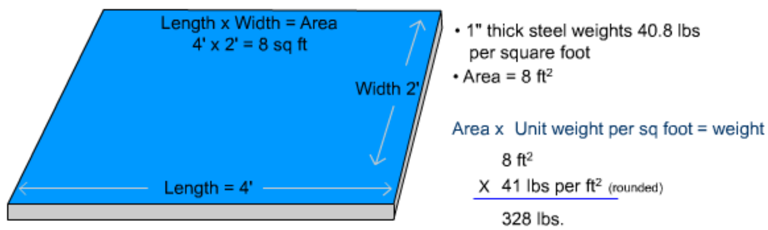


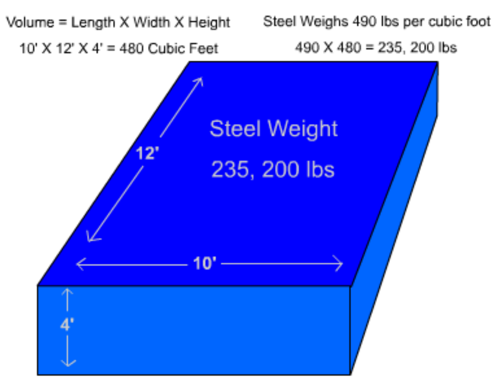
Finding Weight

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.



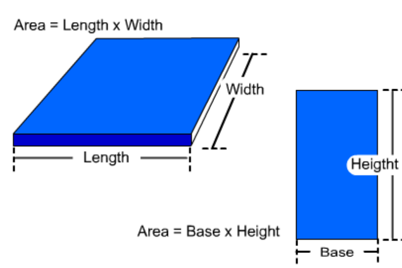


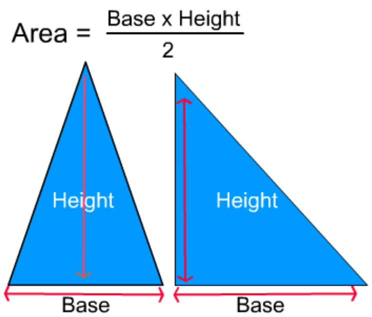
Calculating Weight By Volume

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.



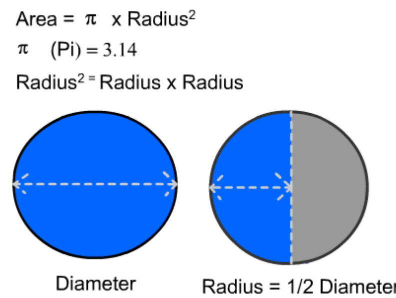


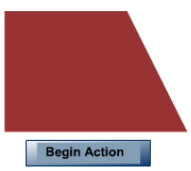
Calculating the Area of a Triangle

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.

Calculating the Area of a Circle

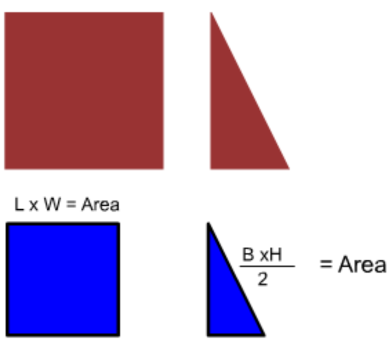
To calculate the area of a circle, multiply Pi, which is 3.14, by the radius squared.
Find the radius of the circle by dividing its diameter in half. To square the radius, multiply the radius by itself. For example, if a circle has a diameter of 3 feet, the radius will be 1.5 feet. 1.5 feet times 1.5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

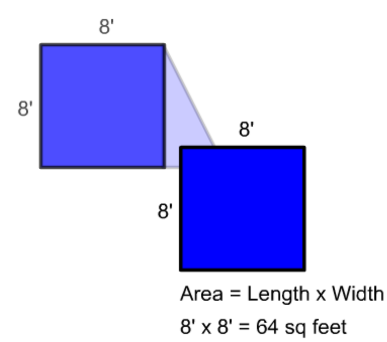
Most complex shapes can be broken down into a series of simple shapes.

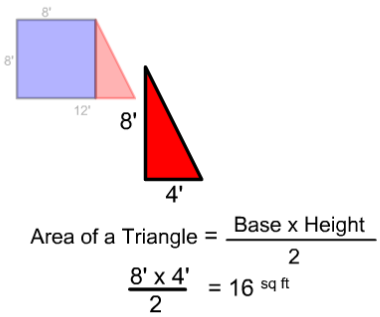


To calculate the area of this complex shape, calculate the area of the square using the formula length times width. Next, calculate the area of the triangle using the formula base times the height divided by 2. Then add the areas together to get the total area of the complex shape.

Area 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.



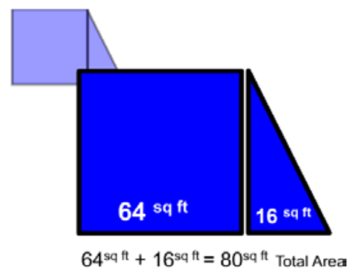


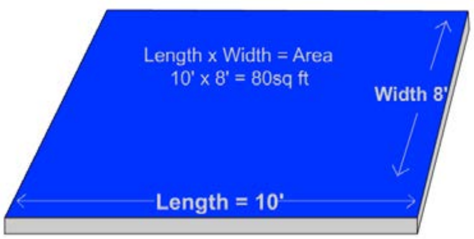
Area of the Second Part

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 ft times 8 ft equals 32 ft^2
32 ft^2 divided by 2 equals 16 ft^2

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.



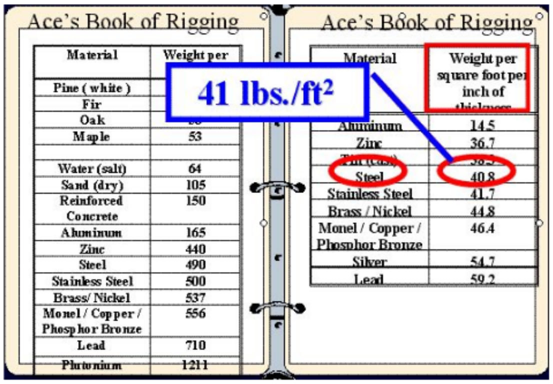


Calculating Area and Material Weight Step One

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.

Step Two

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



Step Three

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.

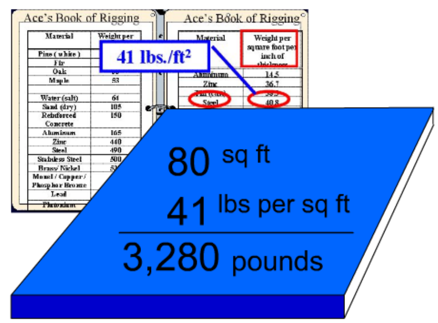
We find steel listed in the "Materials" column. The unit weight is 40.8 pounds per square foot, per inch thickness of steel plate. Now let's apply the rule we learned earlier in the lesson to make the math easier and give us a safety margin in our calculations. What was the rule on rounding that we should apply to this unit of weight? Round up! So, 40.8 pounds per square foot is rounded up to 41 pounds per square foot.

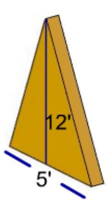
Step Four

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 Weight of a Triangle

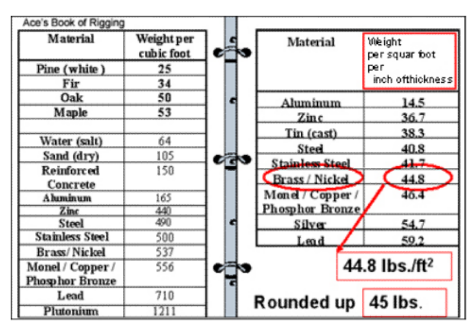
Step One

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.

Step Two

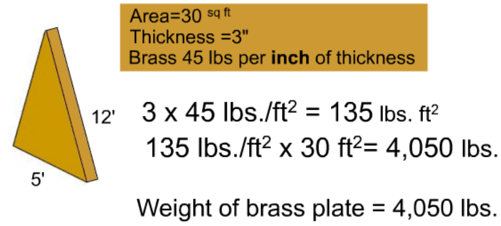
To find the weight of this plate, we have to multiply the area (30 square feet) by the unit weight of the material per inch of thickness.

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.



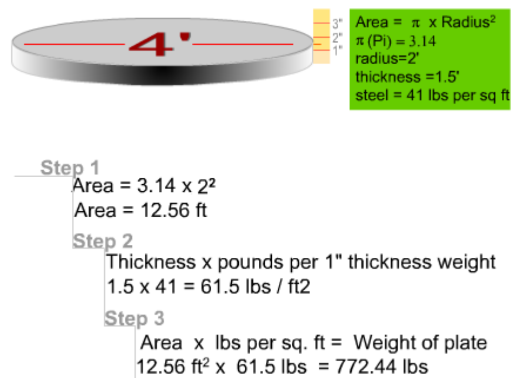
Step Three

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



Calculating Weight of a Circle Using Area

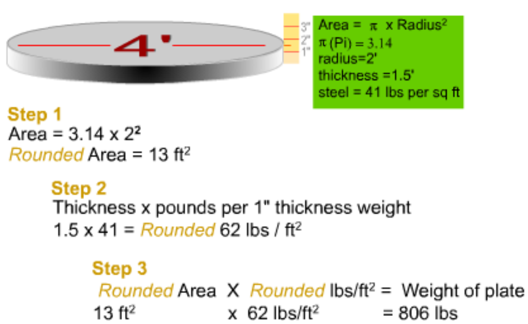
To calculate the area of a circle, multiply Pi, 3.14, by the radius squared.
This steel plate is 4 feet in diameter. Therefore, the radius is 2 feet. The plate is 1 ½ inches thick.



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

Rounding numbers make calculations easier.
Always round up.
Rounding up gives 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. 1,100 pounds
   B. 1,300 pounds
   C. 1,000 pounds
   D. 1,200 pounds

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

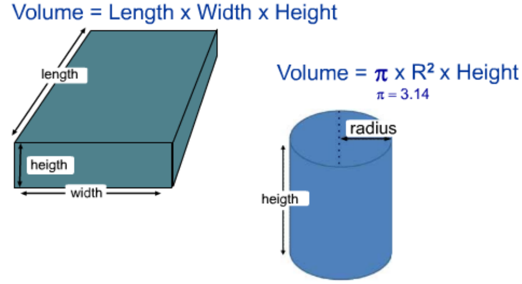
   A. 8 x 12 / 2
   B. 8 x 6 / 2
   C. 6 x 12 / 2
   D. 12 x 10 / 2

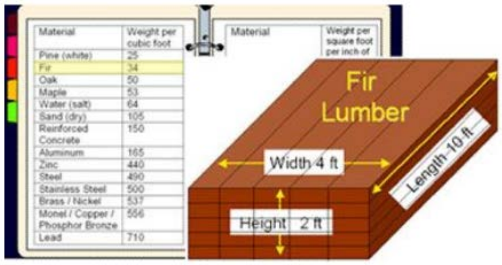
6. Select the best answer. The formula for determining the area of a triangular shaped object is:

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

Calculating Volume

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





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

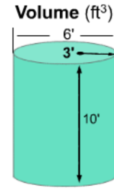
Calculating Weight Using Volume

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

Volume of a Cylinder

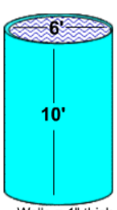
What is the formula for finding the volume of a cylinder?
To calculate the volume we must first find the area of the circular end. The formula for area is Pi times radius squared. Once we know the area, we simply multiply it times the height or length. So the formula we use to find the volume of a solid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

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



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

Calculating the Volume of a Cylinder



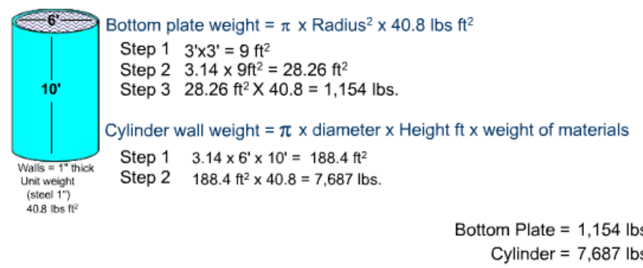
Walls = 1" thick

Dimensions:
Height=10'
Diameter = 6' Radius = 3'

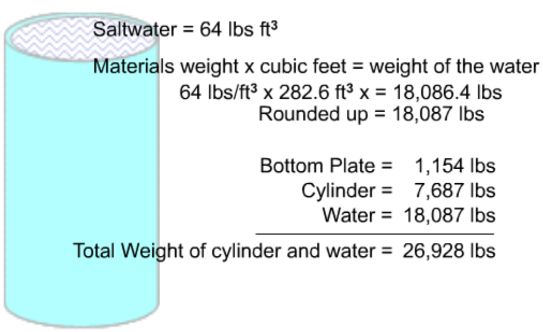
Area of a Cylinder = π x $Radius^2$ x Height
3.14 x (3'x3') = 28.26 sq feet
28.26 sq feet X 10' = 282.6 cubic feet

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

Calculating the 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 of 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.



Cylinder Weight with Contents

Using the volume calculation, let's find the weight of the water contained in this thin-walled cylindrical tank.
Let's calculate the weight of this cylinder full of salt-water. We need to know the weight per cubic foot of salt water. Looking at our material weight chart we see saltwater weighs 64 pounds per cubic foot. We multiply the material weight times the cubic feet to find the weight of the water in the cylinder. 282.6 cubic feet times 64 pounds per cubic foot equals 18,086.4 pounds.
Now we will add up the weights. 1,154 pounds for the bottom plate, 7,687 pounds for the cylinder wall; and 18,087 pounds of water, for a total load of 26,928 pounds.

Knowledge Check

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

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

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

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

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

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

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

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

NOTES

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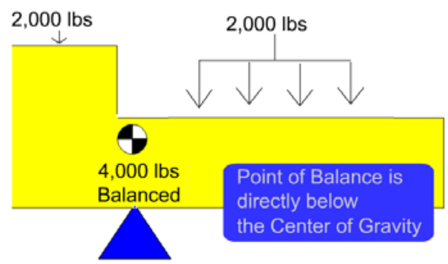
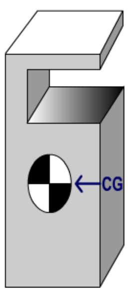
LOAD WEIGHT DISTRIBUTION

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.

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

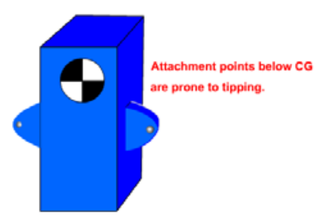


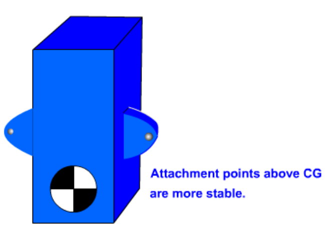


Center of Gravity
The center of gravity is the point where the entire weight of the object would balance in any direction, as if all the weight were concentrated in that one point.
It is a fixed point and does not change unless the shape of the object is altered.
Center of gravity is generally located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

Why Find the Center of Gravity (CG)
The location of the center of gravity will affect an object's reaction to movement.

If the attachment points are below the center of gravity, the object will tip over more easily when moved.





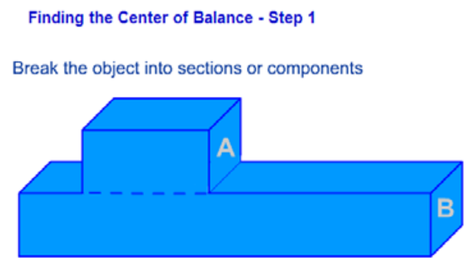
If the attachment points are above the center of gravity, the object is not likely to tip.

Finding the Center of Balance

Step One

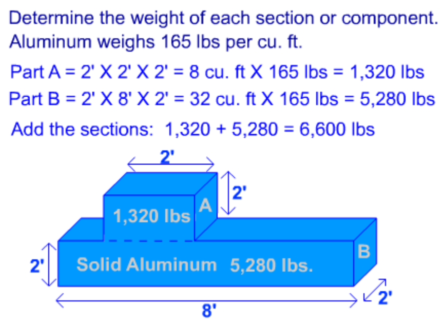
The balance point of a symmetrical object will be directly under its center.

To find the balance point of a complex shape, we must first break the object into symmetrical sections or components.



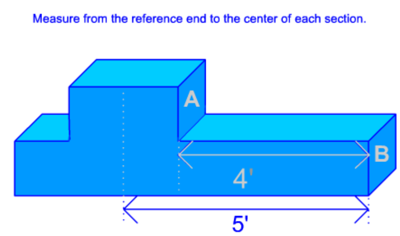
Step Two

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



Step Three

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

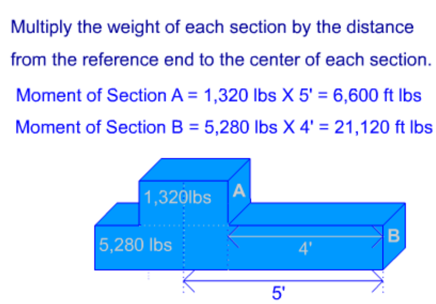


Step Four

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.

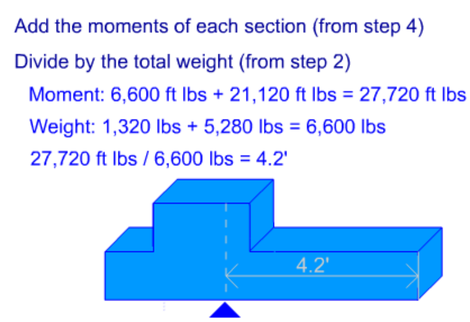
Moment, like torque, is often described in foot-pounds or pound-feet.

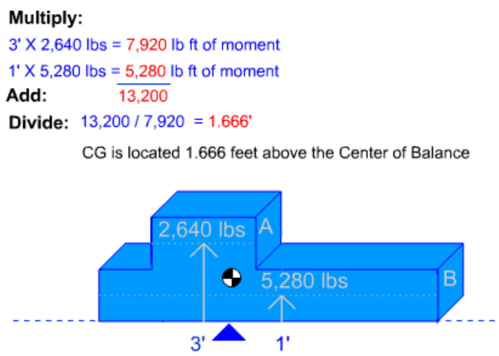


Step Five

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.





Pinpointing the Center of Gravity

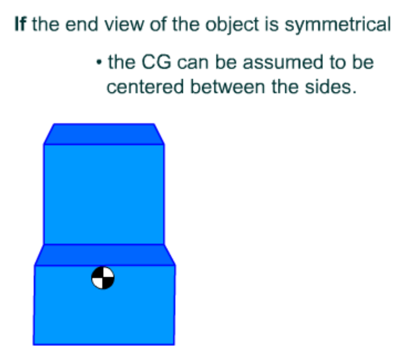
CG Height

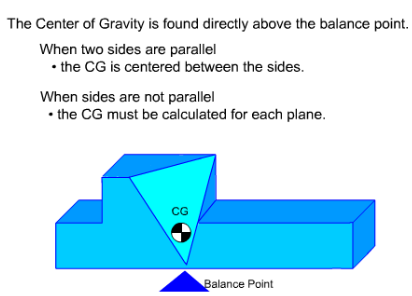
In this example the weight of section A is 2,640 pounds.
The weight of section B is 5,280 pounds.
Measure the distance from the reference end to the center of each section.
Multiply the weight of each section by the distance from the reference end to the center of the section to obtain the moment.
The 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 the CG Depth

To find the depth of the center of gravity, follow the five-step process using the front of the object as the reference end for step 3.

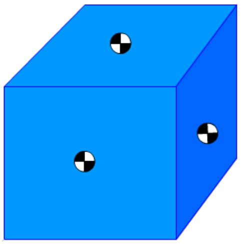
In this example, the end view shows the object is symmetrical. Therefore, we can assume the center of gravity is in the center of the object – one foot from the front.





Center of Gravity Pinpointed

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

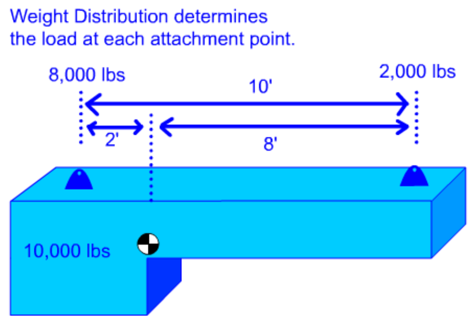


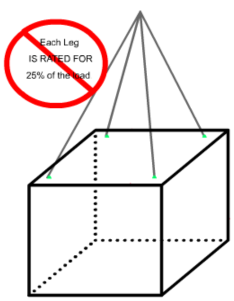
Center of Gravity Review

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

Weight Distribution

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



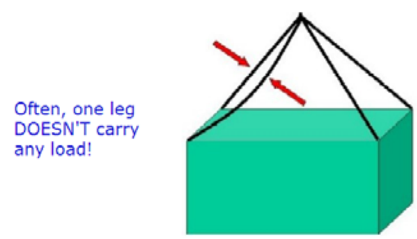


A Wrong Assumption

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

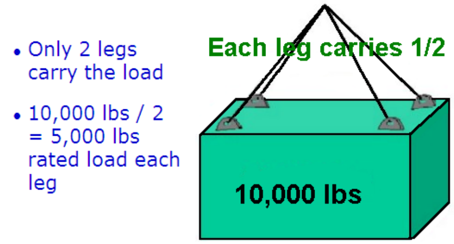
How Many Legs Really Carry the Load?

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

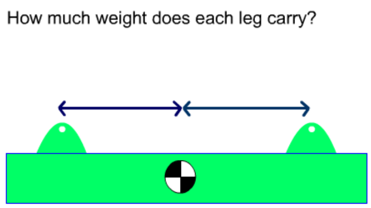


A Safe Assumption

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.

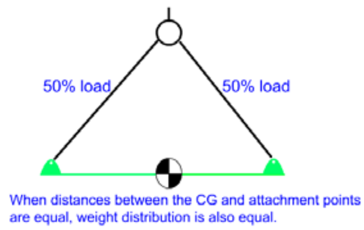


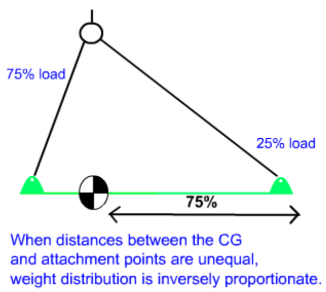
Determining Leg Weight

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.



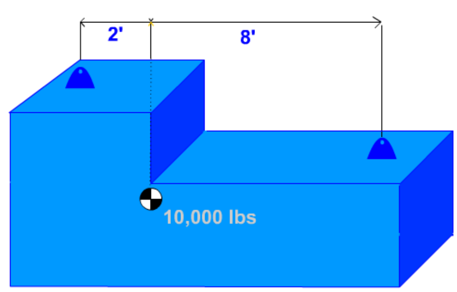


Unequal Weight Distribution

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

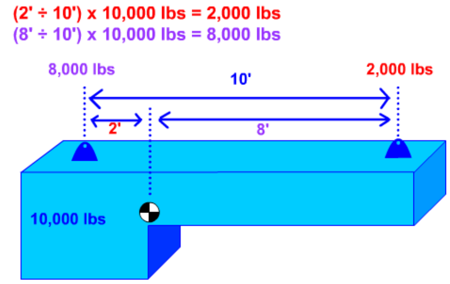
Calculating Weight Distribution

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.



Calculating 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. 75%, 25%
   B. 25%, 75%
   C. 50%, 50%
   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. True or False. The center of gravity is located below the center of balance.

   A. True
   B. False

4. True or False. 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. 3 divided by 6 multiplied by 10,000 (3 / 6 x 10,000)
   B. 3 divided by 9 multiplied by 10,000 (3 / 9 x 10,000)
   C. 6 divided by 3 multiplied by 10,000 (6 / 3 x 10,000)
   D. 9 divided by 3 multiplied by 10,000 (9 / 3 x 10,000)

6. True or False. 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

Rigging Gear Test, Inspection, and Marking Requirements

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

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

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

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

Why Test and 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.

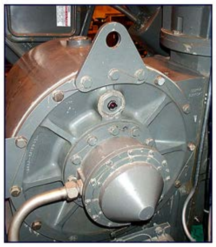
Covered Equipment

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 Covered Equipment

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

Equipment Not Covered



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

Knowledge Check

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

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

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

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

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

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

Equipment Markings

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

Wire Rope Endless Slings

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

Markings on Chain Slings

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

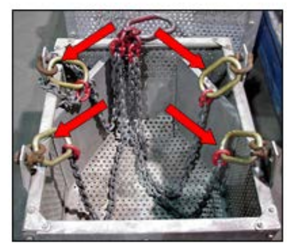
Markings on Lashing

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

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.

Markings on Multi-leg Sling Assemblies



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

Multi-Part Wire Rope Slings

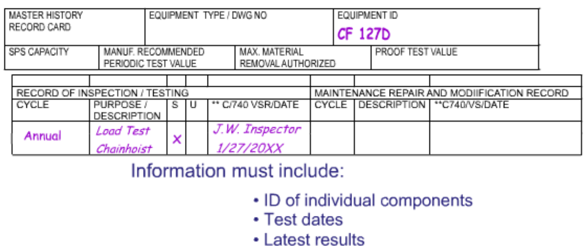
NAVFAC P-307 requires that braided slings shall have the OEM's marking re-marked at 70% of the OEM's rated load unless destructive tests are conducted on sample slings. The documentation is reviewed by the Navy Crane Center.
So, there are many additional markings that may be required for different equipment.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

Hard to Read or Missing Markings

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

Required Records

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



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

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

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

Information must include:

- ID of individual components
- Test dates
- Latest 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.

Matching Gear to its Record

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

Gear Marking Example

This is an example of how the gear is marked at one Naval Shipyard. This is just one example of how an activity could choose to identify individual components to their records.

This example reflects a fairly complex system that may be useful for activities who own multiple groups of equipment that need to be segregated.

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

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

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

Identifies the specific piece of gear with a serialized number.

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

Secondly, "P28" identifies the specific piece of gear with a serialized number.
This particular number indicates that it was the 28th sling manufactured or certified on a specific day.

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

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

The number 94-350 identifies the day it was manufactured or certified, 94 being the year 1994, 350 being the day of the year.

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

Knowledge Check

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

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

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

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

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

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

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

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

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 Inspection

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. True or False. 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. Periodic and Random
    B. Annual and Biannual
    C. Periodic and Pre-Use
    D. Frequent and Annual

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, Pre-Use Inspection
    B. Gear Room Qualified Personnel, Pre-Use Inspection
    C. Gear Room Personnel, Pre-operational Inspection
    D. The User, Periodic Inspection
    E. Rigging gear room personnel, Prior to Use Inspection

Sling Rejection Criteria

A knot in any part of a sling is cause for rejection.

Inspecting Chain Slings

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 (Continued)

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 cannot 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.

Link Stretch

Chain links stretch when they are overloaded. Worn chain links will also cause the sling length to increase.

Measure the length of each sling leg and look for increased chain length that may indicate overloading or link wear.

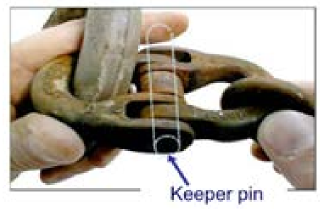
Chain Sling Rejection Criteria

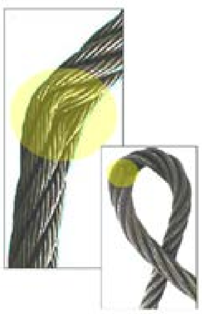
In addition to the removal criteria of ASME B30.9, the sling shall be removed from service if inspection reveals any of the following: an increase in length of a measured section due to stretch exceeding five percent and a link with a raised scarf or defective weld.

Inspect Coupling Link

Inspect coupling links carefully.

Make sure the keeper pin is not loose or protruding.





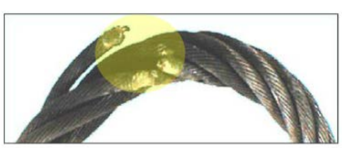
Wire Rope Slings Rejection Criteria

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.

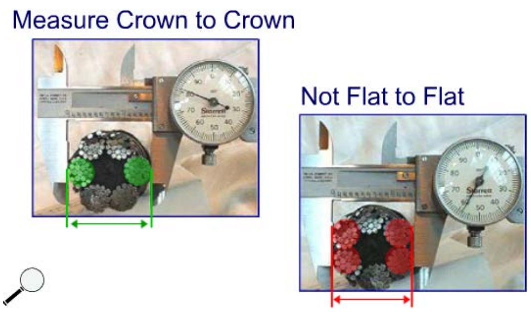


Rejection Criteria III – Heat Damage

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

Rejection Criteria IV – Corrosion, Pitting, Abrasion

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.

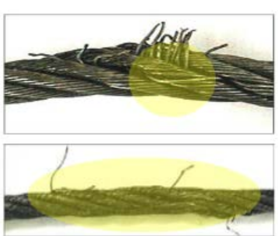


Measuring Wire Rope

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 – Broken Wires

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.

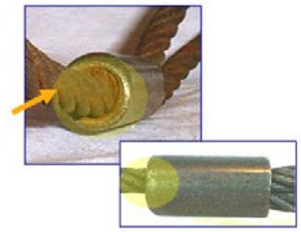
Rejection Criteria – Braided Wire Rope Slings

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.

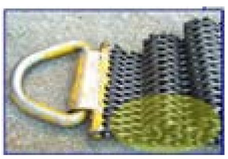
Rejection Criteria – Cable Laid Wire Rope Slings

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.

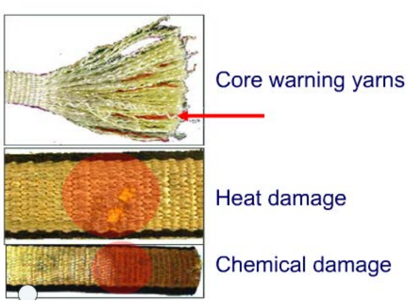


Rejection Criteria - Metal Mesh Slings

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.

Rejection Criteria (Continued)

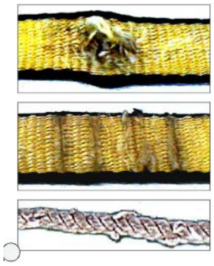
Remove the sling from service if the eye openings in the end fitting are increased by more than 10%, or if there is a reduction of 15% of the original cross sectional area at any point around the hook opening of the end fitting.



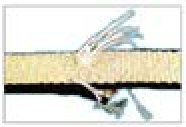
Synthetic Slings Rejection Criteria

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.

Rejection Criteria II



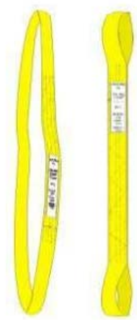
Other damage that would require a synthetic sling to be removed from service includes heat or chemical damage, melting or charring of any part of the sling, punctures, cuts, or snags, indications of rotting, variations in size, crushed webbing, excessive abrasive wear, and embedded abrasive particles.



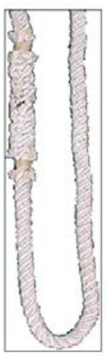
Rejection Criteria III

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

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 Removal Criteria

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 Removal Criteria

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

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

   A. Grade 70
   B. Grade 100
   C. Grade 60
   D. Grade 80

2. True or False. A knot in a synthetic sling is allowed as long as it does not cause permanent damage to the sling.

   A. True
   B. False

3. True or False. Chain slings used in cargo transfer should be inspected annually.

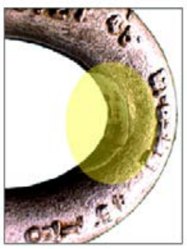
   A. True
   B. False

4. True or False. A metal mesh sling can remain in service if only one wire is broken in the mesh.

   A. True
   B. False

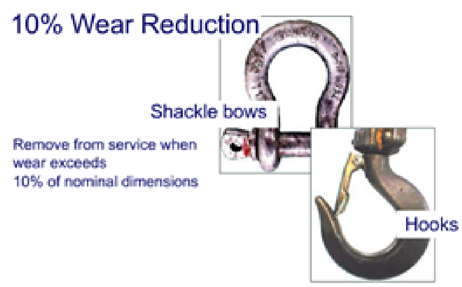
Hardware Damage
Types of Gear Damage

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
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.

Areas to Inspect II – 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.

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° and the bail should pivot at least 180°.

Tackle Blocks

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, 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.

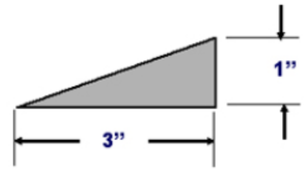
Load Indicating Devices

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.

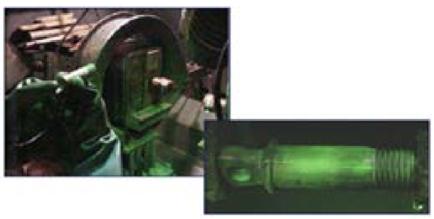
Overview of Repairs and Alterations

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

1. True or False. Rigging hardware that is bent can be repaired by straightening it back to original shape.

   A. True
   B. False

2. True or False. Rigging hardware such as eyebolts, links, rings, and shackles are required to have a periodic inspection every 2 years.

   A. True
   B. False

3. Select the best answer. Distorted rigging hardware must be:

   A. Evaluated for repairs
   B. Heat treated and returned to service
   C. Removed from service and destroyed
   D. Remarked for a reduced capacity

4. Select the best answer. Documentation for alteration or repair of rigging equipment is required to be retained for:

   A. Until replaced by another record
   B. 2 years
   C. 1 year
   D. The life of the equipment

NOTES

Rigging Gear General Use

Welcome
Welcome 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.

Rigging Manuals


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

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

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

Selecting Rigging Gear


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

Selecting Rigging Gear (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.

Hazards to Rigging Gear

The first major hazard we must talk about is abuse.

Here the biggest hazard is you, the user!

Don’t drag your slings on the ground. Cement or paved surfaces will quickly abrade slings and gear.

Contact with the ground can embed grit and abrasives into the sling, which will cause damage.

Don’t pull slings from under a load while the load is resting on them. Set the load down on blocking to keep from crushing the sling.

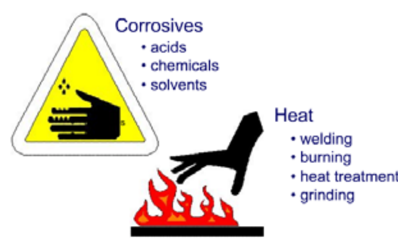
Hazards (Corrosives and Heat)

Keep gear away from corrosives, acids, paint thinners, and any other harmful chemicals.

Chemicals that may have a corrosive effect on one type of gear may not affect another.

For example, acids would quickly destroy a nylon sling but might not harm another synthetic material.

Protect your gear from all heat sources such as welding, burning, grinding, or heat-treating.



Hazards (Sharp Edges)

Another common hazard is sharp edges.

No matter what type of gear you use, sharp edges will leave their mark if the gear is not protected.

Never use slings against sharp edges without adequate protection.

Hazards (Electrical)

You must be aware of the danger electricity presents when working around energized components or electrical lines.

Watch out for welding leads, light strings, shore power and other common hazards when looking for lay down areas.

Wire rope, chain, and metal mesh slings should never be used if they could increase the possibility of electrical shock. Protect yourself and the gear by ensuring all power is secured prior to installing your gear on or around electrical components.

Protective Materials

Slings can be easily cut at sharp corners or edges, or otherwise damaged by abrasion or excessive bearing stress. Cutting of synthetic slings is the most common type of sling failure, leading to dropped loads.

Sling protection material shall be of sufficient thickness and strength to prevent sling damage.

When wrapped around corners and sharp edges, synthetic slings shall be completely blocked from contacting the edge with hard material such as split piping, blocks, or special rounded shoes, not soft material such as canvas, fire hose or leather gloves. Sling manufacturers also provide products that protect slings from sharp corners or edges. Activities should contact the manufacturer for availability of such products.

Sling Protection

Ensure the rigging configuration is stable and slings cannot slide off the sling protection. The level of protection required is based on potential damage at the contact interface. Damage potential levels are classified as abrasion, bearing, and cutting. The level of protection chosen shall be commensurate with the type of damage potential.

The person responsible for rigging the load shall be trained in recognizing the different damage types and determining what protection methods, material, and components are required to adequately protect the slings.

Hoist and Crane References

Portable manual and powered hoists/winches shall meet the criteria of ASME B30.16 and OEM recommendations.

Portable floor cranes/shop cranes (including attachments used solely on portable floor cranes/shop cranes) shall meet the criteria of ASME PASE and OEM recommendations.

Lever hoists shall meet the criteria of ASME B30.21 and OEM recommendations.

Other equipment shall meet the criteria of applicable ASME B30 (e.g., trolleys maintained and inspected in accordance with ASME B30.17) and/or OEM recommendations.

Using Hoists and 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.

Usage Do's

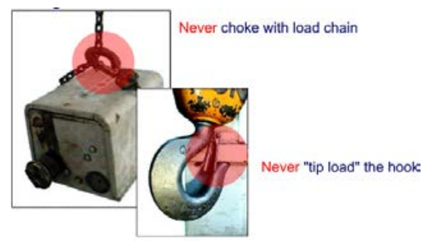
Do not move the load (travel, hoist with a crane, etc.) when it is suspended from a manual chain hoist unless the hand chain is tied off or otherwise secured. This prevents inadvertent operation.

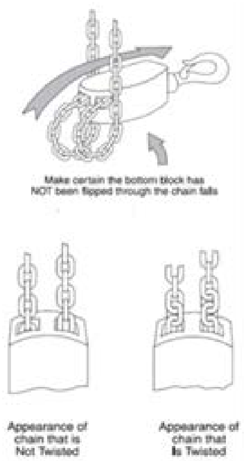
A bag can be attached to the hoist body to hold excess chain.

Never use more than one person to pull the hand chain of a manual chain hoist. Do not use excessive force to operate a hoist. Never use extension bars on lever-operated hoists.

Usage Don'ts

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





Additional Chain Hoist Requirements

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

Additional Rigging Practices

Loads shall be rigged so that the load cannot fall out of the rigging. Frapping shall be used where necessary to ensure the load does not fall out of the rigging. When using slings in a sweeping or basket configuration under a load, the load should be balanced and the slings should be secured with frapping to prevent inadvertent shifting or movement of the load.

Ends of unused slings/sling legs shall be secured against inadvertent contact when lifting a load.

Items susceptible to falling or dislodgement from the lifted load shall be secured or removed prior to the lift.

Pallets shall be of such material and construction and so maintained as to safely support and carry the loads being handled on them.

When handling taglines, always face the load, keep hands and feet clear, and do not wrap the tagline around the hands, arms, or any other part of the body.

In a choker hitch, a shackle is recommended to be used in the choke point with the shackle pin located in the eye of the sling.

Below the Hook Lifting Devices

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

Knowledge Check

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

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

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

    A. True
    B. False

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

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

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

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

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

    A. True
    B. False

NOTES

Rigging Hardware

Welcome

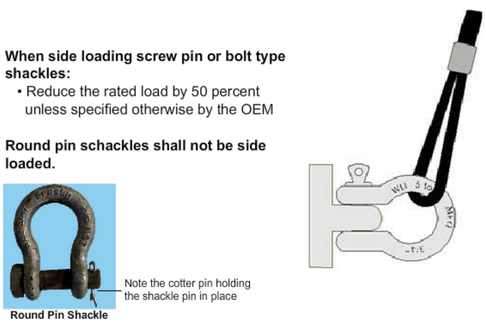
Welcome to the Rigging Hardware module.

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.

Using Rigging Hardware

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

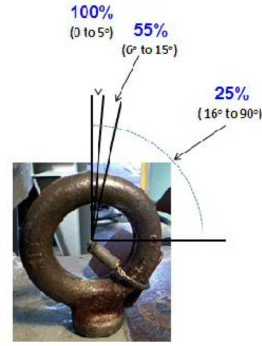
Non-shouldered eyebolts may be used in vertical applications only. Angled pulls greater than five degrees, even in the plane of the eye are not permitted.

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.

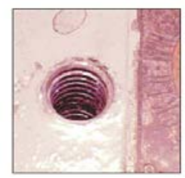


Installing Shouldered Eyebolts

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.

Checking the 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.

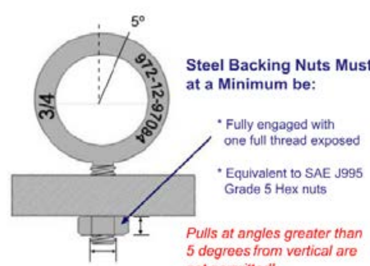
When installing eyebolts into aluminum, the minimum thread engagement is two times the diameter.

For other materials contact your activity's engineering organization or the OEM.

Eyebolts Used With Backing Nuts

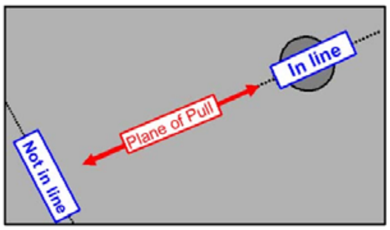
When eyebolts are used with backing nuts, the backing nut must be at least SAE J995 grade five and fully engaged with at least one full thread exposed.

Note: With engineering approval, nut type eyebolts can be used without the shoulder being flush.



Threaded Attachment Points

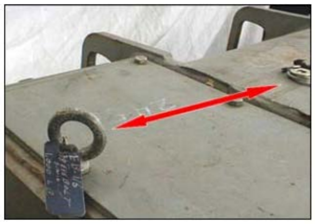
Remember to use extreme caution when using a threaded item such as an eyebolt or a hoist ring as a single attachment point!
Never rotate or spin an object being lifted with a single threaded attachment point. The lifting attachment may unthread and the object may fall.



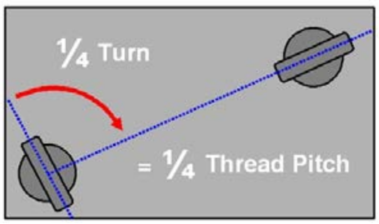
Aligning the Eye with the Plane of Pull

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.

Shims May Be Used To Align Eyebolts



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 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.

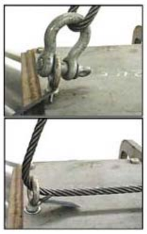


Determining Shim Thickness

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 Shim Usage

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)

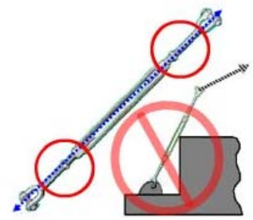
Swivel hoist rings shall be selected and used in accordance with ASME B30.26 and OEM recommendations.
They must be tightened to the OEM specified torque.
The torque value is normally marked on the top washer of the hoist ring.
Before using backing nuts on hoist rings, check the OEM requirements to see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

Selection and Use of 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.

Selection and Use of 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. True or False. 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. ½ inch
   C. 1 inch
   D. 1 ½ inch

3. True or False. An angular pull of 45 degrees is allowed on non-shoulder type eyebolts.

   A. True
   B. False

4. True or False. The rated load of swivel hoist rings must be reduced when they are used for angular pulls.

   A. True
   B. False

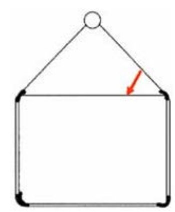
NOTES

Sling Use

Welcome
Welcome to the Sling Use module.

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

Wire Rope Sling Use
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 (1:1) in the body of the sling. In other words, never bend a wire rope around a diameter smaller than itself! Bending a wire rope around a diameter smaller than its minimum D-to-d ratio will damage the wires and weaken the sling.

Wire Rope Sling Use (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° Fahrenheit.
Fiber core rope wire should not be used above 180° 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.

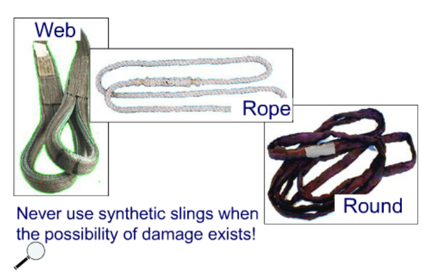
Chain Sling Temperature Restrictions

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

Synthetic Sling Types



- Natural fiber rope slings are not to be used for overhead lifting.

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

Using Synthetic Slings

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

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

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

Web Sling Use

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

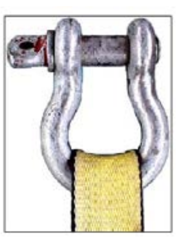
Where a synthetic webbing sling is used in a choker hitch, the straight-line rated load shall be reduced to reflect the efficiency percentages shown in table 14-3 of NAVFAC P-307.

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

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

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

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



Using Shackles with Web Slings

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.

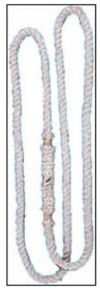
Synthetic Web Sling Temperature Restrictions

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

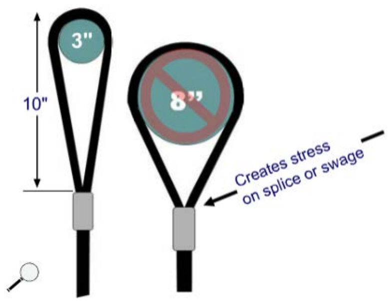
Roundslings constructed of yarns other than nylon or polyester, (e.g., Kevlar, Spectra, Dyneema, Vectran, Technora) (referred to here as “high performance fiber roundslings”) shall be used in accordance with WSTDA- RS-1-HP in addition to ASME B30.9, OEM recommendations, and the additional requirements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

Common Sling Use Rules

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



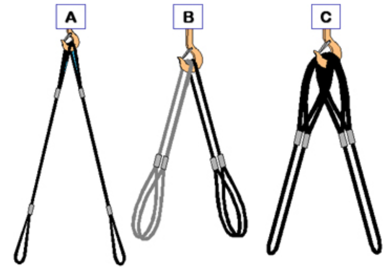
Eye Length vs. Hook Diameter

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

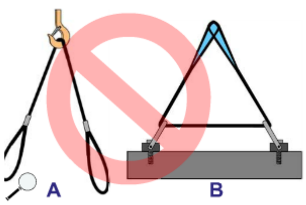
Attaching Gear to Hooks

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

Correct Attachment of Slings to Hooks



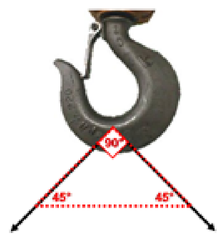
These graphics illustrate correct ways to attach slings to a hook.
Graphic “A” shows a vertical application with two sling eyes seated in the bowl of the hook.
Graphic “B” shows two slings doubled over the hook and sling eyes pointing down to attachment points.
Graphic “C” shows two slings doubled with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



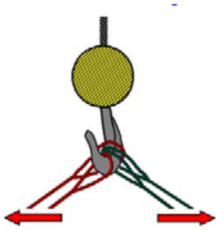
Incorrect Attachment of Slings to Hooks

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

Included Sling 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.



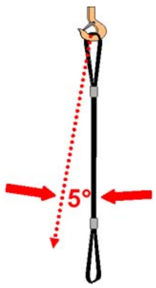
Inside and Outside Sling Attachment

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.

Types of Hitches

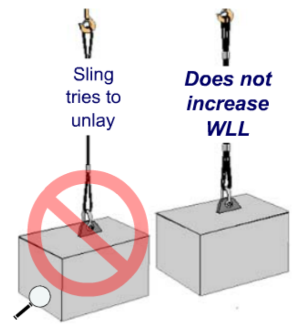
Slings are used in straight-line, choker, and basket hitches.
A straight-line hitch is commonly referred to as a vertical hitch.
The rated load for the same sling with each hitch will be different.



Rated Loads of Straight-Line Hitches

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

Straight-Line Hitch and 2 Legs

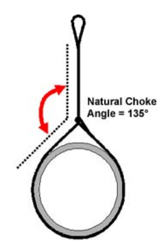


To prevent unlaying of wire rope (except for braided slings) or stranded synthetic rope slings, the slings shall not be used in a single part straight-line (vertical hitch) or choker hitch, unless a method is used to prevent unlaying of the rope.
Use two legs for single point lifts. The second leg prevents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

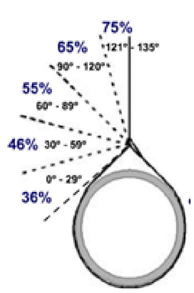
Choker Hitches

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

Rated Loads of Choker Hitches

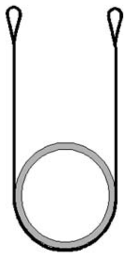


Whenever a choker hitch is used the sling's rated load is reduced.
The natural choke angle is 135° if a choker hitch is allowed to tighten itself as the load is lifted.
When Choke angles are less than 121° the rated load must be reduced further.



Wire Rope and Synthetic Sling 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° to 135°, the rated load is reduced to 75% of the vertical capacity (Synthetic Web Slings, Roundslings, and Chain Slings are rated at 80%).
Check with the OEM or activity engineering organization for ratings of chain slings at angles of choke less than 121 degrees.
This does not apply to braided multi-part wire rope slings.



Rated Load of Basket Hitches

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

Knowledge Check

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

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

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

   A. True
   B. False

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

   A. True
   B. False

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

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

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

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

NOTES

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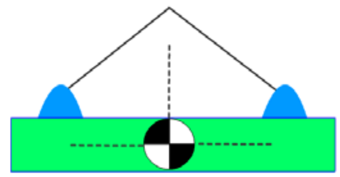
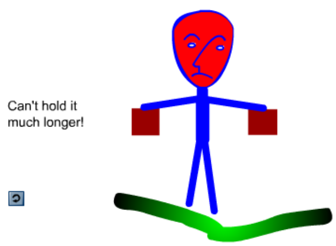
Sling Angle Stress

Welcome
Welcome to Sling Angle Stress.

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

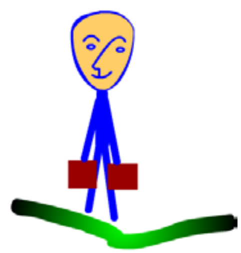
What is Sling Angle Stress?
What is sling angle stress?
It is the added force or load created in the rigging when the slings are not perfectly plumb, vertical, and parallel.





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

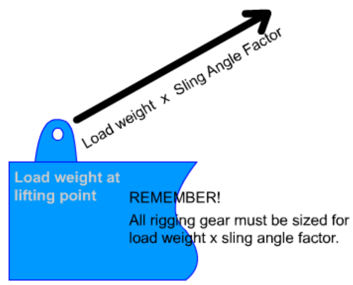
Sling Angle Stress 90 Degrees
Here's Ace. He is holding a fifty-pound weight in each hand.
His arms are vertical, similar to a 90° horizontal sling angle. The amount of stress in Ace's arms is equal to the amount of weight he's holding, fifty pounds.
See what happens as Ace moved his arms increasingly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



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

Sling Angle Stress 30 Degrees

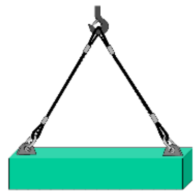
At a 30° angle, the amount of stress in Ace's arms increases further. The stress increase at 30° is 100% of the weight he's holding.
Now Ace feels like he's holding 100 pounds in each arm even though the weight is still actually 50 pounds.
This same effect, called sling angle stress, occurs in rigging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



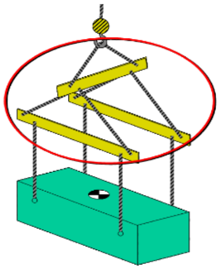
Choosing Your Gear

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

What Does 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

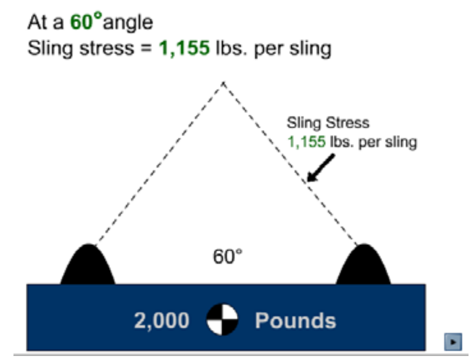
Sling angle stress can be minimized by using spreaders or other below the hook lifting devices.
Lifting beams or strong-backs can help ensure each sling is carrying its share of the load and that the load remains level.
Sling angles may still affect the rigging gear between the hook and spreaders, even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

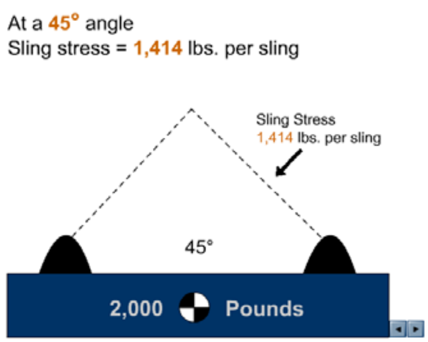
Sling Angle Stress Summarized

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.

Sling Angle Stress Examples

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

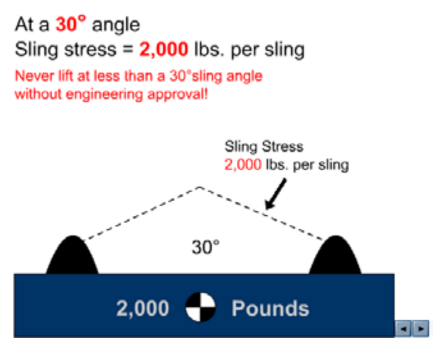


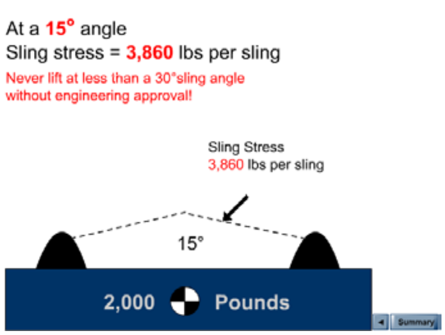


At a 45° angle the load has increased to 1,414 pounds in each sling. That's nearly a 42% increase!

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

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





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

Why Must We Account for Sling Angle Stress?

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

Selecting the Minimum Rated Capacity of Rigging Gear

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 Minimum Rated Capacity

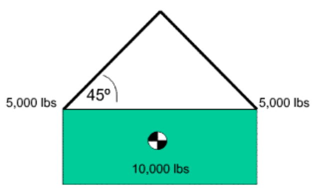
There are several ways to determine sling angle stress. We will use the angle factor chart, as it is readily available and easy to use.

Using an Angle Factor Chart

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

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

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

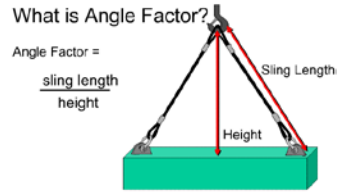


1.414 x 5,000 lbs.=7,070 lbs. in each leg.

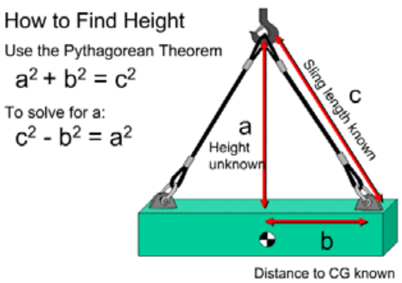
Angle Factor Chart Example

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

What is Angle Factor?



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



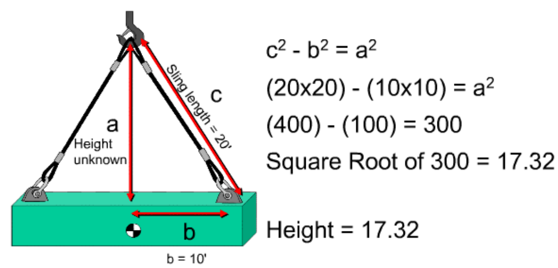
How to Find Height

The Pythagorean theorem states that the length of a side of a right triangle squared, equals the length of the base squared plus the height squared. A squared, plus B squared, equals C squared.

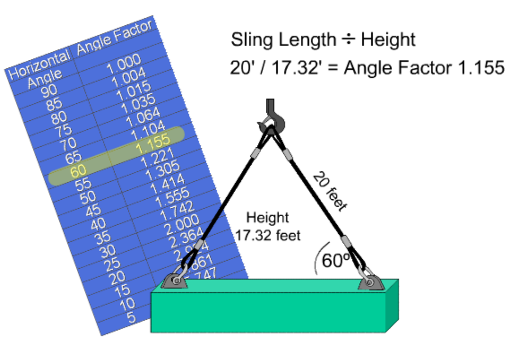
Here the height of the lift triangle is A, the horizontal base is B and length of the sling is C. Only A, the height, is unknown.

To find the unknown height, A, use this variation: C squared minus B squared equals A squared.

How to Find 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.

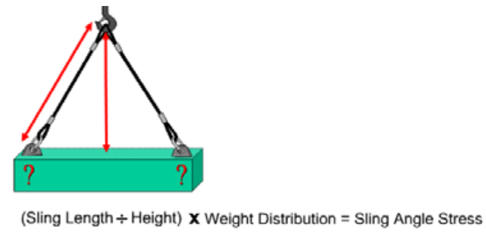


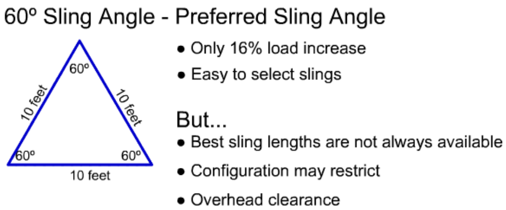
Finding Angle Factor

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.

Solving for Sling Angle Stress Mathematically

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.





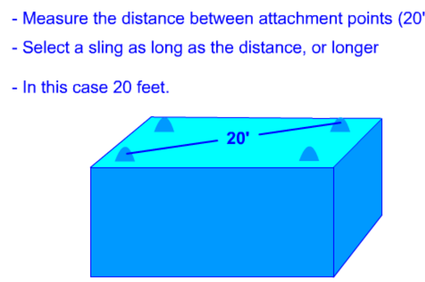
60 Degree Sling Angle

60° is the preferred sling angle.

At 60°, the load in the slings increases by 16%.

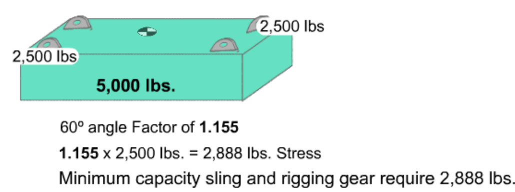
Selecting Sling Lengths for a 60 Degree Sling Angle

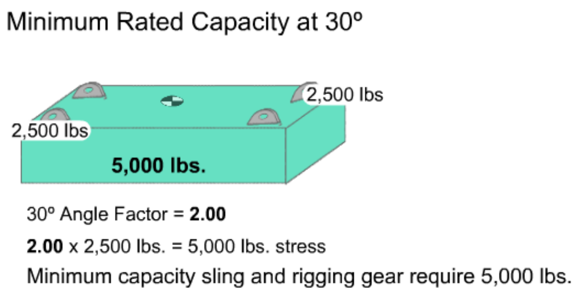
To ensure your slings will have at least a 60° sling angle simply measure the distance between attachment points. Measure diagonally when there are more than two attachment points because it's the longest distance. Then select a sling that is as long, or longer than the distance measured.
If you use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



Selecting Minimum Rated Capacities for a 60 Degree Sling Angle

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



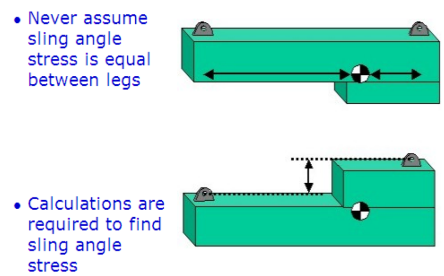


Minimum Rated Capacity at 30 Degrees

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

Unequal Distance

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



Knowledge Check

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

   A. True
   B. False

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

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

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

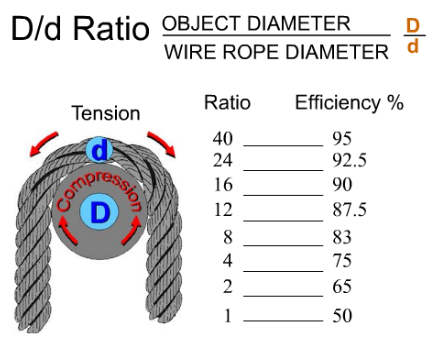
NOTES

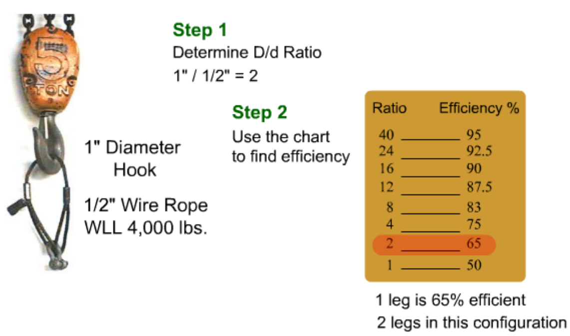
D/D RATIO

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.

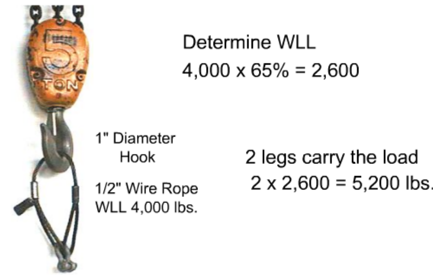
D/d Ratio
D/d ratio is the relationship between diameter of an object that a sling is bent around to the diameter of the sling. D/d ratio is generally applied to wire rope slings.
The tighter the bend, the greater the loss of strength. The sling can be weakened and severely damaged if it's bent around 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 to Find the Rated Load



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.

NOTES

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LOAD CHARTS – MODULE 1

Welcome

Welcome to Load Charts Module One.

Learning Objectives

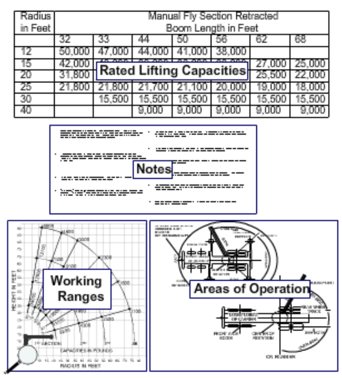
Upon successful completion of this module you will be able to identify the uses of the parts of a load chart, explain the difference between gross and net capacities, describe the purpose of the crane's range diagram and working area diagram, and identify two consequences of exceeding the crane's rated capacity.

Introduction to Load Charts

A good working knowledge of the OEM load chart is necessary to calculate safe lifting capacities.

Generally, load charts list the maximum rated capacity of the crane for every permissible configuration, specify the crane's operational limitations, and set-up requirements for safe operation.

Load charts also show configuration variables affecting the capacity of the crane at the time of the lift and identify factors influencing the crane's capacity, such as boom angle, boom length, load radius, deductions from gross capacity, configuration of the crane, and quadrants of operation.



Parts of a Load Chart

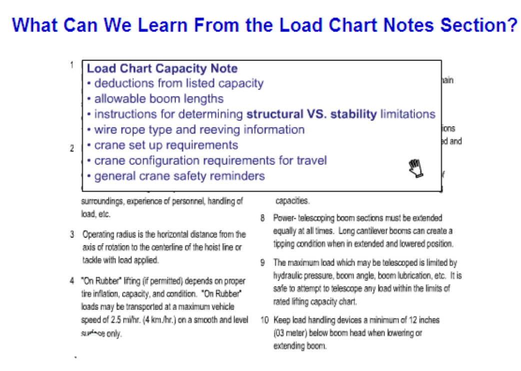
The load chart usually contains the following parts: rated capacities chart, notes section, range diagram, and a working area diagram.

What Can We Learn from the Notes Section?

Before calculating the crane's capacity, the operator must read the general notes found on the load chart or in the load chart package.

Load chart notes contain important information such as: deductions from listed capacities, allowable boom lengths, instructions for determining structural vs. stability limitations, wire rope type and reeving information, crane set up requirements, crane configuration requirements for travel and general crane safety reminders.

Load chart notes serve as a safety refresher.



Rated Lifting Capacity Chart

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

Rated Lifting Capacity Chart

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.

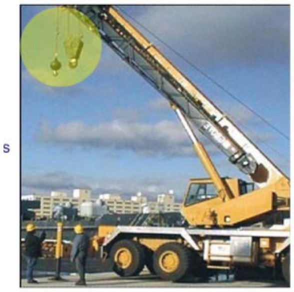
RADIUS	BOOM LENGTH 33'			BOOM LENGTH 45'			BOOM LENGTH 57'		
	Angle	FRONT	360º	Angle	FRONT	360º	Angle	FRONT	360º
10	67	80,000 *	80,000*	74	75,000*	75,000*	74	59,600*	59,600*
12	63	76,100*	76,100*	71	73,000*	72,900*	72	55,000*	55,000*
15	57	64,200*	63,200*	67	61,700*	61,700*	66	46,300*	45,700*
20	46	45,800*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

45,800 **Gross Lifting Capacity**

What is 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.

Knowledge Check

1. Select the best answer. Gross capacities would be listed in which part of the load chart?

   A. Notes
   B. Range Diagram
   C. Rated Lifting Capacities
   D. Working Area Diagram

2. Select the best answer. Wire rope type and reeving information would be listed in which part of the load chart?

   A. Rated Lifting Capacities
   B. Working Area Diagram
   C. Range Diagram
   D. Notes

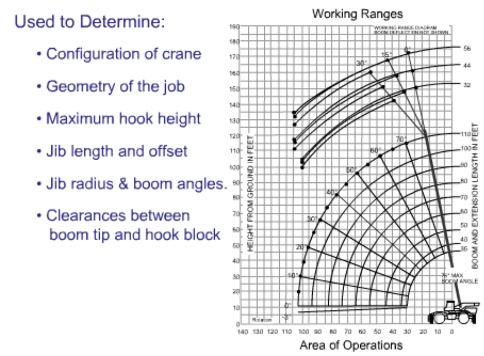
3. Select the best answer. Deducting the weight of all attachments, hooks, blocks, rigging and lifting gear from the capacities listed in the load chart provides the operator with ____________________.

   A. Safety Margins
   B. Gross Capacities
   C. Net Capacities
   D. Reduced Capacities

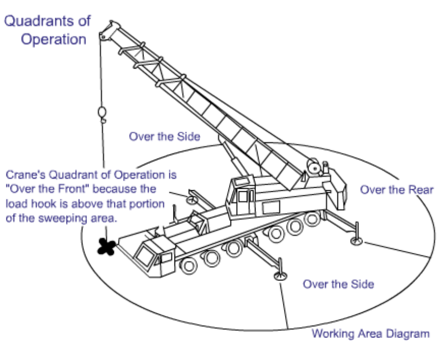
4. Select the best answer. General crane safety reminders would be listed in which part of the load chart?

   A. Rated Lifting Capacities
   B. Notes
   C. Range Diagram
   D. Working Area Diagram

Range Diagram



Range diagrams are used for planning lifts.
You can use them to determine the configuration of the crane needed for a particular job.
By laying out the geometry of the job on the diagram, the operator can determine the boom length, boom angle, jib length and jib offset required for the lift.
When loads must be placed above grade, the boom-tip height must allow for clearance between the boom tip and the load blocks, and the height of the load including the slings.
When loads must be set a certain distance in from the edge of a roof, the length of jib and necessary jib offset are easily determined by using the range diagram.
It may be used to determine the boom angle of telescopic booms, when the boom is only partially extended and the radius is known. The range diagram may also be used to identify the allowable clearances between the load blocks and boom tip.

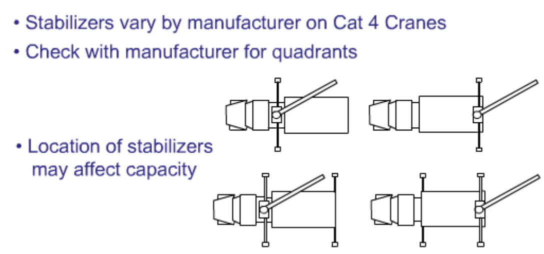


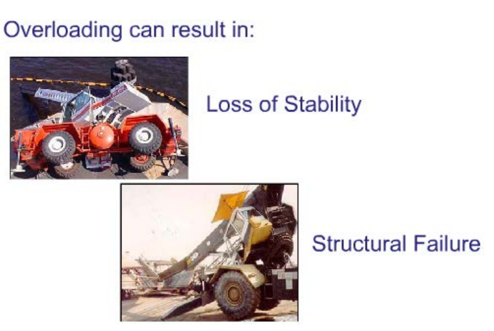
Working Area Diagram

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

Category 4 Quadrants of Operation

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





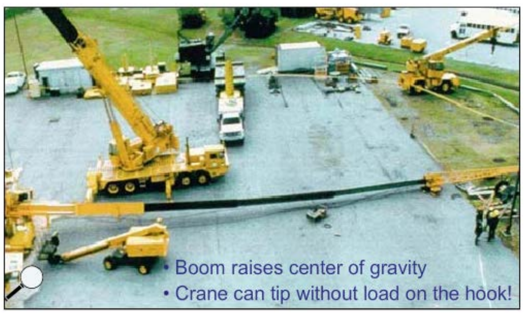
Consequences of Overloading

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

Loss of Stability

When a crane loses stability, the tipping force of the load overcomes the counteracting load, or counterweight of the crane. When tipping begins, especially with loads high in the air, it's very unlikely that the crane operator can do much to prevent overturning. As the crane begins to tip, the load radius increases; as the load radius increases the capacity of the crane decreases...rapidly. This happens so quickly that recovery is almost impossible.

It is therefore critical for the operator to maintain focus, situational awareness, and a thorough understanding of the crane's capability and capacity in its current configuration.



Loss of Stability: Telescopic Boom

Loss of stability with telescopic boom cranes can happen more rapidly than other types of cranes because of the increased weight and higher center of gravity of the boom.

Many telescopic boom cranes will tip with no load on the hook at all, if the boom angle is too low and the boom is extended too far.

Loss of Stability: Guessing

Never rely on signs of tipping to determine whether a load can be lifted.

This is called operating by the seat-of-the-pants and may result in a catastrophe.

Structural Failure

If the rated capacity 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.

Summary

In this lesson you explored the parts of a load chart including the notes section, rated capacity chart, range diagram, and working area diagram.

You also looked at differences in gross and net capacity, various capacity limiting factors, and the consequences of overloading a crane.

Click on each button or the view-all button to review additional information on each topic.

Knowledge Check

1. Select the best answer. Quadrants of Operation would be listed in which part of the load chart?

    A. Working Area Diagram
    B. Rated Lifting Capacities
    C. Notes
    D. Range Diagram

2. Select the best answer. Possible capacity loss due to quadrant changes could be determined by checking which parts of the load chart?

    A. Range Diagram and Working Area Diagram
    B. Working Area Diagram and Rated Lifting Capacities Chart
    C. Rated Lifting Capacities Chart and Notes Pages
    D. Notes Pages and Range Diagram

3. Select the best answer. Maximum height a load may be hoisted would be determined with which part of the load chart?

    A. Working Area Diagram
    B. Rated Lifting Capacities
    C. Notes
    D. Range Diagram

4. Select the best answer. Available Jib Offset would be listed in which part of the load chart?

    A. Working Area Diagram
    B. Rated Lifting Capacities
    C. Range Diagram
    D. Notes

5. Select the best answer. Overloading a crane may result in which of the following consequences?

    A. Damaged wire rope
    B. Tipping (Loss of Stability)
    C. Boom Failure
    D. Overturning
    E. All of the consequences listed above

NOTES

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LOAD CHARTS - MODULE 2

Welcome

Welcome to Load Charts Module 2.

Learning Objectives

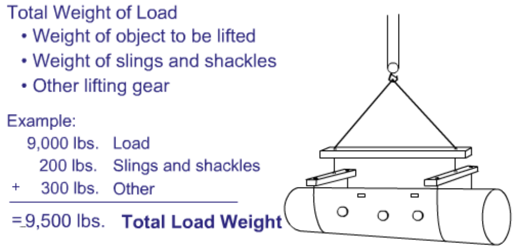
Upon successful completion of this module you will be able to identify considerations for planning mobile crane lifts, find gross capacities, and calculate net capacities.

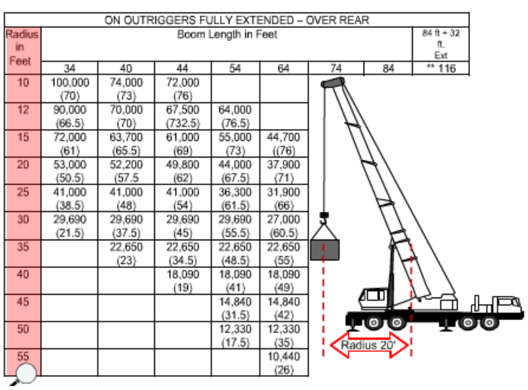
Pre-planning mobile crane lifts

To select the right crane for the job – the lift must be carefully pre-planned.
The information needed for pre-planning a crane lift is the total weight of the load including rigging gear; the maximum radius that the crane will be working, in each quadrant of operation; the maximum height of the lift; and the job site conditions.

Total Weight of the Load

Determining the total weight of the load begins with finding the weight of the object to be lifted.
In this example lift, the object weight is 9,000 pounds.
The total weight of the load includes the weight of the object to be lifted and the weight of the rigging gear.
In the example, the object weight is 9,000 lbs. Slings and shackles weigh 200 lbs. and the lifting beams add 300 lbs.…bringing the total load weight to 9,500 lbs.
Failure to factor in the weight of all rigging and lifting gear may cause an overload.



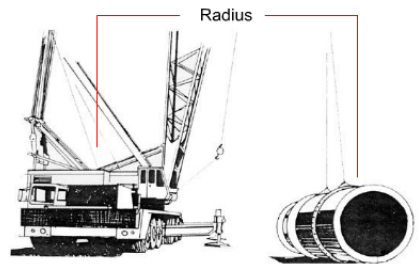


ON OUTRIGGERS FULLY EXTENDED – OVER REAR								
Radius in Feet	Boom Length in Feet							84 ft + 32 ft. Ext
	34	40	44	54	64	74	84	** 116
10	100,000 (70)	74,000 (73)	72,000 (76)					
12	90,000 (66.5)	70,000 (70)	67,500 (732.5)	64,000 (76.5)				
15	72,000 (61)	63,700 (65.5)	61,000 (69)	55,000 (73)	44,700 ((76)			
20	53,000 (50.5)	52,200 (57.5	49,800 (62)	44,000 (67.5)	37,900 (71)			
25	41,000 (38.5)	41,000 (48)	41,000 (54)	36,300 (61.5)	31,900 (66)			
30	29,690 (21.5)	29,690 (37.5)	29,690 (45)	29,690 (55.5)	27,000 (60.5)			
35		22,650 (23)	22,650 (34.5)	22,650 (48.5)	22,650 (55)			
40			18,090 (19)	18,090 (41)	18,090 (49)			
45				14,840 (31.5)	14,840 (42)			
50				12,330 (17.5)	12,330 (35)			
55					10,440 (26)			

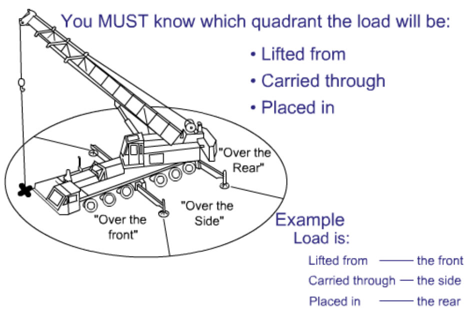
Load Radius

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.
On telescoping boom cranes, boom deflection can increase the radius and must be taken into account.
On critical lifts, the radius should be manually measured. Monitor the radius throughout the lift.

Measuring Radius



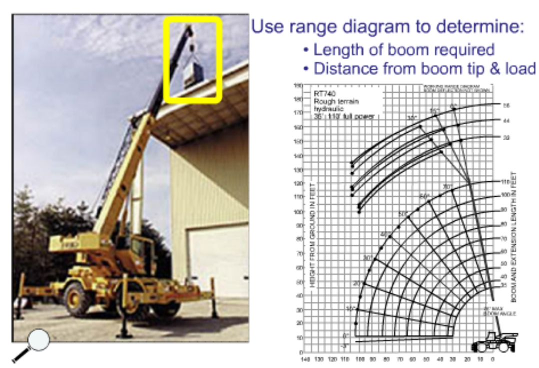
For some lifts you must verify radius by actual measurement. Measurement is required for all lifts exceeding 80% of the crane's capacity at the maximum anticipated radius.
For lifts exceeding 50 percent of the crane's capacity at the maximum anticipated radius planned for use, verify by actual measurement or by operating the crane with an empty hook through the lift evolution and verifying the radii from the radius indicator.



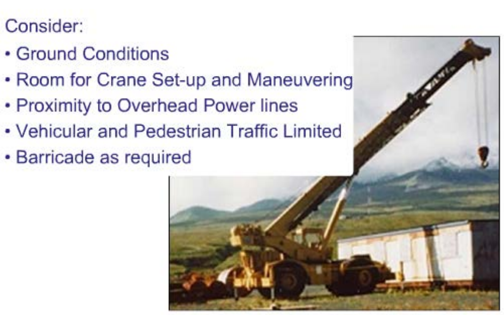
Quadrants of Operation

As mentioned earlier, the crane's working area is divided into areas called quadrants of operation. In pre-planning the lift, you must know which quadrant the load will be lifted from, carried through, and landed in. Knowing the load's weight and travel path with respect to a crane's capacity in each quadrant-of-operation are three necessary considerations in selecting the right crane for the job.

Lift Height Considerations



The range diagram is useful for crane selection. For example, for loads that must be placed or picked on a roof, the maximum hook height needed must accommodate the minimum allowable clearance between the boom tip and the hook blocks.
The range diagram can also be used to determine the required boom length depending on the height of the load and rigging gear.



Job Site Considerations

The ground must be firm enough to support the crane and keep it level during the lift.
Load chart ratings apply only with adequate support.
Make sure there is enough room at the job site to set up and maneuver the crane.
When lifts must be made near power lines, make sure limits of approach and safety requirements are observed.
Limit vehicle and pedestrian traffic. Accessible areas within the swing radius should be barricaded to prevent anyone from being struck or crushed by the crane.

Crane Selection

One requirement for safe lifting is selecting the crane to suit the job.
If the crane's characteristics do not match the job requirements then the overall safety of the lift can be compromised.
Consider the maximum radius of the lift, quadrants of operation, boom length, configuration of the crane and crane capacity.

Lift Requirements

Consideration:	Requirement:
Weight of Object and Lifting Gear	9,500 lbs.
Maximum Estimated Radius	45 ft.
Quadrants of Operation	Over Rear/Over Side
Height of Lift (Load + Rigging)	25 ft.

Requirements

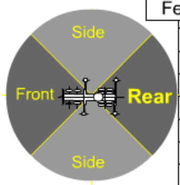
You have been asked to lift a steam condenser from a loading dock and place it on a trailer for shipping.
You pre-plan the lift with the crane team members and learn the condenser and lifting gear weigh 9,500 pounds.
The lift radius has been estimated at a maximum of 45 feet.
The load will be picked up over-the-rear quadrant of the crane and set down over-the-side.
The height of the lift is 25 feet, requiring a minimum boom length of 54 feet.
Using this information you can select the right crane for the job.

Crane Selection

From the available cranes, you select a 50 ton, truck mounted, hydraulic extendible boom crane with a 4 part main hoist, a single part whip hoist, an auxiliary boom head, and a stowed swing-away extension.

Next, determine the allowable quadrants of operation by referring to the crane's load chart.

- 4 part main hoist
- Whip hoist
- Auxiliary boom head
- Stowed swing-away extension



Radius in Feet	ON OUTRIGGERS FULLY EXTENDE[D] OVER REAR Boom Length in Feet						
	34	40	44	54	64	74	84
	100,000 (70)	74,000 (73)	72,000 (76)				
12	90,000 (66.5)	70,000 (70)	67,500 (732.5)	64,000 (76.5)			
15	72,000 (61)	63,700 (65.5)	61,000 (69)	55,000 (73)	44,700 ((76)		
20	53,000 (50.5)	52,200 (57.5	49,800 (62)	44,000 (67.5)	37,900 (71)	35,000 (74)	31,000 (76.5)
25	41,000 (38.5)	41,000 (48)	41,000 (54)	36,300 (61.5)	31,900 (66)	29,200 (70)	27,500 (73.5)
30	29,690 (21.5)	29,690 (37.5)	29,690 (45)	29,690 (55.5)	27,000 (60.5)	25,000 (65.5)	23,900 (69.5)
35		22,650 (23)	22,650 (34.5)	22,650 (4[illegible].5)	22,650 (55)	21,800 (61)	20,500 (66)
40			18,090 (19)	1[illegible]090 ([illegible]1)	18,090 (49)	18,090 (56.5)	17,900 (62)
45			→	Gross Capacity 14,840			14,840 (58)
50				12,330	12,330	12,330	12,330 (53.5)

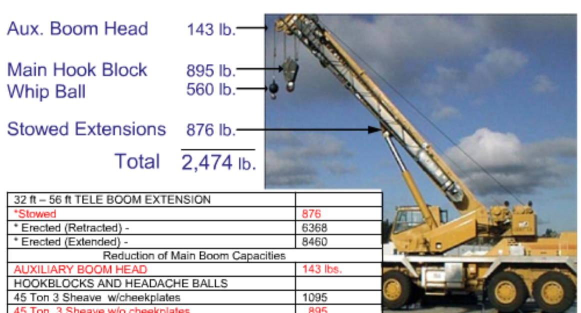
Finding Gross Capacity

Since the crane's capacity may be affected by the quadrant of operation, it is important to choose load charts for the quadrants the lift will be made in and lifted through.
The load will be picked up over-the-rear quadrant. Select the appropriate capacity chart for this quadrant.
Now, find the gross capacity.
Since the lift radius is 45 feet, read down the radius column to 45 feet.
From 45 feet read across to the 54 foot boom-length column.
In this example, the gross capacity is 14,840 pounds.
Since the load will be placed over-the-side, the next step is to check the load charts for a capacity change when the load swings into this new quadrant.

Finding Over the side capacity

To find the gross capacity for over-the-side, select the appropriate capacity chart. Read down the radius column to 45 feet.
From 45 feet read across to the gross capacity in the 54 foot boom-length column.
Notice, in this example, the listed gross capacity is 12,840 pounds, 2,000 less than the over-the-rear capacity.
The crane's gross capacity has been identified for all quadrants the load will pass through.
To calculate the crane's net capacity, deductions must first be established.

Radius in Feet	ON OUTRIGGERS FULLY EXTENDED OVER SIDE Boom Length in Feet						
	34	40	44	54	64	74	84
10	100,000 (70)	74,000 (73)	72,000 (76)				
12	90,000 (66.5)	70,000 (70)	67,500 (73.5)	64,000 (76.5)			
15	72,000 (61)	63,700 (65.5)	61,000 (69)	55,000 (73)	44,700 (76)		
20	53,000 (50.5)	52,200 (57.5)	49,800 (62)	44,000 (67.5)	37,900 (71)	35,000 (74)	31,000 (76.5)
25	39,800 (38.5)	39,800 (48)	39,800 (54)	36,300 (61.5)	31,900 (66)	29,200 (70)	27,500 (73.5)
30	27,030 (21.5)	27,030 (37.5)	27,030 (45)	27,030 (55.5)	27,000 (60.5)	25,000 (65.5)	23,900 (69.5)
35		20,280 (23)	20,280 (34.5)	20,280 (4[illegible]5)	20,280 (55)	20,280 (61)	20,280 (66)
40			15,950 (19)	15,950 (41)	15,950 (49)	15,950 (56.5)	15,950 (62)
45			→	Gross Capacity 12,840		12,840 (51.5)	12,840 (58)

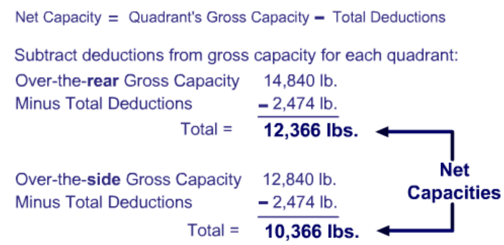


32 ft – 56 ft TELE BOOM EXTENSION	
*Stowed	876
* Erected (Retracted) -	6368
* Erected (Extended) -	8460
Reduction of Main Boom Capacities	
AUXILIARY BOOM HEAD	143 lbs.
HOOKBLOCKS AND HEADACHE BALLS	
45 Ton 3 Sheave w/cheekplates	1095
45 Ton 3 Sheave w/o cheekplates	895
50 Ton 4 Sheave	1285
15 Ton 1 Sheave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

Deductions

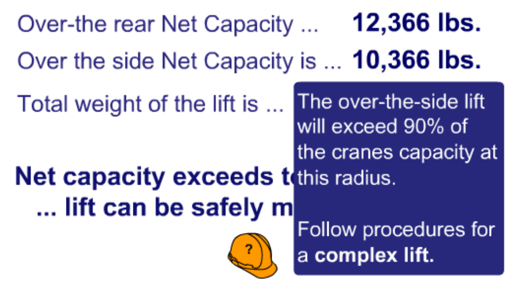
In this example the crane is configured with an auxiliary boom head weighing 143 pounds, a main hook block weighing 895 pounds, a whip ball weighing 560 pounds, and a stowed telescoping extension having an effective weight of 876 pounds.
Total deductions equal 2,474 pounds.
For this crane, no deduction is required for excess wire rope.
Now you can calculate the net capacity.

Calculations

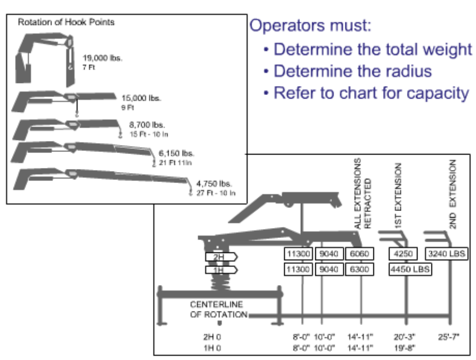


In this example you must determine net capacities for two working quadrants.
Gross capacity over-the-rear is 14,840 pounds.
Deductions add up to 2,474 pounds. Gross capacity less deductions results in a net capacity of 12,366 pounds over the rear.
Gross capacity over-the-side is 12,840 pounds. Gross capacity less deductions results in a net capacity of 10,366 pounds over the side.
Over the rear net capacity equals 12,366 pounds.
Over the side net capacity equals 10,366 pounds.

Final Checks



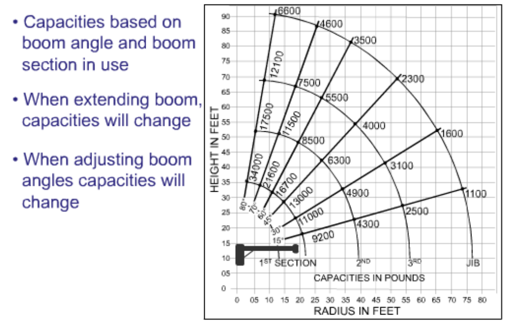
For this example, compare the net capacities with the total weight of the load.
Over-the-rear net capacity at 45 foot radius is 12,366 pounds. Over-the-side net capacity at 45 foot is 10,366 pounds. The total weight of the lift is 9,500 pounds.
Since the net capacity in both over-the-rear and over-the-side quadrants exceeds the total weight of the lift, you know this lift can be safely made.
Since the over-the-side lift exceeds 90% of the cranes capacity at this radius, this lift requires the crane team to follow procedures for a complex lift.
If practical, the operator might try shortening the radius by booming up and/or using a shorter boom before swinging over-the-side.



Examples of Category 4 Capacity Charts

These are examples of load charts that may be found on some articulating-boom category 4 cranes.
To use this type of chart in determining safe capacities, the operator must determine the weight of the load and rigging gear, determine the maximum load radius, from the centerline of crane rotation to the center of gravity of the load, and carefully review the load chart to insure that the load does not exceed the crane's capacity.
If the crane is equipped with a winch, insure that the load does not exceed the rated load of the wire rope.

Cat 4 Capacity Chart Example



In this load chart for a telescoping boom Category 4 crane, the manufacturer placed the capacity values on the range diagram.

Capacities are based on boom angle and boom section in use.

When extending the boom, the listed capacity is reduced.

For example, extending the boom beyond minimum length would require the operator to refer to the capacity listed for the next section.

This holds true for each additional section.

When adjusting the boom angle, the operator must be aware of the changes in capacity.

When working between boom angles the operator will always use the capacity listed for the next lower angle.

Knowledge Check

1. Select the best answer. When pre-planning mobile crane lifts, the crane operator must know the maximum height and _______________ at which the crane will be working.

   A. Radius
   B. Distance
   C. Speed

2. Select the best answer. When pre-planning mobile crane lifts the crane operator must know the operating _______________ that the load will be lifted from, carried through, and placed in.

   A. Route
   B. Industrial area
   C. Quadrants

3. Select the best answer. When pre-planning mobile crane lifts the crane operator must know the ___________ conditions where the lift is to be made.

   A. Weather
   B. Site

4. Select the best answer. Which of the following is most critical to maintain crane capacity?

   A. Hook radius
   B. Boom angle
   C. Hoisting speed
   D. Boom tip height

5. Select the best answer. When setting up mobile cranes at the job site, which of the following job site conditions should be considered?

   A. Ground Conditions
   B. Traffic
   C. Proximity to Power Lines
   D. Room to maneuver and set up the crane
   E. All of the conditions listed above

6. True or False. The range diagram can be used to determine the required boom length.

   A. True
   B. False

7. Select the best answer. The values listed in the manufacturer's capacity charts for most mobile cranes are ____________.

   A. Suggested guidelines
   B. Gross capacities
   C. Net capacities
   D. Maximum radii

8. Select the best answer. Calculating _____________ capacity requires subtracting the total of all deductions from crane capacity.

   A. Net
   B. Boom
   C. Gross
   D. Crane
   E. Deductions

9. Select the best answer. The total weight of the load includes ___________.

   A. The load and all rigging gear
   B. Only the load

NOTES

LOAD CHARTS - MODULE 3

Welcome
Welcome to Load Charts Module 3.

Learning Objectives
Upon successful completion of this module you will be able to find gross capacities when lift requirements are between values listed on the load chart, determine safe hoist capacity based on parts of line and hook capacity and identify operator or environmental conditions that affect crane capacities.

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

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

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

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

25 Ft. = Next longer radius

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

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

45 Ft. = Next LOWER CAPACITY

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

Between Values for Two Variables

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

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

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

Gross Capacity = 62,000 lbs.

ALWAYS Choose the Lower Values Shown

When actual BOOM ANGLE is between listed values,

...use the LOWER ANGLE

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

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

Boom Angle between Values

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

Capacity Limiting Factors

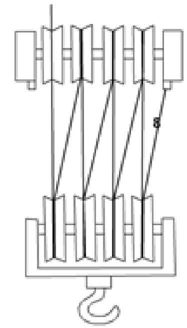
The lifting capacity of a crane may be limited to the rated load of the hook and block installed on your crane.

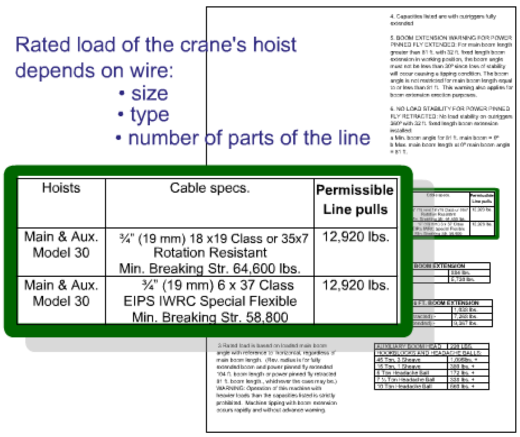
Hook block capacity information is normally located on side of block.

Parts of Line

Before making any lift, you must ensure that the crane has sufficient net capacity to lift the load and is reeved with enough parts of line to lift the load without exceeding the rated load of the hoist wire rope.

The number of parts used may limit lifting capacity. Count the number of lines suspending the load. In this example we have 8 parts of line between the hoisting sheaves and the hoist block sheaves.





Wire Rope Capacity

The rated load of the crane's hoist depends on the wire rope size, type, and the number of parts of line.

The allowable line pull is found in the crane's load chart.

In this example the allowable line pull of each part of the wire rope is 12,920 pounds.

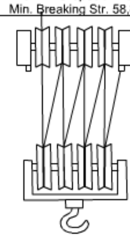
Calculating Wire Rope Capacity

To find the capacity of the crane's wire rope, multiply the rated load or line pull by the number of parts.

In this example we multiply the rated load of 12,920 pounds by eight parts. Eight parts of wire rope have a rated load of 103,360 pounds.

If the hook block capacity is less than the rated load of the wire rope, the hook will be the limiting factor.

Hoists	Cable specs.	Permissible Line pulls
Main & Aux. Model 30	¾" (19 mm) 18 x 19 Class or 35 x 7 Rotation Resistant Min. Breaking Str. 64,600 lbs.	12,920 lbs.
Main & Aux. Model 30	¾" (19 mm) 6x37 Class EIPS IWRC Special Flexible Min. Breaking Str. 58,800	12,920 lbs.



Multiply the rated load by the number of parts:

12,920 lbs.
x 8 parts
103,360 lbs.

Knowledge Check

1. True or False. The crane lifting capacity may be limited by the rated load of the hook and block installed on your crane.

    A. True
    B. False

2. Select the best answer. When the actual load radius falls between the values listed on the capacity chart, use the gross capacity rating _____________.

    A. For the maximum radius defined on the chart
    B. For the next shorter radius chart listing
    C. For the next longer radius chart listing

3. Select the best answer. When working between values shown on a capacity chart always choose the …

    A. Lower value listed
    B. The maximum value listed
    C. The highest value for the two listed values

4. True or False. Wire rope capacity is determined by multiplying the number of parts of line by the rated load of the wire rope.

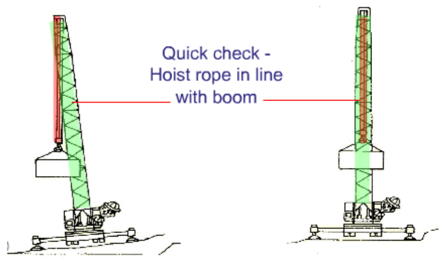
    A. True
    B. False

5. Select the best answer. Hook block capacity information is normally located __________________.

    A. On the Crane History Card
    B. On the ODCL Checklist
    C. On the side of the block

Other Conditions Affecting Capacity

The crane's capacity may be affected by operational conditions and environmental conditions.
Some conditions that the operator can control are crane level, outrigger position, side-loading, and load swing.
Environmental conditions that you must be aware of are ground support and wind.

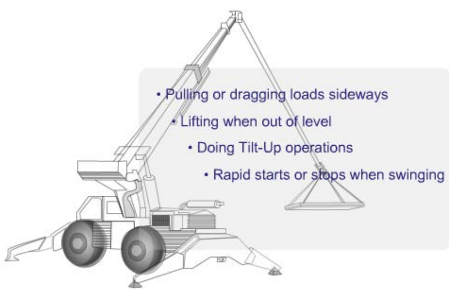


Out of Level

Capacities shown on the load chart for each crane are based on the crane being perfectly level. A crane that is three degrees out of level can reduce capacity by as much as 50%. A crane that is out of level can tip more easily.
A quick way to check for level is to sight along the hoist rope. It should hang in line with the boom centerline in all quadrants.
Always set cranes up as level as possible!

Outrigger Position

Outrigger positions can affect capacity.
On-outrigger load-chart ratings apply when all outriggers are fully extended, extended to intermediate positions, or in other positions, as allowed by the OEM load charts and all tires are clear of the ground.
Unless these conditions are met, the on rubber capacity, if allowed must be used. There is no in-between capacity.

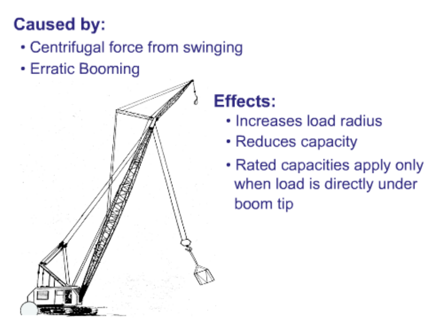


Side-Loading

Another controllable condition affecting crane capacity is side-loading.
Causes of side loading include pulling or dragging a load sideways, out of level, tilt-up operations and rapid starting or stopping of swing.
Since load chart ratings apply only when the load is picked up directly under the boom tip, if a load is lifted off to either side of the boom tip, side-loading occurs.
The stresses caused by side-loading could cause boom failure. Failure often occurs without warning and affects both lattice and telescopic booms.

Load Swing

Load swing affects the capacity and sometimes the stability of cranes.
Load swing can be caused by the centrifugal force from rotating a crane too fast.
Load swing can also be caused from booming the crane up or down in an erratic manner.
Load swing increases the effective radius resulting in reduced capacity and may cause the crane to tip.
Load chart ratings apply only when he load remains directly under the boom tip.

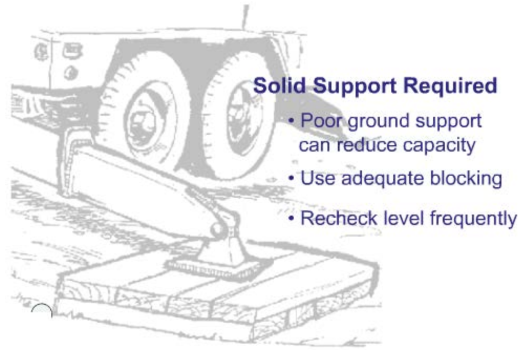


Ground Conditions

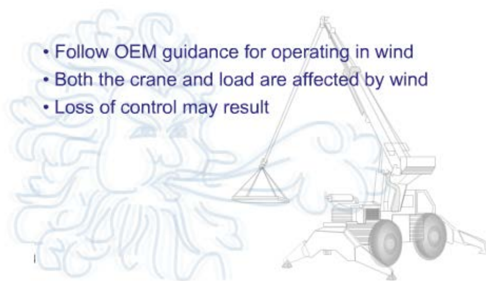
Ground conditions are a product of the environment. Soft or unstable ground can result in loss of capacity or stability.

Operators cannot control ground conditions but must compensate to ensure adequate support for the crane.

When soft ground cannot be avoided use adequate blocking under all floats or pads and re-check the level of the crane frequently.



Any blocking used to support outriggers/stabilizers shall be strong enough to prevent crushing, be of sufficient width and length to prevent shifting or toppling under load, and shall be inspected before use to ensure it is free from defects.



Wind

Follow OEM guidance for operating in windy conditions.

Both the crane and load are affected by wind.

Loss of control of the load and crane may result even though the weight of the load is within the normal capacity of the crane.

Knowledge Check

1. Select the best answer. What is an acceptable adjustment for a crane's out of level set-up?

   A. 2 degrees
   B. 3 degrees
   C. 5 degrees
   D. 10 degrees
   E. None

2. Select the best answer. When making a lift, rapid starting and stopping could cause __________________.

   A. Side-loading
   B. Traffic tickets
   C. Lack of outrigger stability

3. Select the best answer. Load swing increases the effective radius, resulting in _________________________.

   A. Reduced capacity and possible overloading
   B. More effective load radius
   C. More effective use of capacity charts

4. Select the best answer. Solid ground is required to support mobile cranes. If ground conditions are not adequate to support the crane ____________________.

   A. Use bricks and cement blocks for stability
   B. Reduce the capacity by 50%
   C. Use blocking or cribbing under the outriggers
   D. Do not make the lift

NOTES

Crane Communications

Welcome
Welcome to Crane Communications.

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

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

Hand Signals
Hand signals are 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).

Communication - Radio

Radios can be used to direct crane lifts while keeping crane team members informed of the lift status.

Radio guidelines

The device, or devices, used shall be tested on-site prior to crane operations. Use an isolated channel and clear the line of other traffic. Limit background noise. The operator's reception of signals shall be by a hands-free system

Radio work practices

Voice directions given to the operator shall be given from the operator's directional perspective. Identify the crane and yourself. Each voice signal shall contain the following elements, given in the following order: function (such as hoist, boom), direction; distance and/or speed; function, stop command. Allow time between commands. Verify the command

Note: The operator shall stop the crane at any time and in any situation judged to be unsafe or when communication is lost or unclear. In addition, the operator shall immediately respond to a direction from any person to stop the crane.

Knowledge Check

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

    A. 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 rigger has not learned hand signals
    D. The operator and rigger are working in close proximity and ambient noise is low

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

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

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

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

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

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

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

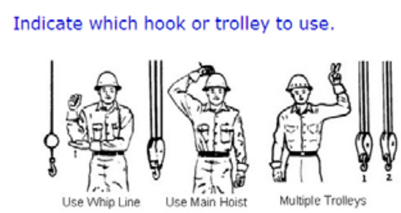
    A. Approved by the ASME
    B. Approved by OSHA
    C. Approved by the activity
    D. Approved by NOSH

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

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

Hook and Trolley Signals

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



Auxiliary Hoist or Whip Line Signal

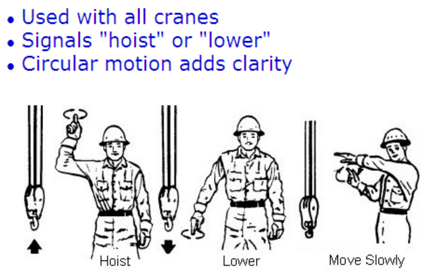
When calling for the whip line or auxiliary hoist, the elbow is tapped with the opposite hand and followed with the appropriate hook movement signal.

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 Hook & Trolleys

When working with a multiple trolley crane, these signals indicate which trolley to use.
They are always followed by movement signals.
- One finger up for the number "1" hook or trolley
- Two fingers up for the number "2" hook or trolley
- Each followed with standard signals to indicate the desired motion



Hoist Signals

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

Hoist

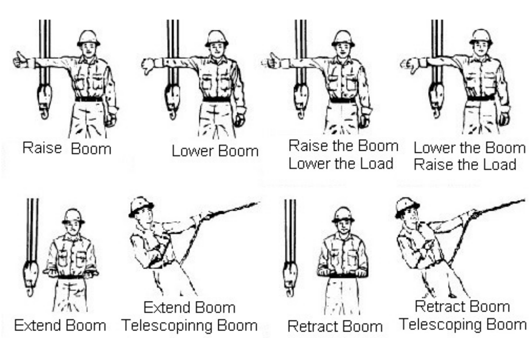
The hoist signal is given with the forearm vertical, the index finger pointing up, and the hand moving in small horizontal circles.

Lower

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

Move Slowly

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



Boom Signals

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

Raise Boom (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 / Lower Load

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

Lower Boom / Raise Load

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

Extend Boom

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

Extend Boom One Handed

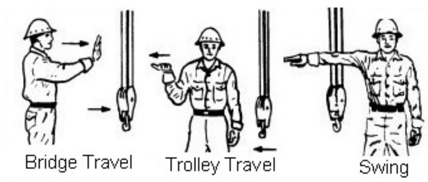
The one handed extend signal is made with one fist in front of the chest and the thumb pointing inward with a tapping motion.

Retract Boom

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

Retract Boom One Handed

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



Directional Signals

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

Travel

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

Trolley Travel

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

Swing

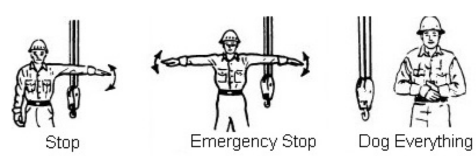
The signal for swing or rotate is an extended arm with the index finger pointed in the desired direction of rotation.

Stop Signals

Stop and emergency stop signals can be given by anyone.

When these signals are given, the operator must stop operations as quickly and as safely as possible.

The dog everything signal is used when all operations must be secured.



Stop

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

Emergency Stop

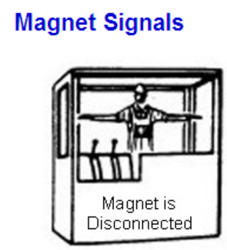
The signal for an emergency stop is both arms extended with palms down, moving them back and forth horizontally.

Dog Everything

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

Magnet Signals Overview

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



Magnet Disconnected

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

Summary

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

Knowledge Check

1. Select the best answer. This signal indicates:

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

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

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

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

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

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

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

5. Select the best answer. This signal indicates:

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

6. Select the best answer. This signal indicates:

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

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

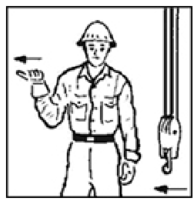
   A. Magnet disconnected
   B. Emergency stop

8. Select the best answer. This signal indicates:

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

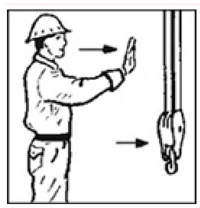
9. Select the best answer. What is the bridge crane communications hand signal pictured, with the palms up, fingers closed; thumb pointing in the direction of motion, and jerking horizontally?

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



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

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



NOTES

CRANE TEAM CONCEPT

Welcome

Welcome to Crane Team Concept.

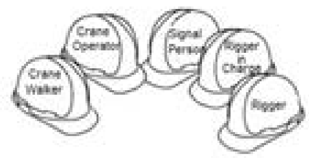
Learning Objectives

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

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

   A. The EOM designation
   B. The supervisor as required
   C. The crane operator as required
   D. The crane rigger as required

Crane Team Shared Responsibilities

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

Pre-job Briefing

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

Crane Team 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 Responsibilities

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

The crane operator is responsible for performing the pre-use check of the crane and the operator's main concern during crane operation is operating safely.

The crane operator must have a full understanding of each lift prior to execution and moves only when directed by the signal person.

Pre-Use Check

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

ODCL Includes:

- walk around check
- machinery check
- operator's cab check
- no load operational check

Full Understanding

Before making a lift, the crane operator must have a full understanding of the lift and how it is to be executed.

The operator must know the exact or estimated load weight, the destination and the capacity of the crane as it is configured.

Stop for Safety

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

Knowledge Check

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

   A. Support the goal of safe 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

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

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

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

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

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

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

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

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

Rigger-in-Charge Responsibility

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 Responsibility

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 Responsibilities

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 rigger 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

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

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

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

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

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

    A. Activities
    B. Crane Supervisor
    C. Rigger-in-Charge
    D. Crane Operator
    E. Crane Rigger

NOTES

SAFE OPERATIONS MODULE 1

Welcome
Welcome to the Safe Operations module.

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

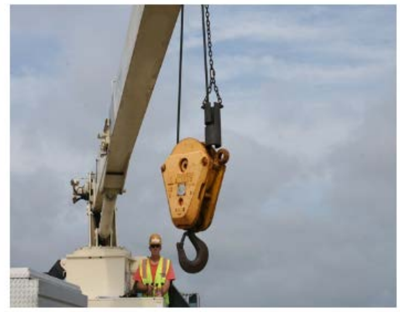
Understanding the Crane
The vast majority of crane accidents are the result of personnel error and are therefore avoidable. Where team personnel are at fault, it is typically due to inattention, poor judgment, overconfidence, or haste to get the job done.
Crane operators at naval activities may be required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

Operator Training
Prior to being licensed, operator trainees must be thoroughly trained on the operation of the type of crane for which a license is to be issued.
The operator trainee shall operate the crane only under the direct observation of a licensed operator. The licensed operator shall retain full responsibility for the safe operation of the crane.
The supervisor shall approve lifting of loads based upon the candidate's demonstration of knowledge, 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. Operate safely
    B. Keep the crane clean
    C. Do pre-use checks
    D. Use the shortest boom length possible

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

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

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

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

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

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

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

Operator Awareness

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

Unsafe Conditions

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

Lifts Near Personnel

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

Never Ride Loads

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

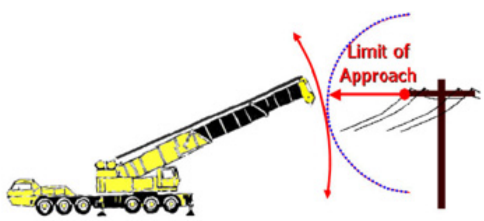
Overhead Lines

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

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

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

Figure 10-3



Limit of Approach

When operating a crane in the vicinity of overhead electrical transmission lines, for voltages less than 350 kV, the minimum required clearance is 20 feet. Where the voltage is known to be 350 kV or more, the minimum required clearance is 50 feet.

A designated spotter shall be assigned by the supervisor and be positioned to effectively gauge and monitor the clearance distance and communicate directly with the operator.
When operating in the vicinity of overhead transmission lines the best crane set up is one in which no part of the crane or load can enter the clearance limit.
Even boom failure should not allow the crane, load line, or load to enter the limit.

Operating Practices

The crane operator must operate the crane in a safe manner, moving loads slowly and smoothly. Avoid rapid starts and sudden stops to help reduce load swing. Anticipate stopping points, and slow down before bringing loads to a stop.
Crane swing should be relatively slow to prevent outward swing of the load due to centrifugal force.
The operator shall remain at the controls at all times while a load is suspended from the crane. This does not include slings and other gear used to rig the load and does not include a load attached to the crane with slack in the rigging gear. This also does not apply to under-running bridge cranes, jib cranes, pillar cranes, pillar jib cranes, monorails, and fixed overhead hoists used in industrial processes that require a suspended load such as cleaning, degreasing, painting, testing, and similar processes. For such cases, the suspended load shall be less than 80 percent of the crane's rated capacity, the area shall be secured to prevent unauthorized personnel from entering, the crane shall be tagged to indicate this condition, and the load shall not be suspended longer than required.

Crane Operating Characteristics

There are a variety of operating characteristics and issues that the users of Category 2 and 3 cranes must consider. Listed below are just a few.
Operating of Category 2 and 3 cranes may be from the cab or from the ground using a pendant controller or remote controls. A disadvantage of operating a very high mounted overhead traveling crane from the cab is that the operator may have difficulty in judging position and in seeing signals.
Some cranes are equipped with dynamic lowering controls. A dynamic lowering control is an automatic device that speeds the lowering of an empty hook or light load, and slows a heavy load.
On some cranes a heavy load may lower when the hoist control is initially moved from the neutral position to the hoist position. The load may not lift until the hoist speed is high enough to support and raise the load. This characteristic is called hoist roll back. When positioning heavy loads, the final vertical adjustment should be made by lowering the load because of hoist roll back.

Operating OET and Gantry Cranes

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

Operating Techniques

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

Lifting Loads

Prior to lifting, position the freely suspended hook directly over the loads 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

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 the following:
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, operator awareness, and proper methods for lifting and landing loads.
The rules and requirements, including limits of approach, for operating cranes in the vicinity of overhead power lines; and how effective teamwork and safe operating practices reduce accidents.

Knowledge Check

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

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

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

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

3. 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 completely suspended and stop
    C. Lift the load until a desired height and stop

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

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

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

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

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

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

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

   A. By hoisting. When lowering, the speed may not be controllable.
   B. By hoisting. When hoisting, the load may lower before the speed is high enough to lift the load.
   C. 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.

NOTES

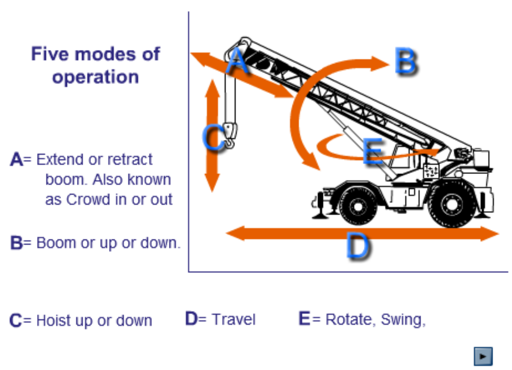
Safe Operations Module 2

Welcome

Welcome to Safe Operations Module 2.

Learning Objectives

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



Mobile Crane Operating Terms

T here 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.

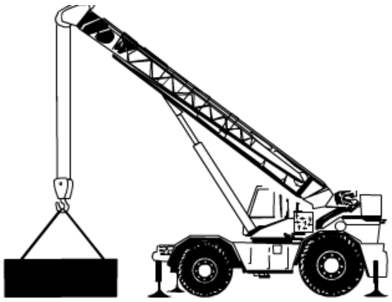
A weak link connection shall be used to secure the hook block to the crane. The breaking strength of the connecting piece shall be less than the rated load of the hook block's wire rope as reeved.

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

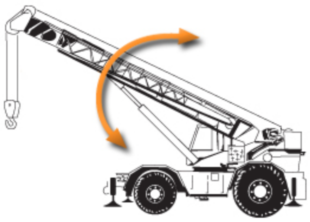
When lifting and landing heavy loads with mobile cranes adjust the boom position as necessary to compensate for deflection.
The signal person should assist in keeping the boom tip directly over the load.
Use the shortest boom length practical for maximum stability and strength.
Use power lowering for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

Mobile Cranes – 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?

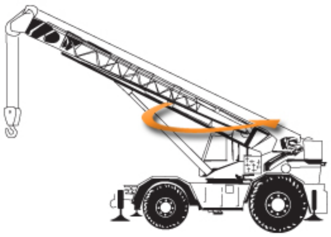


   A. Booming up or down
   B. Hoist up or down
   C. Rotate
   D. Extend or Retract Boom

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. Booming up or down
   C. Extend or retract boom
   D. Hoist up or down

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



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

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

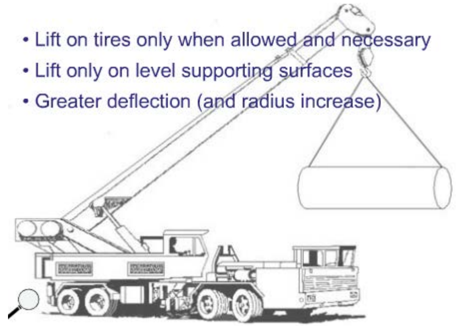
   A. Jacks
   B. Hooks
   C. Oiler
   D. Rigging gear
   E. Jib

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

   A. Adjust as necessary for boom deflection before lifting the load
   B. Remove stowed jib to lighten boom
   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.

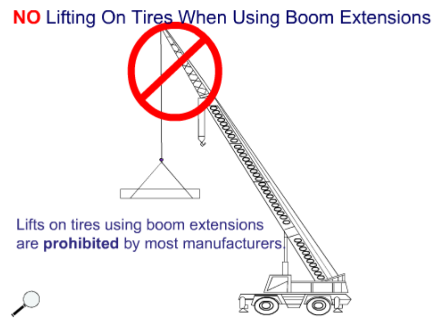


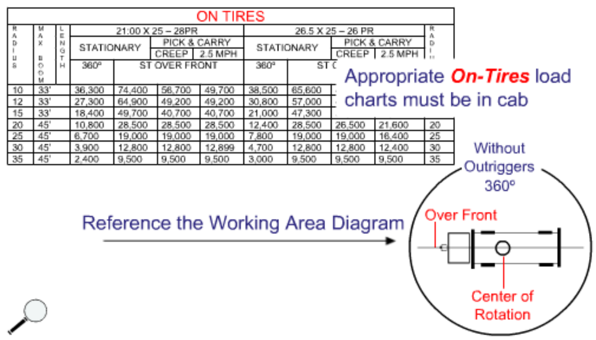
Issues

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.





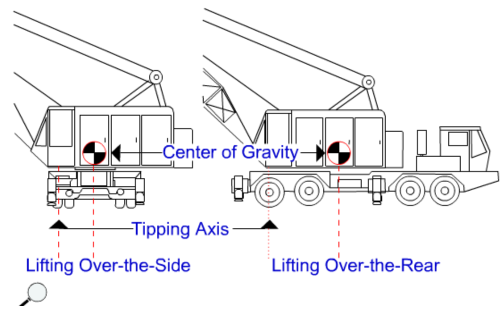
RADIUS	MAX BOOM LENGTH	21:00 X 25 – 28PR STATIONARY 360°	21:00 X 25 – 28PR STATIONARY ST OVER FRONT	PICK & CARRY CREEP	PICK & CARRY 2.5 MPH	26.5 X 25 – 26 PR STATIONARY 360°	STATIONARY ST OVER FRONT	PICK & CARRY CREEP	PICK & CARRY 2.5 MPH	RADIUS
10	33'	36,300	74,400	56,700	49,700	38,500	65,600			
12	33'	27,300	64,900	49,200	49,200	30,800	57,000			
15	33'	18,400	49,700	40,700	40,700	21,000	47,300			
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

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.

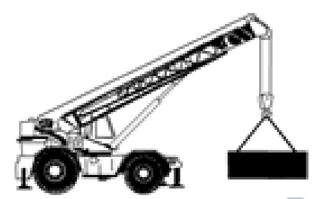
Crane Center of Gravity

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.



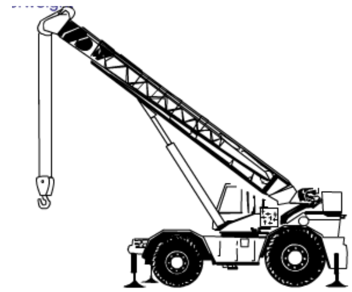
Mobile Cranes – Pick and Carry

Travel with suspended loads only when permitted by the OEM and the local activity.
Cranes must have appropriate Pick and Carry Load Charts in the operator's cab.
Set the rotate lock and travel with the load directly over the end in-line with the carrier as required by the OEM. Generally this means carrying over the front with RT cranes and over the rear with truck cranes.



Rotate brakes are normally used for holding operating position when the crane is not in line with the crane carrier.
When practical and as permitted by the OEM, extend the outriggers and keep the outrigger pads a few inches off the ground.
Always check that the automatic or manual axle lock-outs, when equipped are released.
Be sure the ground which the crane will travel over can support the machine.

Extendible Boom Cranes – Operating



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

Extendible Boom Cranes – Securing

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

Mobile Lattice Boom Cranes – Operating

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

Mobile Lattice Boom Cranes – Securing

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

Knowledge Check

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

   A. Spin
   B. Raise
   C. Lower

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

   A. True
   B. False

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

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

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

   A. Safe
   B. Horizontal
   C. Vertical

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

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

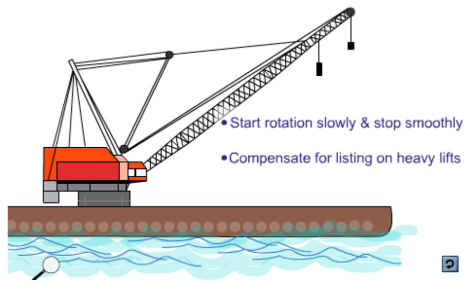
6. True or False. Lowering a fixed boom with the load block close to the boom tip sheaves may result in two-blocking.

   A. True
   B. False

Floating Cranes – Operating

When swinging or rotating floating cranes you must start slowly and stop smoothly. Abrupt starts and stops cause barge rotation putting unnecessary strain on mooring lines.

To compensate for the list of the floating crane when lifting heavy loads from the pier, position the hook directly over the load, take a strain on the rigging, and then boom up.



Floating Cranes – Securing

When securing floating cranes, follow OEM and local instructions and set the boom at the recommended angle or so the hooks are over the deck anchor point.

Secure the hooks to the barge using tie-down pendants with a weak link.

Floating Crane Barge – Securing

Secure the floating crane barge as required.

Set the gangway when the crane is moored pier-side.

Clean and secure the deck. Store, or secure loose cargo. Stow unused rigging gear, mooring lines, & ropes. Check mooring line tension to allow for tidal changes.

At high tide, ensure that lines are slack enough to avoid over-stressing or parting as the tide recedes.

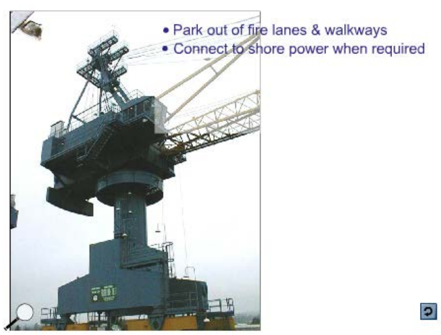
At low tide, snug up mooring lines to minimize barge movement as the tide rises and lines slacken.

Energize exterior lighting such as anchor lights and aircraft warning lights as required.

Secure personnel access areas, ladders, auxiliary machinery and close all watertight doors and hatches.

Portal Cranes – Operating

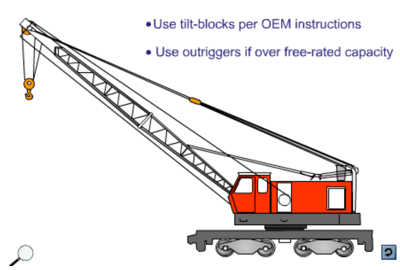
Travel with caution, especially in congested work areas and when approaching curves, intersections, building entrances, and access to ladders leading into dry docks.
It is a good practice to stop before crossing rail switches to verify correct alignment.
When possible, the operator should position the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

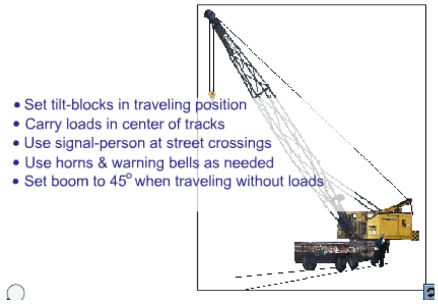
When securing portal cranes, follow OEM recommendations.
Park away from fire-lanes, gangways, and pedestrian walkways.
When required connect to shore power using the proper electrical safety procedures.

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.

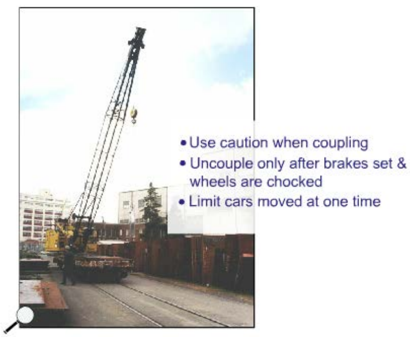
Locomotive Cranes - Traveling



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.



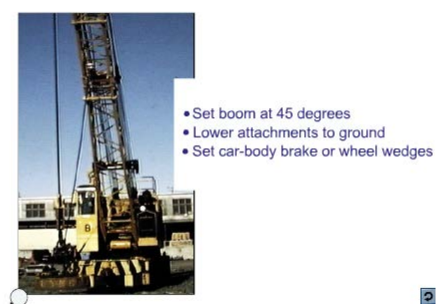
Locomotive Cranes – Moving Cars

If you need to move rail cars using a locomotive crane use caution when coupling or disconnecting cars. The crane crew shall make sure that no one is working in, on, or under the car, and that nothing will prevent its safe movement. Crews shall uncouple cars only when brakes are set and wheels are properly chocked.

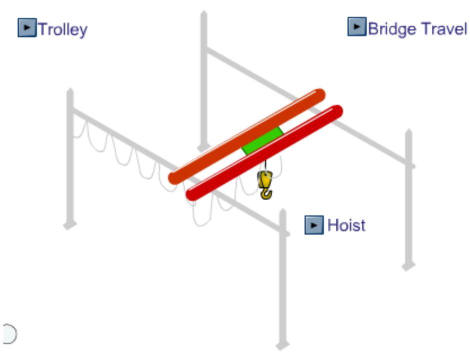
Limit the number of cars moved at one time, loaded or unloaded, to the number recommended by the crane manufacturer or by local policy.

Locomotive cranes are not usually designed to charge the braking systems of additional cars or to move several cars at a time.

Locomotive Cranes – Securing



When securing locomotive cranes, set the boom at about a 45 degree angle. If equipped with a magnet, clam-shell, or other lifting attachment, lower it to the ground. Set the car-body brake or place wheel wedges against the inner set of travel wheels.



OET & Gantry Cranes – Operations

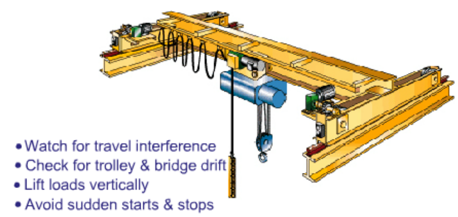
The bridge travel function is used to travel the crane in the selected direction along the length of the runway rails. This allows the operator to move the entire crane along its supporting rail structure, in the selected direction.

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.

OET & Gantry Cranes – Operating

Overhead electric traveling cranes are generally operated indoors so congestion is often an issue. Watch for changes in the work area that may cause interference. Storage racks with material stacked too high are a common problem.



Operators should always check for trolley and bridge drift before operating the crane.

Lift loads vertically. Side pulls can cause uneven or overlapped spooling of the hoist wire and may cause the wire rope to be cut or severely damaged.

In addition, ensure the hook and block are not swinging prior to hoisting. Improper or overlapped spooling of the wire rope on the drum can occur with or without a load on the hook when hoisting.

Avoid sudden starts and stops with the bridge. This can result in skidding and uneven wear on the wheels.

A sudden start with a heavy load on one end of the bridge may cause a crane to skew. Skewing means that the bridge and trucks are out of alignment with the rails, often resulting in wheel chatter from flange contact with the sides of the rail head.

OET and Gantry Cranes – Operating

Always board cab-operated cranes at designated places. Access the crane cab or bridge walkway using fixed ladders, stairs, or platforms.

Remain aware of other cranes working on the same rail system.

For gantry cranes, watch travel truck clearances. For cab-operated gantry cranes, this may require additional personnel to ensure a clear travel path.

Use radio controls according to the manufacturer's instruction.

Turn off power to the radio controller and properly store when finished operating.

OET & Gantry Cranes – Securing

Move cab-operated cranes to a boarding platform or ladder. Never attempt to walk the rails to enter or exit an OET crane.

Ensure that crane power is turned off and the lower block is not an obstruction. Do not store the hook block in the upper limit unless allowed by the OEM or activity instruction; additionally, provide sufficient clearance below the upper sheave assembly or trolley so that the subsequent operator performing a pre-use check will be able to stop the hoist motion before a two-block event occurs in case the hoist does not operate in the correct direction upon initiation.

When necessary for OET or gantry cranes located outside, secure the crane against movement by the wind. Chock the travel trucks or wheels as necessary.

Activities are required to develop instructions for securing WHE in adverse weather conditions. Operators shall be aware of these requirements.

Knowledge Check

1. True or False. When operating floating cranes you must start swinging or rotating quickly and stop abruptly.

   A. True
   B. False

2. Select the best answer. Lifting heavy loads with floating cranes will cause the barge to ___________.

   A. Drift
   B. Skew
   C. List
   D. Rotate
   E. Sink

3. True or False. Portal crane operators shall stop crane travel if materials or vehicles are inside crane clearance lines.

   A. True
   B. False

4. Select the best answer. When making heavy lifts with locomotive cranes, the use of tilt-blocks or bed-wedges will increase ________________ stability.

   A. On rubber
   B. Over the end
   C. On outriggers
   D. Over the side

5. Select the best answer. Failure to disengage tilt-blocks or bed-wedges for locomotive crane travel may result in _________________.

    A. Derailing the crane
    B. Overloading the crane
    C. Loss of stability
    D. Overheating brakes

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

    A. Luff
    B. Skew
    C. Hoist

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

    A. Luff
    B. Trolley
    C. Swing

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

    A. Rotate
    B. Extend
    C. Bridge

NOTES

CRANE AND RIGGING ACCIDENTS

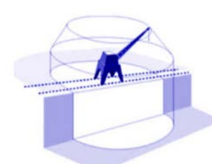
Welcome
Welcome to Crane and Rigging Accidents.

Learning Objectives
Upon successful completion of this module you will be able to identify the elements in the crane and rigging operating envelopes, define a crane accident, define a rigging accident, near miss, and unplanned occurrence, identify the primary causes of accidents, and explain the procedures to follow when an accident occurs.

Accident Categories
There are two general categories of accidents: crane accidents and rigging accidents. Crane accidents are those that occur during operation of a category 1, 2, 3, or 4 crane. Rigging accidents are those that occur when gear and equipment identified in section 14 is used by itself in a weight handling operation, i.e., without category 1 through 4 cranes, or when covered gear is used with multi-purpose machines, MHE (e.g., forklifts), and equipment covered by NAVFAC P-300 in a weight handling operation. In addition, accidents that occur during the operation of entertainment hoists shall be classified as rigging accidents.

Significant Accidents
A significant accident is an accident that typically has a greater potential to result in serious injury or substantial property damage.
The following accident types are considered significant accidents: injuries (regardless of severity), overloads, dropped loads, two-blocks, crane derailments, or contact with overhead electrical power lines.
Other types of accidents that result in OPNAV Class A, B, C, or D reporting thresholds for material property damage are also considered significant accidents.

Crane Operating Envelope
In order to define a crane accident, you must first understand the crane operating envelope.



The operating envelope consists of any of the following elements: the crane (except a crane being operated in transit as defined in NAVFAC P-307 appendix A), the operator, the riggers, signal persons, and crane walker, other personnel involved in the operation, the rigging gear between the hook and the load, the load, the crane's supporting structure (ground, rail, etc.), and the lift procedure.

Rigging Operating Envelope

The operating envelope around any rigging or other section 14 equipment operation includes the rigging gear or miscellaneous equipment identified in section 14, the user of the gear or equipment (including operators of multi-purpose machines, MHE, and construction equipment), other personnel involved in the operation, the load, the gear or equipment's supporting structure (padeyes, ship's structure, building structure, etc.), the load's rigging path, and the rigging or lift procedure.

Knowledge Check

1. Select all that apply. The crane operating envelope includes the crane, the operator, the riggers, the crane walkers, and …

   A. Rigging gear between the hook and the load
   B. Any supporting structures
   C. The load
   D. The area where the load will be landed

2. Select all that apply. The rigging operating envelope contains the rigging gear and miscellaneous equipment covered by NAVFAC P-307 section 14, the load itself and …

   A. Other personnel involved in the operation
   B. The user of the gear or equipment
   C. The rigging procedure
   D. The load rigging path
   E. The crane removal procedure
   F. The gear or equipment's supporting structure

Near Miss

A near miss is an unplanned event during a weight handling operation that did not result in a definable accident but easily had the potential to do so. Only a break in the chain of events prevented an accident. Simply put, a near miss is an accident that almost took place. The difference between a near miss and an accident (serious or otherwise) is often a fraction of an inch or a split second of time. A near miss report is used to learn from situations where an accident "almost" happened so that the real event can be averted.

Unplanned Occurrence

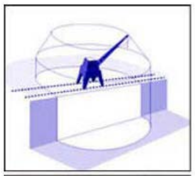
An "unplanned occurrence" describes an event that does not meet the definition of a crane or rigging accident but results in injury or damage to a crane, crane component, or related equipment due to an event not directly related to a weight handling operation. Examples include, but are not limited to, injury or damage caused by weather, damage to a parked or stationary crane caused by another moving object (e.g. vehicle, forklift), and flooding or fire damage.

Reporting

Near Misses and unplanned occurrences that do not fall under the crane and rigging accident definitions shall be reported using figure 12-2 (available on the Navy Crane Center website).

These reports shall be submitted in accordance with NAVFAC P-307 section 12 within 30 days of the event.

Crane Accident



A crane accident occurs when any of the elements in the crane operating envelope fails to perform correctly during a crane operation including operation during maintenance or testing, resulting in any of the following: personnel injury or death, material or equipment damage, dropped load (including any part of the load or rigging gear and any item lifted with the load or rigging gear), derailment, two-blocking, overload (including load tests when the nominal test load is exceeded), or collision (avoidable contact between the load, crane, and/or other objects).

Rigging Accidents

A rigging accident occurs when any of the elements in the operating envelope fails to perform correctly during a rigging operation resulting in any of the following: personnel injury or death, material or equipment damage that requires the damaged item to be repaired because it can no longer perform its intended function, dropped load (including any part of the load or rigging gear and any item lifted with the load or rigging gear), two-blocking of cranes and powered hoists identified in section 14, or overload (including load tests when the test load tolerance is exceeded).

Note: A dropped load, two-blocking, and overload are considered accidents even though no material damage or injury occurs.

Damaged Rigging Gear

When damage to rigging gear is discovered during an inspection or when damaged rigging gear is returned to the gear room, and an accident is suspected, the gear shall be immediately removed from service and a comprehensive investigation initiated.

For a suspected accident, the activity shall follow the investigation and reporting requirements of NAVFAC P-307, section 12, promptly perform a comprehensive investigation, and prepare a Crane and Rigging Accident Report and forward a copy to the Navy Crane Center (Code 06) within 30 days of the accident.

Local Weight Handling Equipment accident reporting procedures shall also be followed.

Accident Examples
Some common examples of accidents are: dropped loads, injuries from a shifting load, failure of rigging gear resulting in a dropped load, overloads, and improperly secured loads falling from pallets.

Accident Exception
A component failure (e.g., motor burnout, gear tooth failure, bearing failure) shall be considered an accident only if damage to the load or another component occurs as a result of the failure.

Accident Causes
In most cases, crane accidents result from personnel error and can be avoided.
Most crane accidents are caused by: inattention to the task, poor judgment, bad communication, team members having too much confidence in their abilities, or operating the crane too fast.

Operator Responsibilities
The operator can play a significant role in eliminating human error and accidents.
Drugs and alcohol can affect a person's capability to think, reason, or react in normal situations and can certainly lead to serious accidents.
Operators must always consult their physicians regarding effects of prescription drugs before operating equipment, and recognize that medications often affect people differently. An operator is responsible for evaluating his or her physical and emotional fitness.

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.

Crane Accident Actions

If a crane accident occurs, personnel must take the following actions:
Stop operations as soon as possible, however don't stop at the expense of safety.
In some circumstances, for example, if a crane is involved in a collision as a load is being lowered, the operator should first land the load, then, follow the accident response procedure.
Don't try to correct the problem unless life or limb is in danger.
Call, or have someone call 911 if an injury occurs.
Secure the crane.
Secure power as required.
If danger exists to the crane or personnel, place the crane and load in a safe position.
Notify supervision as soon as safely possible.
Ensure that the accident scene is preserved to aid the investigation.

Notification and Reporting

For accidents involving a fatality, inpatient hospitalization, overturned crane, collapsed boom, or any other major damage to the crane, load, or adjacent property, notify the Navy Crane Center by e-mail as soon as practical, but not later than eight hours following the accident. Notification for all other accidents shall be made as soon as practical but no later than three working days after the accident.
For each suspected accident, activities shall promptly perform an investigation, prepare a crane and rigging accident report using figure 12-1 (available on the Navy Crane Center web site), and forward a copy to the Navy Crane Center (Code 06) within 30 days of the accident.

Accident Reporting - Contractor

The contractor shall: notify the contracting officer as soon as practical, but not later than four hours, after any WHE accident, secure the accident site and protect evidence until released by the contracting officer, and conduct an investigation to establish the root cause(s) of any WHE accident, near miss, or unplanned occurrence.
Crane operations shall not proceed until the cause is determined and corrective actions have been implemented to the satisfaction of the contracting officer.
The contractor shall provide the contracting officer a report for an accident or near miss within 30 days using the appropriate form provided in NAVFAC P-307 section 12 consisting of a summary of circumstances, an explanation of causes, photographs (if available), and corrective actions taken.

Accident Reporting - Contracting Officer

The contracting officer shall notify the host activity of any WHE accident upon notification by the contractor. Additionally, the contracting officer shall notify the Navy Crane Center, by e-mail (nfsh_ncc_accident@navy.mil), of an accident involving a fatality, in-patient hospitalization, overturned crane, collapsed boom, or any other major damage to the crane or adjacent property as soon as possible, preferably within 8 hours of notification by the contractor. For all other accidents, notify the Navy Crane Center as soon as practical but no later than three working days after the accident.

The contracting officer shall provide the Navy Crane Center and host activity a copy of every accident and near miss report, regardless of severity, upon receipt from the contractor.

The contracting officer or designated weight handling representative shall sign all crane and rigging accident and near miss reports to indicate that they are satisfied that the contractor's investigation and corrective action are sufficient.

Knowledge Check

1. Select the best answer. During maintenance the rigging gear between the crane hook and the load fails and results in equipment damage. This is reported as a:

   A. Rigging gear deficiency
   B. Rigger error
   C. Operator error
   D. Crane accident

2. Select the best answer. During crane operations the load shifts. The operator reacts quickly and saves the load but causes the crane to derail. This is reported as a:

   A. Operator error
   B. Crane walker's error
   C. Load configuration error
   D. Crane accident

3. Select the best answer. When rigging gear covered by NAVFAC P-307 Section 14 fails while suspended from a structure and drops the load it is a:

   A. Load configuration error
   B. Crane accident
   C. Rigging error
   D. Rigging accident

4. Select the best answer. If component failure occurs, such as motor burnout, and does not result in damage, the component failure is considered:

   A. A non-accident
   B. A rigging accident
   C. A crane accident
   D. Crane maintenance's responsibility

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

   A. Crane operators
   B. Weather conditions
   C. Equipment failure
   D. Riggers or signalmen
   E. Personnel error

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

   A. Inattention to the task
   B. The crane operating envelope
   C. Engineering lift specifications
   D. Operating the crane too fast

7. Select the best answer. If you have an accident with a crane or you find damage and suspect an accident has happened, your first step is to:

   A. Call emergency services if anyone is injured
   B. Secure the crane and power as required
   C. Notify your supervisor immediately
   D. Stop operations as soon as safely possible

NOTES

Naval Facilities Engineering Command
NAVY CRANE CENTER

CATEGORY 4 CRANE SAFETY COURSE EVALUATION SHEET

Student Name: ____

Command/Activity/Organization: ______________________________

Instructor: ________________________________ Date: ________________

Directions: To assist in evaluating the effectiveness of this course, we would like your reaction to this class. Do not rate questions you consider not applicable.

Please rate the following items:	Excellent	Very Good	Good	Fair	Poor
Content of the course met your needs and expectations.					
Content was well organized.					
Materials/handouts were useful.					
Exercises/skill practices were helpful.					
Training aids (slides, videos, etc) were used effectively.					
Instructor presented the material in a manner, which was easy to understand.					
Instructor was knowledgeable and comfortable with the material.					
Instructor handled questions effectively.					
Instructor covered all topics completely.					
Probability that you will use ideas from the course in your work.					
Your opinion of the course.					
Your overall opinion of the training facilities.					

What were the key strengths of the training? How could the training be improved? Other comments?

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List other training topics in which you are interested: ______________________

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Note: If you would like a staff member to follow up and discuss this training, please provide your phone number____