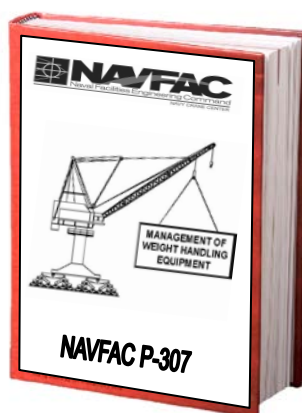




# Navy Crane Center



## NAVFAC P-307 Training

### CATEGORY 2 CRANE SAFETY REFRESHER WEB BASED TRAINING STUDENT GUIDE NCC-C2CSR-04

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## INTRODUCTION

### Welcome

Welcome to Category 2 and Cab-Operated Category 3 Crane Safety Refresher. Category 2 and Cab-Operated Category 3 Crane Safety Refresher is designed to refresh crane operators with Navy requirements for the safe operation of Category 2 and Cab-Operated Category 3 cranes.

Topics covered include: Crane Types and Components, Operator's Daily Checklist (ODCL), Complex and Non-Complex Lifts, Crane Communications, Crane Team Concept, Rigging Gear Requirements and Use, Sing Angle Stress, Sling Use, Safe Operations, and Crane and Rigging Accidents.

### Course Learning Objectives

Upon successful completion of this course you will be able to: understand crane types and components, complete an Operator's Daily Checklist (ODCL), identify complex and non-complex Lifts, understand crane communications and the crane team concept, identify inspection, marking requirements, and use of rigging gear, understand sing use and sling angle stress, identify 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.

## Reference Area

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

Load Test Director and General Crane Safety are two such courses and require you to have the load chart or certification packages handy. Note that the reference button is not available when taking the final exam. Student Guides, a glossary of terms, and pictorial representations of equipment are also available from the reference area.

## Knowledge Checks

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

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

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

## Exam Directions

When taking exams, keep the following in mind...

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

Single answer questions have circles next to the choices.

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

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

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

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

## Feedback

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

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

### Reference Area



- \* **Load Test Director Course**
  - Calculations module
  - Final exam
- \* **General Crane Safety**
  - Load test exercises
  - Final exam
- \* **Student Guides, Glossary**

**Note:** The reference button is not available during the final exam.



## CATEGORY 2 CRANE SAFETY REFRESHER STUDENT GUIDE

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.

# NOTES



## CRANE TYPES AND COMPONENTS

### Welcome

Welcome to Crane Types and Components.

### Learning Objectives

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

### Category 1 Cranes

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

\*Note: Other cranes on barges or floating mountings are the category of the crane itself, e.g., monorail, jib crane, gantry crane.

### Category 1 Crane Examples

Here, and on the next few slides, are some un-narrated pictures and descriptions of different types of category 1 cranes.

#### Category 1 Crane Hammerhead

**Consists of:**

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

**Supported by:**

- a pintle or turntable mounted atop a traveling or fixed tower



Hammerhead

#### Category 1 Crane Floating Crane

**Types:**

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

**Luffing booms:**

- capable of continuous 360° rotation

**Primary power**

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



Floating Crane

#### Category 1 Crane Container Cranes

**Consists of:**

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

**At military port facilities**

**Used for:**

- quickly transferring containers on and off ships



Container Cranes

### Category 1 Crane

#### Derrick

**Example:**

- crane with a boom hinged near the base of a fixed mast

**Typically:**

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



Derrick



### Category 1 Crane

#### Portal

**Consists of:**

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

**Primary power:**

- diesel-engine driven generators or hydraulic pumps
- electric driven

**Support:**

- supported by wide gauge rail allowing the portal crane to move about the facility



Portal



### Category 1 Crane

#### Mobile Crane

**Example:**

- Truck mounted hydraulic Cranes
- most common mobile cranes

**Consists of:**

- rotating superstructure
- upperworks mounted on a specialized truck chassis equipped with a power plant and cab for traveling over the road

**Primary power:**

- one engine for both the upper works and the carrier or
- a separate engine for each

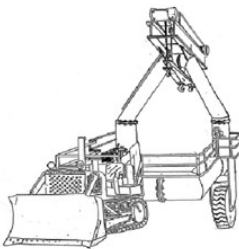


Mobile



### Mobile Boat Hoist

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



### Landing Craft Retrieval Unit

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

### Rubber Tire Gantry 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.

#### Category 2 and 3 Cranes

##### Bridge or OET Crane

**Example:**

- cab-operated
- can be pendant or radio controlled

**Principal parts include:**

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

**Mobility:**

- limited to the area between the runways



Bridge or OET Crane

#### Category 2 and 3 Cranes

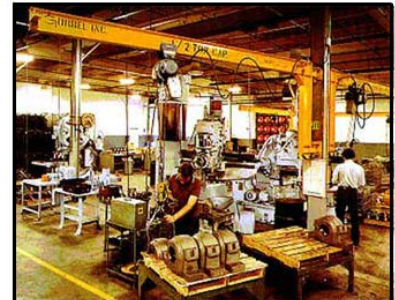
##### Jibs

**Points:**

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

**Consists of:**

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



Jib

#### Category 2 and 3 Cranes

##### Pillar-Jib Crane

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

- Normally rotates 360°



Pillar Jib

#### Category 2 and 3 Cranes

##### Trolley Mounted Overhead Hoist

**Consists of:**

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

**Powered by:**

- manual
- electric
- hydraulic
- or pneumatic powered

**Mobility:**

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



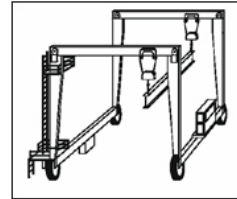
Trolley Mounted Overhead Hoist

### Knowledge Check

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

### Category 1 and 4 Crane Power Types

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

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



### Category 2 and 3 Crane Power

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

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

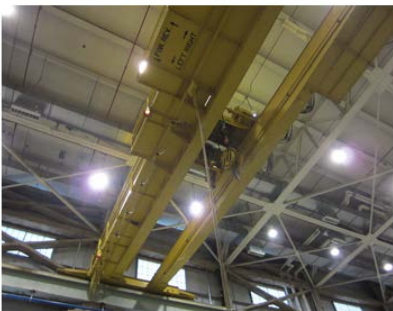
A power-operated crane is driven by electric, pneumatic, hydraulic, or internal combustion means.

Pneumatic and hydraulic power may be delivered to the crane via pipes and/or hoses.

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

### Category 1 and 4 Crane Components

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



### Category 2 and 3 Crane Components

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

## Critical Crane Components

Careful repair and maintenance are essential to safe crane operations.

To ensure repairs are not compromised by sub-standard parts, critical crane components are clearly identified.

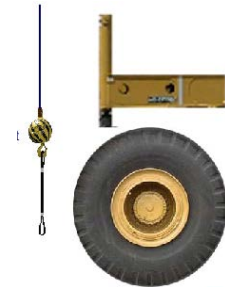
NAVFAC P-307, Appendix F provides examples of load bearing parts, load controlling parts, and operational safety devices.

## Load-Bearing Parts

Load-bearing parts support the load.

Failure of a load-bearing part can cause dropping, uncontrolled shifting or uncontrolled movement of the load.

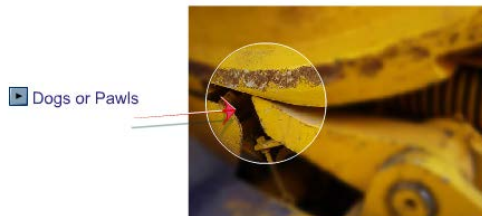
There are many different load bearing parts; this picture shows three examples.



Wire rope,



Sheaves



Dogs or Pawls

prevent unwanted drum rotation

## 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.

## 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.







### 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

### 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

### Examples 2

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

### Safety Devices

Safety devices are divided into two groups, general safety devices and operational safety devices.

Operational safety devices affect the safe lifting and handling ability of the equipment. Operational safety devices are critical crane components.

General safety devices provide protection for personnel and equipment on or in the crane operating path.

### General Safety Devices

General safety devices are those devices that protect or alert the operator or personnel working in the vicinity of the crane.

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



### Load Moment Indicators

Load-moment indicators are operational aids providing the crane operator necessary information to stay within the capacity of the crane. Load-moment indicators that provide shutdown capabilities are operational safety devices. They may provide the operator with load weight, boom angle, and boom length.

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

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



### 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.

### 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.

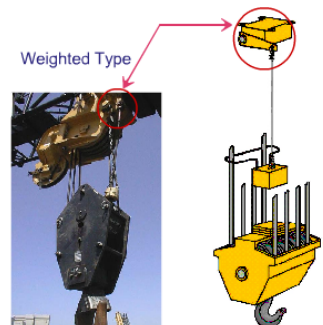
The purpose of a hoist limit switch is to prevent over-travel of the hook block and the possibility of two-blocking.

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.



### Over-speed Devices

Over-speed, pressure, and temperature devices on crane-mounted engines are operational safety devices.

When the engine provides the power to move loads, the devices provide shutdown ability to protect the engine from damage.

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

### Knowledge Check

1. Select the best answer. What types of power does a Category 1 or 4 crane generally use and what is its source?
  - A. Pneumatic and hydraulic power supplied by a compressor
  - B. Hydraulic and water power supplied by a compressor
  - C. Electric or hydraulic power supplied by a diesel engine
  - 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. Handling
  - B. Operation
  - C. Controlling
  - D. Bearing
  - E. Lifting
  
3. Select the best answer. A hook is what type of component?
  - A. Operational Safety Device
  - B. General Safety Device
  - C. Load-Bearing Part
  - D. Load-Controlling Part
  
4. Select the best answer. Hydraulic foot brakes are what type or group of components?
  - A. General Safety Device
  - B. Load-Bearing Parts
  - C. Operational Safety Device
  - D. Load-Controlling Parts
  
5. Select the best answer. Load - \_\_\_\_\_ parts are those that support the load.
  - A. Controlling
  - B. Operational
  - C. Lifting
  - D. Bearing
  - E. Handling

6. Select the best answer. How is electrical current conveyed from the revolving portion of the crane to the lower crane structure?
- A. Through the electrical panels
  - B. Through the collector ring system
  - C. Through the main circuit board
  - D. Through transistors
7. Select the best answer. Safety devices that provide protection for personnel and equipment are considered \_\_\_\_\_ safety devices.
- A. Operational
  - B. General
  - C. Load-bearing
  - D. Universal
8. Select the best answer. Safety devices that affect the safe load lifting and handling capabilities of equipment are considered \_\_\_\_\_ safety device.
- A. Universal
  - B. Operational
  - C. General
  - D. Load-bearing
9. Select the best answer. Which of the following does not affect the safe operation of the crane?
- A. Load-Controlling Parts
  - B. Operational Safety Devices
  - C. General Safety Devices
  - D. Load-Bearing Parts
10. Select the best answer. A travel alarm is what type or group of components?
- A. Operational Safety Devices
  - B. Load-Controlling Part
  - C. Load-Bearing Part
  - D. General Safety Device

## 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.



### ODCL 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.

4 OPERATIONAL CHECK		S	U	NA
3 OPERATOR CAB CHECK				
2 MACHINERY HOUSE CHECK				
1 WALK AROUND CHECK				
a	Safety Guards and Plates *			
b	Carrier Frame and Rotate Base *			
c	General Hardware			
d	Wire Rope *			
e	Reeving			
f	Hooks			
g	Within each section -			
h	Each area is marked:			
i	S = Satisfactory			
j	U = Unsatisfactory			
k	NA = Not Applicable			
l	Wires			
m	Tires, Wheels and Tracks			
n	Leaks			
o	Outriggers and Stabilizers *			
p	Load Chain *			
q	Area Safety *			

### 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. Securing the crane each day
  - B. Complex lifts only
  - C. The first use of the crane each day
  - D. Moving the crane to a new location
2. Select the best answer. The ODCL is used to identify:
  - A. Necessary and missing paperwork
  - B. Who is licensed to operate the crane
  - C. Members of the current crane team
  - D. Conditions that may render the crane unsafe
3. Select all that apply. What are the four sections of a properly performed pre-operational check?
  - A. Walk around check
  - B. Operational check
  - C. Electrical function check
  - D. Stability check
  - E. Machinery House/Machinery Area check
  - F. Operator's cab check
4. Select the best answer. What method of inspection is used in the operator's daily check of the crane?
  - A. Review of OEM manual
  - B. Observing the crane in operation
  - C. Sight, sound and touch
  - D. CCI inspection

## 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 Crane 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.

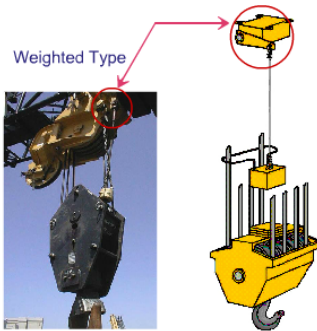
1	WALK AROUND CHECK												
							S	U	NA				
a	2	MACHINERY HOUSE CHECK											
b							S	U	NA				
c	a	3	OPERATOR CAB CHECK										
d	b						S	U	NA				
e	c	a	4	OPERATIONAL CHECK									
f	d	b					S	U	NA				
g	e	c	a	Area Safety *						S	U	NA	
h	f	d	b	Outriggers and Stabilizers *									
i	g	e	c	Unusual Noises									
j	h	f	d	Wire Rope or Chain									
k	i	g	e	Brakes and Clutches *									
l	j	h	f	Boom Angle									
m	k	i	g	Limit Switch									
n	l	j	h	Emergency									
o	m	k	i	Other Operator									
p	n	l	j	Load									
q	o	m	k	General Safe									
r	p	n	l	Fleetling She									

**\* Critical components:**

- Load bearing parts
- Load controlling parts
- Operational safety devices



\*Critical components:  
 • Load bearing parts  
 • Load controlling parts  
 • 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.

## 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.

<p>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 (*).</p> <p>Operations may continue if the condition has been reviewed and continued operation has been authorized by the activity engineering organization.</p> <p>For any unsatisfactory item, identify the specific components and describe the deficiency in the "Remarks" block.</p>	
REMARKS	<p><i>Bridge lights not working</i></p>

## Recording ODCL Results

Results of the inspection must be noted on the ODCL.

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

The operator signs the ODCL after performing the pre-operational check. The ODCL shall be turned in to the supervisor after the last use of the crane each day.

CRANE OPERATOR'S DAILY CHECK LIST											
CRANE NO.	FREQUENCY	LOCATION	CERTIFICATION/ENDORSEMENT	SHIFT	START	STOP	HOURLY METER	WIND OPERATED	DATE		
				1	2	3					
OPERATOR'S SIGNATURE				ISSUE				U = UNSATISFACTORY NA = NOT APPLICABLE			
1. WALK AROUND CHECK				2. MACHINERY HOUSE CHECK				3. OPERATOR CAB CHECK			
a. Safety Guards and Plates				a. Housekeeping				a. Slings			
b. Carrier Frame and Rotator Base				b. Diesel Engine and Generator				b. Indicator and Warning Lights			
c. General Hardware				c. Lube				c. Hydraulic			
d. Wire Rope				d. Lubrication				d. Load Rating Charts			
e. Hoisting				e. Battery				e. Load/Truss Indicator (Floating Crane)			
f. Block				f. Lights				f. Boom Angle/Radius Indicator			
g. Hook				g. Claws				g. Fire Extinguisher			
h. Drums or Drums/Reels				h. Outdrums and Brakes				h. Load Indicator (Floating Crane)			
i. Boom and Jib				i. Electric Motors				i. Danger/Warning Signs			
j. Spacing, Pins, and Boom Stops				j. Auxiliary Engine and Compressor				j. Other Operational Safety Devices			
k. Walkways, Ladders, and Handrails				k. Danger/Warning Signs				k. General Safety Devices			
l. Windlocks, Stops, and Bumpers				l. Fire Extinguishers				l. Freeing Devices			
m. Tires, Wheels and Trails				m. Hoist Drum Pads and Ropes							
n. Lulls											
o. Outdrums and Drums/Reels											
p. Load Chain											
q. Area Safety											
<p>INSTRUCTIONS – Check all applicable items indicated, each day. 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.</p>											
DATE				OPERATOR'S SIGNATURE				SUPERVISOR'S SIGNATURE			
DATE				OPERATOR'S SIGNATURE				OPERATOR'S SIGNATURE			
REMARKS				DATE				DATE			

- Mark each item:
  - S = Sat
  - U = Unsat
  - NA = not applicable
- Sign card
- Turn in daily

## Knowledge Check

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

- Ampersand (&)
- Bold letters
- Asterisks (\*)
- 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?

- Batteries
- Windlocks, Stops and Bumpers
- Emergency Stop button



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. Stop, secure the crane and notify your supervisor
  - D. Report the situation to crane inspection
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 worksheet
  - B. Delivered to maintenance and engineering for action
5. Select the best answer. Each item on the ODCL shall be marked:
  - A. Satisfactory, unsatisfactory, or not applicable
  - B. Stable, unstable, or not applicable
  - C. Serviceable, unserviceable, or not applicable
  - D. Correct, incorrect, not applicable
6. Select the best answer. What is the purpose of a hoist limit switch?
  - A. To cut off power to the crane when contacted
  - B. To prevent rotation of the hook
  - C. To cause the operator to slow down
  - D. To prevent over-travel of the hook block and the possibility of two-blocking
7. Select the best answer. Which of the following tags prohibits operation of equipment when its operation could jeopardize the safety of personnel or endanger equipment?
  - A. Out of Service tag
  - B. Lockout tag
  - C. Danger tag
  - D. Caution tag
8. Select the best answer. Who can remove a danger, caution, or lockout tag?
  - A. The building custodian
  - B. The person who attached the tag or his or her supervisor when they are not available
  - C. The crane operator
  - D. All crane maintenance personnel

### 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	Windlocks, 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.

### General Hardware

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



### Wire Rope and Reeving

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

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

### Block and Hook

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

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



### Sheaves or Sprockets

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



### Walkways, Ladders, Handrails

Check the condition of walkways, ladders, and handrails for loose mountings, cracks, excessive rust, loose rungs, or any other signs of unsafe conditions.

Ensure safety chains and gates are functional.

### Stops and Bumpers

Check stops and bumpers on the crane for cracks or other damage.



### Wheels and Tracks

Check wheels to ensure they are not loose or damaged.

Check tracks for 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.



### Load Chain

Check for damaged or deteriorated links.



### Area Safety

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

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

Verify temporary connections are removed or cleared for operation (e.g., temporary shore power or hotel power).

### Machinery House / Machinery Area Check

This graphic represents the machinery check section of a typical ODCL.

The operator shall perform a machinery house/machinery area check on those cranes and trolleys equipped with a safe access means.

For category 2 and 3 cab-operated cranes, the machinery area check shall be from the ground, the operator's cab, and the walkways.

Machinery House / Machinery Area Check

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



### Housekeeping

Check to ensure that the machinery house 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.

### Leaks

Inspect for excessive grease on machinery.

Look for hydraulic brake fluid leaks around brake linings and cylinders.

Check for lubricating oil leaks around gear cases.

If they appear to be more than normal seepage, report the condition to your supervisor.



### Lubrication

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





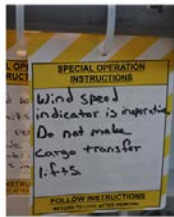
### Clutches and Brakes

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

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

### Electric Motors

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



### 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. Overheating
  - B. Overloading the crane
  - C. Lubrication
  - D. Normal operations
2. Select the best answer. During inspection, cracked or flaking paint may indicate:
  - A. Poor quality paint
  - B. Latex paint over alkyd primer
  - C. Aluminum paint on steel components
  - D. Structural damage or loose bolts

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



### 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.

### Gauges, Indicator and Warning Lights

Check gauges to ensure none are broken or missing and that they are operating normally.

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



### Visibility

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

### Load Rating Charts

Ensure that the load rating charts are posted in the operator's cab and that they are legible.

Verify that the crane number is correct, the certification expiration date is not expired, and the crane capacity is listed.

The two expiration dates that are of particular importance to all crane operators are the expiration date of the certification of the crane being operated, and the expiration date of the operator's license. The operator cannot operate a crane if his or her license is expired, and a crane may not be operated to perform production lifts if the crane certification is expired.



### 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.



### 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

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.

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			



### Area Safety

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

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.



### 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.

### 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.







### Limit Switches

Checking of limit switches shall be performed at slow speed and include each upper hook hoist primary limit switch and the upper and lower boom hoist primary limit switches. (Except for cranes used in construction, verifying the operation of the upper and lower boom hoist limit switches is required only during the initial check of the crane each day.)

Checking of hook hoist lower limit switches is not required if the hook can be lowered to its lowest possible position (e.g., bottom of drydock being worked at minimum radius, floor level for a typical building crane) while still maintaining a minimum of two wraps of

rope on the hoist drum (three wraps for ungrooved drums) or extra chain for a chain hoist.

For cranes that do not have the requisite number of wraps or sufficient chain, the hook hoist lower limit switch shall be checked where operationally possible, i.e., if the crane is at a location where the limit switch can be checked (where the lower limit switch is not checked during the pre-use check, it shall be checked if the crane is subsequently relocated to a position where it can be checked).

When lower limit switch checks are not required, this shall be noted on the crane operators pendant, master switch, or operating instructions.

For cranes that have hoist overload clutches or two-block damage prevention features, do not check the overload clutches or damage prevention features. The ODCL shall be annotated to ensure that these features are not checked.

Checking of secondary limit switches is not required unless a specific operation is planned where the primary limit switch will be bypassed.

### Emergency Stop

Check the emergency stop or power-off button. Know its location and ensure it is working properly. If the emergency stop is checked while a motion is in operation, check at the slowest possible speed.

Note: This is not applicable to diesel engine shutdowns on portal and floating cranes.



### Other Operational Safety Devices

Check any other operational safety devices as directed by the activity engineering organization. An example would be deadman controls. Deadman controls refer to controllers that automatically stop operations when released.

These pictures show two types of deadman controls. A foot switch and a push-button thumb switch on top of the controller.

### General Safety Devices

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



### Summary

Performing a thorough and complete pre-operational crane check is the first step toward safe and reliable crane operations.

The ODCL identifies unsafe conditions and enhances crane reliability. It verifies proper operation of the crane and is conducted once each day.

The ODCL is reviewed by subsequent operators. The operational check is required once per shift.

The ODCL is separated into four sections: the walk around check, machinery house/machinery area check, operator's cab check and the operational check.

### Knowledge Check

1. Select the best answer. The crane number, certification expiration date and certified capacity are found:
  - A. Posted in the crane maintenance area
  - B. Posted on the crane
  - C. In the operator's manual
  - D. In the EOM
  - E. In the load lift review
2. Select the best answer. Dead man controls refer to controllers that automatically ...
  - A. Stop operations when released
  - B. Push your hand away from the handle when the crane stops
  - C. Compensate for slow operator response
  - D. Change operational speeds to suit conditions
3. Select the best answer. If you observe a red tag on a piece of equipment, you should:
  - A. Verify the tag was from previous work
  - B. Under no circumstances operate this piece of equipment
  - C. Remove the tag and continue operations
  - D. Review the special instructions and operate accordingly
  - E. Fix the problem and operate the equipment
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. Fix the problem and operate the equipment
  - C. Remove the tag and continue operations
  - D. Review the special instructions and operate accordingly
  - E. Verify the tag was from previous work

# NOTES



## COMPLEX AND NON-COMPLEX LIFTS

### Welcome

Welcome to the Complex and Non-Complex lifts module.

### Learning Objectives

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

### Non-Complex Lifts

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

### Complex Lifts Overview

Complex lifts have a moderate to high level of risk.

Activities are required to identify complex lifts and prepare detailed written procedures for their execution.

Procedures may be in the form of standard instructions or detailed procedures specific to a lift.

### Complex Lift Categories

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

### Complex Lift Procedures

Activities shall identify complex lifts and prepare procedures (including rigging sketches where required) for conducting these lifts. Procedures may be standard written instructions or detailed procedures specific to a lift.

A supervisor or working leader must review on-site conditions and conduct a pre-job briefing for all complex lifts.

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

A rigger supervisor, operator supervisor, or working leader shall personally supervise lifts exceeding 80 percent of the certified capacity of the crane's hoist used for the lift (except for lifts of ordnance with category 3 cranes and all lifts with jib cranes, pillar jib cranes, fixed overhead hoists, and monorails), multiple-hook lifts when the weight of the

object being lifted exceeds 80 percent of the certified capacity of any hoist used for the lift, and lifts of ordnance involving the use of tilt fixtures.

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

### Complex Lift Exceptions

Exceptions to the complex lift requirements include lifts over 80% of the certified capacity made with jib cranes, pillar jib cranes, fixed overhead hoists, and monorail cranes. These cranes are usually smaller capacity cranes used primarily to service only one workstation, machine or area.

Lifts of test weights during maintenance or load test are excluded from the complex lift requirements.

Ordnance lifts covered by NAVSEA OP 5 in lieu of the NAVFAC P-307 are also excluded; except for lifts using tilt fixtures, lifts where binding may occur, lifts of submerged loads, multiple crane or multiple hook lifts.

### Knowledge Check

1. Select the best answer. Detailed written procedures are required for:
  - A. Complex lifts
  - B. All lifts
  - C. Non-complex lifts
  - D. Some lifts
2. Select the best answer. For all complex lifts, a rigger supervisor, operator supervisor, or rigging or crane operator working leader shall review on-site conditions and shall...
  - A. Select rigging gear
  - B. Conduct a pre-job briefing
  - C. Inspect all rigging gear
  - D. Define the crane operating envelope
3. Select the best answer. Lifts of test weights during maintenance or load test are ...
  - A. Evaluated according to the complex lift requirements
  - B. Routine lifts because they are not complex shapes
  - C. Included in the complex lift requirements
  - D. Excluded from the complex lift requirements
4. Select the best answer. A crane with a capacity of 100,000 pounds is performing a lift of 40,000 pounds. This is a(n):
  - A. Complex lift
  - B. Non-complex lift
  - C. Hazardous lift
  - D. Overload lift

### Complex Lift Examples

#### 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 Shapes

Complex lifts also include large and complex shapes.

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

#### 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.

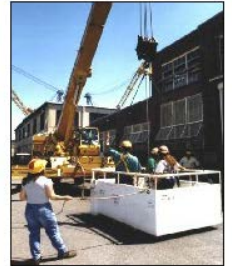
A body harness and shock absorbing lanyard shall be worn and attached to a structural member within the personnel platform capable of supporting the impact from a fall. The harness and anchorage system shall conform to OSHA requirements.

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% of capacity

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

Use a larger capacity hoist if possible to avoid exceeding 80% of capacity.



### Submerged Lifts

Lifts of submerged or partially submerged objects are complex lifts. The following lifts are not considered complex:

Removal of valves, rotors, pipes, etc., from dip tanks for cleaning or coating purposes.

Lifting boats of known weight from the water if the boats are of open design with bilge compartments accessible for visual inspection; the boats have label plates indicating weights; and the boats have pre-determined lifting points established by the OEM or the activity engineering organization.

Lifting submerged or partially submerged objects that meet the following criteria: the object is verified to not contain fluid in pockets and/or voids that is unaccounted for in the weight of the object; the object is verified or known to not be stuck by suction or adhesion by corrosion, marine growth, excessive surface tension, mud, etc.; and the object is verified to be clear of obstructions such as other objects in the water, or underwater cables.



### Lift Requirements for Multiple Crane or Multiple 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 established and the LID shall be carefully monitored to ensure the stop point is not exceeded.

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



### Other 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 personal protective gear is worn
  - B. Always considered complex lifts
  - C. Not considered complex if personnel lifting devices are used
  - D. Considered complex only under special conditions
3. Select the best answer. Personnel in a man-lift platform or basket must ...
  - A. Wear a full body harness with a shock-absorbing lanyard
  - B. Wear aircraft reflective tape on their hard hat
  - C. Wear a safety belt with a shock-absorbing lanyard
  - D. Stand with knees bent to absorb motion shock
4. Select the best answer. For personnel lifts, the total load must not exceed ...
  - A. 80% of the hoist's rated capacity
  - B. The load chart capacity
  - C. 50% of the hoist's rated capacity
  - D. The gross capacity if designated as a complex lift

## NOTES

## CRANE COMMUNICATIONS

### Welcome

Welcome to Crane Communications.

### Learning Objectives

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

### Crane 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 re-established.

In addition, the operator shall immediately respond to a direction from any person to stop the crane.

Radio communications are well suited for blind and complex lifts.

As a general rule, direct voice should only be used when the operator and rigger are working in close proximity and ambient noise is not a factor.

### Hand Signals

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).



### 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 signaler communicates with the crane operator at a time.

## Radio Communications

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

### Radio guidelines

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



### Radio work practices

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

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

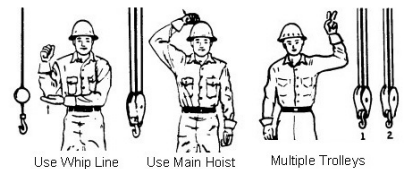
## Knowledge Check

1. Select the best answer. Direct voice should only be used when:
  - A. The operator and the rigger are working in close proximity and ambient noise is high
  - B. No other form of communication is available 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. EOM
  - B. Crane lift history
  - C. ASME Hand Signal Chart
  - D. Crane maintenance records
3. Select the best answer. How many signalers shall communicate with the crane operator at the same time?
  - A. One signaler at a time
  - B. No signalers unless directed by the rigger-in-charge
  - C. Up to three signalers
  - D. One signaler for each crane involved

4. Select the best answer. A universal language understood by everyone involved with weight handling is:
  - A. Hand signals
  - B. Spoken word
  - C. Direct voice commands
  - D. Signal flags
5. Select the best answer. Any additional hand signals must be ...
  - A. Approved by the ASME
  - B. Approved by OSHA
  - C. Approved by NIOSH
  - D. Approved by the activity
6. Select the best answer. Another form of communication, other than hand signals, must be used if ...
  - A. Activities designate alternative methods
  - B. The signaler is in clear view of the rigger-in-charge
  - 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.



#### Whip Line or Auxiliary Hook

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

#### Main Hoist

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

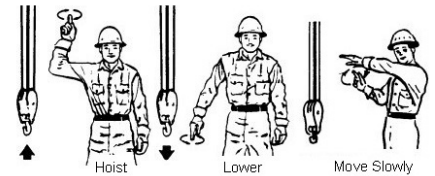


#### Multiple Hooks/Trolleys

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

## Hoist Signals

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



### Hoist

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

## Lower

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



### Hoist/Move Slowly

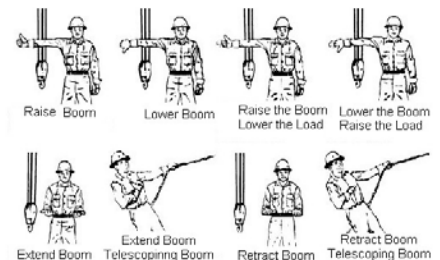
A hand held motionless in front of any signal indicates to move slowly.

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 the Boom

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

## Lower Boom

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





### Raise Boom/Lower Load

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



### Lower Boom/Raise Load

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

### 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 and thumbs pointing toward each other, motioning in and out.

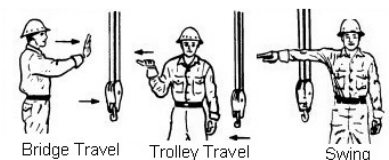


### Retract One Handed

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

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

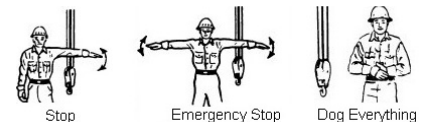
### Swing

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



### Signals for Stopping Crane Movements

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.

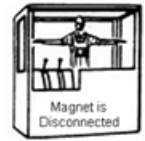


### Dog Everything

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.

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



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

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



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

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



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

- A. Separate the load
- B. Move closer
- C. Retract the boom
- D. Lower 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. Stop
- B. Emergency Stop
- C. Swing
- D. Magnet disconnect



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

- A. Magnet disconnected
- B. Emergency stop



8. Select the best answer. This signal indicates:

- A. Dog everything
- B. Emergency stop
- C. Retract boom
- 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. Hoist
- C. Move slowly
- D. Trolley travel
- E. Swing



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



## NOTES



## CRANE TEAM CONCEPT

### Welcome

Welcome to Crane Team Concept.

### Learning Objectives

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

### Crane Team Concept

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

### Crane Team Members

The basic crane team consists of the crane operator and the rigger-in-charge. The supervisor may assign other personnel as required. Additional members may include: riggers, signal persons, and crane walkers.

A rigger supervisor, operator supervisor, or a rigging or crane operator working leader may conduct team briefings.



### Knowledge Check

1. Select the best answer. The Crane Team Concept was developed to ensure that all operations involving the crane are executed without:
  - A. Injury to personnel
  - B. Damage to property
  - C. Damage to equipment
  - D. All of the above
2. Select the best answer. The minimum Crane Team consists of:
  - A. The crane operator, crane supervisor, and crane rigger
  - B. The crane operator and rigger-in-charge
  - C. The crane operator, crane walker, and crane rigger
  - D. The crane operator, rigger supervisor, and crane rigger
3. Select the best answer. Additional crane team members may be assigned by ...
  - A. The crane operator as required
  - B. The EOM designation
  - C. The supervisor as required
  - D. The crane rigger as required

### Shared Responsibilities

While each member of the crane team has individual responsibilities, all team members share some common responsibility, including participation in pre-job briefings, watching for potential problems and making other team members aware of them.

All team members are responsible for keeping non-essential personnel away from the crane's operating envelope during lifting evolutions.

Any crane team member shall stop the job any time unsafe conditions are found and report to supervision problems that cannot be resolved by the team.

### Pre-Job Briefing

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

Any newly assigned personnel shall be briefed by the supervisor or working leader.



### Communications

Communications during the lift are just as important as the pre-lift brief.

All team members must be made aware of any problems that are discovered.

When making lifts where hand signals are not feasible, the rigger giving the signals shall remain in continuous voice communication with the operator. If the communication ceases, the operator shall stop operation until communication is reestablished.

### Safety

Stop crane operations before personnel board the crane.

Cranes should be positioned to allow safe boarding.

Stop work if you're unsure about the assigned task or, if you feel safety is in jeopardy.

Have problems resolved before resuming operations.



### Crane Operator Responsibilities

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

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

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

### Pre-Use Check

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



### Full Understanding of the Lift

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. Combined responsibility of all team members
  - B. Sole responsibility of the crane operator
  - C. Sole responsibility of the rigging supervisor
  - D. Combined responsibility of the crane operator and the crane supervisor
3. Select the best answer. Crane operators are responsible for all of the following except:
  - A. Lifting and landing all loads safely
  - B. Doing a thorough ODCL inspection
  - C. Maintaining communication with the signaler
  - D. Slowing down when signals are unclear

4. Select the best answer. If you feel safety is in jeopardy during the performance of your task, you should:
  - A. Call your supervisor for clarification
  - B. Evaluate the lift plan
  - C. Stop work and have the problem resolved
  - D. Use the OEM manual to solve the problem
5. Select all that apply. The crane operator must immediately stop operations when ...
  - A. Any time a stop signal is given
  - B. The weather forecast is not good
  - C. The operating envelope is penetrated
  - D. Operations have exceeded allowed time
  - E. Communications are lost during a blind or complex lift

### Rigger-In-Charge Responsibilities

The rigger-in-charge (RIC) has overall control of the operation including: planning all aspects of the lift; determining the weight of the load to be lifted; establishing the appropriate method of communication with the operator; ensuring the load is properly rigged; ensuring the crane operating envelope remains clear of all obstructions; providing signals to the operator or assigning another rigger or signal person to provide the signals; and conducting the operation in a safe manner.

The RIC shall coordinate the activities of other crane team members.

The RIC shall not perform functions that would compromise their overall control of the operation.



### Rigger Responsibilities

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

### Crane Walker Responsibilities

Often a crane supervisor will assign a crane walker to the crane team. Like the crane rigger, the crane walker is responsible for carrying out the assignments of the rigger-in-charge and the rigging supervisor.



### Assisting with the Pre-Use Check

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



### Signal Person Responsibility

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

### Supervisor Responsibilities

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

### Site Conditions

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

### Operation near 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. Supervisor
  - B. Crane rigger
  - C. Crane operator
  - D. Rigger-in-charge
  
2. Select the best answer. Planning the lift route is the responsibility of the:
  - A. Crane supervisor
  - B. Crane operator
  - C. Crane rigger
  - D. Rigger-in-charge
  
3. Select the best answer. Coordinating the activities of the crane team is the responsibility of the:
  - A. Rigger-in-charge
  - B. Activities
  - C. Crane operator
  - D. Crane supervisor
  - E. Crane rigger



## 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.

### The 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. In an inspection program
  - B. Authorized for use
  - C. New to the activity
  - D. Not damaged
3. Select the best answer. Equipment test and inspection requirements in section 14 of NAVFAC P-307 do not apply to:
  - A. Personnel platforms
  - B. Container spreaders
  - C. Cranes and hoists integral to larger machines
  - D. OEM installed bolt-on pads

## Equipment Markings

Markings on each piece of equipment are the most apparent way for you, the user, to know the requirements of NAVFAC P-307 have been met. Equipment must be marked per the applicable ASME B30 volume (B30.9 for slings, B30.10 for hooks, B30.16 for portable hoists, B30.20 for below-the-hook lifting devices, B30.21 for lever hoists, and B30.26 for rigging hardware).



In addition to the identification and marking requirements of the applicable ASME volume, except as noted in NAVFAC P-307 paragraphs 14.8 and 14.11, each piece of equipment must be clearly marked, tagged or engraved with an indication of the re-inspection due date and a unique serial number that will allow it to be traced to its test and inspection documentation.

Below the hook lifting devices weighing more than 100 pounds shall be marked with the weight of the device.

Markings must be done in a manner that will not affect the strength of the component. Vibra-etch methods and low stress dot faced stamps are acceptable methods for marking equipment.

Contact the OEM for guidance on where and how to mark equipment.

Load tests, documented inspections, and special equipment markings (other than the manufacturer's markings required by B30.26) are not required for equipment covered by ASME B30.26 (shackles, adjustable hardware, compression hardware, links, rings, swivels, rigging blocks, and portable load indicating devices.)

### Wire Rope Endless Slings

Endless slings shall have a marked rated load based on a D/d efficiency of 50 percent and may be used over various size pins at loads not exceeding the marked rated load.

Where endless wire rope slings are designed for a particular use, they shall be marked to indicate the pin diameter used to determine the rated load.



### Chain Slings

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

### Markings on Lashing

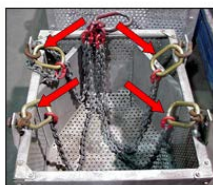
Lashing must be marked to identify it to the spool or reel from which it came.

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.

### Braided Wire Rope Slings

NAVFAC P-307 requires that braided slings shall have the OEM's marking re-marked at 70% of the OEM's rated load unless destructive tests are conducted on sample slings.

The documentation is reviewed by the Navy Crane Center.

So, there are many additional markings that may be required for different equipment. Not only do these markings have to be present, they must be legible.



### Illegible or Missing Markings

Sometimes markings become hard to read due to wear or they may even be removed during a repair process.

Replace markings that are hard to read or have been removed.

Remember, all rigging equipment must be marked.



### Required Records

Equipment markings should link the piece of equipment to its test and inspection records.

NAVFAC P-307 requires documentation of tests and inspections.

Records are the auditable proof that equipment has been tested and inspected and provide a basis for ongoing evaluation of the equipment.

The latest test and inspection record will be retained on file at the activity.

Computer generated files are acceptable if they identify the individual components and inspection results.

### Record Information

NAVFAC P-307 requires that the records include identification of individual components, latest test and inspection results, and dates of inspections and tests.

There are many ways to identify the equipment to the records.

MASTER HISTORY RECORD CARD		EQUIPMENT TYPE / DWG NO		EQUIPMENT ID	
SPS CAPACITY	MANUF. RECOMMENDED PERIODIC TEST VALUE	MAX. MATERIAL REMOVAL AUTHORIZED		CF 1270	PROOF TEST VALUE
RECORD OF INSPECTION / TESTING		MAINTENANCE REPAIR AND MODIFICATION RECORD			
CYCLE	PURPOSE / DESCRIPTION	S	U	CYCLE	DESCRIPTION
Annual	Load Test Chainhoist	X			
			J.W. Inspector		
			1/27/20XX		



### Matching Gear to Record

A unique identification number may be used to identify the equipment to its record.

The ID number can be as simple or complex as you need it to be.

A simple method might be to use a letter designator that represents a particular type of gear followed by a serialized number.

Mark the equipment ID number on the gear. Write the ID number on the record.

Now the gear has identifiable records!

### Gear Marking Example

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

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

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

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

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



This particular number indicates that it was the 28th sling manufactured or certified on a specific day.

The number 94-350 identifies the day it was manufactured or certified:

- 94 being the year 1994
- 350 being the day of the year.

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

### Knowledge Check

1. Select all that apply. Which of the following markings are required on lashing?
  - A. The re-inspection due date
  - B. Size
  - C. Serial number
  - D. Rated load
2. Select the best answer. Rigging gear test and inspection records must include:
  - A. Identification of individual components
  - B. Dates of tests and inspections
  - C. Latest test inspection results
  - D. All of the data listed above
3. Select the best answer. Matching ID marks on rigging gear are required for:
  - A. All rigging equipment
  - B. End fittings on slings
  - C. Chain slings with permanent attachments
  - D. Rope or chain sling bridle assemblies
  - E. Components that can be separated
4. Select the best answer. Rigging gear test and inspection records are required to be kept on file:
  - A. Until replaced by a more current record
  - B. For 1 year
  - C. For 3 years
  - D. For 6 months

## NOTES



## RIGGING GEAR GENERAL USE

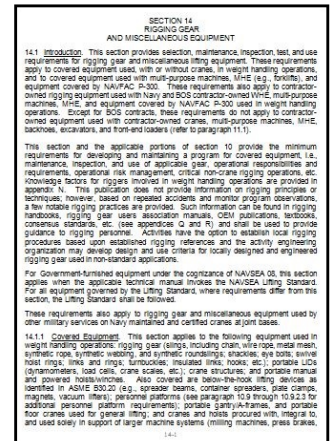
Welcome to the Rigging Gear General Use module.

### Learning Objectives

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

### NAVFAC P-307 Section 14

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



### 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.



### Rigging Gear Hazards

The first major hazard we must talk about is abuse.

Here the biggest hazard is you, the user!

Don't drag your slings on the ground. Cement or paved surfaces will quickly abrade slings and gear. Contact with the ground can embed grit and abrasives into the sling, which will cause damage.

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

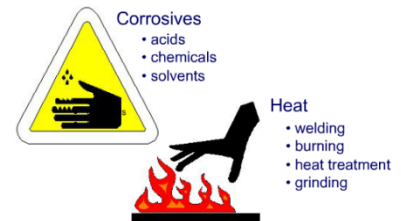
### Hazards (Corrosives and Heat)

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

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

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

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



### Hazards – Sharp Edges

Another common hazard is sharp edges.

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



### Hazards - Electrical

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

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

Wire rope, chain, and metal mesh slings should never be used if they could increase the possibility of electrical shock.

Protect yourself and the gear by ensuring all power is secured prior to installing your gear on or around electrical components.



### Protective Materials

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

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

When wrapped around corners and sharp edges, synthetic slings shall be completely blocked from contacting the edge with hard material such as split piping, blocks, or special rounded shoes, not soft material such as canvas, fire hose or leather gloves.

Sling manufacturers also provide products that protect slings from sharp corners or edges. Activities should contact the manufacturer for availability of such products.

### Sling Protection

Ensure the rigging configuration is stable and slings cannot slide off the sling protection. The level of protection required is based on potential damage at the contact interface.

Damage potential levels are classified as abrasion, bearing, and cutting. The level of protection chosen shall be commensurate with the type of damage potential.

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

### Hoist and Crane References

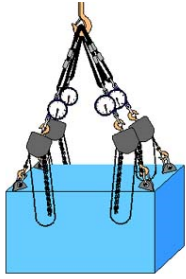
Portable manual and powered hoists/winches shall meet the criteria of ASME B30.16 and OEM recommendations.

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

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

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





### Hoists and Crane Usage

When using chain hoists and portable floor cranes, ensure hoist capacities meet or exceed the expected load.

Load indicating devices may be used in conjunction with hoists to help prevent overload of the hoist and related gear when leveling, rotating, or tilting objects.

### Using Hoists and Cranes (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.



### Using Hoists and Cranes



Never choke with load chain



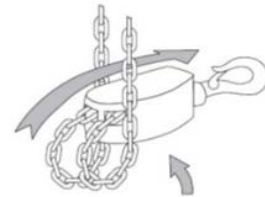
Never "tip load" the hook

### Usage Don'ts

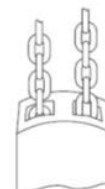
Never use the load chain to choke around an object and never "tip load" the hook!

### Additional Chain Hoist Requirements

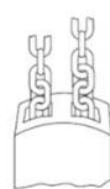
Do not run the load chain all the way out (bitter end) on a chain hoist as this puts extra pressure on the holding pin and doesn't allow for any payout adjustment once it is hooked into the load. When using chainfalls, ensure the chain is not twisted due to the lower block being "capsized", or twisted.



Make certain the bottom block has NOT been flipped through the chain falls



Appearance of chain that is Not Twisted



Appearance of chain that Is 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 12
  - B. Section 14
  - C. Section 8
  - D. Section 10
2. True or False. It is okay to use home-made rigging gear as long as you are lifting light loads.
  - A. True
  - B. False

3. Select the best answer. When selecting rigging gear for a job, which of the statements below should be followed?
  - A. Never use damaged gear
  - B. Consider height restrictions when selecting sling lengths
  - C. Never use gear past its inspection due date
  - D. Base rigging gear on the total stress, not just the weight of the load
  - E. Follow all of the above
4. Select the best answer. What should be used between the rigging gear and the load to prevent damage to the load and rigging?
  - A. Metal spacers
  - B. Appropriate Sling Protection
  - C. Your hand
5. True or False. Two people can operate a chain fall if the pull chain is too hard for one person to pull while hoisting a load.
  - A. True
  - B. False

## NOTES





## SLING ANGLE STRESS

### Welcome

Welcome to Sling Angle Stress.

### Learning Objectives

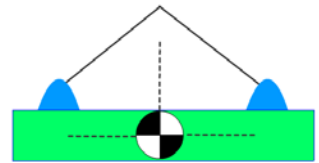
Upon successful completion of this module you will be able to: define sling angle stress and explain why it must be accounted for, calculate sling angle stress and determine the minimum sling length and rated capacity for lifts.

### Introduction to Sling Angle Stress

#### Definition

What is sling angle stress?

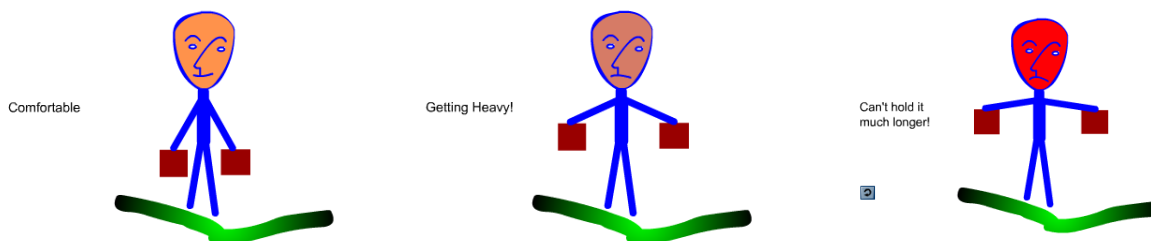
It is the added force or load created in the rigging when the slings are not perfectly plumb, vertical, and parallel.



#### Demonstration

It may be beneficial to use an illustration that we can relate to.

Though this is not exactly sling angle stress, it illustrates the concept very well.



### 90° Example

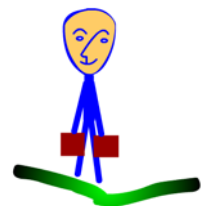
Here's Ace.

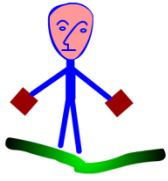
He is holding a fifty-pound weight in each hand.

His arms are vertical, similar to a 90° horizontal sling angle.

The amount of stress in Ace's arms is equal to the amount of weight he's holding, fifty pounds.

See what happens as Ace moved his arms increasingly further away from his body.





### 45° Example

When Ace has his arms at a 45° angle the stress in his arms increases even more.

The stress increase is 42% of the weight he's holding. It feels like he's holding 71 pounds in each arm.

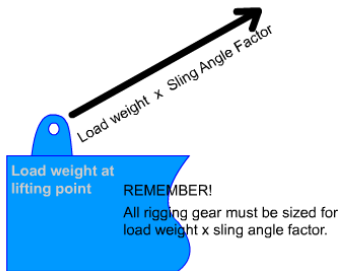
### 30° Example

At a 30° angle, the amount of stress in Ace's arms increases further.

The stress increase at 30° is 100% of the weight he's holding.

Now Ace feels like he's holding 100 pounds in each arm even though the weight is still actually 50 pounds.

This same effect, called sling angle stress, occurs in rigging gear because the legs of a lift are almost always at angles. This additional stress must be considered when selecting rigging gear.



### Choosing Your Gear

The two-leg rule is followed when choosing gear capacities for a lift.

Rigging gear must have a capacity greater than the applied load.

The load applied to the rigging gear includes the weight carried by the attachment points multiplied by the sling angle factor.

### The Effects of Sling Angle

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.

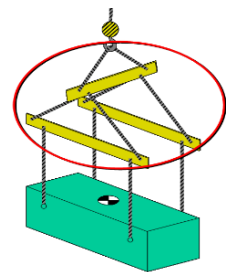
Remember, sling angle stress does not change the weight of the load being lifted; only the load on the rigging.

### 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.

## Examples

At a 60° angle the load on the rigging has increased to 1,155 pounds.

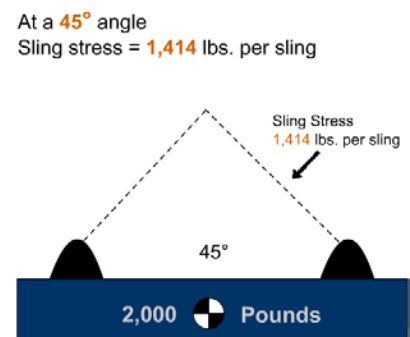
Keep in mind each leg has 1,155 pounds of stress even though only one leg is shown.

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!

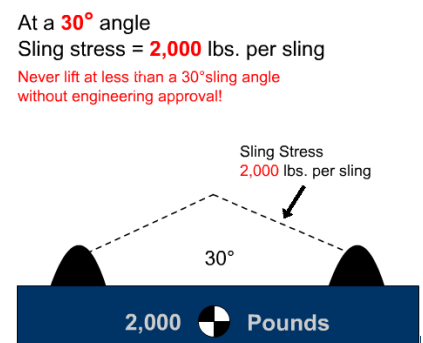


At a 30° angle the stress has increased to 2,000 pounds.

Each sling now has a load equal to the weight of the object!

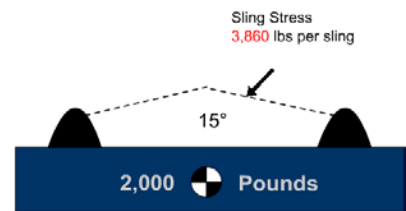
That is a 100% increase!

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!

At a 15° angle  
Sling stress = **3,860 lbs per sling**  
**Never lift at less than a 30° sling angle without engineering approval!**



#### Effects of Sling Angle Stress on each leg

**60° angle** - the load increases to 1,555 lbs.  
Each leg has 1,155 lbs. of stress - a **16% increase**.  
A 60° sling angle is the preferred angle to use.

**45° angle** - the load increases to 1,415 lbs.  
Each leg has 1,415 lbs. of stress - a **43% increase**.

**30° angle** - the load increases to 2,000 lbs.  
Each leg has 2,000 lbs. of stress - a **100% increase**.



### Why Must We Account for Sling Angle Stress?

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

### Minimum Rated Capacity

Remember, two legs must have the capacity to lift the weight of the object, plus the added force from sling angle stress.

After we calculate the sling angle stress, we can determine the minimum requirements for our rigging gear.

### Angle Factor

#### Determining Sling Angle Stress

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

#### 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.

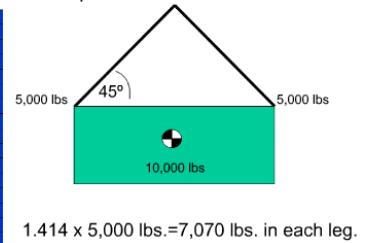
Horizontal Angle	Angle Factor
90	1.000
85	1.004
80	1.015
75	1.035
70	1.064
65	1.104
60	1.155
55	1.221
50	1.305
45	1.414
40	1.555
35	1.742
30	2.000
25	2.364
20	2.924
15	3.861
10	5.747
5	11.490

### 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.

### Angle Factor Chart Example

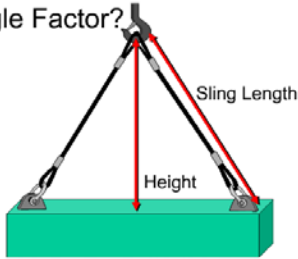
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40	1.555
35	1.742
30	2.000
25	2.364
20	2.924
15	3.861
10	5.747
5	11.490



### What is Angle Factor?

Angle Factor =

$$\frac{\text{sling length}}{\text{height}}$$



### 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.

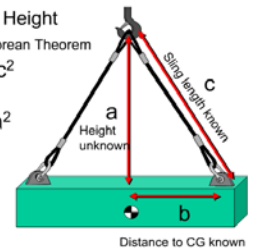
### How to Find Height

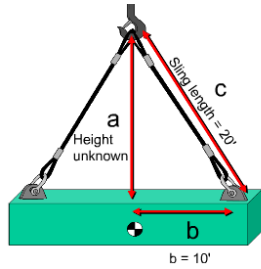
Use the Pythagorean Theorem

$$a^2 + b^2 = c^2$$

To solve for a:

$$c^2 - b^2 = a^2$$





$$c^2 - b^2 = a^2$$

$$(20 \times 20) - (10 \times 10) = a^2$$

$$(400) - (100) = 300$$

$$\text{Square Root of } 300 = 17.32$$

$$\text{Height} = 17.32$$

### 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 the Angle Factor

Remember the angle factor equals sling length divided by height.

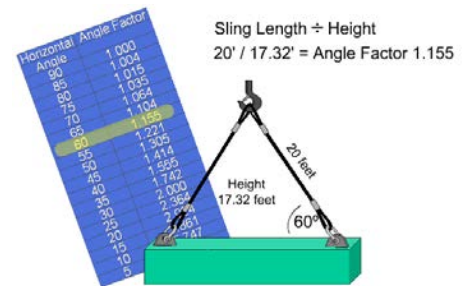
We just found the height of the lift triangle.

Now, here's how to find the angle factor:

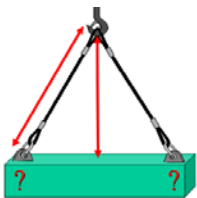
The sling is 20 feet long and we found the height to be 17.32 feet.

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



$$(\text{Sling Length} \div \text{Height}) \times \text{Weight Distribution} = \text{Sling Angle Stress}$$

Now we can use everything we've covered thus far to solve for sling angle stress.

Here's the formula: Sling length divided by height, times the weight distributed to each leg.

Remember, weight distribution is determined by the distance from the center of gravity to the attachment points.

This works for all lifts with level attachment points.

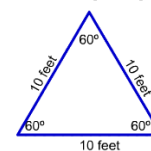
### Sling Angle Methods

#### 60 Degree Sling Angle

60° is the preferred sling angle.

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

#### 60° Sling Angle - Preferred Sling Angle



- Only 16% load increase
- Easy to select slings

But...

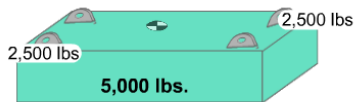
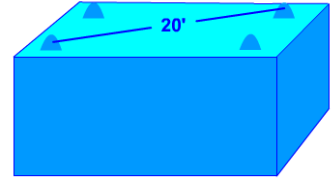
- Best sling lengths are not always available
- Configuration may restrict
- Overhead clearance



### 60° Sling Length

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°.

- In this case 20 feet.



60° angle Factor of 1.155

$1.155 \times 2,500 \text{ lbs.} = 2,888 \text{ lbs. Stress}$

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

### 60° Minimum Capacity

Now we can easily determine the stress in the rigging before we attach the gear. Let's say the weight of the object is 5,000 pounds.

How much weight would each attachment point carry?

Each would carry 2,500 pounds.

What is the angle factor for a 60° 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!

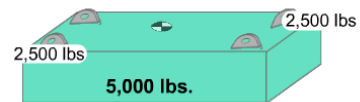
### 30° Minimum Capacity

Using the same weight, let's look at the minimum rated capacities for a 30° sling angle.

The angle factor for 30° is 2. At a 30° sling angle, the rigging and attachment point stress will double.

Two times 2,500 pounds equals 5,000 pounds of stress.

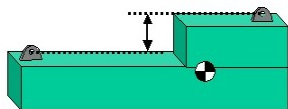
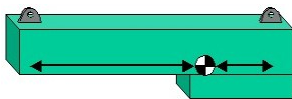
The minimum capacity sling and rigging gear required is five thousand pounds.



30° Angle Factor = 2.00

$2.00 \times 2,500 \text{ lbs.} = 5,000 \text{ lbs. stress}$

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



### Unequal Distances from the Center of Gravity

Where the center of balance is not equally distant between attachment points or when attachment points are on different levels, sling angle stress will not be equal between legs and extra calculations will be required.

Contact your supervisor and consult the activity engineers for guidance when there is a question about sling angle stress for these types of lifts.

### Knowledge Check

1. True or False. 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 6 degrees or greater?
  - A. 3
  - B. 4
  - C. 6
  - 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 rated capacity of the gear
  - C. Multiply the weight of the item with the distance between attachment points
  - D. Multiply the weight in the attachment point with the height of the lift triangle

## 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 capital D represents the diameter of the object and the small d represents the diameter of the sling.

When using wire rope slings always maintain a minimum D-to-d ratio of one to one in the body of the sling.

In other words, never bend a wire rope around a diameter smaller than itself!

Bending a wire rope around a diameter smaller than its minimum D-to-d ratio will damage the wires and weaken the sling.

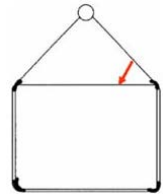
### Wire Rope (Continued)

For loads with a non-circular cross section the bend diameter is derived from the minimum bend diameter of the wire rope around the corner of the load.

For slings bent around corners, the corners must be rounded to provide the minimum D/d efficiency.

Chafing protection is used to protect the load and sling from damage.

Except for braided slings, wire rope slings shall not be used in single leg vertical hitches, unless a method is used to prevent un-laying of the rope.



### Wire Rope Temperature Restrictions

Wire rope must also be protected from extreme temperatures, which can seriously affect the wire's strength.

Do not use wire rope slings below minus 40 degrees or above 400° Fahrenheit.

Fiber core rope wire should not be used above 180° Fahrenheit.



### Wire Rope Restrictions

Wire rope clips should not be used to fabricate slings.

And wire rope slings should never be knotted.



### Chain Sling Use

Chain slings are a good choice when the job demands abrasion and damage resistant slings. However, if used improperly, they too can be damaged.

Chain slings should not be used on loads that are damaged easily.

Never use knots or bolts to shorten or extend the sling.

Use sling protection materials on sharp corners and edges to prevent damage to slings and the load.

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

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

For chain slings with an angle of choke less than 121 degrees, the percent of rated capacity shall be determined by the sling OEM or the activity engineering organization.



### Chain Sling Temperature Restrictions

The sling manufacturer should be consulted when the slings are to be used in temperatures of minus or negative 40 degrees Fahrenheit (F).

For slings exposed to temperatures of 400 degrees Fahrenheit or above, follow ASME B30.9 requirements for rated load reduction.

### Metal Mesh Sling Temperature Restrictions

Metal mesh slings are often used in abrasive or high temperature environments that would damage slings.

Do not use bare metal mesh slings when temperatures are below -20° or above 550° Fahrenheit.

Do not use elastomer coated slings when temperatures are below 0° or above 200° Fahrenheit.

Metal mesh slings shall be used in accordance with ASME B30.9 and OEM recommendations.



### Types of Synthetic Slings

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.

### Synthetic 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.

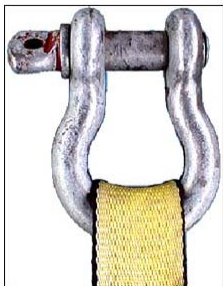
Web slings must be installed flat around the load without kinks or twists.

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.

### 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 Use

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

Stranded synthetic rope slings shall not be used in a single part vertical hitch, unless a method is used to prevent unlaying of the rope.

When making single point lifts with eye and eye synthetic rope slings, use two slings or double up a single sling. If they are allowed to spin, the splice could come undone and drop the load!

The minimum D-to-d ratio is 1 to 1.

This means a one half-inch diameter synthetic rope sling cannot bend around any object that is smaller than one half-inch.

Synthetic rope slings shall not be substituted for other types of slings shown on rigging sketches without prior engineering approval.

### Synthetic Rope Sling Temperature Restrictions

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



### Roundsling Use

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

Roundslings shall be used only in the lifting application for which they were designed by the OEM, and in strict compliance with the OEM's instructions.

For new roundslings, a certificate of proof test shall be retained in the history file for the life of the sling.

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

They shall not be used in a choker hitch if the sling OEM recommends against this practice.

### Other Roundslings

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



### Roundsling Temperature Restrictions

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



### Sling Use Considerations

Slings must not be used at angles less than 30° from horizontal unless specifically authorized by an engineering work document.

Never use a sling that has been knotted.

Use sling protection as needed.

Rigging gear including slings, shackles, turnbuckles, and eyebolts, must be sized such that two legs can carry the load to allow for variations in sling length and load flex.

### Eye and Hook Considerations

The size of the hook or shackle relative to the size of the sling eye can be critical.

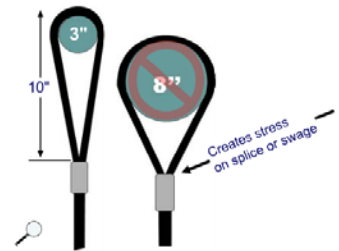
If we place a ten-inch long sling eye on a load which is 3 inches in diameter, the eye opens slightly and causes very little added stress to the eye or the splice.

However, if we place that sling on a hook with a diameter of 8 inches, this can stress the eye and can cause the swage or stitches to fail.

Never place the eye of a wire rope sling around an object which has a diameter greater than 1/2 the length of the eye.

Never place the eye of a synthetic web or rope sling around an object which has a diameter greater than 1/3 the length of the eye.

If the hook diameter is too large, a shackle can be used to connect the slings to the hook, thereby reducing the diameter over which the sling eyes are placed.



### Attaching Gear to Hooks

When attaching rigging gear to hooks be sure the safety latch is working properly and closes the throat opening without obstruction.

Failure to do so can allow the gear to come off the hook.

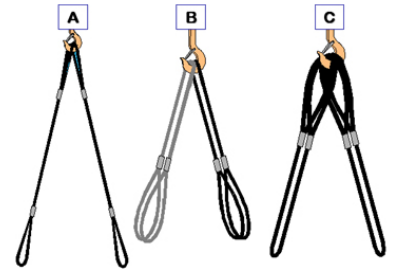
All gear attached to the hook must seat properly in the bowl. Do not stack slings or allow slings to cross each other in the hook. That can lead to crushing of the slings!

### Correct 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 on the hook.

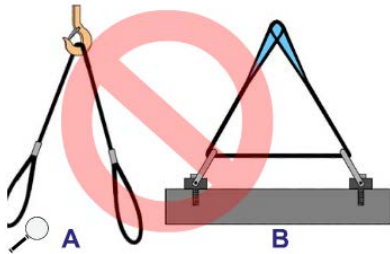
Graphic "B" shows two slings doubled over the hook and sling eye attachment points.

Graphic "C" shows two slings doubled with sling eyes on the hook down to attachment points.



When wire rope slings are used as in graphics "B" and "C", and a heavy load is applied, individual wires may become permanently deformed or bent.

If a sling is doubled to the point where it is permanently set, it should not be used in a vertical or straightened out configuration because straightening the sling could cause the wires to break in the strands.



### Incorrect Use of Slings on Hooks

These graphics illustrate some incorrect ways of attaching slings to a hook.

Incorrect sling applications can be extremely dangerous and can result in loss of load control and personnel injury! Graphic "A" shows a single sling with the "bight" riding the hook and the eyes attached to two separate attachment points.

Slings applied in this manner could slip on the hook causing the load to shift.

Graphic "B" shows a sling through two attachment points.

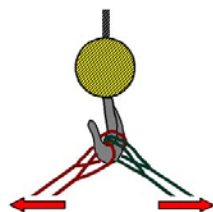
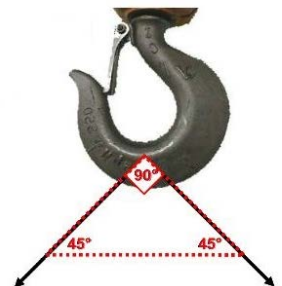
Installing a sling through more than one attachment point will create excess stress on the sling, the attachment points, and the gear.

### Included Angle

Included angle is the angle measured between two slings sharing a common attachment point.

Where slings are supported in a hook, the included angle of the slings shall not exceed 90 degrees, unless otherwise approved by the activity engineering organization.

Hooks shall not be loaded at the point or tip, or be side loaded.



### Inside and Outside 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

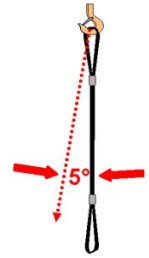
Slings are used in straight-line, choker, and basket hitches.

A straight-line hitch is commonly referred to as a vertical hitch.

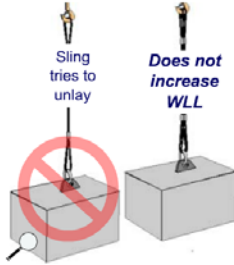
The rated load for the same sling with each hitch will be different.

## Straight-Line Hitch

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.



2 Legs prevent unlaying



## 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.

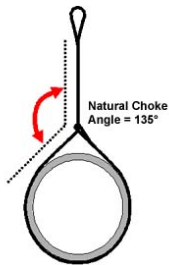
## Choker Hitches

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.

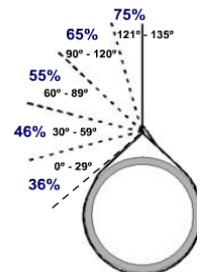
## Choker Hitch Efficiency

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.





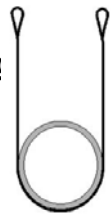
### Basket Hitches

Basket hitches are the strongest of the three hitches.

Slings in a basket hitch can carry 200% of the sling's single rated load when the sling angle is less than 5° from vertical, and the required D-to-d ratio is maintained.

Wire rope requires a D-to-d ratio of greater than 40 to 1.

Synthetic rope requires a D-to-d ratio of at least 8 to 1.



### Knowledge Check

1. Select the best answer. The minimum D/d ratio in the body of a synthetic rope sling is:  
  - A. 1:1
  - B. 2:1
  - C. 3:1
  - D. 4:1
2. True or False. D/d ratio does not affect synthetic web slings.  
  - A. True
  - B. False
3. True or False. It is acceptable to bend a 1 inch wire rope sling around a ¾ inch shackle.  
  - A. True
  - B. False
4. Select the best answer. The minimum D/d ratio allowed for wire rope slings is:  
  - A. 1:1
  - B. 2:1
  - C. 3:1
  - D. 4:1
5. Select the best answer. With the proper D/d ratio a sling in a basket hitch can lift \_\_\_\_\_ of the rated load of the sling.  
  - A. 75%
  - B. 100%
  - C. 150%
  - D. 200%

## NOTES





## SAFE OPERATIONS

### Welcome

Welcome to Safe Operations.

### 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. Use the shortest boom length possible
  - B. Do pre-use checks
  - C. Keep the crane clean
  - D. Operate safely
2. Select the best answer. Crane operators at naval activities may operate various types, makes, and models of cranes for which they are licensed. How must safety and operator proficiency be assured under these circumstances?
  - A. Operators must receive written and performance tests by a crane license examiner as outlined in the NAVFAC P-307 manual
  - B. Operators must be familiarized (as directed by a supervisor) before operating
  - C. Operators must operate at reduced speeds until confident and capable
3. Select the best answer. What information should be posted, clearly understandable, and readily available to the operator?
  - A. Travel speed through congested areas
  - B. Crane operator's license number
  - C. Certification information

4. Select the best answer. Which of the following operator responsibilities is considered the basis for ensuring a safe and reliable crane?
  - A. Firm and level supporting surface
  - B. Proper set-up on outriggers
  - C. The Pre-Use Check or Operators Daily Checklist (ODCL)
  - D. Periodic lubrication and servicing
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. ODCL Checks
  - C. Operator's License Number
6. Select the best answer. When can an unlicensed crane operator trainee operate a crane?
  - A. In an emergency
  - B. Only under the direct observation of a licensed operator
  - C. When he or she needs to operate a crane to get the job done
  - D. When their supervisor tells them to operate a crane

### Operator Awareness

When operating a crane, the operator must be aware of everything in the operating envelope including hazards, obstructions, and personnel.

At the same time the operator must be aware of the sound, feel and behavior of the crane.



### Unsafe Conditions

Whenever an unsafe condition exists, operators must immediately stop operation and the condition must be resolved before continuing.

If you cannot resolve a safety issue with the team members, contact the supervisor for assistance.

Remember, operators have the authority and responsibility to stop and refuse to operate the crane until safety is assured.



### Lifts Near Personnel

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



### Riding Loads

Personnel must never ride loads.

Use only approved personnel-lifting devices if personnel must be lifted.

### Overhead Power Lines

Whenever working near overhead power transmission lines, have the power de-energized and visibly grounded.

When the power cannot be de-energized, the minimum required clearances described in figure 10-3 of NAVAC P-307 must be maintained.

If any part of the crane or load could approach the distances noted in figure 10-3 of NAVAC P-307, a designated spotter shall be assigned.

In addition, a supervisor shall visit the site, assess potential hazards, and establish procedures to safely complete the operation.

Follow the requirements of NAVFAC P-307 paragraphs 10.13.1 through 10.13.6 for crane operations near or below overhead electrical transmission lines, operation near communication towers, and travelling below power lines.

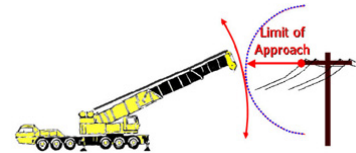
Minimum clearance distances for operation near electric power lines and for transit with no load and boom or mast lowered.

VOLTAGE, KV (PHASE TO PHASE)	MINIMUM REQUIRED CLEARANCE, FT (M)
<b>Operation Near High Voltage Power Lines</b>	
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)
<b>In Transit with No Load and Boom or Mast Lowered</b>	
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

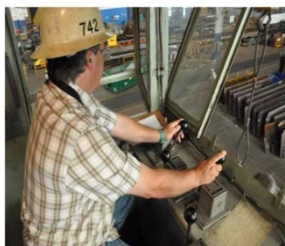
When operating a crane in the vicinity of overhead electrical transmission lines, for voltages less than 350 kV, the minimum required clearance is 20 feet. Where the voltage is known to be 350 kV or more, the minimum required clearance is 50 feet.



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.

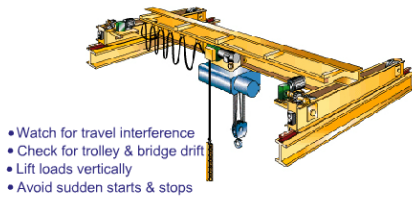
### Crane Operating Characteristics

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 at one speed until the load lifts
  - B. Hoist slowly and remove slack from the rigging gear
  - C. Hoist slowly until the load lifts
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. Refuse to continue until safety is assured
  - B. Proceed slowly with caution
  - C. Note the incident on the back of the ODCL card
  - D. Tell his/her supervisor at the end of the shift
5. Select the best answer. Side loading a crane boom by dragging loads or lifting a load with a non-vertical hoist may result in:
  - A. Destructive stresses placed on the boom and sheaves
  - B. Possible overload due to swinging of the load after lifting
  - C. Uncontrolled movement of the load due to shifting
  - D. Any of the listed factors above
6. Select the best answer. In general, which of the following things should an operator do when traveling cranes with loads?
  - A. Keep loads just high enough to clear obstacles
  - B. Start slowly and increase speeds gradually
  - C. Avoid sudden stops
  - D. Stow or secure unused hooks
  - E. Perform all of the listed actions above
7. Select the best answer. If a heavy load shall be inched into an exact vertical position, should the final adjustment be made by raising or lowering? Why?
  - A. By hoisting. When hoisting, the load may lower before the speed is high enough to lift the load.
  - B. 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.
  - C. By hoisting. When lowering, the speed may not be controllable.

## 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.

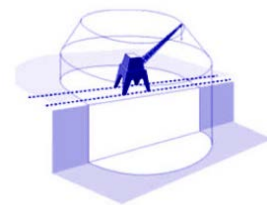
The following accident types are considered significant accidents: injuries (regardless of severity), overloads, dropped loads, two-blocks, crane derailments, or contact with overhead electrical power lines.

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. Any supporting structures
  - B. The load
  - C. The area where the load will be landed
  - D. Rigging gear between the hook and the load
2. Select all that apply. The rigging operating envelope contains the rigging gear and miscellaneous equipment covered by P-307 section 14, the load itself and ...
  - A. The crane removal procedure
  - B. The gear or equipment's supporting structure
  - C. Other personnel involved in the operation
  - D. The load rigging path
  - E. The user of the gear or equipment
  - F. The rigging procedure

### Near Miss

A near miss is an unplanned event during a weight handling operation that did not result in a definable accident but easily had the potential to do so. Only a break in the chain of events prevented an accident. Simply put, a near miss is an accident that almost took place. The difference between a near miss and an accident (serious or otherwise) is often a fraction of an inch or a split second of time. A near miss report is used to learn from situations where an accident "almost" happened so that the real event can be averted.

### Unplanned Occurrence

An "unplanned occurrence" describes an event that does not meet the definition of a crane or rigging accident but results in injury or damage to a crane, crane component, or related equipment due to an event not directly related to a weight handling operation. Examples include, but are not limited to, injury or damage caused by weather, damage to a parked or stationary crane caused by another moving object (e.g. vehicle, forklift), and flooding or fire damage.

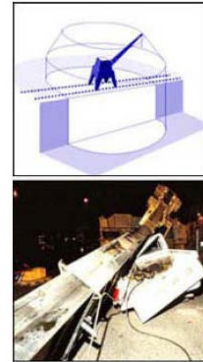
## Reporting

Near Misses and unplanned occurrences that do not fall under the crane and rigging accident definitions shall be reported using figure 12-2 (available on the Navy Crane Center website).

These reports shall be submitted in accordance with NAVFAC P-307 section 12 within 30 days of the event.

## Crane Accident

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.

### Contractor Accident Reporting Procedures

The contractor shall: notify the contracting officer as soon as practical, but not later than four hours, after any WHE accident, secure the accident site and protect evidence until released by the contracting officer, and conduct an investigation to establish the root cause(s) of any WHE accident, near miss, or unplanned occurrence.

Crane operations shall not proceed until the cause is determined and corrective actions have been implemented to the satisfaction of the contracting officer.

The contractor shall provide the contracting officer a report for an accident or near miss within 30 days using the appropriate form provided in NAVFAC P-307 section 12 consisting of a summary of circumstances, an explanation of causes, photographs (if available), and corrective actions taken.

### Contracting Officer Reporting Procedures

The contracting officer shall notify the host activity of any WHE accident upon notification by the contractor. Additionally, the contracting officer shall notify the Navy Crane Center, by e-mail (nfsh\_ncc\_accident@navy.mil), of an accident involving a fatality, in-patient hospitalization, overturned crane, collapsed boom, or any other major damage to the crane or adjacent property as soon as possible, preferably within 8 hours of notification by the contractor. For all other accidents, notify the Navy Crane Center as soon as practical but no later than three working days after the accident.

The contracting officer shall provide the Navy Crane Center and host activity a copy of every accident and near miss report, regardless of severity, upon receipt from the contractor.

The contracting officer or designated weight handling representative shall sign all crane and rigging accident and near miss reports to indicate that they are satisfied that the contractor's investigation and corrective action are sufficient.

### Knowledge Check

1. Select the best answer. During maintenance the rigging gear between the crane hook and the load fails and results in equipment damage. This is reported as a:
  - A. Rigger error
  - B. Rigging gear deficiency
  - C. Crane accident
  - D. Operator error
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. Crane walker's error
  - B. Crane accident
  - C. Operator error
  - D. Load configuration error
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. Crane maintenance's responsibility
  - C. A rigging accident
  - D. A crane accident

5. Select the best answer. To whom or to what are the majority of crane accidents attributed?
- A. Riggers or signalmen
  - B. Equipment failure
  - C. Personnel error
  - D. Crane operators
  - E. Weather conditions
6. Select all that apply. Over-confidence and poor judgment among team members can contribute to crane and rigging gear accidents. Select additional factors that can contribute to accidents:
- A. The crane operating envelope
  - B. Inattention to the task
  - C. Operating the crane too fast
  - D. Engineering lift specifications
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. Notify your supervisor immediately
  - C. Stop operations as soon as safely possible
  - D. Secure the crane and power as required

## NOTES



## CATEGORY 2 CRANE SAFETY REFRESHER EVALUATION SHEET

Student Name: \_\_\_\_\_

Command/Activity/Organization: \_\_\_\_\_

Instructor: \_\_\_\_\_ Date: \_\_\_\_\_

Directions: To assist in evaluating the effectiveness of this course, we would like your reaction to this class. Do not rate questions you consider not applicable.

Please rate the following items:	Excellent	Very Good	Good	Fair	Poor
Content of the course met your needs and expectations.					
Content was well organized.					
Materials/handouts were useful.					
Exercises/skill practices were helpful.					
Training aids (slides, videos, etc) were used effectively.					
Instructor presented the material in a manner, which was easy to understand.					
Instructor was knowledgeable and comfortable with the material.					
Instructor handled questions effectively.					
Instructor covered all topics completely.					
Probability that you will use ideas from the course in your work.					
Your opinion of the course.					
Your overall opinion of the training facilities.					

What were the key strengths of the training? How could the training be improved? other comments?

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List other training topics in which you are interested: \_\_\_\_\_

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Note: If you would like a staff member to follow up and discuss this training, please provide your phone number \_\_\_\_\_