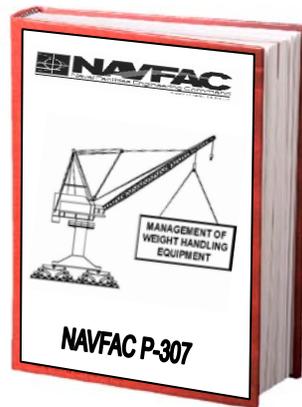




Navy Crane Center



NAVFAC P-307 Training

GENERAL CRANE SAFETY STUDENT GUIDE

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NAVFAC P-307 MODULE

PURPOSE

The overall purpose of NAVFAC P-307 is to maintain the level of safety and reliability that was originally built into the equipment, ensure optimum service life, provide uniform standards for weight handling equipment operator licensing, and ensure safe weight handling operations.

Weight Handling Equipment includes both cranes and the rigging gear used for lifting operations.

NAVFAC P-307 APPLICABILITY

NAVFAC P-307 applies to naval shore activities, naval construction forces, including the Naval Construction training centers, and naval special operating units.

NAVFAC P-307 meets, or exceeds, all OSHA regulations that apply to the operation of cranes.

WEIGHT HANDLING REQUIREMENTS

NAVFAC P-307 provides requirements for Weight Handling Equipment including maintenance (repairs and alterations), inspection, test, certification, operations, training, licensing, and rigging gear use.

WHE MAINTENANCE AND INSPECTION

NAVFAC P-307 also provides requirements for documentation.

CERTIFICATION POSTING

The crane identification number, certified capacity and certification expiration date must be posted on or near the crane.

Posting a copy of the actual certification, crane test cards, stickers or signs, are all acceptable methods provided they include the required information.

Certification

CRANE NO	TYPE CRANE	TEST LOAD (lbs.)	TEST PROCEDURE
12345-7	OET	12,500	APPENDIX E
MAIN HOIST	MAIN HOIST	AUX HOIST	WHP HOIST
RATED CAPACITY	10,000 lbs.	5,000 lbs.	lbs.
TYPE SERVICE AUTHORIZED	SPECIAL PURPOSE SERVICE OR GENERAL PURPOSE SERVICE		
GPS			
CERTIFICATION DATE	CERTIFICATION EXPIRATION DATE		
1 July 20xx	30 JUNE 20xx 1 YEAR		
I certify inspection and test has	Certification Includes:		July 20xx
SIGNATURE OF TEST DIR John Q. Teste	• Crane Number • Crane Capacity • Certification • Expiration Date		
OPERATOR AND LICENSE Pat Operate			

Crane Testing Information Card can be used to display crane certification information.

All cranes require certification in accordance with NAVFAC P-307

NAVFAC P-307 COVERED EQUIPMENT

NAVFAC P-307 covers category 1, 2, 3, and 4 cranes, as well as rigging gear. Detailed descriptions of the cranes are included in Section 1. Illustrations of individual crane types can be found in Appendix B.

GENERAL CRANE SAFETY STUDENT GUIDE

Rigging gear is covered in Section 14.

NAVFAC P-307 OVERVIEW SECTION 1

Section 1 describes cranes and crane-related equipment and lists types of cranes and related equipment used at Naval Shore activities by category.

Knowledge Check

1. Circle all that apply. The purpose of the NAVFAC P-307 is to:

- a. Ensure safe crane and rigging operations.
- b. Maintain built in safety and reliability.
- c. Maintain curriculum standards for the NCC.
- d. Provide standards for crane operations and rigging.
- e. Ensure crane operators become licensed.

2. Circle the correct answer. The standards defined in the P-307

- a. do not pertain to OSHA regulations.
- b. meet or exceed all OSHA regulations that apply to operating a crane.

CATEGORY 1 CRANES

Category 1 Cranes include:

- Portal Cranes
- Hammerhead Cranes
- Locomotive Cranes
- Derricks
- Floating Cranes
- Tower Cranes
- Container Cranes
- Mobile Cranes
- Aircraft Crash Cranes
- Mobile Boat Hoists
- Rubber Tire Gantry Cranes

All category 1 cranes require a license to operate.

GENERAL CRANE SAFETY STUDENT GUIDE

Category 1 Crane Floating Crane

Types:

- barge
- pontoon or
- hull-mounted
- rotating superstructure mounted on an integral base

Luffing booms:

- capable of continuous 360° rotation

Primary power

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



Floating Crane

Category 1 Crane Hammerhead

Consists of:

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

Supported by:

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



Category 1 Crane Container Cranes

Consist 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



Category 1 Crane Derrick

Example:

- jib-equipped crane having 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

Load movement:

- toward the mast by raising the boom
- away from the mast by lowering the the boom



Derrick

Category 1 Crane Portal

Consist of:

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

Primary power:

- diesel-engine driven generators or hydraulic pumps

Support:

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



Portal

Category 1 Crane Mobile Crane

Example:

- Truck mounted hydraulic Cranes
- most common mobile cranes

Consists of:

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

Primary power:

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

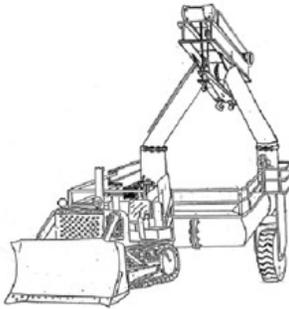
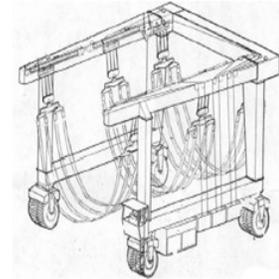


Mobile

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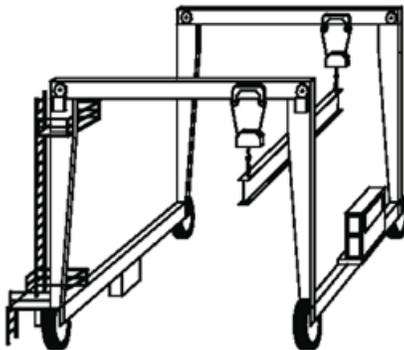
Mobile Boat Hoist

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



The landing craft retrieval unit 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



- Portable elevated bridge crane mounted on legs
- Legs are supported by powered or unpowered wheels with rubber tires

CATEGORY 2 AND 3 CRANES

Category 2 and Category 3 cranes include:

- Bridge Cranes
- Rail Mounted Gantry
- Pillar Jib
- Wall cranes
- Jib cranes
- Monorail
- Fixed overhead hoists
 - Manual
 - Powered

GENERAL CRANE SAFETY STUDENT GUIDE

Portable hoists are defined in section 14 of NAVFAC P-307. The activity may, however, treat them as Cat 2 or 3 cranes.

CATEGORY 2 AND 3 CRANE CAPACITY

The certified capacity of these cranes determines the category.

Category 2 cranes have a certified capacity of 20,000 lbs. and **greater**.

Category 3 cranes are those with a certified capacity of **less than** 20,000 lbs.

CATEGORY 2 AND 3 CRANE TYPES

Category 2 and 3 Cranes

Bridge or OET Crane

Example:

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

Consists of:

- a single or multiple bridge girders spanning a building with top-running
- or under-hung trolleys

Mobility:

- limited to the area between the runways



Bridge or OET Crane

Category 2 and 3 Cranes

Pillar Jib - Fixed Crane

Consists of:

- a rotating vertical member
- with a horizontal arm carrying a trolley and hoist

Mobility:

- normally be rotated 360°



Pillar Jib

Category 2 and 3 Cranes

Jibs

Points:

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

Consist 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

Trolley Mounted Overhead Hoist

Consist of:

- an under-hung, trolley-
- one or more drums and sheaves for wire rope or they may utilize chain

Powered by:

- manual
- electric
- hydraulic
- or pneumatic powered

Mobility:

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



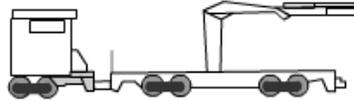
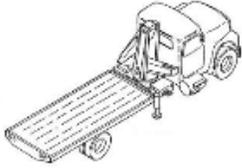
Trolley Mounted Overhead Hoist

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CATEGORY 4 CRANES

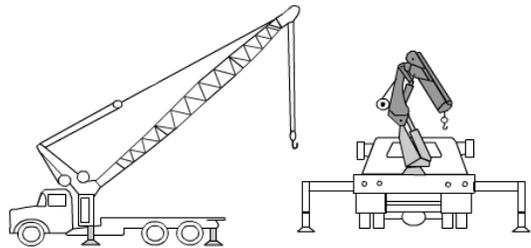
Mounting

Category 4 cranes may be attached to stake beds, trailers, flat bed trucks, rail cars, or may be stationary mounted on piers, barges, etc.



Booms

Category 4 Cranes may have a non-telescoping, telescoping, or articulating boom.



Pedestal Mounted - Capacity

Pedestal mounted commercial boom assembly cranes of with less than 2,000 lbs. capacity are considered Category 3 cranes.

Capacities greater than 2,000 lbs. are Category 4 cranes and require a licensed operator.

Special Considerations

Commercial truck mounted cranes [described in ASME B30.5] and articulating boom cranes [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 4 CRANE TYPES

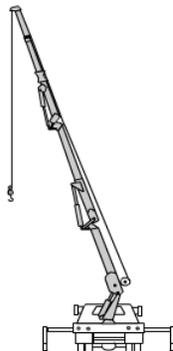
Category 4 Cranes

Boom Assemblies

- Non-Telescoping
- Articulating
- Telescoping

Mounted on:

- Mobile Units
 - flat bed trucks
 - trailers
 - stake beds
 - rail cars
- Stationary Units
 - Piers



GENERAL CRANE SAFETY STUDENT GUIDE

Truck Mounted Commercial Boom Assembly

Hydraulic Boom Crane

- Commercial
- Truck-Mounted
- Standard Ground Control

Structure:

- carrier, usually a flatbed truck
- independently operated crane

Power:

Power to operate may be from the truck's engine by way of a power take off unit

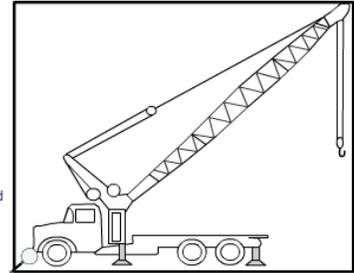


Truck Mounted Commercial Boom Assembly

Non Telescoping Boom

Consists of:

- a rotating superstructure (center post or turn-table)
 - boom,
 - operating machinery
 - one or more operator's stations
- Its function is to lift, lower, and swing loads at various radii.



Non-Telescoping Boom

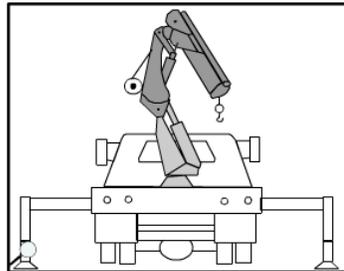
Articulating Boom

Consists of:

- the carrier, usually a flatbed truck
- independently operated articulating boom crane.

Power:

Power to operate may be from the truck's engine by way of a power take off unit



Articulating Boom Crane

Truck Mounted Articulating Boom



Articulating Boom Crane Truck Mounted

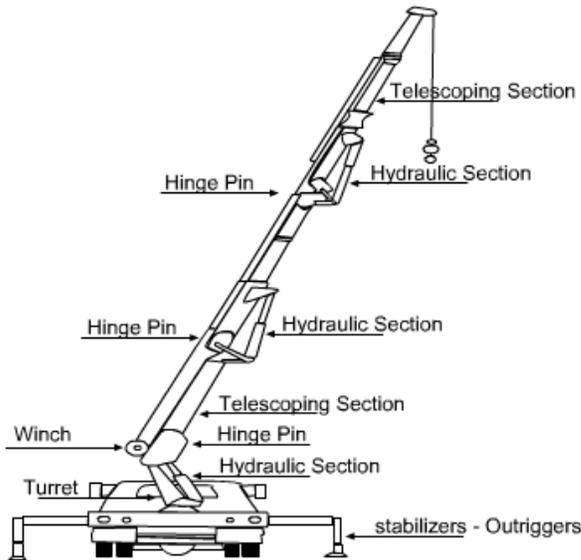
Hydraulic Extendible Boom



Hydraulic Extendible Boom

GENERAL CRANE SAFETY STUDENT GUIDE

CATEGORY 4 CRANE COMPONENTS



LICENSING (SECTIONS 6, 7, AND 8)

All personnel who work with Navy cranes must be trained in accordance with the NAVFAC P-307 Section 13.

Cat 1, Cat 2, cab-operated Cat 3, and Cat 4 operators must be trained and licensed according to Sections 6, 7, and 8.

Licenses are not required to operate non-cab operated Cat 3 cranes. However, training and a demonstration of ability to operate safely is required.

Knowledge Check

1. Non-Cab Operated Cat 3 cranes require a license to operate.

- A. True
- B. False

2. **Circle all that apply.** A license is required to operate:

- A. Category 1 cranes.
- B. Category 2 cranes.
- C. Cab operated Category 3 cranes.
- D. Most Category 4 cranes.

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3. **Select the best answer.** Category 2 and Category 3 cranes are separated by:

- A. certification date.
- B. licensing requirements.
- C. boom capacity and length.
- D. certified capacity

NAVFAC P-307 SECTION 12 CRANE AND RIGGING ACCIDENTS

In the event of an accident, activities shall investigate and report the accident in accordance with NAVFAC P-307 Section 12, as well as OPNAV Instructions 5102.1.

Crane and Rigging Gear Accident definitions can be found in Section 12.

Crane Accident Definition

A crane accident occurs when any of the elements of the operating envelope fail to perform correctly during operations, including operation during maintenance or testing resulting in the following:

- Personnel Injury or death
(Minor injuries that are inherent in any industrial operation, including strains and repetitive motion related injuries, shall be reported by the normal personnel injury reporting process of the activity in lieu of these requirements.)
- Material or equipment damage
- Dropped load
- Derailment
- Two-blocking
- Overload
- Collision including unplanned contact between the load, crane, and/or other objects.

Rigging Gear Accident Definition

A rigging gear accident occurs when any of the elements of the operating envelope fails to perform correctly during weight handling operations resulting in the following:

- Personnel injury or death.
(Minor injuries that are inherent in any industrial operation, including strains and repetitive motion related injuries, shall be reported by the normal personnel injury reporting process of the activity in lieu of these requirements.)
- Material or equipment damage that requires the damaged item to be repaired because it can no longer perform its intended function.
- Dropped load

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- Two-blocking or cranes and powered hoists covered by section 14 (Rigging Gear and Miscellaneous Equipment)
- Overload

NAVFAC P-307 - SECTION 13 TRAINING

Section 13 of NAVFAC P-307 provides training and qualification requirements for personnel involved in the management of Navy Weight Handling Equipment. All personnel must be trained.

P-307 SECTION 14 - RIGGING GEAR

Section 14 of NAVFAC P-307 provides maintenance, inspection, and test requirements for rigging gear and miscellaneous equipment not covered in sections 2 through 11.

Knowledge Check

1. Circle the correct answer. NAVFAC P-307 uses the term Weight Handling Equipment to refer to:
 - a. all crane and rigging gear.
 - b. cranes, crane gear, rigging gear, and all equipment.
 - c. only rigging gear.
 - d. anything within the crane envelope.

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NAVFAC P-307 EXAM

1. The purpose of the P-307 is to:
 - A. maintain safety & reliability.
 - B. ensure optimum service life.
 - C. provide standards for crane operations and rigging.
 - D. ensure safe crane and rigging operations.
 - E. ensure all of the above.
2. The P-307 provides guidance to shore based naval activities for management of weight handling equipment.
 - A. True
 - B. False
3. There is no difference in capacity between Category 2 and Category 3 cranes.
 - A. True
 - B. False

4. What is the category of this crane?

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



5. What is the category of this crane?

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



Capacity: Less than 20,000 lbs.

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6. What is the category of this crane?

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



7. What is the category of this crane?

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



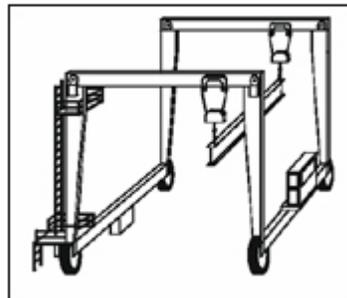
8. What is the category of this crane?

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



9. What is the category of this crane?

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



NOTES

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CRANE COMPONENTS MODULE

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, section 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.

Examples include wire rope, sheaves, hooks, hook blocks, and hoist drum pawls.



Wire rope,
Hooks, & Blocks



Sheaves

Dogs or Pawls



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.



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LOAD BEARING PARTS - BRIDGE CRANES

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 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.

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.



Foot-controlled
Brakes



Travel-Gear
Assemblies



Rotate-Gear
Assemblies

Some additional examples are electrical crane-control circuits related to rotate and travel including brakes and clutches.

Crane-mounted diesel-engines and generators and electrical-power-distribution systems must be treated as load bearing parts even though they meet the technical definition of Load Controlling parts.

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

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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.

LOAD INDICATORS

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

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

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



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



BOOM ANGLE INDICATORS

Mechanical boom angle indicators are operational safety devices.

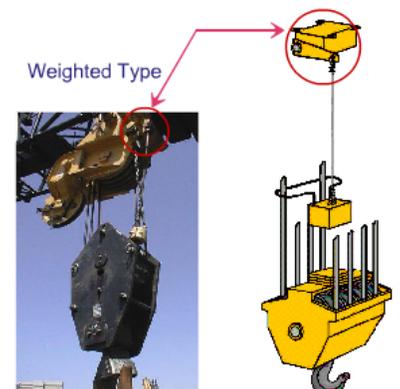
These devices provide the operator with the boom angle needed to calculate the radius of the crane.

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

OPERATIONAL SAFETY DEVICES – LIMIT SWITCHES

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

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



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

OPERATIONAL SAFETY DEVICES – OVER-SPEED, PRESSURE, AND TEMPERATURE DEVICES

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



SAFETY DEVICES - GENERAL

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, travel warning lights, and bumpers.

CRANE COMPONENTS EXAM

1. Load - _____ parts are those that support the load.

- A. controlling
- B. handling
- C. operational
- D. lifting
- E. bearing

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

- A. bearing
- B. handling
- C. lifting
- D. controlling
- E. operation

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3. Safety devices that provide protection for personnel and equipment are considered _____ - safety devices.

- A. universal
- B. general
- C. operational
- D. load bearing

4. Safety devices that affect the safe load lifting and handling capabilities of equipment are considered _____ safety devices.

- A. universal
- B. general
- C. operational
- D. load bearing

5. Which of the following does not affect the safe operation of the crane?

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

6. A horn is what type of component?

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

7. A hook is what type of component?

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

8. Travel gears are what type of components?

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

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9. Hydraulic foot brakes are what type or group of components?

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

10. A travel alarm is what type or group of components?

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

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OPERATOR'S DAILY CHECKLIST (ODCL) MODULE

INTRODUCTION TO THE OPERATORS DAILY CHECK LIST (ODCL)

An Operators Daily Checklist or ODCL is a safety checklist specifically developed for each type of crane.

The ODCL aids the operator in doing a complete check and provides a record of daily inspections.

PURPOSE OF THE OPERATORS DAILY CHECK LIST (ODCL)

The daily inspection conducted by the operator is a general check by sight, sound, and touch.

It helps the operator identify conditions that may render the crane unsafe to operate and enhances crane reliability.

FREQUENCY OF THE ODCL

A complete check of the crane is performed by the operator prior to the first use of the crane each day using a Crane Operator's Daily Checklist, referred to as the ODCL.

The operator signs the ODCL at the completion of this initial check.

Subsequent operators review, perform the operational checks, except boom limit switches, and sign the initial ODCL prior to operating the crane.

If a load is suspended from the hook for a period that spans more than one operator, the appropriate check shall be performed immediately upon completion of the lift, unless the equipment will not be operated again by that operator.

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.

SECTIONS OF THE OPERATORS DAILY CHECK LIST (ODCL)

A proper pre-operational check is performed in four sections: the walk around check, the machinery house check, the operator's cab check, and the no-load operational check.

ODCL CHECKS AND CRITICAL COMPONENTS

The ODCL identifies components that are critical to the safe operation of the crane.

Critical components are load-bearing parts, load-controlling parts, and operational safety devices.

They are identified by an asterisk (*) next to the item.

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

***Critical components:**

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

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If any deficiency to a critical component or safety hazard is found, the operator shall immediately secure the crane and the deficiency must be reported to the supervisor immediately.

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

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.

RECORDING RESULTS FROM THE ODCL CHECKS

Results of the inspection must be noted on the ODCL.

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

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

ODCL WALK AROUND CHECK

This is a sample walk around check section from an ODCL.

Begin this check by walking around the crane and the job site, observing anything that is out of order or out of place as well as any potential hazards or interference.

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



* Walkways, Ladders and Handrails

Check the condition of walkways, ladders, and handrails for loose mountings, cracks, excessive rust, and loose rungs.

Ensure safety chains and gates are functional.

* Structure

Check for damage such as loose or broken bolts, cracking, bending and deformation.

Look carefully for cracking or flaking paint that may indicate a crack or damage in the structure beneath.

Where bolts and rivets are painted, cracked paint may indicate looseness.

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* General Hardware

Check for missing and loose hardware such as nuts, bolts, brackets and fittings.

* Bridge & Trolley

Visually check bridge girders and the trolley platform for obvious physical damage such as cracked paint, indicating loose or bent structural elements or deflection.

* Trolley and Rail Stops

Visually check trolley rails, stops and bumpers for signs of obvious damage, missing fasteners and bent or broken members.

Also check for proper rail alignment and temporary rail stops.

* Safety Guards

Do a visual check for damage, loose or missing safety guards, fasteners or parts.

ODCL MACHINERY HOUSE CHECKS

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

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

Good housekeeping is important to the safety of all crane personnel.

Oil, grease, or mud on floors, ladders, or landings can cause serious falls. Check to ensure that the machinery area and accesses are clean and free of materials and trash. Ensure tools and authorized materials are properly stored and that waste and rags are removed daily.

* Lubrication

Visually check the bearings, bushings and pillow blocks to ensure that the crane has been properly lubricated.

Look for signs of inadequate or excessive lubrication, and heat, often indicated by discoloration.

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* Leaks

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

* Brake Linings

Inspect all brakes for signs of contamination from lubricants, overheating as evidenced by discoloration of the drum and scoring caused by rivet contact. If a brake is equipped with a manual release, ensure that the mechanism is not in the released position.

* Electric Motors

Inspect electric motors for signs of damage including physical damage, excessive carbon dust, and loose or missing fasteners.

ODCL OPERATOR CAB CHECKS

This is a typical Operator's Cab Check section from an ODCL.

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



POSTING REQUIREMENTS

The crane number, certification expiration date and crane capacity must be posted on the crane.

There are several ways to post the required information.

They may be posted as a copy of the certification papers, on signs, stenciled or painted on the crane or on a nearby wall. This information may also be found on a crane test card or on stickers.

* Warning Tags

Before energizing the crane, look for warning tags.

The red danger tag prohibits operation of equipment when its operation could jeopardize the safety of personnel or endanger equipment.

The yellow caution tag is often used to provide temporary special instructions or to indicate a specific caution. A yellow caution tag



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could be used to warn the operator of temporary rail stops, for example.

The striped lockout tag 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.

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

* **Visibility and Glass**

From the operator's cab, check for unrestricted visibility and clean unbroken windows and mirrors.

4 OPERATIONAL CHECK			
	S	U	NA
a Area Safety *	✓		
b Outriggers and Stabilizers *	✓		
c Unusual Noises			
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			



ODCL OPERATIONAL CHECKS

The final check before placing the crane in service is the "No Load" operational check.

When possible, the no load 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.

Cab Controls

Before energizing the crane ensure that all controls are in neutral position and check for proper action of the controllers and brake pedals.

* **Wire Rope**

Visually inspect wire rope for unusual wear, fraying, bird-caging, corrosion and kinking.

During the operational check, where possible, observe sections of wire rope that may not be visible during the walk around check, such as lower layers on the hoist drum that can only be seen when the hook is lowered.

* **Controls and Brakes**

Operate the controls through all speed points. Ensure the controls are functioning properly.

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Check for proper operation of dead man controls, if applicable, by removing your hand from the controller handle. The function should stop. Reset the function by returning the control to neutral.

* **Horns and Alarms**

Activate all horns and alarms to test for proper operation, volume and tone.

Knowledge Check

1. When is the ODCL Check Performed?

- A. The ODCL is performed prior to the first use each day.
- B. The ODCL is performed only during routine maintenance.

2. On the ODCL worksheet, critical components are identified

- A. in bold lettering.
- B. with an asterisk.

3. **Select all that apply.** Critical components must be carefully examined during the ODCL. Which of the following are considered critical components?

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

4. 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. If you find a critical component - load bearing load controlling or operational safety device unsatisfactory you must take what action?

- A. You must stop, secure the crane and notify your supervisor.
- B. Proceed with the expected action and complete the assigned lift.

GENERAL CRANE SAFETY STUDENT GUIDE

ODCL EXAM

1. The ODCL is used to identify:
 - A. members of the current crane team.
 - B. conditions that may render the crane unsafe.
 - C. necessary and missing paperwork.
 - D. who is licensed to operate the crane.

2. What method of inspection is used in the operator's daily check of the crane?
 - A. CCI Inspection
 - B. Sight, sound and touch
 - C. Review of OEM manual
 - D. Observing the crane in operation

3. A complete check of the crane is performed by the operator prior to:
 - A. complex lifts only.
 - B. moving the crane to a new location.
 - C. securing the crane each day.
 - D. the first use of the crane each day.

4. Select four sections. What are the four sections of a properly preformed pre-operational check?
 - A. Electrical function check
 - B. Walk around check
 - C. Stability check
 - D. Machinery check
 - E. No-load operational check
 - F. Operator's cab check

5. During inspection, cracked or flaking paint may indicate:
 - A. latex paint over alkyd primer.
 - B. aluminum paint on steel components.
 - C. poor quality paint.
 - D. structural damage or loose bolts.

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6. Discoloration of the brake drum is usually caused by:

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

7. The crane number, certification expiration date and certified capacity are found:

- A. in the operator's manual.
- B. in the EOM.
- C. posted in the crane maintenance area.
- D. posted on the crane
- E. in the load lift review.

8. If you observe a red tag on a piece of equipment, you should :

- A. review the special instructions and operate accordingly.
- B. under no circumstances operate this piece of equipment.
- C. remove the tag and continue operations.
- D. fix the problem and operate the equipment.
- E. verify the tag was from previous work.

9. If you observe a yellow tag on a piece of equipment, you should:

- A. fix the problem and operate the equipment.
- B. verify the tag was from previous work.
- C. review the special instructions and operate accordingly.
- D. remove the tag and continue operations.
- E. under no circumstances operate this piece of equipment.

10. If you observe a lock out tag on a piece of equipment, you should:

- A. fix the problem and operate the equipment.
- B. verify the tag was from previous work.
- C. under no circumstances attempt to operate the equipment.
- D. remove the tag and continue operations.
- E. review the special instructions and operate accordingly.

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11. Dead man controls refer to controllers that automatically ...
- A. stop operations when it is 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.
12. On the ODCL, critical components are identified by _____.
- A. letter color: red for critical – yellow for cautionary
 - B. bold letters
 - C. ampersands (&)
 - D. asterisks (*)
13. Any deficiency of a critical component or safety hazard must be reported immediately to:
- A. your supervisor.
 - B. crane engineering.
 - C. crane inspector.
 - D. crane maintenance.
14. Each item on the ODCL shall be marked:
- A. satisfactory, unsatisfactory, or not applicable.
 - B. serviceable, unserviceable, or not applicable.
 - C. stable, unstable, or not applicable.
 - D. correct, incorrect, not applicable.
15. If you discover a load bearing part, load controlling part or operational safety device that is unsatisfactory, you should:
- A. stop, secure the crane and notify your supervisor.
 - B. resolve the situation before continuing.
 - C. report the situation to crane inspection.
 - D. report the situation to crane maintenance.

NOTES

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COMPLEX AND NON-COMPLEX LIFTS MODULE

NON-COMPLEX LIFTS

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

COMPLEX LIFTS

Complex lifts have a moderate to high level of risk.

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

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

COMPLEX LIFT CATEGORIES

- Hazardous materials
- Large and complex geometric shapes
- Personnel lifts
- Lifts exceeding 80% of rated capacity of hoist
- 50% hoist capacity for barge-mounted mobile cranes
- Lifts of submerged or partially submerged objects
- Multiple crane or multiple hook lifts
- Other non-routine lifts

SUPERVISOR RESPONSIBILITIES - COMPLEX LIFTS

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

If the lifts are repetitive in nature, supervisors must be present during the first complex lift evolution with each team.

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 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.

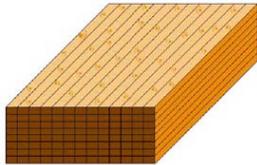
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Ordnance lifts covered by NAVSEA OP 5 in lieu of the NAVFAC P307 are also excluded.

LIFT REQUIREMENTS FOR HAZARDOUS MATERIALS

Lifting hazardous materials with a crane is a complex lift.

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**.



LIFT REQUIREMENTS FOR COMPLEX GEOMETRIC SHAPES

Complex lifts also include large and complex shapes.

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

LIFT REQUIREMENTS FOR PERSONNEL LIFTS

Use cranes for lifting personnel only when no safer method is available.

Cranes, rigging gear and personnel platforms shall conform to OSHA requirements, Title 29 Code of Federal Regulations, Part 1926.550g.

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.

LIFT REQUIREMENTS FOR LIFTS OVER 80% CAPACITY

Lifts exceeding 80% of the capacity of the hoist are considered complex lifts. Use a larger capacity hoist if possible to avoid exceeding 80% of capacity.

GENERAL CRANE SAFETY STUDENT GUIDE

LIFT REQUIREMENTS FOR MULTIPLE CRANE LIFTS

Lifts with two or more cranes are complex lifts.

These lifts require special planning, coordination and skill.

The weight carried by each crane must be calculated carefully.

One signal person must be assigned to direct and control the entire operation.



COMPLEX AND NON-COMPLEX LIFTS EXAM

1. 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. Detailed written procedures are required for:

- A. some lifts.
- B. all lifts
- C. non-complex lifts.
- D. complex lifts.

3. Personnel lifts are

- A. always considered complex lifts.
- B. considered complex only under special conditions.
- C. not considered complex if personal protective gear is worn.
- D. not considered complex if personnel lifting devices are used.

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4. For all complex lifts, a supervisor or working leader must review on-site conditions and
- A. inspect all rigging gear.
 - B. conduct a pre-job briefing.
 - C. define the crane operating envelope.
 - D. select rigging gear.
5. Lifts of test weights during maintenance or load test are
- A. included in the complex lifts requirements.
 - B. routine lifts because they are not complex shapes.
 - C. excluded from the complex lift requirements.
 - D. evaluated according to the complex lift requirements.
6. Personnel in a lifting platform must
- A. stand with knees bent to absorb motion shock.
 - B. wear a full body harness with a shock-absorbing lanyard.
 - C. wear aircraft reflective tape on their hard hat.
 - D. wear a safety belt with a shock-absorbing lanyard.
7. Materials such as oxygen, acetylene, propane or gasoline in bottles, cans or tanks, properly secured in racks designed for lifting by a crane are considered:
- A. hazardous lifts
 - B. complex lifts
 - C. non-complex lifts
 - D. explosive lifts
8. A crane with a capacity of 100,000 pounds is performing a lift of 90,000 pounds. This is a(n)
- A. overload lift.
 - B. non-complex lift
 - C. complex lift
 - D. hazardous lift

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9. A crane with a capacity of 100,000 pounds is performing a lift of 40,000 pounds. This is a(n)

- A. hazardous lift
- B. overload lift
- C. complex lift
- D. non-complex lift

10. For personnel lifts, the total load must not exceed...

- A. the gross capacity if designated as a complex lift.
- B. 80% of the hook capacity.
- C. 50% of the hook capacity.
- D. the load chart capacity.

NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

CRANE SET-UP MODULE

MOBILE CRANE SETUP INTRODUCTION

At the end of this module you will understand the importance of proper crane set-up.

Understanding proper crane set-up and a well prepared working area for the crane is critical for the safety of every lift.

TRAVELING TO THE JOB SITE

For safe travel to the job site, the driver of the carrier must be trained and qualified for the specific type of machine to be moved.

PRE-USE CHECK (ODCL)

A pre-use check using an operator's daily check list should be done on the crane prior to moving.



THOROUGH CHECK OF CRANE

If a pre-use check is not practical, at a minimum, a thorough check of the carrier shall be performed.

Make sure all safety equipment such as lights, mirrors, flares, flags, and fire extinguishers is on board and functional.

TRAVELING CHECKING ROUTE

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

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

Disengage the power take-off unit (PTO) according to OEM instructions. Do not attempt to move the crane until building up the required air pressure.

SITE CONDITIONS

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

GENERAL CRANE SAFETY STUDENT GUIDE

CRANE CLEARANCES

Pay particular attention to counterweight clearance.

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

LIVE MAST CLEARANCE

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

This illustration shows how raising the boom to a high angle on some cranes may cause the live mast to project beyond the counterweight.

Setting up too close to buildings or tall structures with this crane, could lead to a crane accident.



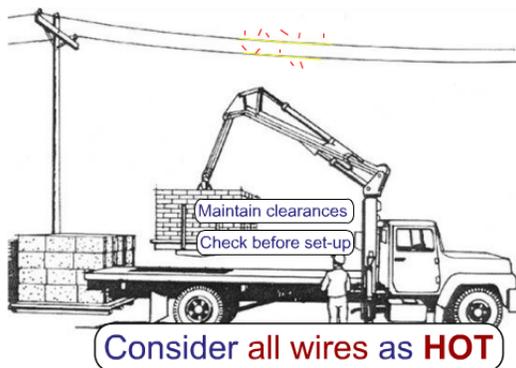
UNDERGROUND HAZARDS

Underground hazards at the worksite must be considered when setting up mobile cranes.

The crane will support the load only if the ground will support the loaded crane.

Avoid areas known to have buried utilities, tunnels or pipelines as machine weight and vibration can cause them to collapse.

If the bearing capacity of the ground is questionable, use additional blocking or cribbing to increase ground support and crane stability.



PROXIMITY TO POWER LINES

Power line contact is the largest single cause of fatalities associated with cranes.

Check for power lines before setting up or operating cranes. Maintain required clearances when setting up the crane.

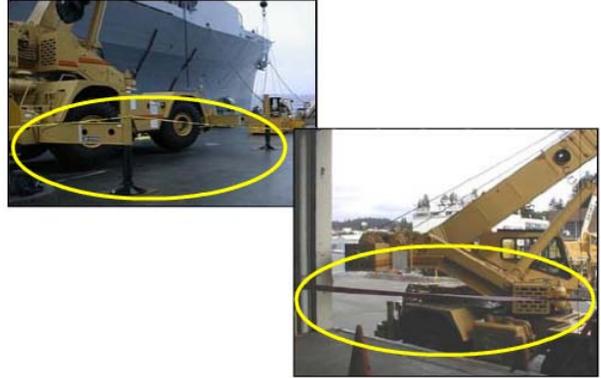
Treat all wires and electrical equipment as if they are hot even when they are de-energized.

GENERAL CRANE SAFETY STUDENT GUIDE

BARRICADING

When a crane must be set up close to fixed objects, barricades are required.

When a 2 foot clearance from all obstructions in all operating positions is not practical, barricades must be erected to assure that no personnel are exposed to this hazard.



CRANE SET-UP CONSIDERATIONS

Many mobile cranes rely on outriggers to support the entire crane.

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

Crane operators must follow OEM set-up requirements to stay within the safe design limits of the crane.

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



FIRM SUPPORTING SURFACE

The supporting surface must be able to support the pressure generated by a crane.

A high percentage of the weight of the crane and load can be transmitted to one float especially when rotating a heavy load directly over it.

Since the area of the outrigger or stabilizer float is relatively small it generates high pressures.

On soft ground or questionable surfaces, always use blocking beneath floats. This distributes the crane's load over a larger area, decreasing the pressure per square inch.

OUTRIGGERS FULLY EXTENDED

Outriggers with extendable beams should be fully extended except where they have OEM designed mid-point extension and zero extension positions for outriggers.

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You must use the corresponding load charts that match these outrigger positions.

TIRES OFF THE GROUND

When a crane is set up on outriggers, the weight of the crane must be off the carrier tires in order for the crane to pick it's full rated capacity. Tires should be just clear of the ground.

On some cranes with pivoting axels, one of the tires may touch the ground.

In either case, the weight of the raised tires are part of crane's counteracting weight that offsets the moment of the load.



Keeping the tires as close the supporting surface as possible provides a safeguard if an outrigger jack or beam fails.

Some cranes use stabilizers in conjunction with the tires to help stabilize the crane for lifting.

A LEVEL CRANE

A level crane is critical to the safety of every lift. The importance of this cannot be over-emphasized!

Operating in an **out of level** condition is **not allowed**.



USING A BUBBLE LEVEL

In-the-cab level indicators should be used for initial setup only. Bubble type levels like this one in the crane cab, should be confirmed if any doubt exists.

For lifts approaching rated capacity, or for load testing, it is best to confirm with a calibrated level.

USING A MACHINIST LEVEL

A level can be placed on the machined surface of the rotate base on the carrier. Normally an area near the boom heel pins provides access.

Do not place the level on the deck plate. They are often not smooth enough.

USING A PLUMB BOB

The crane's whip hoist line can be used as a quick check for level.

Check for level by sighting the hoist line along the centerline of the boom while positioned over the front or over the rear. Repeat this check over the side.

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If the whip hoist does not line up with the boom the crane is out of level.

PADS PINNED

Outrigger floats or pads must be secured to the outriggers and stabilizers.

If it is not secured, the cylinder may disengage the pad if the outrigger becomes light.

They are usually secured with pins or quick release locking devices.

LOCKING BEAMS

When operating a crane with mechanical outrigger locks, be sure they are locked.

The type shown here is usually found on scissor-type outrigger beams that hinge at the carrier frame and are raised and lowered with a hydraulic cylinder between the frame and the beam.

Some cranes use a threaded rod screwed down onto the top of a hydraulic jack cylinder to prevent bleed-off and movement.

Others use cam locks.



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CRANE SET-UP EXAM

1. Which of the following should be considered before traveling a mobile crane?
 - A. Number of riggers required
 - B. Engineering documentation
 - C. Trained and qualified driver

2. Which of the following should be considered before traveling a mobile crane?
 - A. Security clearance
 - B. Pre-use checks performed
 - C. Union requirements for drivers

3. Which of the following should be considered before traveling a mobile crane?
 - A. Number of riggers required
 - B. Check route
 - C. Tire sizes

4. Which of the following should be considered before traveling a mobile crane?
 - A. Adequate Hydraulic pressure
 - B. Adequate Water pressure
 - C. Adequate air pressure

5. When setting up a mobile crane, what is the minimum clearance between the rotating upper works and fixed objects?
 - A. 18 inches
 - B. 2 feet
 - C. 6 feet
 - D. 12 inches
 - E. Whatever the crane operator feels is safe

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6. If the minimum clearance cannot be achieved the crane team must _____.

- A. sound the horn to warn personnel in area.
- B. turn on headlights.
- C. designate a team member to guard area when rotating.
- D. rotate slowly and cautiously.
- E. erect barricades.

7. When setting up a mobile crane you must have _____.

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

8. When on outriggers, outrigger beams must always be _____.

- A. locked
- B. rotated

9. When setting up a mobile crane on outriggers the tires must _____.

- A. be firmly set for stability.
- B. rotated for flexibility.
- C. depressurized.
- D. just clear the ground.

10. When setting up a mobile crane on outriggers the outriggers will be _____.

- A. extended as far as possible.
- B. placed according to engineering specifications.
- C. properly extended.
- D. retracted on the down side.

11. When lifting on tires, ensuring the crane is level is still necessary.

- A. True
- B. False

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12. When traveling the rotate lock should be _____.

- A. disengaged.
- B. rotated.
- C. engaged.
- D. optimized for travel.

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DETERMINING LOAD WEIGHT MODULE

LOAD WEIGHT

Load weight determines the capacity of the crane and the rigging gear required.

Load weight must be verified or calculated whenever it is estimated to exceed 50% of the crane's hook capacity or 80% of the rigging gear capacity.

DETERMINING LOAD WEIGHT ACCEPTABLE METHODS

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

DETERMINING LOAD WEIGHT UNACCEPTABLE METHODS

Never take word of mouth to establish load weight!

DETERMINING LOAD WEIGHT - BASIC RULES

When determining the weight of an object you can always round up the dimensions and the weight, but never round down.

Never mix feet and inches and double-check your answers.

STANDARD MATERIAL WEIGHT

Shown below is a standard chart showing the weights of various materials per square foot, per inch of thickness and weight per cubic foot of volume.

This chart is used as an aid when calculating load weights.

Material	Weight cubic
Ash	42
Birch	41
Cedar	34
Cherry	36
Fir	34
Hemlock	29
Maple	53
Oak	50
Pine (white)	25
Reinforced Concrete	150
Sand	105
Steel	490
Aluminum	165
Brass	543

Material	Weight per sq foot per inch of thickness
Aluminum	14.5
Brass	44.5
Bronze	46.2
Copper	46.3
Iron	41.1
Lead	58.2
Monel	48.3
Nickel	44.8
Silver	54.7
Steel	40.8
Steel (stainless)	41.8
Tin	38.3
Zinc	36.7

FINDING WEIGHT

Weights may be calculated using either area or volume.

Find the weight of two-dimensional objects such as plates by multiplying the area in square feet by the material weight per square foot, for a given thickness.

To find the weight of three-dimensional objects multiply volume in cubic feet by the material weight per cubic foot.

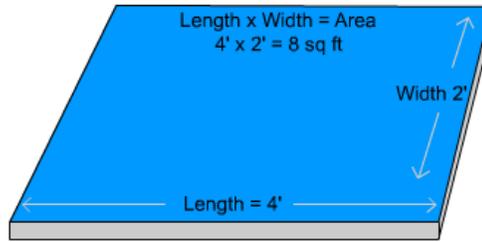
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Which calculating method you use, will depend on the item. You may need to use both methods for complex objects.

CALCULATING WEIGHT BY AREA

To calculate the weight of this plate, we must find the area and multiply it by the material weight per square foot.

Here, we have a steel plate, 4 feet by 2 feet by 1 inch thick. The area is 8 square feet.



- 1" thick steel weights 40.8 lbs per square foot
- Area = 8 ft²

$$\begin{array}{r} \text{Area} \times \text{Unit weight per sq foot} = \text{weight} \\ 8 \text{ ft}^2 \\ \times 41 \text{ lbs per ft}^2 \text{ (rounded)} \\ \hline 328 \text{ lbs.} \end{array}$$

To calculate the weight, we need to find the unit weight, or weight per square foot for the material.

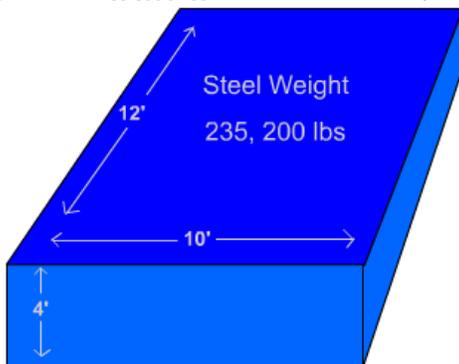
Using the standard material weight chart, we find steel weighs 40.8 pounds per square foot per inch of thickness.

The math can be simplified by rounding to 41 pounds. Multiplying 8 square feet by 41 pounds per square foot gives us 328 pounds.

CALCULATING WEIGHT BY VOLUME

Volume is always expressed in cubic units, such as cubic inches, cubic feet, and cubic yards.

$$\begin{array}{l} \text{Volume} = \text{Length} \times \text{Width} \times \text{Height} \\ 10' \times 12' \times 4' = 480 \text{ Cubic Feet} \end{array} \quad \begin{array}{l} \text{Steel Weighs } 490 \text{ lbs per cubic foot} \\ 490 \times 480 = 235,200 \text{ lbs} \end{array}$$



Let's calculate the volume of this box. The formula is length, times width, times height. The length is 12 feet. The width is 10 feet. The height is 4 feet. When we multiply 12 times 10, times 4, the volume is 480 cubic feet.

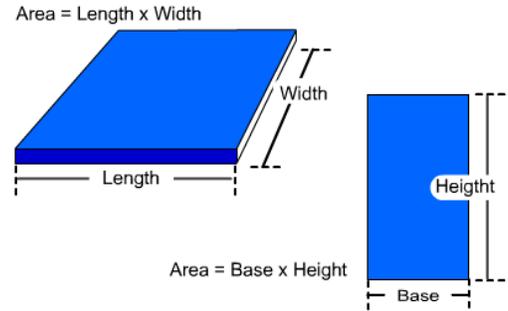
Now we can use the standard materials weight chart and multiply the standard weight by the volume.

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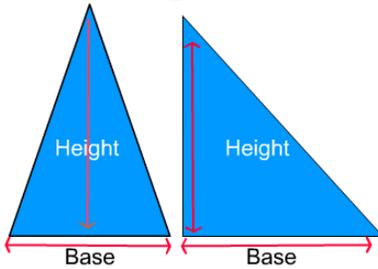
CALCULATING AREA

The area of a square or rectangular shaped object is determined by multiplying length times width or base times height.

It is always expressed in square units such as square feet or square inches, even when the object is circular.



$$\text{Area} = \frac{\text{Base} \times \text{Height}}{2}$$



CALCULATING THE AREA OF A TRIANGLE

To calculate the area of a triangle multiply the base of the triangle by the height of the triangle and then divide by 2.

CALCULATING THE AREA OF A CIRCLE

To calculate the area of a circle, multiply Pi, which is 3.14, by the radius squared.

Find the radius of the circle by dividing its diameter in half. To square the radius, multiply the radius by itself.

For example, if a circle has a diameter of 3 feet, the radius will be 1.5 feet.

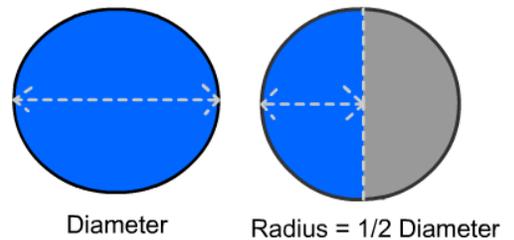
1.5 feet times 1.5 feet equals 2.25 square feet.

Therefore, the radius squared is 2.25 square feet.

$$\text{Area} = \pi \times \text{Radius}^2$$

$$\pi \text{ (Pi)} = 3.14$$

$$\text{Radius}^2 = \text{Radius} \times \text{Radius}$$



Pi times the radius squared would be 3.14 times 2.25 square feet, or 7.065 square feet.

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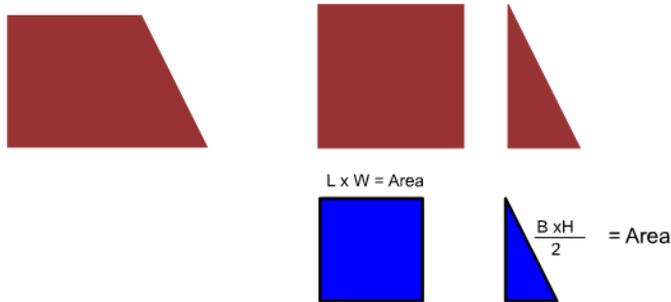
CALCULATING THE WEIGHT OF COMPLEX SHAPES

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

To calculate the area of this complex shape, calculate the area of the square using the formula length times width.

Next, calculate the area of the triangle using the formula base times the height divided by 2.

Then add the areas together to get the total area of the complex shape.

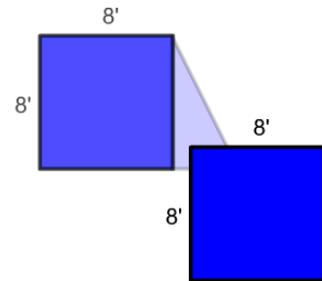


The first step is to calculate the area of the rectangle, or square, as shown in this example.

The formula for the area of a rectangle is, length times width.

The length is 8 feet and the width is 8 feet.

8 feet times 8 feet equals 64 square feet.



Area = Length x Width
 $8' \times 8' = 64 \text{ sq feet}$

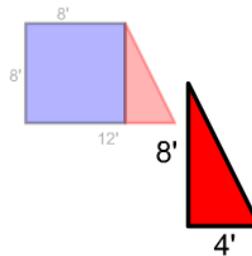
Next, find the area of the triangle.

The formula for the area of a triangle is base times height divided by 2.

The base is 4 feet and the height is 8 feet.

4 feet times 8 feet equals 32 ft².

32 ft² divided by 2 equals 16 ft².



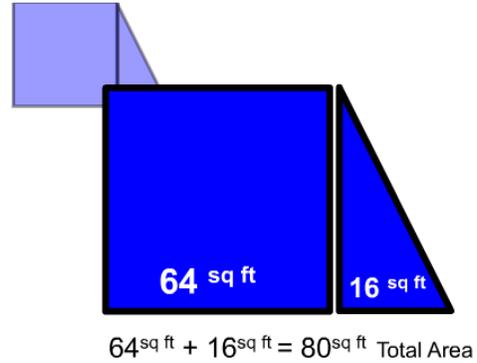
$$\begin{aligned} \text{Area of a Triangle} &= \frac{\text{Base} \times \text{Height}}{2} \\ \frac{8' \times 4'}{2} &= 16 \text{ sq ft} \end{aligned}$$

GENERAL CRANE SAFETY STUDENT GUIDE

Now that we have found the area of the two sections, all we have to do is add the area of the square to the area of the triangle to find the total area of the object.

64 square feet, plus 16 square feet, equals 80 square feet.

If we know what the material is and how thick it is, we can find its weight with one more calculation.

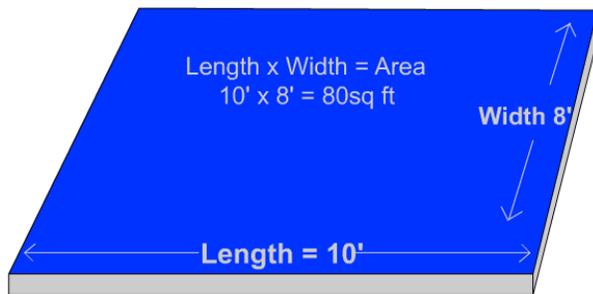


CALCULATING AREA

To calculate the weight using area, we must find the material weight per square foot based on its thickness.

Then, we simply multiply the base weight by the area of material.

The area of this steel plate is 80 square feet.



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

We can find the weight of common materials listed in several reference books available from various industry sources.

Here, in "Ace's Book of Rigging", we find these tables.

Material weight per cubic foot is in the left table.

In the right table, unit weights are listed by weight per square foot, per inch of material thickness.

We will use the table on the right since the material weights here are based on the thickness of material.

Material	Weight per	Material	Weight per square foot per inch of thickness
Pine (white)		Aluminum	14.5
Fir		Zinc	36.7
Oak	50	Steel	40.8
Maple	53	Stainless Steel	41.7
Water (salt)	64	Brass / Nickel	44.8
Sand (dry)	105	Monel / Copper / Phosphor Bronze	46.4
Reinforced Concrete	150	Silver	54.7
Aluminum	165	Lead	59.2
Zinc	440		
Steel	490		
Stainless Steel	500		
Brass / Nickel	537		
Monel / Copper / Phosphor Bronze	556		
Lead	710		
Platinum	1211		

GENERAL CRANE SAFETY STUDENT GUIDE

We find steel listed in the “Materials” column.
The unit weight is 40.8 pounds per square foot, per inch thickness of steel plate.

Now let’s apply the rule we learned earlier in the lesson to make the math easier and give us a safety margin in our calculations. What was the rule on rounding that we should apply to this unit of weight? Round up!

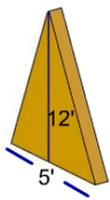
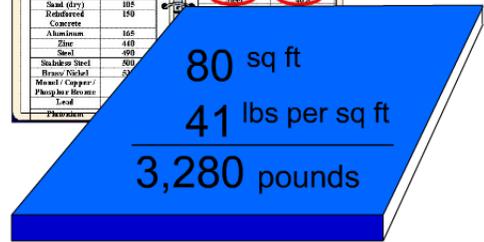
So, 40.8 pounds per square foot is rounded up to 41 pounds per square foot.
To calculate the weight of the plate:

Multiply the area, 80 square feet by the unit weight of 41 pounds per square foot.
The weight of the plate is 3,280 pounds

If 1-inch thick steel plate weighs 41 pounds per square foot, a 2-inch thick steel plate would weigh 82 pounds per square foot.

What would 1/2 inch thick steel plate weigh per square foot?
It would weigh 20.5 pounds.

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



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

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

CALCULATING WEIGHT OF A TRIANGLE

In this example, we have a triangular shape.

How do we find the area of this plate?

Multiply the base times the height and divide by 2.
12 times 5, divided by 2
The area of this plate is 30 square feet.

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

The material is brass, and the thickness is 3 inches.

To find the total weight of the material we need to reference a table or chart to obtain the unit weight.

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

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

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We now know that brass weighs 45 pounds per square foot, per inch of thickness.

We multiply the thickness, 3 inches, by the unit weight of 45 pounds. The material weighs 135 pounds per square foot.

Next, we multiply the area, 30 square feet, times the weight per square foot, 135 pounds. We find that this item weighs 4,050 pounds.

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

12'
5'

$3 \times 45 \text{ lbs./ft}^2 = 135 \text{ lbs. ft}^2$
 $135 \text{ lbs./ft}^2 \times 30 \text{ ft}^2 = 4,050 \text{ lbs.}$

Weight of brass plate = 4,050 lbs.

CALCULATING THE AREA OF A CIRCLE

To calculate the area of a circle, multiply Pi, 3.14, by the radius squared.



This steel plate is 4 feet in diameter. Therefore, the radius is 2 feet. The plate is 1 ½ inches thick.

To find the area: multiply Pi, or 3.14 times the radius squared. 3.14 times 2, times 2 equals 12.56 square feet.

To find the weight per square foot: multiply the plate thickness, 1 ½ inches, times the weight of 1 square foot of 1-inch thick steel. 1.5 times 41 equals 61.5 pounds.

To find the weight: multiply the area, 12.56 times the unit weight of 1 ½ inch thick steel plate which is 61.5 pounds.

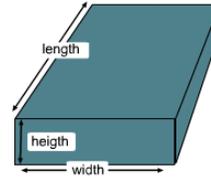
The weight of this circular steel plate is 772.44 pounds.

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CALCULATING VOLUME

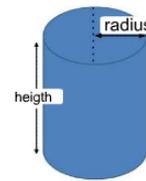
The volume of a square or rectangular object is figured as length times width multiplied by the height.

$$\text{Volume} = \text{Length} \times \text{Width} \times \text{Height}$$



$$\text{Volume} = \pi \times R^2 \times \text{Height}$$

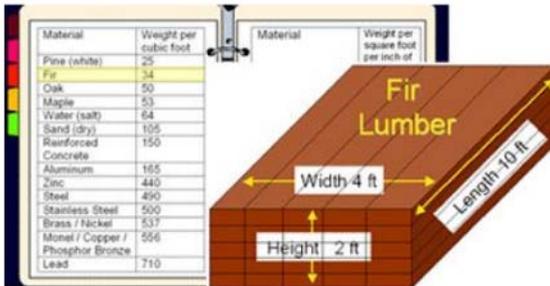
$\pi = 3.14$



The volume of a cylinder is Pi times the radius squared, times the height.

To calculate weight, by volume, we need to find the unit weight, or weight per cubic foot for the material.

We go back to the tables to find the weight for a cubic foot of fir wood. This time we will use the table on the left since the material weights listed here are based on the weight per cubic foot of material.



Using the standard material weight chart, we find that fir weighs 34 pounds per cubic foot.

If the weight were listed in fractions or decimals, such as 33.8 pounds per cubic foot, we would simplify the math by rounding 33.8 up to 34 pounds. Multiplying 80 cubic feet by 34 pounds equals 2,720 pounds.

$$\begin{array}{r} 80 \text{ cubic feet of fir lumber} \\ \times 34 \text{ pounds per cubic foot} \\ \hline 2,720 \text{ pounds load weight} \end{array}$$

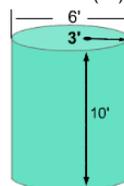
This stack of lumber weighs 2,720 pounds.

VOLUME OF A CYLINDER

What is the formula for finding the volume of a cylinder?

Area (ft²) of the circular end (area of a circle) = $\pi \times \text{radius}^2$

Volume (ft³) of a solid cylinder = $\pi \times \text{radius}^2 \times \text{height}$



Volume of a Cylinder
Volume of a Cylinder = $\pi \times \text{Radius}^2 \times \text{Height}$

To calculate the volume we must first find the area of the circular end. The formula for area is Pi times radius squared.

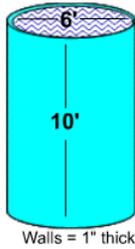
Once we know the area, we simply multiply it times the height or length.

So the formula we use to find the volume of a solid cylinder is, Pi times radius squared times the height.

If the cylinder were lying down you would use its length in place of the height.

GENERAL CRANE SAFETY STUDENT GUIDE

Let's calculate the volume of this cylinder.



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

Area of a Cylinder = $\pi \times \text{Radius}^2 \times \text{Height}$

$$3.14 \times (3' \times 3') = 28.26 \text{ sq feet}$$

$$28.26 \text{ sq feet} \times 10' = 282.6 \text{ cubic feet}$$

If the diameter of this object is 6 feet, what would the radius be?

The radius would be 3 feet.

The height is 10 feet.

We multiply Pi, which is 3.14 times 3 feet times 3 feet. The result is 28.26 square feet.

Now, multiply 28.26 square feet, times the height, 10 feet.

The result is the volume of this cylinder, 282.6 cubic feet.

If the cylinder is hollow, we will need to calculate the volume of the cylinder and the volume of the contents separately.

Calculate the volume as if the cylinder is solid. Then calculate the volume of the hollow. Subtract the volume of the hollow section from the volume of the solid cylinder.

One inch steel plate weighs 40.8 pounds per square foot.

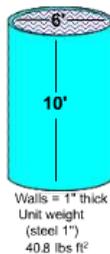
The bottom plate is 6 feet in diameter, so the radius is 3 feet. 3 feet squared equals 9 square feet.

We multiply 9 square feet by 3.14. This gives us the area, 28.26 square feet.

We multiply this by the unit weight for steel plate of 40.8 pounds per square foot.

The bottom plate weighs 1,154 pounds.

Calculate the cylinder wall weight as a flat plate. Multiply Pi, (3.14) times the diameter, 6 feet, times the height, 10 feet.



Bottom plate weight = $\pi \times \text{Radius}^2 \times 40.8 \text{ lbs ft}^2$

Step 1 $3' \times 3' = 9 \text{ ft}^2$

Step 2 $3.14 \times 9 \text{ ft}^2 = 28.26 \text{ ft}^2$

Step 3 $28.26 \text{ ft}^2 \times 40.8 = 1,154 \text{ lbs.}$

Cylinder wall weight = $\pi \times \text{diameter} \times \text{Height ft} \times \text{weight of materials}$

Step 1 $3.14 \times 6' \times 10' = 1,884 \text{ ft}^2$

Step 2 $1,884 \text{ ft}^2 \times 40.8 = 7,687 \text{ lbs.}$

Multiply the area 1,884 square feet by the weight of steel plate, 40.8 pounds per square foot. The resulting weight is 7,687 pounds.

Bottom Plate = 1,154 lbs
Cylinder = 7,687 lbs

GENERAL CRANE SAFETY STUDENT GUIDE

Using the volume calculation, let's find the weight of the water contained in this thin-walled cylindrical tank.

Let's calculate the weight of this cylinder full of salt-water.
We need to know the weight per cubic foot of salt water.

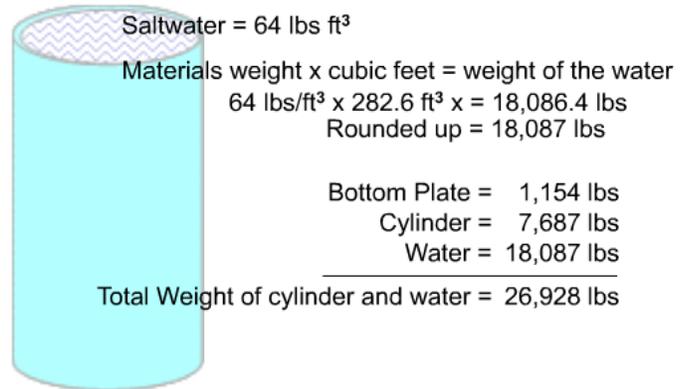
Looking at our material weight chart we see saltwater weighs 64 pounds per cubic foot.

We multiply the material weight times the cubic feet to find the weight of the water in the cylinder.

282.6 cubic feet times 64 pounds per cubic foot equals 18,086.4 pounds.

Now we will add up the weights.

1,154 pounds for the bottom plate,
7,687 pounds for the cylinder wall;
and 18,087 pounds of water, for a
total load of 26,928 pounds.



KNOWLEDGE CHECK

1. To find the weight of a piece of aluminum plate, you would multiply...

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

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

- A. $27 \times 105 = 2,835 \text{ lbs}$
- B. $27 \times 105 = 2,835 + 1,200 = 4,035 \text{ lbs}$
- C. $27 \times 1,200 = 32,400 + 105 = 32,505 \text{ lbs}$

NOTES

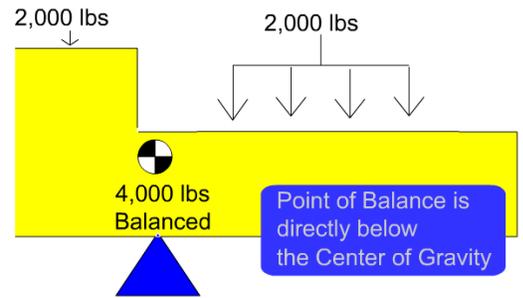
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LOAD WEIGHT DISTRIBUTION

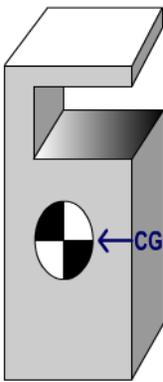
BALANCING POINT

An object will rest in a state of balance when supported at its balance point.

The balance point may not be located at the center of an object, but it is always directly below the center of gravity.



CENTER OF GRAVITY



The center of gravity is the point where the entire weight of the object would balance in any direction, as if all the weight were concentrated in that one point.

It is a fixed point and does not change unless the shape of the object is altered.

Center of gravity is generally located in the center of symmetrical objects made of like material.

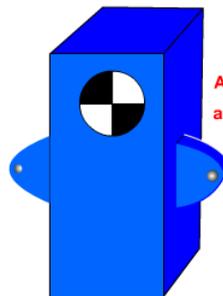
For non-symmetrical objects, it must be calculated and could be located outside the object.

IMPORTANCE OF CENTER OF GRAVITY

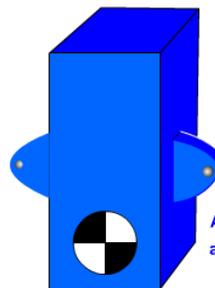
The location of the center of gravity will affect an object's reaction to movement.

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

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



Attachment points below CG are prone to tipping.



Attachment points above CG are more stable.

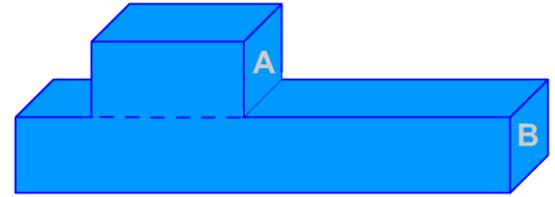
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FINDING THE BALANCING POINT

Finding the Balancing Point - Step 1

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

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



Finding the Balance point - Step 2

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

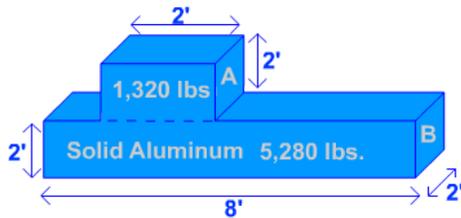
Determine the weight of each section or component.

Aluminum weighs 165 lbs per cu. ft.

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

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

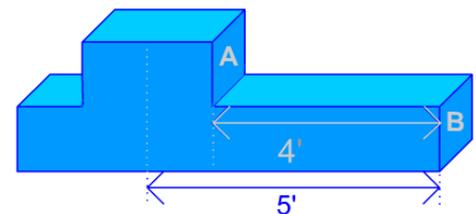
Add the sections: 1,320 + 5,280 = 6,600 lbs



Finding the Balance point - Step 3

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

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



Finding the Balance point - Step 4

Then, multiply the weight of each section, by the distance from the reference end to the center of that section. The result is called moment.

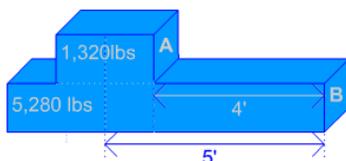
Multiply the weight of each section by the distance from the reference end to the center of each section.

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

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

Moment is an effect produced by a force at some distance from a fixed point, such as the center of gravity.

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



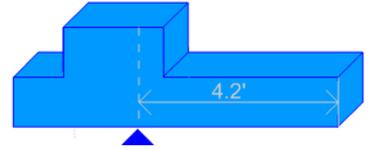
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Finding the Balance point - Step 5

Add the moments together and divide this number by the total weight of the object.

The balance point is where the moments, measured from each end, are equal.

Add the moments of each section (from step 4)
Divide by the total weight (from step 2)
Moment: 6,600 ft lbs + 21,120 ft lbs = 27,720 ft lbs
Weight: 1,320 lbs + 5,280 lbs = 6,600 lbs
 $27,720 \text{ ft lbs} / 6,600 \text{ lbs} = 4.2'$



PINPOINTING THE CENTER OF GRAVITY

In this example the weight of section A is 2,640 pounds.

The weight of section B is 5,280 pounds.

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

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

The distance from the reference line to the center of section A is 3 feet and the distance from the reference line to the center of section B is one foot.

The moment for section A is 7,920 feet. The moment for section B is 5,280 pound feet.

Add the moments together and divide by the total weight to find the height of the center of gravity.

7,920 plus 5,280 equals 13,200 pound-feet.

The weight is 2,640 plus 5,280 or 7,920 pounds.

Now divide 13,200 by 7,920. The center of gravity is 1.666 feet up from the reference end. If we convert decimal feet to inches, this equals 1 foot, 8 inches.

Multiply:

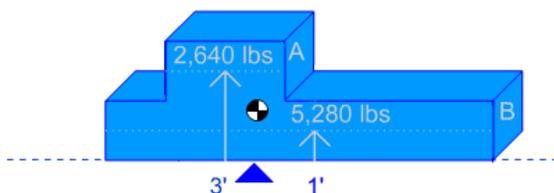
$$3' \times 2,640 \text{ lbs} = 7,920 \text{ lb ft of moment}$$

$$1' \times 5,280 \text{ lbs} = 5,280 \text{ lb ft of moment}$$

$$\text{Add: } \underline{13,200}$$

$$\text{Divide: } 13,200 / 7,920 = 1.666'$$

CG is located 1.666 feet above the Center of Balance



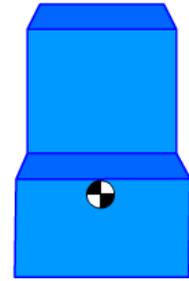
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FINDING CG DEPTH

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

In this example, the end view shows the object is symmetrical.

Therefore, we can assume the center of gravity is in the center of the object –one foot from the front.



CENTER OF GRAVITY PINPOINTED

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

CENTER OF GRAVITY REVIEW

Remember to estimate the location of the Center of Gravity in relation to the attachment points before rigging or lifting loads.

If the center of gravity is difficult to estimate, you may need engineering assistance.

Loads hoisted from the bottom without restraint are susceptible to tipping.

Loads should be lifted from their top, or restrained within the slings.

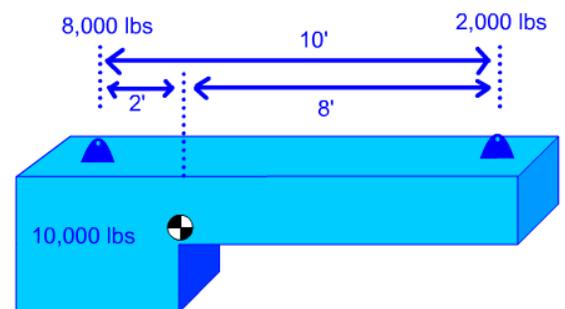
If a load is hoisted without keeping the hook over the center of gravity, the load will shift as it clears the ground.

Sometimes the rigging must be re-adjusted before making the lift.

WEIGHT DISTRIBUTION

The center of gravity provides a quick reference for how the weight is distributed throughout a load. However, before planning the lift it is necessary to refine how the load weight is distributed.

Weight distribution determines what each attachment point will have to carry. This information insures the selection of correctly rated rigging gear.



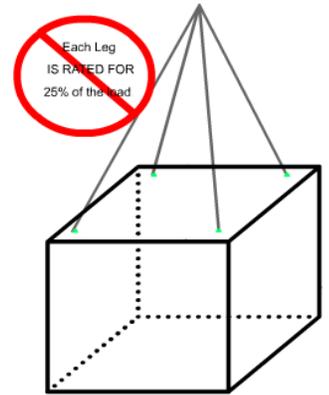
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A WRONG ASSUMPTION

A common assumption is that 4 legs divide the load weight into 4 equal parts.

Each leg then carries 25% of the load.

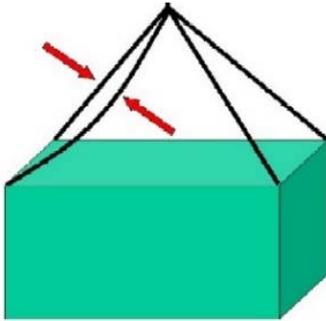
Most often, this is not true.



HOW MANY LEGS REALLY CARRY THE LOAD?

We now understand that each leg will not always carry its share of the load.

In this example, one sling is longer than the others. Therefore that attachment point will not carry its share of the load.



When one sling is longer than the others, the shackles or other hardware are different brands or sizes, or one attachment point is higher than the others, one or more attachments may not carry any load at all.

Never assume that all legs will carry their share of the load.

A SAFE ASSUMPTION

Here is a safe assumption:

At any given time, any two legs may carry the load, even if three or more legs are used.

The “two-legs-carry-the-load” rule helps us to compensate for different sling lengths, attachment points at different elevations, and load flex.

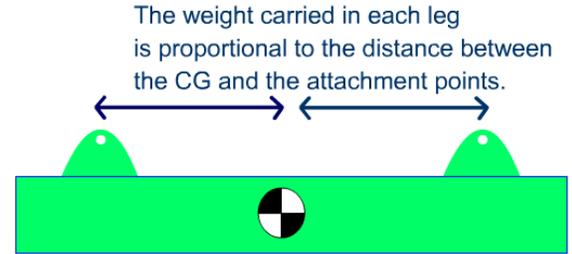
Gear selections should be based on two legs being able to carry the load.

For example, if an object weighs 10,000 pounds then each leg would require a rated load of at least 5,000 pounds.

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How Do We Know How Much Weight Is In Each Leg?

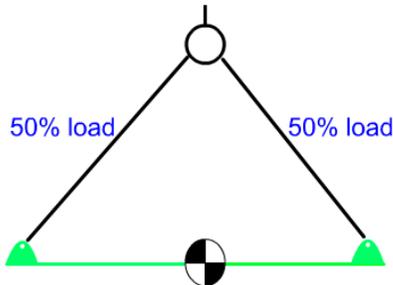
Gear selection is dependent upon how much weight is carried by each leg - the load's weight distribution.



The distances between the Center of Gravity and the attachment points will determine how much of the weight each attachment point will carry.

EQUAL WEIGHT DISTRIBUTION

This drawing represents a load.

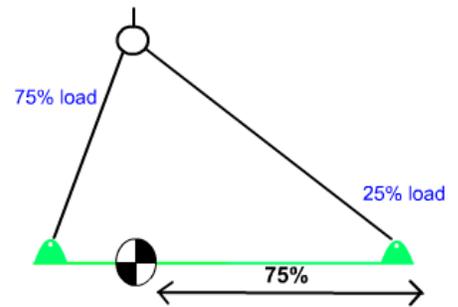


When distances between the CG and attachment points are equal, weight distribution is also equal.

Notice the difference in weight distribution as the center of gravity changes distance from each attachment point.

In this first example, each attachment carries equal weight because the center of gravity is equal distance between the attachment points.

Watch the left attachment point as we move the center of gravity.



When distances between the CG and attachment points are unequal, weight distribution is inversely proportionate.

In this example, the weight is greatest in the left attachment point because it's closest to the center of gravity.

When one attachment point is closer to the center of gravity than the other attachment point, it carries more weight.

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INFORMATION NEEDED TO CALCULATE WEIGHT DISTRIBUTION

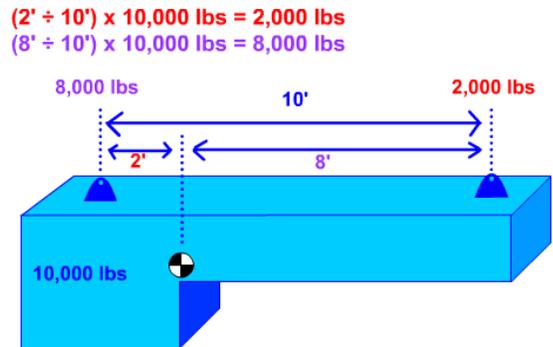
Now, let's move beyond estimating and show how to calculate the weight distribution.

In order to calculate weight distribution, you must know the object weight, the location of the center of gravity and the distance of each attachment point from the center of gravity.

WEIGHT DISTRIBUTION EXAMPLE

If we want to find out how much weight is distributed to the attachment closest to the center of gravity, we divide the 8-foot distance by the overall distance between attachment points, which is 10 feet.

Then we multiply this answer by the total weight of the object.
Eight divided by 10, times 10,000 equals 8,000 pounds.



KNOWLEDGE CHECK

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

- a. 75%, 25%
- b. 25%, 75%
- c. 50%, 50%
- d. 33%, 66%

2. Center of Gravity is best described as:

- a. where the item balances.
- b. always in the center of an object
- c. where all the weight is concentrated

3. The center of gravity is located below the center of balance.

- a. True
- b. False

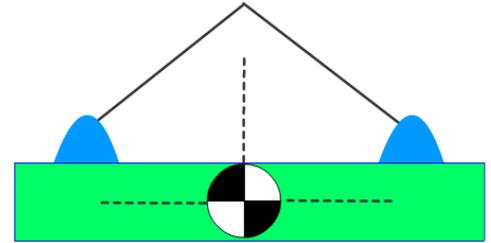
NOTES

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SLING ANGLE STRESS MODULE

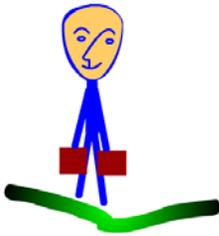
WHAT IS SLING ANGLE STRESS?

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



SLING ANGLE STRESS EXAMPLE

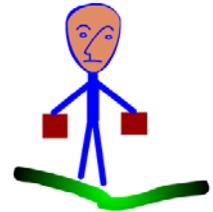
Here's Ace.



He is holding a fifty-pound weight in each hand. His arms are vertical, similar to a 90° horizontal sling angle. The amount of stress in Ace's arms is equal to the amount of weight he's holding, fifty pounds.

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

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.



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.

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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 stress factor.



SLING ANGLE STRESS, WHAT DOES IT AFFECT?

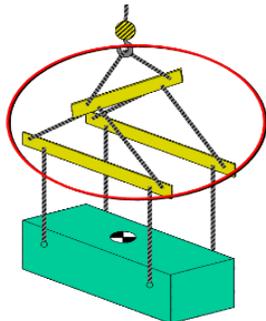
Nearly every lift creates a triangle.

All of the components that make up the sides of a lift triangle are affected by sling angle stress including the attachment points on the load, the 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.

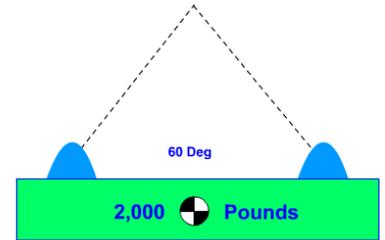
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Let's look at this principle on a load.

EFFECTS OF SLING ANGLE STRESS

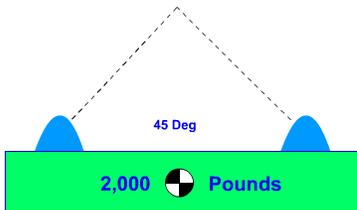
At a 60° angle the load on the rigging has increased to 1,155 pounds. Keep in mind each leg has 1,155 pounds of stress even though only one leg is shown. 60° is the preferred angle!

At a 60 Degree Angle
Sling stress = 1,155 lbs per sling



At a 45 Degree Angle
Sling stress = 1,414 lbs per sling

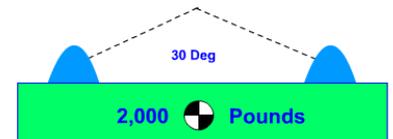
At a 45° angle the load has increased to 1,414 pounds in each sling. That's nearly a 42% increase!



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 30 Degree Angle
Sling stress = 2,000 lbs per sling

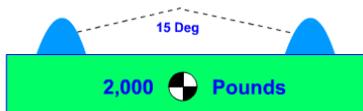
Never lift at less than a 30 degree sling angle without engineering approval!



At a 15 Degree Angle
Sling stress = 3,860 lbs per sling

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

Never lift at less than a 30 degree sling angle without engineering approval!



GENERAL CRANE SAFETY STUDENT GUIDE

WHY MUST WE ACCOUNT FOR IT?

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

SELECTING MINIMUM RATED CAPACITY

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

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

DETERMINE MINIMUM RATED CAPACITY

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

USING AN ANGLE FACTOR CHART

To use an angle factor chart, you first need to determine the sling angle. Sling angle can be determined mathematically or measured.

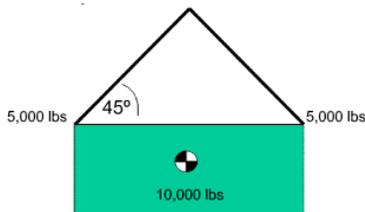
Once you have determined the sling angle, find the corresponding angle factor, and multiply that number by the weight carried in each leg.

When you look at the angle factor column, you will notice a dramatic increase for angles less than 30°.

That's why we do not use sling angles less than 30° unless authorized by an engineering document.

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

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



$$1.414 \times 5,000 \text{ lbs.} = 7,070 \text{ lbs. in each leg.}$$

ANGLE FACTOR CHART EXAMPLE

This shape represents the lift we are about to make.

Let's say that the angle created by the slings we use is 45°.

The angle factor for a 45° angle is 1.414.

We must multiply the angle factor, 1.414 by the weight carried in the leg.

How much weight will the leg carry? That's right, 5,000 pounds.

1.414 times 5,000 equals 7,070 pounds. This is the total stress in each leg! This number represents the minimum gear capacity that can be used for the lift.

GENERAL CRANE SAFETY STUDENT GUIDE

WHAT IS ANGLE FACTOR?

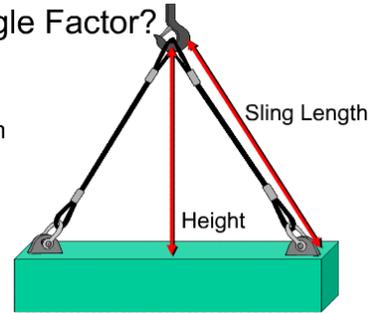
Remember the lift triangle?

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.

What is Angle Factor?

$$\text{Angle Factor} = \frac{\text{sling length}}{\text{height}}$$



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.

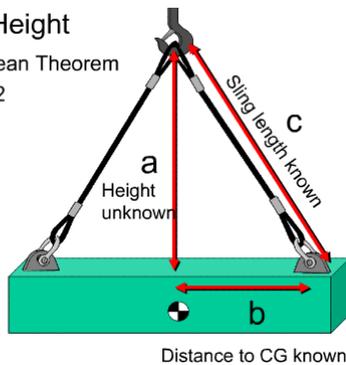
How to Find Height

Use the Pythagorean Theorem

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

To solve for a:

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



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.

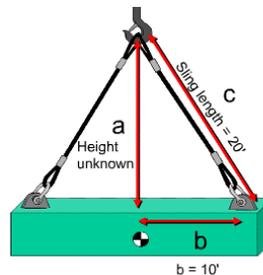
Use C squared minus B squared equals A squared to solve for height. The sling, C, is twenty-feet long.

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.



$$\begin{aligned} c^2 - b^2 &= a^2 \\ (20 \times 20) - (10 \times 10) &= a^2 \\ (400) - (100) &= 300 \\ \text{Square Root of } 300 &= 17.32 \end{aligned}$$

$$\text{Height} = 17.32$$

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Now we use the square root function on our calculator to calculate the square root of 300.

The height equals the square root of 300, which is 17.32 feet.

FINDING ANGLE FACTOR

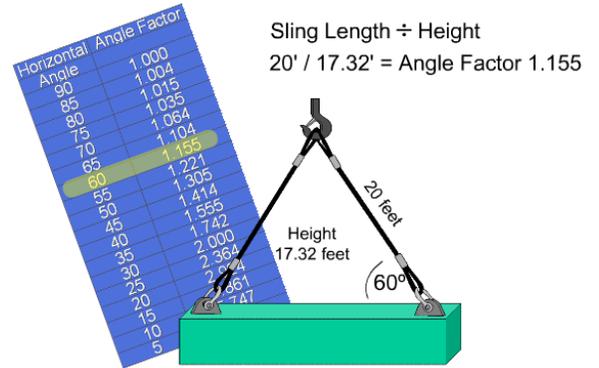
Remember the angle factor equals sling length divided by height.

We just found the height of the lift triangle.

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

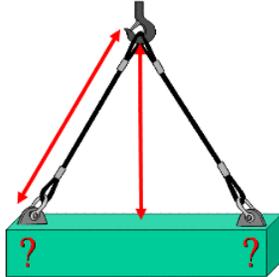
The sling is 20 feet long and we found the height to be 17.32 feet.

20 divided by 17.32 equals 1.155. This is our angle factor.



Finally, we will multiply the angle factor by the amount of weight at the attachment point.

Solving for Sling Angle Stress Mathematically



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

SOLVING SLING ANGLE STRESS MATHEMATICALLY

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

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

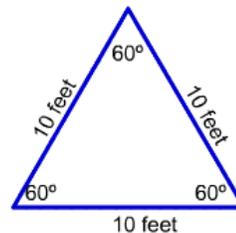
Remember, weight distribution is determined by the distance from the center of gravity to the attachment points.

This works for all lifts with level attachment points.

60° SLING ANGLE

60° is the preferred sling angle.

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



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SELECTING APPROPRIATE SLING LENGTHS FOR A 60° SLING ANGLE

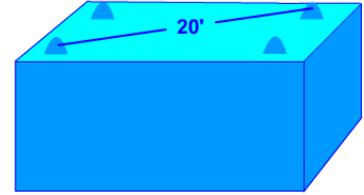
To ensure your slings will have at least a 60° sling angle simply measure the distance between attachment points.

Measure diagonally when there are more than two attachment points because it's the longest distance.

Then select a sling that is as long or longer than the distance measured.

If you use this method to select your slings, you will never have a sling angle less than 60°.

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



SELECTING MINIMUM RATED CAPACITIES FOR A 60° SLING ANGLE



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.

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

How much weight would each attachment point carry? Each would carry 2,500 pounds.

What is the angle factor for a 60° sling angle? The angle factor is 1.155.

Multiply the angle factor, 1.155, times the weight distributed to the attachment point, 2,500 pounds. 2,888 pounds is the stress in the rigging gear and attachment points. It is also the minimum capacity for all rigging for this lift!

MINIMUM RATED CAPACITY AT 30°

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.



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.

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

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NOT LEVEL NOR EQUAL DISTANCE FROM CG

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

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

KNOWLEDGE CHECK

1. A 60° sling angle will be formed when you match the sling length to the diagonal distance between attachment points.
 - a. True
 - b. False

2. An object has a length of 4 feet, a width of 3 feet, and a distance of 5 feet 6 inches between top right and bottom left attachment points. What length slings would you select to ensure the horizontal sling angle was 60° or greater?
 - a. 6 feet
 - b. 3 feet
 - c. 5 feet
 - d. 4 feet

3. To find sling angle stress...
 - a. *multiply* the weight in the attachment point *times* the angle factor
 - b. *multiply* the weight in the attachment point *times* the height of the lift triangle
 - c. *multiply* the weight of the item *times* rated capacity of the gear
 - d. *multiply* the weight of the item *times* the distance between attachment points

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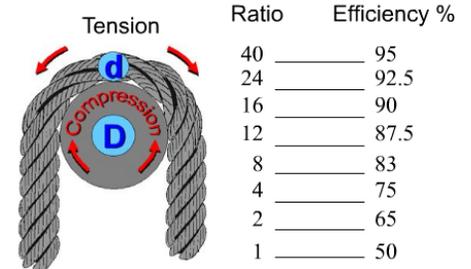
D/d RATIO MODULE

D/d RATIO

D/d ratio is the relationship between diameter of an object that a sling is bent around to the diameter of the sling. D/d ratio is generally applied to wire rope slings.

The tighter the bend, the greater the loss of strength. The sling can be weakened and severely damaged if it's bent around a diameter smaller than its own diameter.

$$\text{D/d Ratio} = \frac{\text{OBJECT DIAMETER}}{\text{WIRE ROPE DIAMETER}} = \frac{D}{d}$$



To determine how the bending will affect the sling: divide "D", the object diameter by "d", the sling diameter. The result is the D/d ratio.

Use table fourteen-three in the P-307 to determine sling efficiencies at various D/d ratios.

UNDERSTANDING EFFICIENCY

Here we have a 1/2-inch wire rope sling with a rated load of 4,000 pounds, bent around a 1-inch hook. The first thing we must do is determine the D/d ratio.

The hook diameter is 1 inch and the sling diameter is 1/2 inch. 1 divided by 1/2 equals 2.



1" Diameter Hook
1/2" Wire Rope
WLL 4,000 lbs.

Step 1
Determine D/d Ratio
 $1" / 1/2" = 2$

Step 2
Use the chart to find efficiency

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

1 leg is 65% efficient
2 legs in this configuration

The D/d ratio is 2.

Looking at the chart, we see that a D/d ratio of 2, provides 65% efficiency. One leg is 65% efficient. There are two legs in this configuration.

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USING EFFICIENCY TO FIND RATED LOAD

Now that we know the efficiency, let's figure out the maximum weight that could be lifted in this configuration. First, we must determine the rated load of each leg. We multiply the rated load by the efficiency; 4,000 times .65 or 65%, equals 2,600. 2,600 pounds is the rated load for one leg.

When we double a sling over an object, we effectively create two legs. Since two legs are carrying the load, we multiply the rated load by 2. 2,600 times 2 equals 5,200. This is the rated load of the doubled sling.

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



Determine WLL
 $4,000 \times 65\% = 2,600$

1" Diameter
Hook

2 legs carry the load
 $2 \times 2,600 = 5,200 \text{ lbs.}$

1/2" Wire Rope
WLL 4,000 lbs.

D/D CALCULATIONS

The D/d principle also applies to slings bent around corners. In this case, the diameter of the curvature of the sling as it bends around the corner of the object to be lifted must be determined.

For many applications, special fittings such as pipe sections are placed on the corners of the object to ensure a large enough diameter of curvature for the sling so as not to reduce the sling efficiency too greatly.

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RIGGING GEAR SELECTION AND USE MARKINGS AND RECORD REQUIREMENTS

NAVFAC P-307 SECTION 14

Let's look at the section of NAVFAC P-307 that deals with rigging, Section 14.

Section 14 provides administrative and technical requirements for inspection, testing, certification, alteration, repair, operation, and use of rigging gear.

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 Navy owned gear and to contractor owned gear used with Navy owned cranes.

THE TEST AND INSPECTION PROGRAM

P-307 requires each activity to establish a program that includes initial visual inspection and load test of all equipment and markings, pre-use inspections before equipment is used, documented periodic inspections of all equipment, and documented periodic load tests of certain equipment.

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.

COVERED EQUIPMENT

Test and inspection requirements apply to the following equipment used in weight handling operations.

Rigging hardware such as shackles, links and rings, swivels, eye bolts, swivel hoist rings, turnbuckles, and hooks. These requirements also apply to slings including chain slings, wire rope slings, metal mesh slings, synthetic web slings, synthetic rope slings and synthetic round slings.

These requirements also apply to crane structures without permanently mounted hoists.

Equipment covered also includes manually operated hoists as identified in ASME B30.16 and B30.21 which include chain hoists and lever operated hoists.

Also, miscellaneous equipment, including below the hook lifting devices as identified in ASME B30.20, such as spreader beams, plate clamps, magnet lifters, pallet lifters, and tongs.

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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, and OEM provided rigging gear used for limited lifts such as off-loading, re-loading, initial storage, and shipment.



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.



Each piece of equipment must be clearly marked, tagged or engraved with the rated load of the equipment and indication of the re-inspection due date.

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 generally acceptable ways of marking equipment.

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

SPECIAL ROUNDSLING MARKINGS

NAVFAC P-307 has additional requirements for alternate yarn roundslings. Alternate yarn roundslings are roundslings made from yarns other than nylon or polyester.

The certificate of proof test must include the diameter of the pin used for the proof test. This will be the minimum diameter over which the sling may be used.



The sling must be marked with the minimum allowable pin diameter.

SPECIFIC USE ENDLESS WIRE ROPE SLING MARKINGS

In specific applications 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.

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MARKINGS ON CHAIN SLINGS

In accordance with CFR 29 1915.112 and CFR 29 1917.42 chain slings used in ship repair or cargo transfer require quarterly periodic inspections and must be marked to show the month they were inspected.

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.

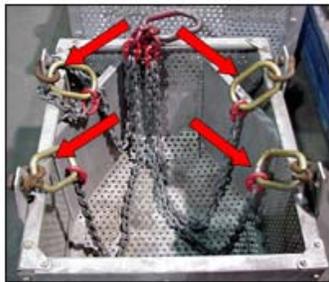
MARKINGS ON BELOW THE HOOK LIFTING DEVICES

Any below the hook lifting device weighing more than 100 pounds must have the weight clearly marked on it.

MULTIPLE PART EQUIPMENT

Some rigging gear has multiple parts that can be disassembled.

To help avoid miss matching parts, all individual components of equipment such as shackles and pins must be identified to each other. Matching ID marks are needed on the primary and subordinate parts.



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.

WLL MARKINGS FOR MULTI-PART SLINGS

NAVFAC P-307 **requires** that multi-part braided slings must 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.

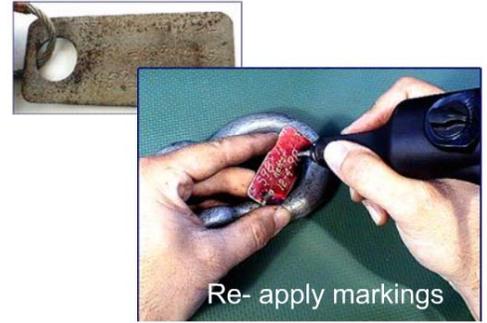
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HARD TO READ OR MISSING MARKINGS

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

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

Remember, all rigging equipment must be marked.



MASTER HISTORY RECORD CARD		EQUIPMENT TYPE / DWG NO		EQUIPMENT ID					
SPS CAPACITY	MANUF. RECOMMENDED PERIODIC TEST VALUE	MAX. MATERIAL REMOVAL AUTHORIZED		PROOF TEST VALUE					
THIS CARD IS TO BE USED FOR RECORD BASE (ORIGINAL) DIMENSIONS AND INFORMATION FOR SPECIAL PURPOSE EQUIPMENT, REFER TO NAP 2A12 - 3 FOR DETAILED INSTRUCTIONS.									
FILL IN APPLICABLE ITEM ONLY. USE REVERSE SIDE TO RECORD HISTORY AS REQUIRED BY NAP 2A12 - 3									
ITEM	DESCRIPTION	ORIGINAL VALUE	SIGNATURE / DATE *	FIRST REPLACEMENT VALUE	SIGNATURE / DATE *	SECOND REPLACEMENT VALUE	SIGNATURE / DATE *	THIRD REPLACEMENT VALUE	SIGNATURE / DATE *
HOOKS	CAPACITY								
	FORM DIMENSION								
FITTINGS	FORGED TYPE								
	SIZE (INCLUDE THREAD LENGTH)								
CRAN	SLING THICK								
	AVERAGE LENGTH OVER 5 LINKS								
SLINGS	LINK DIAMETER AT BEARING								
	TYPE								
LOAD INDICATOR	CLASSIF ES								
	DIMAMWITH (ATTACH CERTIFICATION)								
REMARKS REQUIRED		<p>Documented Test and Inspections provide:</p> <ul style="list-style-type: none"> • Auditable proof of tests and Inspections • The basis for ongoing evaluation • Latest record to be kept on file 							

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.

RECORDS MUST INCLUDE

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

MASTER HISTORY RECORD CARD		EQUIPMENT TYPE / DWG NO		EQUIPMENT ID	
SPS CAPACITY	MANUF. RECOMMENDED PERIODIC TEST VALUE	MAX. MATERIAL REMOVAL AUTHORIZED		PROOF TEST VALUE	
				CF 127D	
RECORD OF INSPECTION / TESTING				MAINTENANCE REPAIR AND MODIFICATION RECORD	
CYCLE	PURPOSE / DESCRIPTION	S	U	** C/740 VSR/DATE	CYCLE DESCRIPTION **C740/VS/DATE
Annual	Load Test Chainhoist	X		J.W. Inspector 1/27/20XX	

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

GENERAL CRANE SAFETY STUDENT GUIDE

IDENTIFYING GEAR TO ITS RECORD

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

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



Unique identification number
Letter designator followed by a number

Example:
S-27
"S" represents *shackles*
27 individually identified shackle

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

For example, "S" could represent shackles. If you have 50 shackles they could each be individually identified S1, S2, S3, etc.

Mark the equipment ID number on the gear. Write the ID number on the record. Now the gear has identifiable records!

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.

Identifies shop

Identifies gear

Date Manufactured

- Year
- Julian date

Use your mouse to explore information

Identifies the owner of the equipment:

- shop
- group
- code

Identifies the specific piece of gear with a serialized number.

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

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

- 94 the year -1994
- 350 the Julian date

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

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 Julian date.

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

KNOWLEDGE CHECK

1. The reason test and inspection is required is to:

- A. Prevent personnel injury
- B. Identify sub-standard equipment
- C. Remove unsafe equipment
- D. All of the above

2. Rigging gear that has been inspected by a trained inspector does not require inspection before it is used.

- A. True
- B. False

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GENERAL CRANE SAFETY STUDENT GUIDE

RIGGING GEAR SELECTION AND USE GENERAL USE

SECTION 14 OF THE P-307

NAVFAC P-307 provides specific rules for using rigging equipment described in section 14.

It does not, however, provide specific direction on rigging practices or techniques.



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 Homemade Gear

Never use shop or homemade equipment unless it has been approved by engineering and certified for use in weight handling operations!

GENERAL CRANE SAFETY STUDENT GUIDE

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." But, do not use rigging gear, such as shackles, as a hammer or wrench! This may damage the rigging gear.

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!

KEEP THE FOLLOWING IN MIND WHEN SELECTING RIGGING EQUIPMENT.

Rigging equipment must be selected based on the total force that will be applied to the gear, not just the weight of the load. Remember, in some cases, the force in one leg of a multiple sling leg could exceed the weight of the load.

Keep the overhead height restrictions or clearances in mind when selecting sling length. Sling lengths that are too long may cause the hook to reach the limit switch before the load reaches the desired height.

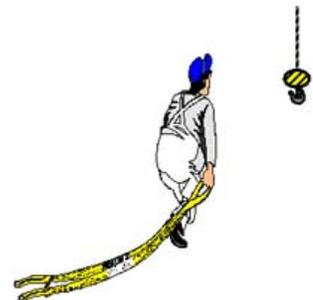
You must also think about the hazards the gear may be subjected to so you can choose the appropriate equipment.

HAZARDS TO RIGGING GEAR

The first major hazard we must talk about is abuse.
Here the biggest hazard is you, the user!

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

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



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

GENERAL CRANE SAFETY STUDENT GUIDE

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.

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.

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

So how do we protect our gear from being damaged by sharp edges?

It's necessary to use protective materials, known as "chafing gear," to prolong the life of our rigging gear and items being lifted.



Chafing gear can be any material used for protecting rigging gear or loads. Chafing gear increases friction thereby reducing the tendency for rigging to slip.

Wood blocks, canvas, cardboard, rubber, leather and old fire hose are great for protecting critical or machined surfaces and increasing friction.

These are just a few examples of chafing gear.

GENERAL CRANE SAFETY STUDENT GUIDE

USING CHAFING GEAR

Chafing gear can be many types of materials and it may be used many different ways.

Wood blocks may be used to keep slings away from sharp edges.

Old fire hose can be placed between your gear and sharp edges or a sling can be passed through the hose and used as a protective sleeve.



Remove the hose to inspect for damage before and after each use. hose can hide sling damage if left on the sling!

HOIST AND CRANE REFERENCES

Portable floor cranes, portable a-frames, portable gantries, and cranes integral to larger machine systems must be operated in accordance with applicable ASME B30 criteria and OEM recommendations.

Chain Hoists and portable hoists must be operated in accordance with ASME B30.16 and OEM recommendations.

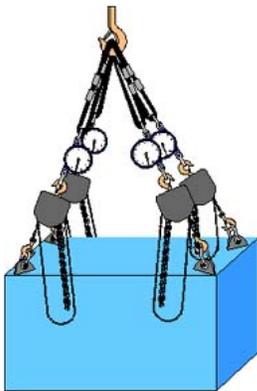
Lever operated hoists must be operated in accordance with ASME B30.21 and OEM recommendations.

Other applicable equipment must be operated in accordance with ASME B30 and OEM recommendations.

USING HOISTS AND CRANES

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

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



USING HOISTS TO DISTRIBUTE SLING LOADING

When chain hoists are used to equalize a load at four or more points, they must be used in conjunction with load indicating devices.

GENERAL CRANE SAFETY STUDENT GUIDE

USING HOISTS AND CRANES

Secure hand chain and excess load chain to prevent tangling and inadvertent operation.

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

Do not use excessive force to operate a hoist. And never use extension bars on lever-operated hoists.



Never choke with load chain

Never "tip load" the hook

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

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. Which section of the NAVFAC P-307 is the rigging gear section?

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

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GENERAL CRANE SAFETY STUDENT GUIDE

RIGGING GEAR SELECTION AND USE USING RIGGING HARDWARE

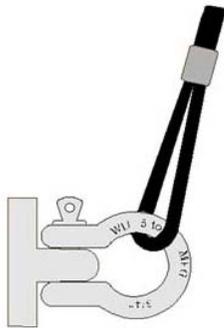
USING RIGGING HARDWARE

Use the same size and type of shackle on each leg in multiple leg applications.

Different types, sizes, or brands of shackles may vary significantly in physical size. This in turn will affect the overall length of the leg and the tension created in each leg.



When installing the pin into the bail, be sure the pin is fully seated into the bail.



SIDE LOADING SHACKLES

It may be sometimes necessary to apply a side load to a shackle.

When side loading a screw pin or bolt type shackle reduce the rated load by 50% or as specified by the OEM .

Round pin shackles shall not be side loaded.

USING EYEBOLTS, SWIVEL HOIST & LIFTING RINGS

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

MINIMUM THREAD ENGAGEMENT

The minimum thread engagement depends on the material into which you are installing the piece of rigging equipment.

When installing eyebolts into steel the minimum required thread engagement is one and one half times the diameter.

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

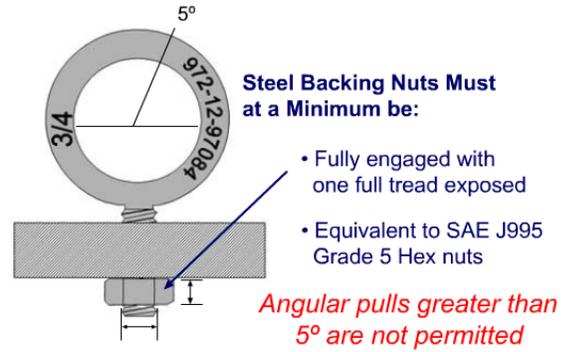


For other materials contact your activity's engineering organization or the OEM.

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EYEBOLTS

When eyebolts are used with backing nuts, the backing nut must be at least SAE grade 5 and fully engaged with at least 1 full thread exposed.



EYEBOLT TYPES

There are two types of eyebolts you may find at your work site, shouldered eyebolts and non-shouldered eyebolts.



Non-shouldered eyebolts are sometimes referred to as plain pattern or regular nut eyebolts.

All eyebolts must be used in accordance with OEM instructions.

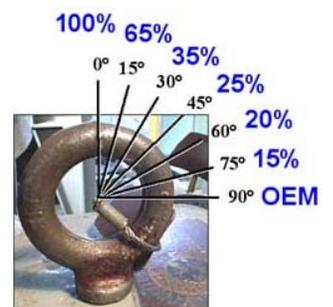
NON-SHOULDERED EYEBOLTS

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

SHOULDERED EYE-BOLTS

Shouldered or machinery eyebolts may be loaded at an angle as long as it is loaded in the plane of the eye.

When loading a shouldered eyebolt at an angle the capacity of the eyebolt is reduced.



INSTALLING SHOULDERED EYEBOLTS

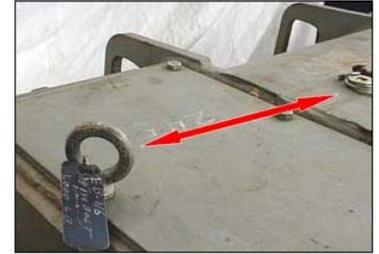
Shouldered eyebolts must be installed with the shoulder seated flush against the mounting surface.

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SHIMS MAY BE USED TO ALIGN EYE

If the shoulder seats flush and the eyebolt is not in the plane of pull shims may be used to align the eye with the plane of the pull.

When using shims, use the minimum thickness that will orient the eye the plane of the pull. The total thickness of shims must never exceed one thread pitch.

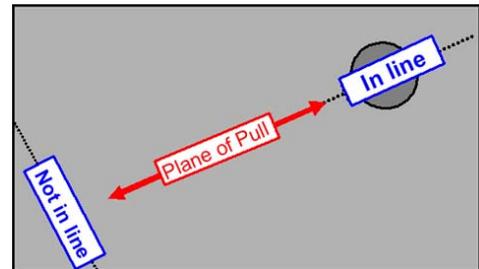


The thread pitch represents one full revolution or rotation of the shank. If there are 16 threads per inch, then the thread pitch is 1/16th inch.

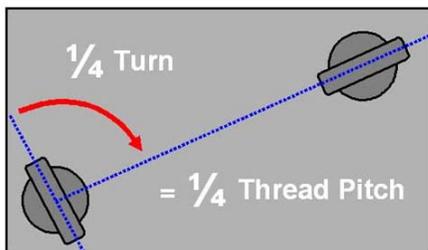
ALIGN THE EYE WITH THE PLANE OF PULL

To use eyebolts with an angular load, the loading must be in line with the plane of the eye. This may not always happen when installing eyebolts.

Look at this shape and imagine two slings connected to each eyebolt shown from the top. You can see that the top eyebolt would be in line with the plane if two slings were attached.



The bottom eyebolt ended up out of plane when tightened against the seating surface.



DETERMINING SHIM THICKNESS

In order to determine shim thickness we must determine how much rotation is required. How far would this eyebolt have to rotate in order to line up in the plane of pull?

It must rotate 1/4 of a turn.

How much shim would that require?

One quarter of the thread pitch would orient the eyebolt in line to the plane of pull.

For the eyebolt noted previously with a thread pitch of 1/16th inch, total shim thickness would be 1/64th inch.

INCORRECT USE OF SHIMS TO ALIGN EYE

This is an example of shims being used incorrectly. Do you see the problem with this eyebolt installation?

The total shim thickness is more than the thread pitch and a lock washer is being used.



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SIDE PULLS

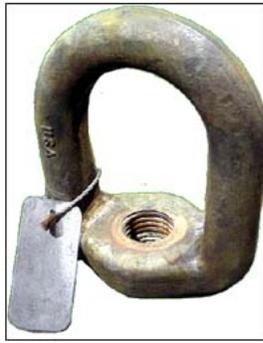


Never pull an eyebolt to the plane of the eye

Never install a single sling through two eyebolts

EYE-NUTS

- Full thread engagement
- One full thread exposed
- Vertical applications only!



SWIVEL HOIST RINGS

Angular pulls do not reduce rated load of a swivel hoist ring.

When using swivel hoist rings, they must be installed with the shoulder flush with the mounting surface.



They must be tightened with a calibrated torque wrench in accordance with OEM requirements. The torque requirements are usually marked on the hoist ring.

Check the OEM instructions prior to installing any shims. Most manufacturers do not allow the use of shims with swivel hoist rings.

SELECTION AND USE OF TURNBUCKLES

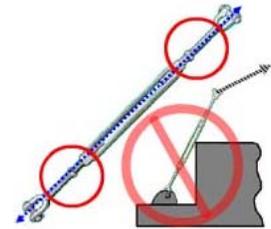
Turnbuckles are commonly used for tensioning lines and securing loads but may be used for crane rigging if they meet the test, inspection and certification requirements of NAVFAC P-307.

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Turnbuckles are used only for in-line pulls.

Jam nuts, when used, must be tightened in accordance with OEM instructions to prevent rotation.

If the possibility of rotation still exists, the turnbuckle must be secured by safety wire or other suitable means in addition to jam nuts.



THREADED ATTACHMENT POINT

Remember to use extreme caution when using a threaded item such as an eyebolt or a hoist ring as a single attachment point!

Never rotate or spin an object being lifted with a single threaded attachment point.

The lifting attachment may unthread and the object may fall.

KNOWLEDGE CHECK

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

- A. True
- B. False

2. The minimum depth of thread engagement for a 3/4 inch eyebolt into a steel object is:

- A. 1/2 inch
- B. 1 1/8 inch
- C. 1 inch
- D. 1 1/2 inch

3. An angular pull of 45° is allowed on non-shoulder type eyebolts.

- A. True
- B. False

NOTES

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RIGGING GEAR SELECTION AND USE SLING USE MODULE

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 SLING USE

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

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

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

WIRE ROPE TEMPERATURE RESTRICTIONS

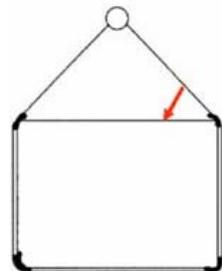
Wire rope must also be protected from extreme temperatures, which can seriously affect the wire's strength.

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

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

ROPE SLING RESTRICTIONS

Wire rope clips should not be used to fabricate slings and wire rope slings should never be knotted.



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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 chafing on sharp corners and edges to prevent damage to slings and load.

Always check OEM instructions for the chain sling you are using.



CHAIN SLING TEMPERATURE RESTRICTIONS

NAVFAC P-307 requires that chain slings should not be used when temperatures are below minus 40° Fahrenheit.

When chain slings are used at or above 400° Fahrenheit, follow OEM recommendations.



METAL MESH SLINGS

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

Do not use metal mesh slings when temperatures are below 0° or above 550° Fahrenheit.

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

Always follow OEM recommendations.

TYPES OF SYNTHETIC SLINGS

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.



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USING SYNTHETIC SLINGS

Synthetic slings cannot be substituted for other slings specified on rigging sketches.

Avoid chemical exposure to synthetic slings and always use chafing gear!

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

And always follow OEM recommendations when using synthetic slings.

SYNTHETIC WEB SLING USE

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

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.

WEB SLING TEMPERATURE RESTRICTIONS

Do not use synthetic web slings at temperatures above 180° Fahrenheit

MINIMUM D/D RATIO FOR SYNTHETIC ROPE SLING USE

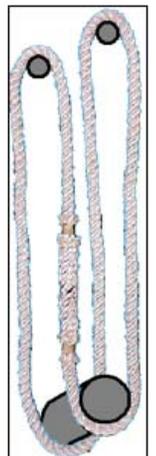
When making single point lifts with eye to eye synthetic rope slings, use two slings or double up a single sling.

These slings are hand spliced.

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 be bent around any object that is smaller than one half-inch.



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SYNTHETIC ROPE TEMPERATURE RESTRICTIONS

Do not use nylon or polyester synthetic rope slings at temperatures above 180° or under minus 40° Fahrenheit.

Do not use polypropylene slings at temperatures above 150° or under minus 40° Fahrenheit.

ROUND SLING USE

For roundslings, NAVFAC P-307 recommends that you use the shackle types listed by the OEM.



Alternate yarn synthetic round slings must not be used around items smaller in diameter than the pin used to test the sling. The minimum D-to-d ratio shall be marked on all alternate yarn round slings.

Follow OEM recommendations when using roundslings in extreme temperatures.

COMMON SLING USE RULES

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

Never use a sling that has been knotted.

Chafing gear should be used where needed.

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

EYE LENGTH VS. HOOK DIAMETER

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

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

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

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

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ATTACHING GEAR TO HOOKS

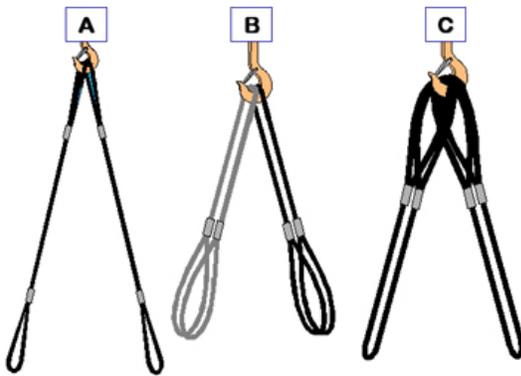
When attaching rigging gear to hooks be sure the safety latch is working properly and closes the throat opening without obstruction. Failure to do so can allow the gear to come off the hook.



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

CORRECT USE OF SLINGS ON HOOKS

These graphics illustrate correct ways to attach slings to a hook.



Graphic “A” shows a vertical application with two sling eyes seated in the bowl of the hook.

Graphic “B” shows two slings doubled over the hook and sling eyes pointing down to attachment points.

Graphic “C” shows two slings doubled with sling eyes on the hook and the bight pointing down to attachment points.

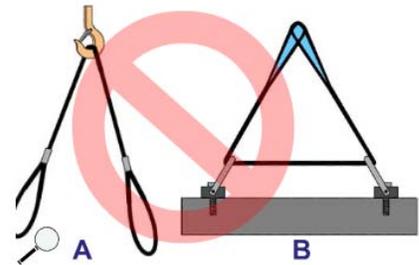
When wire rope slings are used as in graphics “B” and “C”, and a heavy load is applied, individual wires may become permanently deformed or kinked. If the slings become kinked, they should not be used again in vertical applications.

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.

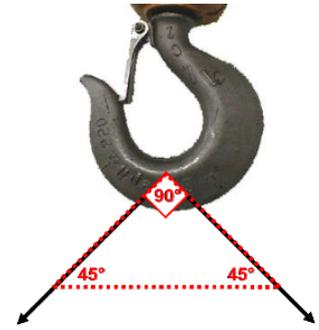
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ATTACHING LEGS TO A HOOK

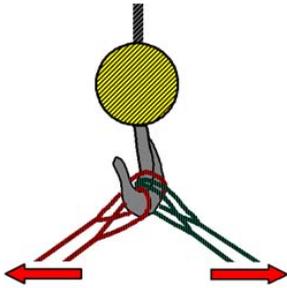
Included angle is the angle measured between two slings sharing a common attachment point.

To prevent tip loading when lifting with two slings, the included angle created by slings attached to the hook must not exceed 90° .

If the horizontal angle of the slings is less than 45° , the included angle will exceed 90° .



In this case, you must use a shackle or other collection device to connect the slings to the hook.



INSIDE AND OUTSIDE SLINGS

When rigging four slings to a hook, separate the slings into two pairs, inside and outside so they do not pull in the plane of the hook.

Attach the inside slings to one end of the object and the outside slings to the other end, being careful that they are not crossed.

3 TYPES OF HITCHES

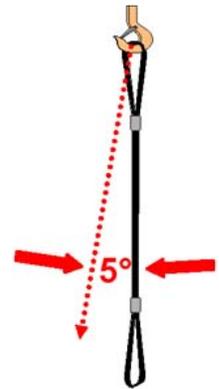
Slings are used in three types of hitches: the vertical hitch, the choker hitch and the basket hitch.

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

WLL OF VERTICAL HITCHES

The rated load for a vertical hitch is 100% of the sling's capacity.

Sling angle stress is encountered any time the vertical angle exceeds 5° and must be taken into account.



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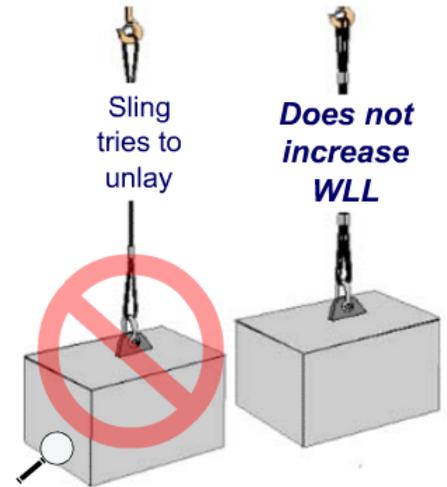
USE 2 LEGS FOR VERTICAL HITCHES

To prevent unlaying of the wire rope, do not use a single sling leg wire rope sling in a vertical hitch.

Use two legs for single point lifts. The second leg prevents the sling from spinning.

It is important to note that the configuration shown here does not increase the rated load because slings are rarely the exact same length.

The shorter of the two will carry the load.



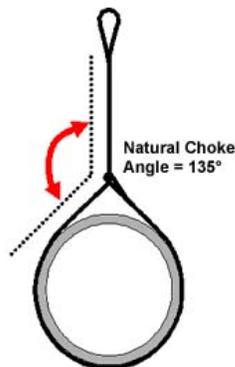
CHOKER HITCHES

Using a shackle to set a choker hitch will prolong the life of the sling.

Whenever a shackle is used to set a choker hitch set the eye of the sling on the pin of the shackle. This will prevent the "running" part of sling from rotating the pin of the shackle as it passes over it.

Never set the choker so the running part of the sling passes against the shackle pin.

RATED LOADS OF CHOKER HITCHES



- Reduce rated load
- Angles less than 120° reduces the rated load even more!
- Don't exceed OEM rated load!

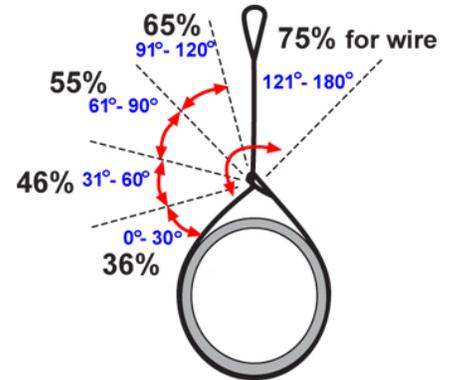
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WIRE AND SYNTHETIC SLING EFFICIENCY

This chart shows the efficiency of the sling's capacity when choking with a wire rope or synthetic rope sling. Refer to Table 14-4 in NAVFAC P-307 for choker efficiencies for other slings.

For angles 121° to 180° the rated load is reduced to 75% of the vertical capacity.

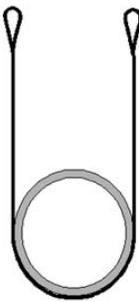
This does not apply to braided multi-part wire rope slings. Contact the Wire Rope Technical Board for recommended efficiency factors for braided multi-part slings.



WLL OF BASKET HITCHES

Basket hitches are the strongest of the three hitches.

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



200% rated load when:

- Vertical angle 5° or less
- No twists in sling
- Maintain D/d ratio
 - Wire rope = **greater than 40**
 - Synthetic rope = 8 or **greater**

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.

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LOAD CHARTS MODULE 1

INTRODUCTION TO LOAD CHARTS

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

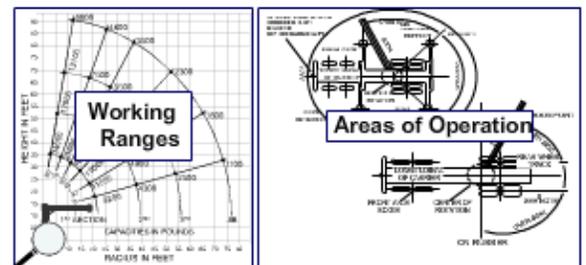
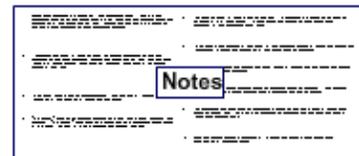
Generally, load charts list the maximum rated capacity of the crane for every permissible configuration, specify the crane's operational limitations, and set-up requirements for safe operation.

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

PARTS OF A LOAD CHART

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

Radius in Feet	Manual Fly Section Retracted Boom Length in Feet						
	32	33	44	50	56	62	68
12	50,000	47,000	44,000	41,000	38,000		
15	42,000					27,000	25,000
20	31,800	Rated Lifting Capacities				25,500	22,000
25	21,800	21,800	21,700	21,100	20,000	19,000	18,000
30		15,500	15,500	15,500	15,500	15,500	15,500
40			9,000	9,000	9,000	9,000	9,000



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WHAT CAN WE LEARN FROM THE NOTES SECTION?

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

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

1 Load Chart Capacity Note

- deductions from listed capacity
- allowable boom lengths
- instructions for determining **structural VS. stability** limitations
- wire rope type and reeving information

2

- crane set up requirements
- crane configuration requirements for travel
- general crane safety reminders

surroundings, experience of personnel, handling of load, etc.

3 Operating radius is the horizontal distance from the axis of rotation to the centerline of the hoist line or tackle with load applied.

4 "On Rubber" lifting (if permitted) depends on proper tire inflation, capacity, and condition. "On Rubber" loads may be transported at a maximum vehicle speed of 2.5 mi/hr. (4 km./hr.) on a smooth and level surface only.

8 Power-telescoping boom sections must be extended equally at all times. Long cantilever booms can create a tipping condition when in extended and lowered position.

9 The maximum load which may be telescoped is limited by hydraulic pressure, boom angle, boom lubrication, etc. It is safe to attempt to telescope any load within the limits of rated lifting capacity chart.

10 Keep load handling devices a minimum of 12 inches (03 meter) below boom head when lowering or extending boom.

Load chart notes serve as a safety refresher.

RATED LIFTING CAPACITY CHART

The rated capacity chart is that part of the load chart that we reference to determine the crane's gross capacities.

Radius in Feet	Manual Fly Section Retracted Boom Length in Feet								Manual Fly Ext. *92
	32	33	44	50	56	62	68	71	
12	50,000	47,000	44,000	41,000	38,000				
15	42,000	40,000	39,000	36,000	33,000	27,000	25,000		
20	31,800	31,400	31,000	29,500	28,000	25,500	22,000	20,000	12,000
25	21,800	21,800	21,700	21,100	20,000	19,000	18,000	17,000	11,500
30		15,500	15,500	15,500	15,500	15,500	15,500	15,500	11,000
40			9,000	9,000	9,000	9,000	9,000	9,000	9,000
50					5,700	5,700	5,700	5,700	5,700
60							3,500	3,500	3,500
70									3,100
80									2,100
89									1,500

Capacities appearing above bold line are based on machinery strength, and tipping should not be relied upon as the capacity limitation.
 * Indicates capacity of extended fly section, regardless of boom length.

Gross capacities are listed for various boom lengths and load radii.

The bold line, running between the listed capacities, separates capacities based on strength of materials where overload may cause structural failure and

capacities based on stability where overload may cause the crane to become unstable and tip over. Capacities above the line are based on material strength. Capacities below the line are based on stability.

Not all manufacturers use the bold line method of separating the listed capacities.

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ASTERISKS

Some manufacturers use asterisks to mark the structural areas of the load chart.

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

* Asterisks may be used to mark the structural areas of the load chart

SHADED AREAS

In this example shaded areas identify capacities based on structural strength.

JIB POINT RADIUS FEET	CAPACITIES IN POUNDS								JIB POINT RADIUS FEET
	BOOM LENGTH FEET								
	110	120	130	140	150	160	170	180	
75*	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	75*
80	40,000	40,000	40,000	40,000	40,000	40,000	39,200	38,400	80
85	39,400	39,400	39,400	38,600	37,800	37,000	36,200	35,400	85
90	36,400	36,400	34,900	34,500	33,900	33,600	33,100	32,600	90
95	33,700	33,700	32,900	32,200	31,800	31,200	30,900	30,400	95
100	31,300	30,700	30,500	29,900	29,400	28,800	28,500	28,000	100
105	29,200	28,600	28,400	27,700	27,300	26,700	26,400	25,800	105

Shaded areas indicate structural or strength of materials lifting areas

JIB POINT RADIUS FEET	CAPACITIES IN POUNDS								JIB POINT RADIUS FEET
	BOOM LENGTH FEET								
	110	120	130	140	150	160	170	180	
90	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	90
95	30,000	30,000	30,000	30,000	30,000	30,000	29,300	28,600	95
100	30,000	30,000	30,000	30,000	29,300	28,600	27,900	27,200	100
105	29,600	29,000	28,800	28,100	27,400	26,700	26,000	25,300	105
110	27,700	27,100	26,800	26,200	25,700	25,100	24,500	24,000	110
120	24,300	23,700	23,500	22,800	22,400	21,800	21,500	21,000	120

GROSS CAPACITY

What can be safely lifted on the hook?

To answer that question you must understand gross capacity.

Gross capacity is the value shown on a manufacturer's load chart.

These **values are not the loads** that can be suspended from the crane hook.

What then can be safely lifted on the hook?

To answer this question you must find the net capacity of the crane.

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

45,800 Gross Lifting Capacity

GENERAL CRANE SAFETY STUDENT GUIDE

WHAT IS NET CAPACITY?

Net capacity is the value shown on the manufacturer's load chart, minus all deductions.

To calculate net capacity, subtract the effective weight of all deductions from the gross capacity.

Common deductions include the weight of attachments including extensions, swing-away jibs, and auxiliary boom nose sections.

The same attachments may have different effective weights in the stowed and erected position.

The effective weight of these attachments is listed in the load chart notes, in an area titled weight reductions for load handling devices.

COMMON DEDUCTIONS

The weight of attachments, such as swing away jibs, stowed or erected, and the weight of auxiliary boom heads and rooster sheaves, must be deducted from gross capacity.

The weight of the hooks, blocks and overhaul ball are also deducted from the gross capacity.

The crane may be equipped with standard or optional hook blocks having different weights.

Hook block weights and capacities should be stamped on each hook block.

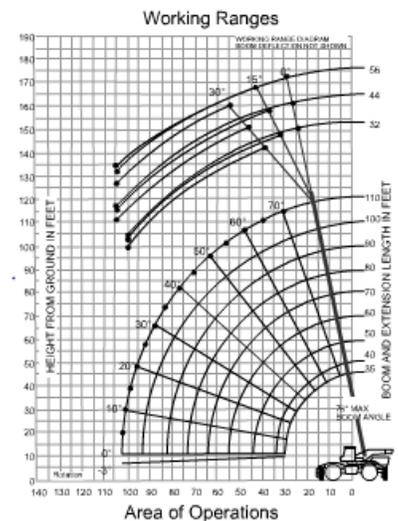
Be aware that some manufacturers require the weight of excess wire rope, not necessary for a lift, to be deducted.

RANGE DIAGRAMS

Range diagrams are used for planning lifts. You can use them to determine the configuration of the crane needed for a particular job.

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

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

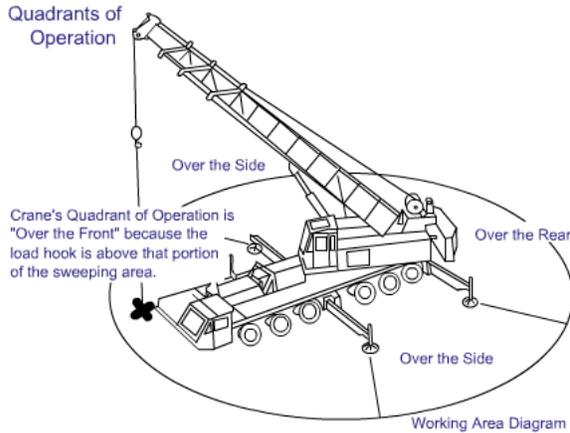


GENERAL CRANE SAFETY STUDENT GUIDE

When loads must be set a certain distance in from the edge of a roof, the length of jib and necessary jib offset are easily determined by using the range diagram.

It may be used to determine the boom angle of telescopic booms, when the boom is only partially extended and the radius is known.

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



WORKING AREA DIAGRAM

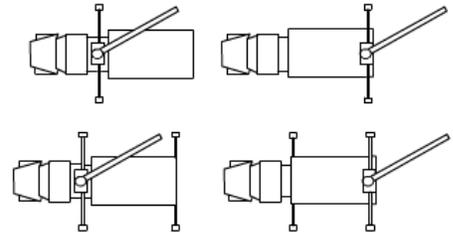
Another important part of the load chart is the working area diagram. Crane stability and capacity will vary as the load moves from one quadrant of operation to another.

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

CATEGORY 4 QUADRANTS

Always check OEM documentation for the location of quadrants on your machine.

These are examples of the variety of crane and stabilizer placements on category 4 machines.



CONSEQUENCES OF OVERLOADING

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

GENERAL CRANE SAFETY STUDENT GUIDE

LOSS OF STABILITY

When a crane loses stability the tipping force of the load overcomes the counteracting load of the crane.

When tipping begins, especially with loads high in the air, it is very unlikely that the crane operator can do much to prevent overturning.



As the crane begins to tip, the load radius increases. As the load radius increases the capacity of the crane decreases rapidly.

This happens so rapidly that recovery is nearly impossible.

It is critical for you the crane operator to know the safe capacity of your crane at all times!

LOSS OF STABILITY: TELESCOPIC BOOM

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

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



LOSS OF STABILITY: TIPPING

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

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

STRUCTURAL FAILURE

Cranes can fail structurally if the rated capacity is exceeded.

Structural failure can occur before any signs of tipping, when capacities in the strength area of the load chart are exceeded.

Structural failure is not limited to total fracture of a component. It includes hidden or less visible damage such as cracking, bending, or twisting of any component. It is difficult to predict which component in a crane may fail structurally when overloaded.

Loss of stability and structural failure from overloading the crane are avoidable when you understand and follow the crane capacity or load chart.

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CHART EXAM

1. Gross capacities would be listed in which part of the load chart?
 - A. Range Diagram
 - B. Rated Lifting Capacities
 - C. Working Areas Diagram
 - D. Notes

2. *Quadrants of Operation* would be listed in which part of the load chart?
 - A. Rated Lifting Capacities
 - B. Range Diagram
 - C. Working Area Diagram
 - D. Notes

3. *Available Jib Offset* would be listed in which part of the load chart?
 - A. Working Area Diagram
 - B. Rated Lifting Capacities
 - C. Notes
 - D. Range Diagram

4. Wire rope type and reeving information would be listed in which part of the load chart?
 - A. Rated Lifting Capacities
 - B. Range Diagram
 - C. Notes
 - D. Working Area Diagram

5. Possible capacity loss due to quadrant changes could be determined by checking which parts of the load chart?
 - A. Notes Pages and Range Diagram
 - B. Range Diagram and Working Area Diagram
 - C. Rated Lifting Capacities Chart and Notes Pages
 - D. Working Area Diagram and Rated Lifting Capacities Chart

GENERAL CRANE SAFETY STUDENT GUIDE

6. General crane safety reminders would be listed in which part of the load chart?

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

7. The maximum load that can be lifted without losing stability would be listed in which part of the load chart?

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

8. Maximum height a load may be hoisted would be determined with which part of the load chart?

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

9. Overloading a crane may result in which of the following consequences?

- A. Damaged Wire Rope
- B. Tipping (Loss of Stability)
- C. Boom Failure
- D. Overturning
- E. All of the consequences listed

10. Deducting the weight of all attachments, hooks, blocks, rigging and lifting gear from the capacities listed in the load chart provides the operator with

_____.

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

NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CHARTS MODULE 2

PRE-PLANNING MOBILE CRANE LIFTS

To select the right crane for the job – the lift must be carefully pre-planned.

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

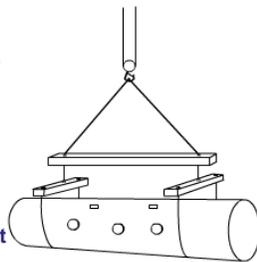


TOTAL WEIGHT OF THE LOAD

Determining the total weight of the load begins with finding the weight of the object to be lifted.

- Total Weight of Load
 - Weight of object to be lifted
 - Weight of slings and shackles
 - Other lifting gear

Example:
 9,000 lbs. Load
 200 lbs. Slings and shackles
 + 300 lbs. Other
 = 9,500 lbs. **Total Load Weight**



In this example lift, the object weight is 9,000 pounds. The total weight of the load includes the weight of the object to be lifted and the weight of the rigging gear.

Slings and shackles weigh 200 pounds, and the lifting beams add 300 pounds, bringing the total load weight to 9,500 pounds.

Failure to factor in the weight of all rigging and lifting gear may cause an overload.

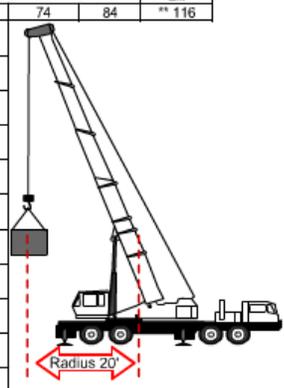
LOAD RADIUS

The load radius is the horizontal distance measured from the center of rotation of the crane center pin, to the center of the hook.

Load radius can be established by centering the hook over the load and referring to the crane's radius indicator.

For fixed boom lengths, radius can be calculated using boom angle and a load chart.

Radius in Feet	ON OUTRIGGERS FULLY EXTENDED – OVER REAR							
	Boom Length in Feet							
	34	40	44	54	64	74	84	84 ft - 32 ft. Ext ** 116
10	100,000 (70)	74,000 (73)	72,000 (76)					
12	90,000 (66.5)	70,000 (70)	67,500 (73.5)	64,000 (76.5)				
15	72,000 (61)	63,700 (65.5)	61,000 (69)	55,000 (73)	44,700 (76)			
20	53,000 (50.5)	52,200 (57.5)	49,800 (62)	44,000 (67.5)	37,900 (71)			
25	41,000 (38.5)	41,000 (48)	41,000 (54)	36,300 (61.5)	31,900 (66)			
30	29,690 (21.5)	29,690 (37.5)	29,690 (45)	29,690 (55.5)	27,000 (60.5)			
35		22,650 (23)	22,650 (34.5)	22,650 (48.5)	22,650 (55)			
40			18,090 (19)	18,090 (41)	18,090 (49)			
45				14,840 (31.5)	14,840 (42)			
50				12,330 (17.5)	12,330 (35)			
55					10,440 (26)			



GENERAL CRANE SAFETY STUDENT GUIDE

On telescoping boom cranes, boom deflection can increase the radius.

On critical lifts the radius should be measured. Monitor the radius throughout the lift.

MEASURING RADIUS

For some lifts you must verify radius by actual measurement.

Measurement is required for all lifts exceeding 80% of the crane's capacity at the maximum anticipated radius.

Doing a dry run with an empty hook to maximum anticipated radius is required for all lifts exceeding 50% capacity for a given radius.

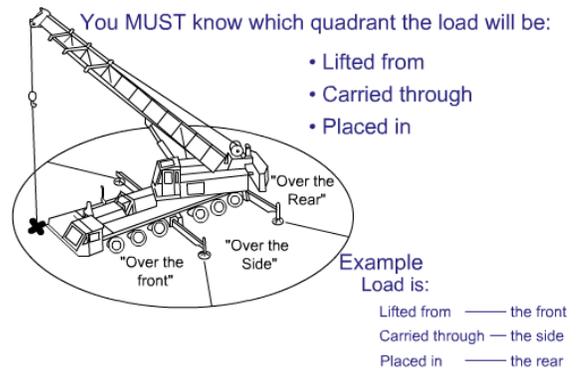
Verify the radius using the radius indicator.

QUADRANTS OF OPERATION

The crane's working area is divided into areas called quadrants of operation.

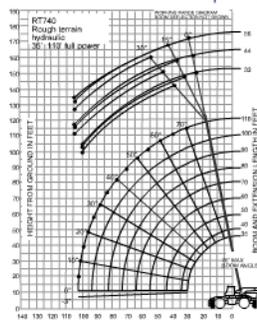
In pre-planning the lift, you must know which quadrant the load will be lifted from, carried through, and placed in.

Knowing the load path is important for selecting the right crane for the job.



Use range diagram to determine:

- Length of boom required
- Distance from boom tip & load



LIFT HEIGHT CONSIDERATIONS

The range diagram is useful for crane selection.

For example, for loads that must be placed or picked on a roof, the maximum hook height needed must accommodate the minimum allowable clearance between the boom tip and the hook blocks.

The range diagram can also be used to determine the required boom

length depending on the height of the load and rigging gear.

GENERAL CRANE SAFETY STUDENT GUIDE

JOB SITE CONSIDERATIONS

The ground must be firm enough to support the crane and keep it level during the lift.

Load chart ratings apply only with adequate support.

Make sure there is enough room at the job site to set up and maneuver the crane.

When lifts must be made near power lines, make sure limits of approach and safety requirements are observed.

Limit vehicle and pedestrian traffic. Accessible areas within the swing radius should be barricaded to prevent anyone from being struck or crushed by the crane.

CRANE SELECTION

One requirement for safe lifting is selecting the crane to suit the job.

If the crane's characteristics do not match the job requirements then the overall safety of the lift can be compromised.

Consider the maximum radius of the lift, quadrants of operation, boom length, configuration of the crane and crane capacity.

REQUIREMENTS

You have been asked to lift a steam condenser from a loading dock and place it on a trailer for shipping.

You pre-plan the lift with the crane team members and learn the condenser and lifting gear weigh 9,500 pounds.

The lift radius has been estimated at a maximum of 45 feet.

The load will be picked up over-the-rear quadrant of the crane and set down over-the-side.

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

The height of the lift is 25 feet, requiring a minimum boom length of 54 feet.

Using this information you can select the right crane for the job.

GENERAL CRANE SAFETY STUDENT GUIDE

CRANE SELECTION

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



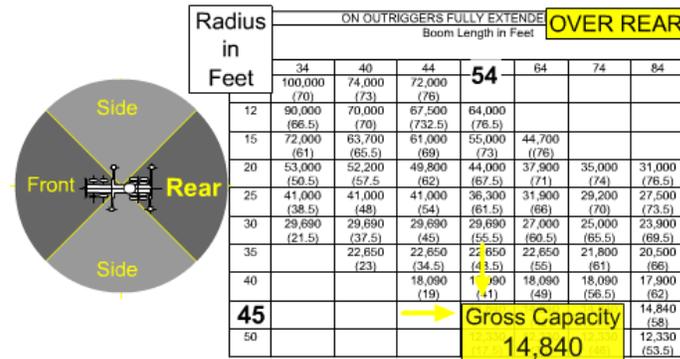
Next, determine the allowable quadrants of operation by referring to the crane's load chart.

FINDING GROSS CAPACITY

Since the crane's capacity may be affected by the quadrant of operation, it is important to choose load charts for the quadrants the lift will be made in and lifted through.

The load will be picked up over-the-rear quadrant. Select the appropriate capacity chart for this quadrant.

Now, find the gross capacity.



Since the lift radius is 45 feet, read down the radius column to 45 feet.

From 45 feet read across to the 54 foot boom-length column.

In this example, the gross capacity is 14,840 pounds.

Since the load will be placed over-the-side, the next step is to check the load charts for a **capacity change when the load swings into this new quadrant**

FINDING OVER THE SIDE CAPACITY

To find the gross capacity for over-the-side, select the appropriate capacity chart. Read down the radius column to 45 feet.

From 45 feet read across to the gross capacity in the 54 foot boom-length column.

Notice, in this example, the listed gross capacity is 12,840 pounds, 2,000 less than the over-the-rear capacity.

Radius in Feet	ON OUTRIGGERS FULLY EXTENDED OVER SIDE						
	Boom Length in Feet						
	34	40	44	54	64	74	84
10	100,000 (70)	74,000 (73)	72,000 (76)				
12	90,000 (66.5)	70,000 (70)	67,500 (73.5)	64,000 (76.5)			
15	72,000 (61)	63,700 (65.5)	61,000 (69)	55,000 (73)	44,700 (76)		
20	53,000 (50.5)	52,200 (57.5)	49,800 (62)	44,000 (67.5)	37,900 (71)	35,000 (74)	31,000 (76.5)
25	39,800 (38.5)	39,800 (48)	39,800 (54)	36,300 (61.5)	31,900 (66)	29,200 (70)	27,500 (73.5)
30	27,030 (21.5)	27,030 (37.5)	27,030 (45)	27,030 (55.5)	27,000 (60.5)	25,000 (65.5)	23,900 (69.5)
35		20,280 (23)	20,280 (34.5)	20,280 (43.5)	20,280 (55)	20,280 (61)	20,280 (66)
40			15,950 (19)	15,950 (41)	15,950 (49)	15,950 (56.5)	15,950 (62)
45				Gross Capacity 12,840		12,840 (61.5)	12,840 (58)

GENERAL CRANE SAFETY STUDENT GUIDE

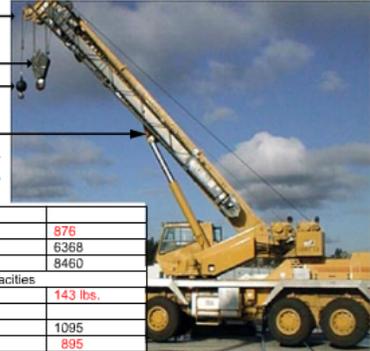
The crane's gross capacity has been identified for all quadrants the load will pass through.

To calculate the crane's net capacity, deductions must first be established.

DEDUCTIONS

In this example the crane is configured with an auxiliary boom head weighing 143 pounds, a main hook block weighing 895 pounds, a whip ball weighing 560 pounds, and a stowed telescoping extension having an effective weight of 876 pounds.

Aux. Boom Head	143 lb.
Main Hook Block	895 lb.
Whip Ball	560 lb.
Stowed Extensions	876 lb.
Total	2,474 lb.



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

Total deductions equal 2,474 pounds.

For this crane, no deduction is required for excess wire rope. Now you can calculate the net capacity.

CALCULATION

In this example you must determine net capacities for two working quadrants.

Gross capacity over-the-rear is 14,840 pounds. Deductions add up to 2,474 pounds. Gross capacity less deductions results in a net capacity of 12,366 pounds over the rear.

Gross capacity over-the-side is 12,840 pounds. Gross capacity less deductions results in a net capacity of 10,366 pounds over the side.

Over the rear net capacity equals 12,366 pounds.

Over the side net capacity equals 10,366 pounds.

FINAL CHECKS

For this example, compare the net capacities with the total weight of the load.

Over-the-rear net capacity at 45 foot radius is 12,366 pounds. Over-the-side net capacity at 45 foot is 10,366 pounds. The total weight of the lift is 9,500 pounds.

Since the **net capacity** in both over-the-rear and over-the-side quadrants **exceeds the total weight of the lift**, you know this lift can be safely made.

Since the over-the-side lift exceeds 90% of the cranes capacity at this radius, this lift requires the crane team to follow procedures for a complex lift.

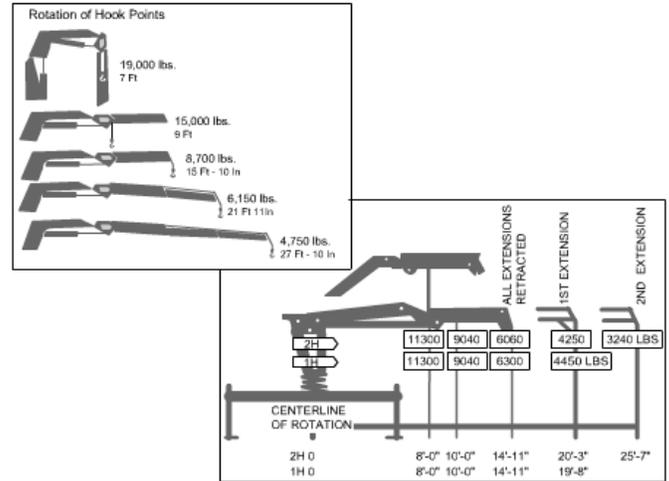
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If practical, the operator might try shortening the radius by booming up and/or using a shorter boom before swinging over-the-side.

EXAMPLES OF CATEGORY 4 CAPACITY CHARTS

These are examples of load charts that may be found on some articulating-boom category 4 cranes.

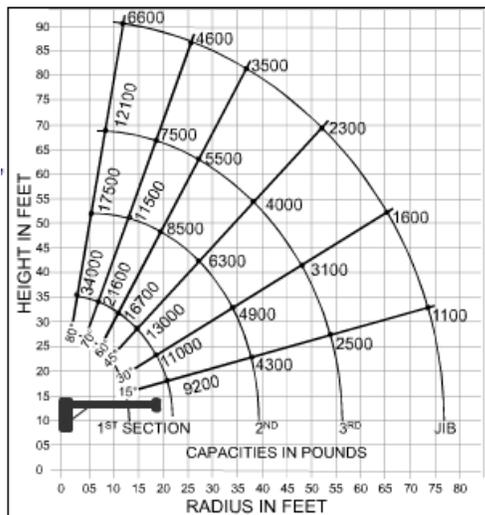
To use this type of chart in determining safe capacities, the operator must determine the weight of the load and rigging gear, determine the maximum load radius, from the centerline of crane rotation to the center of gravity of the load, and carefully review the load chart to insure that the load does not exceed the crane's capacity.



If the crane is equipped with a winch, insure that the load does not exceed the rated load of the wire rope.

EXAMPLES

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



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

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

This holds true for each additional section.

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

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

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CHART MODULE 2 EXAM

1. When pre-planning mobile crane lifts, the crane operator must know the maximum height and _____ at which the crane will be working.
 - A. radius
 - B. distance
 - C. speed

2. When pre-planning mobile crane lifts the crane operator must know the operating _____ that the load will be lifted from, carried through, and placed in.
 - A. route
 - B. quadrants
 - C. industrial area

3. When pre-planning mobile crane lifts the crane operator must know the _____ conditions where the lift is to be made.
 - A. site
 - B. weather

4. Which of the following is most critical to maintain crane capacity?
 - A. Boom tip height
 - B. Hoisting speed
 - C. Hook radius
 - D. Boom angle

5. The values listed in the manufacturer's capacity charts for most mobile cranes are _____.
 - A. net capacities
 - B. gross capacities
 - C. suggested guidelines
 - D. maximum radii

GENERAL CRANE SAFETY STUDENT GUIDE

6. Calculating _____ capacity requires subtracting the total of all deductions from crane capacity.

- A. net
- B. deductions
- C. boom
- D. crane
- E. gross

7. When setting up mobile cranes at the job site, which of the following job site conditions should be considered?

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

8. In pre-planning the lift, you must know which quadrant the load will be lifted from, carried through, and _____.

- A. placed in
- B. returned to

9. The range diagram can be used to determine the required boom length.

- A. True
- B. False

10. The total weight of the load includes _____.

- A. the load and all rigging gear
- B. only the load

NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CHARTS MODULE 3

WORKING BETWEEN VALUES

What should you do when the actual load radius, boom length, or boom angle is not listed on the load chart?

The following examples show how to find safe lifting capacities when the job requires working between values shown on the load chart.

RADIUS BETWEEN VALUES

When the actual load radius falls between the values listed in the capacity chart, use the **gross capacity rating for the next longer radius** chart listing.



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

In this example the load is at a 24 foot radius.

The chart shows values in the 20 and 25 foot radius, but none at 24 foot.

To find the correct radius - **use the value shown on the chart for the longer radius.**

In this example the next longer radius is 25 feet.

BOOM LENGTH BETWEEN VALUES

When the actual boom length falls between the values listed in the capacity chart, **use the gross capacity rating for the boom length with the next lower capacity listed.**



This example shows the boom length is 36 feet. The chart shows a column for 33, and 45 foot boom lengths.

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

GENERAL CRANE SAFETY STUDENT GUIDE

To find the correct capacity, use the column for **the boom length with the next lower capacity** shown on the chart.

In this example, the correct column to use is for 45 feet of boom. So, when using a boom length anywhere between 33 and 45 feet, the gross capacity for any load radius, is obtained using the 45 foot column.

Some cranes have a slightly higher capacity at a longer boom length for the same radius in some areas of the load chart. In this case you would choose the capacity of the shorter boom length.

BETWEEN VALUES FOR TWO VARIABLES

Sometimes you must determine gross capacity for values between those listed for both boom length and radius.

For a 24-foot radius, choose the row for the 25 foot radius,

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

For a 36-foot boom length, read down the column for the 45-foot boom length.

Following this procedure, the gross capacity for both radius and boom length is 62,000 pounds.

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

Gross Capacity = 62,000 lbs.

Remember, when working between values shown on a capacity chart, **always choose the lower values listed on the load chart to determine safe capacity.**

BOOM ANGLE BETWEEN VALUES

When the boom angle falls between the values listed in the capacity chart, refer to the boom angle with next lower capacity.



In this example the load will be lifted at a 55 degree boom angle. As you can see on the capacity chart, 55° falls between the listed angles of 49° and 56°

To find the correct capacity, read the row with **the next lower capacity** shown on the chart. In this example the correct reference boom angle is 49°.

LOAD RATING IN POUNDS				
MAIN BOOM				
WITH OUTRIGGER FULLY EXTENDED AND SET				
Radius in Feet	Angle in Degrees	Over Front in Pound	Over Rear and Side	Boom Point Elevation (Feet)
25	78		87,970	106
30	75	69,670	69,670	105
35	72	53,970	53,970	104
40	69	43,670	43,670	102
45	66	36,270		
50	63	30,770		
60	56	23,070		
70	49	17,970	17,970	84
80	41	14,270	14,270	74

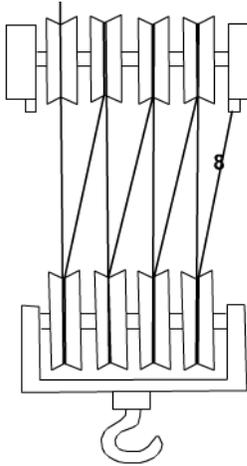
55° is between 56° and 49°
Next lower = 49°

GENERAL CRANE SAFETY STUDENT GUIDE

CAPACITY LIMITING FACTORS

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

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



PARTS OF LINE

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

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

WIRE ROPE CAPACITY

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

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

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

Hoists	Cable specs.	Permissible Line pulls
Main & Aux. Model 30	3/4" (19 mm) 18 x19 Class or 35x7 Rotation Resistant Min. Breaking Str. 64,600 lbs.	12,920 lbs.
Main & Aux. Model 30	3/4" (19 mm) 6 x 37 Class EIPS IWRC Special Flexible Min. Breaking Str. 58,800	12,920 lbs.

GENERAL CRANE SAFETY STUDENT GUIDE

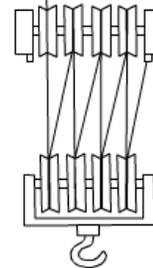
CALCULATING WIRE ROPE CAPACITY

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

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

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

Hoists	Cable specs.	Permissible Line pulls
Main & Aux. Model 30	3/4" (19 mm) 18 x 19 Class or 35 x 7 Rotation Resistant Min. Breaking Str. 64,600 lbs.	12,920 lbs.
Main & Aux. Model 30	3/4" (19 mm) 6x37 Class EIPS IWRC Special Flexible Min. Breaking Str. 58,800	12,920 lbs.



Multiply the rated load by the number of parts:

$$\begin{array}{r} 12,920 \text{ lbs.} \\ \times \quad 8 \text{ parts} \\ \hline 103,360 \text{ lbs.} \end{array}$$

OTHER CONDITIONS AFFECTING CAPACITY

The crane's capacity may be affected by operational conditions and environmental conditions.

Some conditions that the operator can control are crane level, outrigger position, side-loading, and load swing.

Environmental conditions that you must be aware of are ground support and wind.

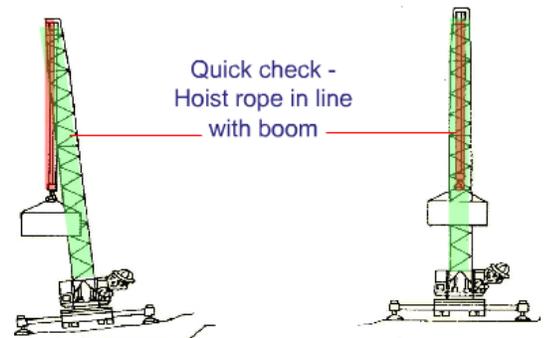
OUT OF LEVEL

Capacities shown on the load chart for each crane are based on the crane being perfectly level.

A crane that is three degrees out of level can reduce capacity by as much as 50%.
A crane that is out of level can tip more easily.

A quick way to check for level is to sight along the hoist rope. It should hang in line with the boom centerline in all quadrants.

Always set cranes up as level as possible!



OUTRIGGER POSITION

Outrigger positions can affect capacity.

On-outrigger load-chart ratings apply only when all outriggers are fully deployed or extended to intermediate positions as allowed by OEM load charts and all tires are clear of the ground.

GENERAL CRANE SAFETY STUDENT GUIDE

Unless these conditions are met, the on rubber capacity, if allowed must be used. There is no in-between capacity.

SIDE-LOADING

Another controllable condition affecting crane capacity is side-loading.

Causes of side loading include pulling or dragging a load sideways, out of level, tilt-up operations and rapid starting or stopping of swing.

Since load chart ratings apply only when the load is picked up directly under the boom tip, if a load is lifted off to either side of the boom tip, side-loading occurs.

The stresses caused by side-loading could cause boom failure. Failure often occurs without warning and affects both lattice and telescopic booms.

LOAD SWING

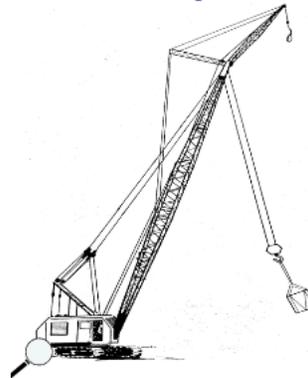
Load swing affects the capacity and sometimes the stability of cranes.

Load swing can be caused by the centrifugal force from rotating a crane too fast. Load swing can also be caused from booming the crane up or down in an erratic manner.

Load swing increases the effective radius resulting in reduced capacity and may cause the crane to tip.

Caused by:

- Centrifugal force from swinging
- Erratic Booming



Effects:

- Increases load radius
- Reduces capacity
- Rated capacities apply only when load is directly under boom tip

Load chart ratings apply only when the load remains directly under the boom tip.

GROUND CONDITIONS

Ground conditions are a product of the environment.

Soft or unstable ground can result in loss of capacity or stability.

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

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

WIND

Follow OEM guidance for operating in windy conditions.

Both the crane and load are affected by wind.

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

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CHARTS MODULE 3 EXAM

1. Wire rope capacity is determined by multiplying the number of parts of line by the rated load of the wire rope.

- A. True
- B. False

2. What is an acceptable adjustment for a crane's out of level set-up?

- A. 2°
- B. 3°
- C. 5°
- D. 10°
- E. None

3. For most mobile cranes, on-outrigger load-chart ratings apply when _____.

- A. outrigger beams are evenly extended.
- B. outriggers are stowed evenly.
- C. all outrigger beams are fully extended.

4. When making a lift, rapid starting and stopping could cause _____.

- A. side-loading.
- B. traffic tickets.
- C. lack of outrigger stability.

5. Load swing increases the effective radius, resulting in _____.

- A. more effective load radius.
- B. more effective use of capacity charts
- C. reduced capacity, and possible overloading.

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

- A. True
- B. False

GENERAL CRANE SAFETY STUDENT GUIDE

7. Solid ground is required to support mobile cranes. If ground conditions are not adequate to support the crane _____.

- A. do not make the lift.
- B. reduced the capacity by 50%.
- C. use bricks and cement blocks for stability.
- D. use blocking or cribbing under the outriggers.

8. When the actual load radius falls between the values listed on the capacity chart, use the gross capacity rating _____.

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

9. When working between values shown on a capacity chart always choose the

- A. the maximum value listed.
- B. the highest value for the two listed values.
- C. lower value listed.

10. Select the best answer. Hook block capacity information is normally located _____.

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

NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CHARTS MODULE 4

LOAD CHART PACKAGE

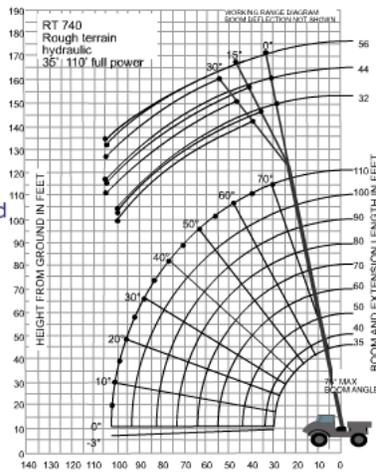
A load chart is a collection of diagrams, tables and notes showing operating quadrants, listing possible crane configurations, describing the lift configurations in which a crane can safely perform, and listing capacities associated with each quadrant and configuration.

Parts of the load chart are used in various combinations, depending on crane configuration and lift complexity.

This sample Load Chart Package is for a Grove Rough Terrain crane.

Range Diagram

- used for planning
- used for considering crane configurations
- relates boom angle and length to boom tip height and distance of the load line from the axis of rotation



Load Chart Capacity Notes

1. All rated loads have been tested to and meet minimum requirements of SAE J1063 OCT80 – Cantilevered Boom Crane Structures– Method of Test, and do not exceed 85% of the tipping load on outriggers (75% of the tipping load on rubber) as determined by SAE J765 OCT 80 Crane Stability Test Code
2. Capacities given do not include the weight of hook blocks, slings, auxiliary lifting equipment and load handling devices. Their weight **MUST** be added to the load to be lifted. When more than minimum required reeving is used, the additional rope weight shall be considered part of the load.
3. Defined Arc = 6° on either side of longitudinal centerline of machine.

Notes section lists:

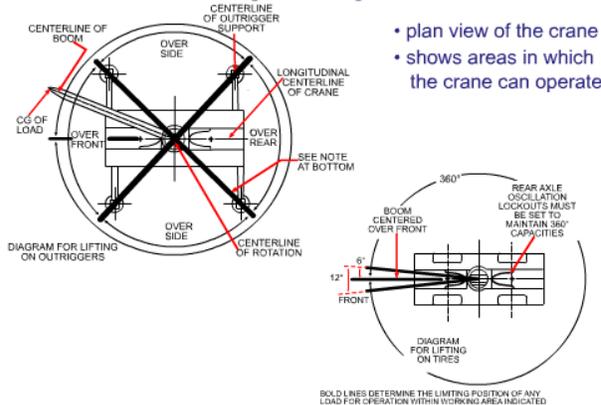
- deductions from listed capacity
- allowable boom lengths
- instructions for determining **structural VS. stability** limitations
- wire rope type and reeving information
- crane set up requirements
- crane configuration requirements for travel
- general crane safety reminders

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tipping should not be relied upon as a capacity limitation.

10. With boom extension in working position and main boom length greater than 80 ft., boom angle must not be less than 40° since loss of stability will occur causing a tipping condition.

Working Area Diagram



- plan view of the crane
- shows areas in which the crane can operate

35' - 110'

Offsettable Extension

Radius in Feet	Main Boom Length in Feet					
	35	45	50	60	70	80
10	80,200 (80.0)	85,000 (85.0)	88,700 (88.7)	92,400 (92.4)	96,100 (96.1)	99,800 (99.8)
12	67,400 (67.4)	72,200 (72.2)	75,900 (75.9)	79,600 (79.6)	83,300 (83.3)	87,000 (87.0)
15	56,500 (56.5)	61,300 (61.3)	65,000 (65.0)	68,700 (68.7)	72,400 (72.4)	76,100 (76.1)
20	44,800 (44.8)	49,600 (49.6)	53,400 (53.4)	57,200 (57.2)	61,000 (61.0)	64,800 (64.8)
25	33,500 (33.5)	38,300 (38.3)	42,100 (42.1)	45,900 (45.9)	49,700 (49.7)	53,500 (53.5)
30	26,500 (26.5)	31,300 (31.3)	35,100 (35.1)	38,900 (38.9)	42,700 (42.7)	46,500 (46.5)
35	20,300 (20.3)	25,100 (25.1)	28,900 (28.9)	32,700 (32.7)	36,500 (36.5)	40,300 (40.3)
40	16,000 (16.0)	20,800 (20.8)	24,600 (24.6)	28,400 (28.4)	32,200 (32.2)	36,000 (36.0)
45	13,000 (13.0)	17,800 (17.8)	21,600 (21.6)	25,400 (25.4)	29,200 (29.2)	33,000 (33.0)
50	10,500 (10.5)	15,300 (15.3)	19,100 (19.1)	22,900 (22.9)	26,700 (26.7)	30,500 (30.5)

36 FT. 110 FT. POWER BOOM ON OUTRIGGERS FULL 360°

Radius in Feet	35	45	50	60	70	80
10	8,770 (8.8)	9,170 (9.2)	9,570 (9.6)	9,970 (10.0)	10,370 (10.4)	10,770 (10.8)
12	7,350 (7.4)	7,750 (7.8)	8,150 (8.2)	8,550 (8.6)	8,950 (9.0)	9,350 (9.4)
15	6,150 (6.2)	6,550 (6.6)	6,950 (7.0)	7,350 (7.4)	7,750 (7.8)	8,150 (8.2)
20	4,950 (5.0)	5,350 (5.4)	5,750 (5.8)	6,150 (6.2)	6,550 (6.6)	6,950 (7.0)
25	4,150 (4.2)	4,550 (4.6)	4,950 (5.0)	5,350 (5.4)	5,750 (5.8)	6,150 (6.2)
30	3,550 (3.6)	3,950 (4.0)	4,350 (4.4)	4,750 (4.8)	5,150 (5.2)	5,550 (5.6)
35	3,050 (3.1)	3,450 (3.5)	3,850 (3.9)	4,250 (4.3)	4,650 (4.7)	5,050 (5.1)
40	2,650 (2.7)	3,050 (3.1)	3,450 (3.5)	3,850 (3.9)	4,250 (4.3)	4,650 (4.7)
45	2,350 (2.4)	2,750 (2.8)	3,150 (3.2)	3,550 (3.6)	3,950 (4.0)	4,350 (4.4)
50	2,100 (2.1)	2,500 (2.5)	2,900 (3.0)	3,300 (3.4)	3,700 (3.8)	4,100 (4.2)
55	1,900 (1.9)	2,300 (2.3)	2,700 (2.8)	3,100 (3.2)	3,500 (3.6)	3,900 (4.0)
60	1,750 (1.8)	2,150 (2.2)	2,550 (2.6)	2,950 (3.0)	3,350 (3.4)	3,750 (3.8)
65	1,650 (1.7)	2,050 (2.1)	2,450 (2.5)	2,850 (2.9)	3,250 (3.3)	3,650 (3.7)
70	1,550 (1.6)	1,950 (2.0)	2,350 (2.4)	2,750 (2.8)	3,150 (3.2)	3,550 (3.6)
75	1,450 (1.5)	1,850 (1.9)	2,250 (2.3)	2,650 (2.7)	3,050 (3.1)	3,450 (3.5)
80	1,350 (1.4)	1,750 (1.8)	2,150 (2.2)	2,550 (2.6)	2,950 (3.0)	3,350 (3.4)
85	1,250 (1.3)	1,650 (1.7)	2,050 (2.1)	2,450 (2.5)	2,850 (2.9)	3,250 (3.3)
90	1,150 (1.2)	1,550 (1.6)	1,950 (2.0)	2,350 (2.4)	2,750 (2.8)	3,150 (3.2)
95	1,050 (1.1)	1,450 (1.5)	1,850 (1.9)	2,250 (2.3)	2,650 (2.7)	3,050 (3.1)
100	950 (1.0)	1,350 (1.4)	1,750 (1.8)	2,150 (2.2)	2,550 (2.6)	2,950 (3.0)
105	850 (0.9)	1,250 (1.3)	1,650 (1.7)	2,050 (2.1)	2,450 (2.5)	2,850 (2.9)
110	750 (0.8)	1,150 (1.2)	1,550 (1.6)	1,950 (2.0)	2,350 (2.4)	2,750 (2.8)

360° Load Chart is for:

- lifting on outriggers fully extended from the main boom tip.

You may drag this message out of the way.

Radius in Feet	35	45	50	60	70	80
10	4,050 (4.1)	4,450 (4.5)	4,850 (4.9)	5,250 (5.3)	5,650 (5.7)	6,050 (6.1)
12	3,450 (3.5)	3,850 (3.9)	4,250 (4.3)	4,650 (4.7)	5,050 (5.1)	5,450 (5.5)
15	2,950 (3.0)	3,350 (3.4)	3,750 (3.8)	4,150 (4.2)	4,550 (4.6)	4,950 (5.0)
20	2,450 (2.5)	2,850 (2.9)	3,250 (3.3)	3,650 (3.7)	4,050 (4.1)	4,450 (4.5)
25	2,050 (2.1)	2,450 (2.5)	2,850 (2.9)	3,250 (3.3)	3,650 (3.7)	4,050 (4.1)
30	1,750 (1.8)	2,150 (2.2)	2,550 (2.6)	2,950 (3.0)	3,350 (3.4)	3,750 (3.8)
35	1,550 (1.6)	1,950 (2.0)	2,350 (2.4)	2,750 (2.8)	3,150 (3.2)	3,550 (3.6)
40	1,400 (1.4)	1,800 (1.8)	2,200 (2.3)	2,600 (2.7)	3,000 (3.1)	3,400 (3.5)
45	1,250 (1.3)	1,650 (1.7)	2,050 (2.1)	2,450 (2.5)	2,850 (2.9)	3,250 (3.3)
50	1,150 (1.2)	1,550 (1.6)	1,950 (2.0)	2,350 (2.4)	2,750 (2.8)	3,150 (3.2)
55	1,050 (1.1)	1,450 (1.5)	1,850 (1.9)	2,250 (2.3)	2,650 (2.7)	3,050 (3.1)
60	950 (1.0)	1,350 (1.4)	1,750 (1.8)	2,150 (2.2)	2,550 (2.6)	2,950 (3.0)
65	850 (0.9)	1,250 (1.3)	1,650 (1.7)	2,050 (2.1)	2,450 (2.5)	2,850 (2.9)
70	750 (0.8)	1,150 (1.2)	1,550 (1.6)	1,950 (2.0)	2,350 (2.4)	2,750 (2.8)
75	650 (0.7)	1,050 (1.1)	1,450 (1.5)	1,850 (1.9)	2,250 (2.3)	2,650 (2.7)
80	550 (0.6)	950 (1.0)	1,350 (1.4)	1,750 (1.8)	2,150 (2.2)	2,550 (2.6)
85	450 (0.5)	850 (0.9)	1,250 (1.3)	1,650 (1.7)	2,050 (2.1)	2,450 (2.5)
90	350 (0.4)	750 (0.8)	1,150 (1.2)	1,550 (1.6)	1,950 (2.0)	2,350 (2.4)
95	250 (0.3)	650 (0.7)	1,050 (1.1)	1,450 (1.5)	1,850 (1.9)	2,250 (2.3)
100	150 (0.2)	550 (0.6)	950 (1.0)	1,350 (1.4)	1,750 (1.8)	2,150 (2.2)
105	100 (0.1)	450 (0.5)	850 (0.9)	1,250 (1.3)	1,650 (1.7)	2,050 (2.1)
110	50 (0.0)	350 (0.4)	750 (0.8)	1,150 (1.2)	1,550 (1.6)	1,950 (2.0)

Minimum boom angle (top) for indicated length (no load)

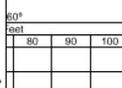
Maximum boom length (ft.) of 3 dip, boom angle (no load)

GENERAL CRANE SAFETY STUDENT GUIDE

On-Rubber Stationary

Radius in Feet	Main Boom Length in Feet							
	35	40	50	60	70	80	90	
10	37,300 (66)	31,100 (69.5)	22,150 (74)					
12	32,700 (62)	26,250 (66)	20,000 (71.5)	18,300 (75)				
15	27,500 (56)	23,000 (61)	16,300 (71.5)	16,950 (71.5)				
20	21,550 (44.5)	20,750 (52)	16,950 (61)	13,500 (68.5)	11,400 (70.5)	10,300 (73.5)		
25	16,950 (28.5)	16,950 (41.5)	13,600 (54)	11,300 (61)	10,250 (66)	9,250 (69.5)	8,050 (72)	
30		11,850 (27)						
35								
40								
45								
50			2,760 (21.5)	15	21,300 (56)	21,300 (61)	15,500 (67.5)	15,500 (71.5)
55				20	13,150 (44.5)	12,750 (52)	42,400 (66.5)	12,400 (70.5)
60				25	8,630 (28.5)	8,230 (41.5)	7,840 (54)	7,790 (66)
				30		5,410 (46)	5,000 (56)	4,870 (61)
				35		3,100 (36.5)	2,870 (49)	3,380 (56)
				40		1,850 (24)	1,430 (41.5)	1,760 (50.5)
							1,750 (57)	1,710 (61.5)

On-Rubber Stationary Chart lists:
 • capacities for both the defined arc over the front for stationary lifts 360°
 You may drag this message out of the way.



ON RUBBER

(PICK & CARRY CAPACITIES UP TO 2.5 MPH)

Radius in Feet	Main Boom Length in Feet						
	35	40	50	60	70	80	90
10	38,000 (66)	31,450 (69.5)					
12	31,150 (62)	29,000 (66)	27,750 (71.5)				
15	27,300 (56)	27,300 (61)	25,000 (68.5)	22,750 (71.5)			
20	20,750 (44.5)	20,750 (52)	20,450 (61)	17,300 (66.5)	13,750 (70.5)		
25	15,950 (28.5)	15,950 (41.5)					
30		11,850 (27)					
35							
40							
45							
50			4,230 (21.5)	4,170 (49)	4,170 (56.5)	4,170 (67.5)	
55				2,760 (21.5)	2,760 (36.5)	2,760 (47.5)	2,760 (53.5)
60							

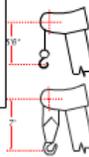
The On-rubber Pick & Carry Chart lists:
 • capacities for up to 2.5 mph.
 • no-load stability notes for on rubber maneuvering
 You may drag this message out of the way.

NOTES FOR RUBBER CAPACITIES		
No Load Stability Data		
Front (No load)	Min. boom angle (deg.) for indicated length	Main Boom 110 ft.
360 Deg. (No load)	Max. boom length (ft.) at 0 deg. boom angle	70
360 Deg. (No load)	Min. boom angle (deg.) for indicated length	55
360 Deg. (No load)	Max. boom length (ft.) at 0 deg. Boom angle	50

32 FT OFFSETTABLE EXTENSION ON OUTRIGGERS - 360°

Radius in Feet	Main Boom Length in Feet						
	35	40	50	60	70	80	90
10	38,000 (66)	31,450 (69.5)					
12	31,150 (62)	29,000 (66)	27,750 (71.5)				
15	27,300 (56)	27,300 (61)	25,000 (67.5)	22,750 (71.5)			
20							
25							
30							
35							
40							
45							
50							
55							
60							

32-ft. Off-settable extension Chart lists:
 • 360° capacities for a fixed-length extension on outriggers for three different offsets
 • reduction from main boom capacities for various accessories
 You may drag this message out of the way.



Accessories	Capacity (lbs.)
15 Ton 1 Sheave	380 lbs.
30 Ton 2 Sheave	843 lbs.
40 Ton 4 Sheave	910 lbs.
40 Ton 4 Sheave (with cheek plates)	1,100 lbs.
45 Ton 3 Sheave	895 lbs.
45 Ton 3 Sheave (with cheek plates)	1,095 lbs.
Auxiliary Boom Nose	143 lbs.
10 Ton Headache Bail	560 lbs.
7 1/2 Ton Headache Bail	338 lbs.

35' - 56' Tele Offsettable Extension

Radius in Feet	32 R. LENGTH						44 R. LENGTH					
	0° OFFSET	15° OFFSET	30° OFFSET	0° OFFSET	15° OFFSET	30° OFFSET	0° OFFSET	15° OFFSET	30° OFFSET	0° OFFSET	15° OFFSET	30° OFFSET
30	73.0	8.88										
35	75.5	8.48	78.0	7.38								
40	73.5	7.88	75.5	6.88	78.0	6.18						
45	71.5	7.48	73.5	6.38	75.5	5.68						
50	69.0	6.88	71.5	5.78	73.5	5.08						
55	67.0	6.43	69.0	5.67	71.5	4.98						
60	64.5	5.88	67.0	5.27								
65	62.0	5.28										
70	59.5	4.68										
75	57.0	4.12										
80	54.5	3.60										
85	52.0	2.98										
90	49.0	2.37										
95	46.5	1.76										
100	43.5	1.00										
105												

32-56-ft. Tele-off-settable Extension
 • shows capacities for three lengths and three offsets.
 • extensions are only used while on outriggers
 You may drag this message out of the way.

Radius	0° OFFSET	15° OFFSET	30° OFFSET
70	62.5	3.70	86.5
75	60.5	3.40	84.0
80	58.0	3.00	82.0
85	56.0	2.70	80.0
90	53.5	2.30	77.5
95	51.0	1.90	75.0
100	48.5	1.50	72.5
105	46.0	1.10	70.0

ZERO DEGREE BOOM ANGLE CHARTS

ON OUTRIGGERS - 360°

Boom Angle	Main Boom Length in Feet								
	35	40	50	*60	70	80	90	100	110
0°	15,490 (27.8)	12,240 (33)	7,860 (43)	4,970 (52.8)	3,670 (63)	2,710 (73)	1,960 (83)	1,360 (93)	880 (102.8)

ON RUBBER

Stationary Capacity Defined Arc(3) Over Front

Zero degree from Angle Chart
 • zero° charts allows reduced capacities down to zero° for special lifting situations
 • main boom capacity chart shows radius in 5-foot increments, no capacity is listed in the last block for each boom length since the boom at zero° cannot reach the radius listed in the next row.
 • main boom chart limits operators to maintain a minimum boom angle for a given length to maintain capacity
 You may drag this message out of the way.

Boom Angle	35	40	50	*60	70
0°	13,900 (27.8)	9,680 (33)	4,830 (43)	2,160 (52.8)	1,010 (63)

Note () Reference radii in feet
 * 60 ft. boom length is with inner- mid extended and outer- mid & fly ret.
 Refer to in-cab load chart for notes.

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CALCULATION WORKSHEET

This is the capacity calculations worksheet you'll use to answer the question:

Can this crane safely lift this load?

Lift Exercise Worksheet

Lift Exercise Work Sheet	
Exercise Number _____	Crane Type: _____
On Outrigger <input type="checkbox"/>	On Rubber <input type="checkbox"/>
Quadrant of Operations *(Check ✓):	Over Rear <input type="checkbox"/> Over Side <input type="checkbox"/> Over Front <input type="checkbox"/>
Maximum Working Radius _____ ft.	Boom Length _____ ft.
Extension (Jib) Yes <input type="checkbox"/> No <input type="checkbox"/>	Stowed <input type="checkbox"/> Erected <input type="checkbox"/>
Stinger®: Retracted <input type="checkbox"/> Extended <input type="checkbox"/>	Offset _____ Degrees
Deductions for Extensions _____	
Deduction for Aux. Boom Nose _____	
Deduction for Main Hook Block _____	
Deduction for Whip Ball _____	
Other Deductions _____	
Total Deductions _____	
Gross Capacity From Chart _____	
Subtract Total Deductions _____	
Net Capacity of Crane (Gross minus deductions) _____	=
Weight of All Rigging _____	
Weight of Load to be Lifted _____	
Total Weight of Lift _____	
Lift is: Within Crane's Capacity <input type="checkbox"/>	Overload <input type="checkbox"/>

The first section of the Lift Exercise Work Sheet deals with:

- the crane,
- lifting considerations, and
- quadrants of operations.

Exercise Number _____	Crane Type: _____
On Outrigger <input type="checkbox"/>	On Rubber <input type="checkbox"/>
Quadrant of Operations *(Check ✓):	Over Rear <input type="checkbox"/> Over Side <input type="checkbox"/> Over Front <input type="checkbox"/>
Maximum Working Radius _____ ft.	Boom Length _____ ft.
Extension (Jib) Yes <input type="checkbox"/> No <input type="checkbox"/>	Stowed <input type="checkbox"/> Erected <input type="checkbox"/>
Stinger®: Retracted <input type="checkbox"/> Extended <input type="checkbox"/>	Offset _____ Degrees

The second section of the Lift Exercise Work Sheet deals with **calculating all deductions.**

Deductions for Extensions _____	
Deduction for Aux. Boom Nose _____	
Deduction for Main Hook Block _____	
Deduction for Whip Ball _____	
Other Deductions _____	
Total Deductions _____	

The third section of the Lift Exercise Work Sheet deals with:

- Chart Capacities
- Calculation using capacities
- Determination of lift execution

Gross Capacity From Chart _____	
Subtract Total Deductions _____	
Net Capacity of Crane (Gross minus deductions) _____	
Weight of All Rigging _____	
Weight of Load to be Lifted _____	
Total Weight of Lift _____	
Lift is: Within Crane's Capacity <input type="checkbox"/>	Overload <input type="checkbox"/>

GENERAL CRANE SAFETY STUDENT GUIDE

PROCESS OVERVIEW

Can a lift be safely made?

Ask and answer three questions.

What is the net lifting capacity of the crane?

What is the total load weight?

Is the net lifting capacity of the crane greater than the weight of the load?

Net Weight

- Net lifting capacity = gross capacity - all deductions
- Gross lifting capacity is listed on the crane's lifting capacity chart

Total weight of the load

Total of:

- the weight of the load itself
- the weight of all rigging gear

Can this lift be safely made?

The lift can be safely made if...
the net lifting capacity of the crane is greater than the total weight of the load

Can a lift be made safely?



What is the crane's (net) lifting capacity?

Radius In Feet	Main Boom Length in Feet		
	35	40	50
10	80,000 (66)	68,000 (69.5)	58,100 (74)
12	67,400 (62)	62,700 (66)	53,700 (71.5)
15	56,500 (56)	54,500 (6.1)	48,050 (67.5)
20	44,000 (44.5)	43,000 (52)	39,400 (61)
25	33,500 (26.5)	33,000 (41.5)	32.4 (54)

- 39,400 lbs.** = Gross Capacity
- 20' Radius
- 50' Main Boom

Specific Crane Configuration Weight Reduction Deductions

15 Ton 1 Sheave	380 lbs.
30 Ton 2 Sheave Hook Block	843 lbs.
40 Ton 2 Sheave	910 lbs.
40 Ton 4 Sheave <small>(with bank plates)</small>	1,100 lbs.
45 Ton 3 Sheaves	895 lbs.
45 Ton 3 Sheaves <small>(with bank plates)</small>	1,095 lbs.
Auxiliary Boom Nose	143 lbs.
10 Ton Headache Bail	560 lbs.
7 1/2 Ton Headache Bail	338 lbs.

Gross capacity 39,400 lbs.

Deductions **986 lbs.**

Net capacity 38,414 lbs.



Can a lift be made safely?



What is the total weight of the load?

Lift:

Dry-dock pump

Rigging gear required:

4 1 1/8" by 20' slings weighing 216 lbs.

4 1 1/8" screw pin shackles weighing 40 lbs.

Load weight 37,000 lbs.

All rigging gear + 256 lbs.

Total load weight 37,256 lbs.

Can a lift be made safely?



Can this crane safely lift this load?

Net capacity of the crane: 38,414 lbs.

Total weight of the load: 37,256 lbs.

Yes, the net capacity of the crane exceeds the weight of the load.

This lift can be made safely made.



GENERAL CRANE SAFETY STUDENT GUIDE

Lift Exercise Work Sheet

Exercise Number Example Crane Type: GROVE RT740

On Outrigger On Rubber

Quadrant of Operations *(Check ✓): Over Rear Over Side Over Front

Maximum Working Radius _____ ft. Boom Length _____ ft.

Extension (Jib) Yes No Stowed Erected

Stinger: Retracted Extended Offset _____ Degrees

Deductions for Extensions _____ 843

Deduction for Aux. Boom Nose _____ 143

Deduction for Main Hook Block _____ 0

Completed Load Chart Exercise Worksheet. _____ 0

Review the process until you understand where the data comes from. _____ 0

Gross Capacity From Chart _____ 39,400

Subtract Total Deductions _____ 986 lbs.

Net Capacity of Crane (Gross minus deductions) _____ = 38,414 lbs.

Weight of All Rigging _____ 90 lbs.

Weight of Load to be Lifted _____ 3,700 lbs.

Total Weight of Lift _____ 3,790 lbs.

Lift is: **Within Crane's Capacity** Overload

EXERCISE LIFT 1 - Crane Configuration

The crane for this lift is configured as follows.

A 40 ton rough terrain (RT) crane equipped with:
 a 35' to 110' boom, a stowed 32' to 56' tele-offsettable boom extension, an auxiliary boom nose, a fully reeved 3-sheave main hook block and a 7.5 ton headache or overhaul ball.

Crane Configuration



40 Ton Rough Terrain (RT) Crane

Equipped With:

- 35' - 110' boom
- 32' - 56' tele-offsettable extension (stowed)
- Auxiliary boom nose
- 45 ton 3-sheave main hook block
- 7½ ton headache ball

Use the **Course Reference** button to access / print the Grove 740 RT Crane Load Chart Package. This load chart package is used as a reference throughout this module and the Load Chart 4 final exam.

Assume the safe working load for the wire rope on each hoist is 10,000 pounds per part.

EXERCISE LIFT 1 - LIFT AND LOAD

The Lift:

- large industrial air conditioning unit
- from a 60 foot high, flat rooftop,
- place it on a truck bed,
- 10 feet in from the edge.

The Load:

- unit weighs 5,140 lbs
- rigging gear weighs 85 lbs
- load will be lifted on outriggers over the front and placed over the side



Lift:

You are assigned to remove a large air conditioning unit from a 60 foot high building, 10 feet in from the edge and place it on a truck bed.

Load:

The unit weighs 5,140 lb. The rigging gear weighs 85 lb. The load will be lifted on outriggers over the front and placed over the side

GENERAL CRANE SAFETY STUDENT GUIDE

EXERCISE LIFT 1 - CONSIDERATIONS

A copy of the range diagram can be used to sketch out the job requirements for lifts over obstacles.

Lift radius must be confirmed at the job site.

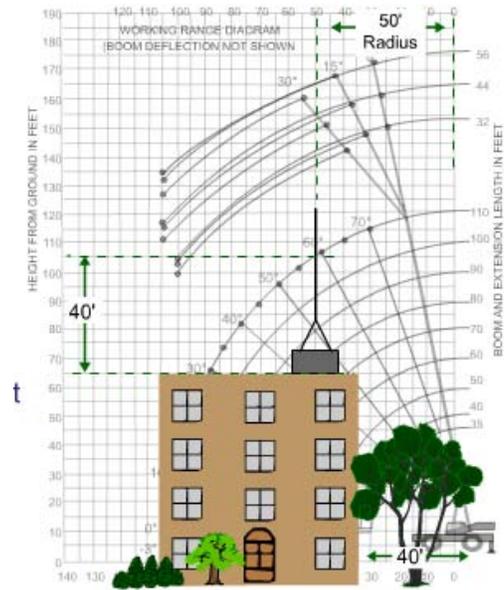
How close can the crane be set-up?
You estimate the center line of the crane will be 40 feet from the building edge.

The load will be lifted 10 feet from the edge of the building making the lift radius 50 feet.
The boom position is penciled in to determine whether the boom will clear all obstacles.

Check for sufficient clearance between the boom and the edge of the roof.

The approximate distance from the boom tip to the hook is 5 feet. The height from rooftop to boom tip is 40 feet.

Since the load and rigging take up less than 20 feet, there is plenty of working height.



Exercise Lift 1 - Gross Capacity

What is the gross capacity for a fully extended boom at a 50 foot radius?

35 FT. - 110 FT. POWER BOOM
ON OUTRIGGERS FULLY EXTENDED - 360°

Radius In Feet	Main Boom Length in Feet					110			
	35	40	50	70	80		90	100	
10	80,000 (88)	68,000 (69.5)	58,100 (74)						
12	67,400 (82)	62,700 (86)	53,700 (71.5)	44,600 (75)					
15				41,550 (71.5)	35,600 (74.5)	33,000 (77)			
20				33,550 (66.5)	30,500 (70.5)	28,000 (73.5)	25,500 (75.5)	22,150 (77.5)	
25				27,750 (61)	25,200 (66)	23,800 (68.5)	21,950 (72)	20,400 (74.5)	18,500 (78)
30				23,300 (55)	21,050 (61)	20,400 (65.5)	19,300 (68.5)	178,550 (71.5)	15,750 (73.5)
35				20,000 (49)	17,950 (66)	17,400 (61.5)	16,400 (65)	15,050 (68)	13,500 (71.5)
40				16,000 (24)	15,850 (41.5)	15,050 (57)	14,100 (61.5)	13,100 (65)	11,500 (70)
45				12,250 (33)	13,000 (45)	13,000 (52.5)	12,300 (57.5)	11,450 (61.5)	10,500 (65)
50				9,720 (21.5)	10,360 (38.5)	10,750 (47.5)	10,000 (53.5)	9,000 (58.5)	8,500 (65)
55					8,300 (31)	8,770 (42)	9,170 (49.5)	8,830 (54.5)	8,500 (61)
60					6,850 (20)	7,150 (36)	7,850 (45)	7,840 (51)	7,500 (57)
65					5,830 (29)	6,340 (40)	6,340 (47)	6,820 (52)	6,500 (58)
70					4,740 (19)	5,100 (34)	5,100 (42.5)	5,590 (48.5)	5,200 (54)
boom boom angle (deg.) for indicated length (no load)						0			
boom boom length (ft.) at 0 deg. Boom angle (no load)						110			

It is 9,500 pounds.

GENERAL CRANE SAFETY STUDENT GUIDE

EXERCISE WORKSHEET

This exercise gives you the opportunity to use the load and lift information to determine if this lift can be safely made.

Lift Exercise Work Sheet

This exercise is broken into three parts.

1. Calculating total Deductions
2. Calculating net Capacity of Crane capacity (gross capacity - deductions)
3. Calculating total lift weight

With this data, you will be prepared to answer the questions:

Can this lift be safely made?



Worksheet Exercise

Good Luck!!!

Begin

Lift Exercise Work Sheet **Grove RT740**

Fill in the data. = reset all data = more information

Deductions for Extensions	846
Deduction for Aux. Boom Nose	_____
Deduction for Main Hook Block	895
Deduction for Whip Ball (Headache Ball)	_____
Other Deductions (if any)	_____
Total Deductions	= _____
Gross Capacity From Chart	_____
Subtract Total Deductions	_____
Net Capacity of Crane (Gross minus deductions)	= _____
Weight of All Rigging	_____
Weight of Load to be Lifted	_____
Total Weight of Lift	= _____

With this data, you can answer the question: Can this lift be safely made?

GENERAL CRANE SAFETY STUDENT GUIDE

EXERCISE LIFT 1 STATUS

Can this lift be made safely?

Is the lift within the capacity of the crane?

EXERCISE LIFT 1 ADJUSTED CAPACITY

Refer to the load chart:

What is the Proper radius and gross capacity?

35 FT. - 110 ft. POWER BOOM
ON OUTRIGGERS FULLY EXTENDED - 360°

Radius In Feet	Main Boom Length in Feet								110
	35	40	50	60	70	80	90	100	
10	80,000 (86)	68,000 (69.5)	58,100 (74)						
12	67,400 (62)	62,700 (66)	53,700 (71.5)	44,600 (75)					
15	56,500 (56)	54,500 (6.1)	48,050 (67.5)	41,550 (71.5)	35,600 (74.5)	33,000 (77)			
20				33,550 (66.5)	30,500 (70.5)	26,000 (73.5)	25,500 (75.5)	22,150 (77.5)	
25				27,750 (61)	25,200 (66)	23,800 (69.5)	21,950 (72)	20,400 (74.5)	18,500 (76)
30				23,300 (55)	21,050 (61)	20,400 (65.5)	19,300 (68.5)	17,550 (71.5)	15,750 (73.5)
35			20,300 (36.5)	20,000 (49)	17,950 (56)	17,400 (61.5)	16,400 (65)	15,050 (68)	13,650 (70.5)
40			16,900 (24)	15,850 (41.5)	15,500 (50.5)	15,050 (57)	14,100 (61.5)	13,100 (65)	12,000 (66)
45				12,250 (33)	13,000 (45)	13,000 (62.5)	12,300 (57.5)	11,450 (61.5)	10,900 (64)
50				9,720 (21.5)	10,350 (38.5)	10,750 (47.5)	10,800 (53.5)	10,000 (58.5)	9,500 (62)
55					8,300 (31)	8,770 (42)	9,170 (46.5)	8,830 (54.5)	8,370 (58.5)
60					6,650 (20)	7,150 (36)	7,850 (45)	7,840 (51)	
65						5,830 (29)	6,340 (40)	6,820 (47)	
70						4,740 (19)	5,100 (34)	5,590 (42.5)	
num boom angle (deg.) for indicated length (no load)									0
num boom length (ft.) at 0 deg. Boom angle (no load)									110

New radius?
New gross?

8,370
 • 55' Radius
 • 110' Main Boom

For a 55-foot radius, the gross capacity is 8,370 pounds.

GENERAL CRANE SAFETY STUDENT GUIDE

EXERCISE LIFT 1 VARIATIONS - RESULTS

Using the gross capacity, subtract the total deductions to determine whether there is sufficient net capacity.

Lift Exercise Work Sheet Grove RT740	
Fill in the data.  = reset all data  = more information	
Deductions for Extensions	<u>846</u>
Deduction for Aux. Boom Nose	<u> </u>
Deduction for Main Hook Block	<u>895</u>
Deduction for Whip Ball (Headache Ball)	<u> </u>
Other Deductions (if any)	<u> </u>
Total Deductions	<u> </u>
Gross Capacity From Chart	<u> </u>
Subtract Total Deductions	<u> </u>
Net Capacity of Crane (Gross minus deductions)	<u> </u>
Weight of All Rigging	<u> </u>
Weight of Load to be Lifted	<u> </u>
Total Weight of Lift	<u> </u>
With this data, you can answer the question: Can this lift be safely made?	

Can this lift still be made safely?

PERCENTAGE OF CAPACITY

What is the percentage of this cranes capacity?

When planning lifts the crane operator may need to determine the percentage of capacity being lifted. Percentage of capacity is used to determine whether a lift is complex or non-complex.

To calculate the percentage divide the total load by the capacity of the crane or hoist.

If a load is 5,225 pounds and the capacity of the hoist is 7,278 pounds, 5,225 pounds divided by 7,278 equals 71.7 rounded to 72%

The total load to be lifted is 72% of the crane's capacity.

This percentage is important for determining whether a lift is a complex lift (80% of capacity) or a non-complex lift.

GENERAL CRANE SAFETY STUDENT GUIDE

EXERCISE LIFT 2 CRANE CONFIGURATION

The crane configuration for this lift is:

A 40 ton rough terrain (RT) crane equipped with:
a 35' to 110' boom, a 32' to 56' tele-offsettable boom extension, an auxiliary boom nose, a fully reeved 45-ton, 3-sheave main hook block, and a 7.5-ton headache or overhaul ball.

Assume the rated load for the wire rope on each hoist is 10,000 lbs. per part.

Crane Configuration



40 Ton Rough Terrain (RT) Crane

Equipped With:

- 35' - 110' boom
- 32' - 56' tele-offsettable extension (stowed)
- Auxiliary boom nose
- 45 ton 3-sheave main hook block
- 7½ ton headache ball

Use the **Course Reference** button to access / print the Grove 740 RT Crane Load Chart Package. This load chart package is used as a reference throughout this module and the Load Chart 4 final exam.

EXERCISE LIFT 2 – LIFT AND LOAD

The Lift:

- place a 40' tall communications antenna on top of the building
- 20' in from the edge of the roof

The Load:

- antenna weighs 2,685 lbs.
- rigging gear weighs 40 lbs. (10' slings and shackles)



EXERCISE LIFT 2 - CONSIDERATIONS

A range diagram is used to determine the requirements for this lift.

The crane center pin is 42 feet from the edge of the building and the antenna will be placed 20 feet in from the edge of the roof.

Therefore, the lift radius is 62 feet.

If you were to draw in the required boom position, on the range diagram you would see the main boom cannot reach to the height of the antenna.

If you are not able to reposition the crane any closer, how can this lift be made with this crane?

The lift can be made using the boom extension to provide the desired height.

GENERAL CRANE SAFETY STUDENT GUIDE

Note the three possible positions for the extension; the zero-degree offset will provide the highest capacity. Next, we need to find the capacity of the crane in this configuration.

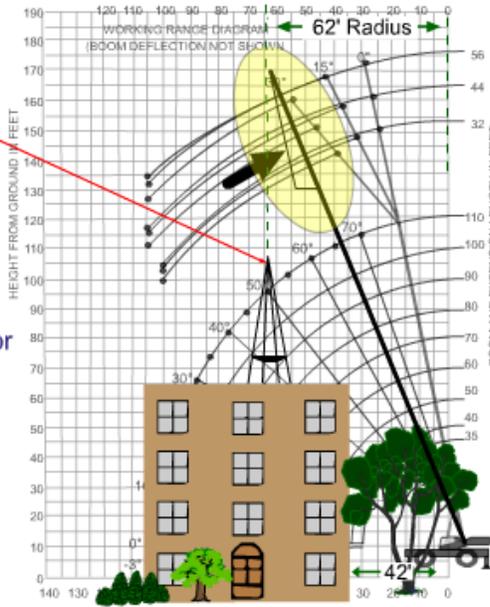
Which capacity chart will we use to find the gross capacity of our crane as configured?

Lift radius is 62'

Main boom cannot reach

How can this lift be made using this crane?

- Use boom extension for additional reach



EXERCISE LIFT 2 - GROSS CAPACITY

The Tele-Offsettable Extension capacity chart is used to find the gross capacity for this lift.

32' - 56' TELE OFFSETTABLE EXTENSION (ON OUTRIGGERS - 360°)

Radius in Feet	32' LENGTH			44' LENGTH			56' LENGTH									
	0° OFFSET Boom Angle Ref. (Deg.)	Cap. lbs.	Boom Angle Ref. (Deg.)	0° OFFSET Boom Angle Ref. (Deg.)	Cap. lbs.	Boom Angle Ref. (Deg.)	15° OFFSET Boom Angle Ref. (Deg.)	Cap. lbs.	30° OFFSET Boom Angle Ref. (Deg.)	Cap. lbs.	0° OFFSET Boom Angle Ref. (Deg.)	Cap. lbs.	15° OFFSET Boom Angle Ref. (Deg.)	Cap. lbs.	30° OFFSET Boom Angle Ref. (Deg.)	Cap. lbs.
30	76.0	6,880		78.0	5,100											
35	75.5	6,480	78.0	7,380	76.5	5,080										
40	75.5	7,980	75.5	6,980	78.0	6,180	74.5	5,000				76.5	4,000			
45	71.5	7,480	73.5	6,580	76.5	5,850	73.0	4,800	76.5	4,300		74.5	3,600			
50	69.0	6,980	71.5	6,180	78.5	5,340	71.0	4,700	78.5	4,150	77.5	3,300	71.0	3,840	77.0	3,300
55	67.0	6,430	69.0	5,830	71.5	4,980	68.5	4,650	72.5	3,920	75.0	3,200	69.5	3,720	75.0	3,100
60	64.5	5,980	67.0	5,450	69.0	4,780	66.5	4,300	70.5	3,750	73.0	3,100	67.5	3,700	73.5	2,920
65	62.0	5,240	64.5	5,110	67.0	4,620	64.5	4,010	68.5	3,570	71.0	3,000	65.5	3,610	71.5	2,760
70	59.5	4,650	62.0	4,650	64.5	4,470	62.5	3,710	66.5	3,400	69.0	2,800	63.5	3,500	69.5	2,620
75	57.0	4,120	59.5	4,120	62.0	4,120	60.5	3,400	64.0	3,200	66.5	2,800	62.0	3,210	68.0	2,500
80	54.5	3,640	57.0	3,640	59.5	3,640	58.0	3,090	62.0	3,000	64.5	2,700	60.0	3,000	66.0	2,400
85	52.0	2,960	54.5	2,960	57.0	2,960	56.0	2,790	60.0	2,780	62.0	2,600	58.0	2,510	64.0	2,320
90	49.0	2,370	52.0	2,370	54.0	2,370	53.5	2,600	57.5	2,500	59.5	2,500	56.0	2,020	61.5	2,020
95	46.5	1,850	49.0	1,850	51.0	1,850	51.0	1,990	55.0	1,990	57.0	1,890	53.5	1,960	59.5	1,860
100	43.5	1,000	46.0	1,000	48.0	1,000	48.5	1,520	52.5	1,520	54.5	1,520	50.5	1,230	57.5	1,230
105							48.0	1,100	50.0	1,100	51.0	1,100	56.0	850	55.0	850



Notice that this capacity chart shows three different extension lengths.

GENERAL CRANE SAFETY STUDENT GUIDE

This is because this type of extension has a multi-position, manually-deployed extension.

The 32 foot length shows the extension fully retracted.
 The 44 foot length shows the extension pinned half way out.
 The 56 foot length shows the extension fully deployed.

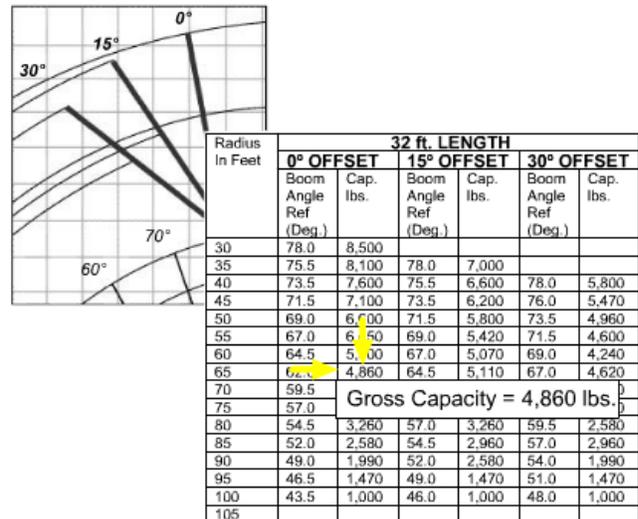
For this lift, you'll use the shortest length needed, so refer to the 32-foot length chart.

EXERCISE LIFT 2 - BOOM ANGLE CAPACITY

This crane has three offset positions for the boom extension. Three different capacities are reflected on the capacity chart. The first capacity is for 0 degree offset, the second is for 15 degree offset, and the third is for 30 degree offset.

Remember use the extension at zero degree offset. This will provide the highest capacity.

With a radius of 62 feet, which radius on the chart will be used to determine capacity?



Use 65 feet (the next longer radius).

The gross capacity is 4,860 pounds.

EXERCISE LIFT 2 - DEDUCTIONS

Deductions are found in the load chart package.

Remember when lifting from an extension do not deduct the weight of the erected extension. It has already been factored into the capacities shown on the chart.

Asterisk indicates deductions that apply only when lifting from the main boom.

All other devices suspended from or attached to the boom must be deducted from the gross capacity shown on the capacity chart.

Deductions:

45-ton, 3 sheave hook block weighing 895 pounds, auxiliary boom head weighing 143 pounds and a 7.5-ton headache ball weighing 338 pounds.

GENERAL CRANE SAFETY STUDENT GUIDE

Weight Reductions for Load Handling Devices

32 ft. Extension with 35 ft. - 110 ft Boom	
* Stowed -	671 lbs.
* Erected -	4,149 lbs.

32 ft - 56 ft. Tele. Ext. with 35 ft. - 110 ft. Boom	
* Stowed	846 lbs.
* Erected (ret.) -	6,368 lbs.
* Erected (ext.) -	8,287 lbs.

DIMENSIONS ARE FOR LARGEST CRANE POWERED HOIST BLOCK AND HEADCAST ONLY AND TO BE USED AS A GUIDE ONLY

When lifting from boom extension or jib, do not deduct weight of erected extension or jib!

Deductions marked with * asterisk apply when lifting from main boom

* Reduction of main boom capacities	
HOOK BLOCKS:	
15 Ton, 1 Sheave	380 lbs.
30 Ton, 1 Sheave	843 lbs.
40 Ton, 4 Sheave	910 lbs.
40 Ton, 4 Sheave (w/cheek plates)	1,100 lbs.
45 Ton, 3 Sheave	895 lbs.
45 Ton, 3 Sheave (w/cheek plates)	1,095 lbs.
Auxiliary Boom Nose	143 lbs.
10 Ton Headache Ball	560 lbs.
7 1/2 Ton Headache Ball	338 lbs.

Deductions:	
Block	895 lbs.
Aux Boom Nose	143 lbs.
H.A. Ball	338 lbs.

EXERCISE WORKSHEET

This exercise gives you the opportunity to use the load and lift information to determine if this lift can be safely made.

Lift Exercise Work Sheet

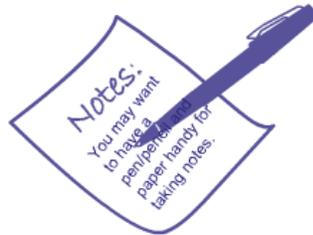
This exercise is broken into three parts.

1. Calculating total Deductions
2. Calculating net Capacity of Crane capacity (gross capacity - all deductions)
3. Calculating total lift weight

With this data, you will be prepared to answer the questions:

Can this lift be safely made?

Worksheet Exercise
Good Luck!!!



GENERAL CRANE SAFETY STUDENT GUIDE

Lift Exercise Work Sheet **Grove 740 RT**

Fill in the data.  = reset all data  = more information

Deductions for Extensions	_____	_____
Deduction for Aux. Boom Nose	_____	_____
Deduction for Main Hook Block	_____	895
Deduction for Whip Ball (Headache Ball)	_____	_____
Other Deductions (if any)	_____	_____
Total Deductions	_____	=
Gross Capacity From Chart	_____	_____
Subtract Total Deductions	_____	-
Net Capacity of Crane (Gross minus deductions)	_____	=
Weight of All Rigging	_____	_____
Weight of Load to be Lifted	_____	_____
Total Weight of Lift	_____	=

Great! With this data, you can answer the question: Can this lift be safely made?

Is the lift within the capacity of the crane?

EXERCISE LIFT 3 CRANE CONFIGURATION

The crane configuration for this lift is:

A 40 ton rough terrain (RT) crane equipped with: a 35' to 110' boom, a 32' to 56' tele-offsettable boom extension, an auxiliary boom nose, a fully reeved 45-ton, 3-sheave main hook block, and a 7.5-ton headache or overhaul ball.

Crane Configuration



40 Ton Rough Terrain (RT) Crane

- Equipped With:
- 35' - 110' boom
 - 32' - 56' tele-offsettable extension (extended and erected)
 - Auxiliary boom nose
 - 45 ton 3-sheave main hook block
 - 7½ ton headache ball

Use the **Course Reference** button to access / print the Grove 740 RT Crane Load Chart Package. This load chart package is used as a reference throughout this module and the Load Chart 4 final exam.

GENERAL CRANE SAFETY STUDENT GUIDE

EXERCISE LIFT 3 – LIFT AND LOAD

Lift:

To offload a forklift from a flatbed truck to the ground. The extension is erected.

Load:

The forklift weighs 14,000 pounds including the rigging gear. Since the weight exceeds the capacity of the whip hoist, you must use the main hook. The position of the flatbed makes the lift radius 31 feet.



Forklift and all rigging gear weighs 14,000 lbs.

- Must use main hoist
- Lift radius will be 31 ft.

Can this lift be made?

EXERCISE LIFT 3 CAPACITY

Refer to the load chart.

What is the highest gross capacity listed for a lift at 31-foot radius?

**35 FT. - 110 ft. POWER BOOM
ON OUTRIGGERS FULLY EXTENDED - 360°**

Radius In Feet	Main Boom Length in Feet								
	35	40	50	60	70	80	90	100	110
10	80,000 (86)	68,000 (69.5)	58,100 (74)						
12	67,400 (62)	62,700 (66)	53,700 (71.5)	44,800 (75)					
15	56,500 (56)	54,500 (6.1)	48,050 (67.5)	41,550 (71.5)	35,600 (74.5)	33,000 (77)			
20	44,000 (44.5)	43,000 (52)	39,400 (61)	33,550 (66.5)	30,500 (70.5)	28,000 (73.5)	25,500 (75.5)	22,150 (77.5)	
25	33,500 (26.5)	33,000 (41.5)	32,400 (54)	27,750 (61)	25,200 (66)	23,800 (69.5)	21,950 (72)	20,400 (74.5)	18,500 (76)
30		26,500 (27)	25,500 (46)	23,300 (55)	21,050 (61)	20,400 (65.5)	19,300 (68.5)	17,850 (71.5)	16,750 (73.5)
35			20,300 (38)	20,300 lbs. gross capacity • 50' Main Boom • 31' Radius (Always use the radius with the next lower capacity. 35')					
40			16,300 (24)						
45									
50									
55				8,300 (31)	8,770 (42)	9,170 (49.5)	8,830 (54.5)	8,370 (58.5)	
60				6,650	7,150	7,850	7,840 (61)	7,410 (55.5)	
65							5,820 (47)	5,590 (52)	
70							5,590 (42.5)	5,680 (48.5)	
boom boom angle (deg.) for indicated length (no load)									0
boom boom length (ft.) at 0 deg. Boom angle (no load)									110

What is the highest gross capacity listed for lifts at 31 ft. radius?

Using a 50-foot boom at 35-foot radius, the gross capacity is 20,300 pounds.

EXERCISE LIFT 3 - DEDUCTIONS

Referring to the deductions page, look for any additional deductions that may apply. The erected tele-off-settable extension with stinger retracted is a 6,368 pound deduction.

Remember, when extension is either erected or stowed and you are lifting from the main boom, you must take the deductions marked with asterisks.

GENERAL CRANE SAFETY STUDENT GUIDE

Weight Reductions for Load Handling Devices	
32 ft. Extension with 35 ft. – 110 ft Boom	
* Stowed	846 lbs.
* Erected (ret.) -	6,368 lbs.
* Erected (ext.) -	8,287 lbs.

HOOK BLOCKS:	
15 Ton, 1 Sheave	380 lbs.
30 Ton, 1 Sheave	843 lbs.
40 Ton, 4 Sheave	910 lbs.
40 Ton, 4 Sheave (w/cheek plates)	1,100 lbs.
45 Ton, 3 Sheave	895 lbs.
45 Ton, 3 Sheave (w/cheek plates)	1,095 lbs.
Auxiliary Boom Nose	143 lbs.
10 Ton Headache Ball	560 lbs.
7 ½ Ton Headache Ball	338 lbs.

Deductions:	
Extension	6,368 lbs.
Aux Nose	143 lbs.
Block	895 lbs.
H.A. Ball	338 lbs.
Total	7,744 lbs.

Add the deductions for the auxiliary boom nose, main hook block, and headache ball.

Deductions total 7,744 pounds.

EXERCISE LIFT 3 - WORKSHEET

To determine if this lift can be made, calculate net capacity. Gross capacity is 20,300 pounds, total deductions of 7,744 pounds equals net capacity of 12,556 pounds.

The weight of the forklift and lifting gear is 14,000 pounds. The lift in this configuration cannot be made.

The additional weight of the erected boom extension severely reduces the net capacity.

How can this lift be made safely with the crane at this radius? The lift could be safely made if the extension is stowed.

Gross Capacity	20,300 lb.
Minus Total of Deductions	- 7,744 lb.
Net Capacity	12,556 lb. ←
Load Weight	14,000 lb. ←

The weight of erected boom extension, severely reduces net capacity

This lift can not be made

Lift could be made if... extension is stowed.



GENERAL CRANE SAFETY STUDENT GUIDE

EXERCISE LIFT 4 CRANE CONFIGURATION

The crane configured for this lift is:

A 40 ton rough terrain (RT) crane equipped with: a 35' to 110' boom, a stowed tele-offsettable boom extension, an auxiliary boom nose, a fully reeved 45-ton, 3-sheave main hook block, and a 7.5-ton headache or overhaul ball.

Crane Configuration



40 Ton Rough Terrain (RT) Crane

Equipped With:

- 35' - 110' boom
- 32' - 56' tele-offsettable extension (stowed)
- Auxiliary boom nose
- 45 ton 3-sheave main hook block
- 7½ ton headache ball

Use the **Course Reference** button to access / print the Grove 740 RT Crane Load Chart Package. This load chart package is used as a reference throughout this module and the Load Chart 4 final exam.

EXERCISE LIFT 4 – LIFT AND LOAD

For this scenario, use the ON RUBBER capacity chart.

Load:

A bundle of lumber weighing 5,440 pounds including the rigging gear.

Lift:

The load will be lifted out of a fenced staging area at a 35-foot radius. The extension has been placed in the stowed position. You will travel with the load making this a Pick-and-Carry lift.

Never attempt to make on rubber lifts with an extension erected.

EXERCISE LIFT 4 – CHANGE IN CAPACITY

Use the chart ON RUBBER - PICK AND CARRY.

On Rubber
(Pick & Carry Capacities up to 2.5 MPH)

Radius in Feet	Main Boom Length in Feet						
	35	40	50	60	70	80	90
10	38,000 (86)	31,450 (69.5)					
12			27,750 (71.5)				
15			25,000 (67.5)	22,750 (71.5)			
20	(44.5)	(52)	20,450 (61)	17,300 (66.5)	13,750 (70.5)		
25	15,950 (28.5)	15,850 41.5	15,550 (54)	13,400 (61)	11,000 (66)	11,000 (69.5)	10,150 (72)
30		11,850 (27)	11,550 (46)	10,600 (55)	9,300 (61)	9,300 (66.5)	9,300 (68.5)
35			8,220	7,910	8,200 (6)	8,200 (61.5)	8,200 (65)
40			8,220		980 (0.5)	5,980 (57)	5,980 (61.5)
45					170 (5)	4,170 (52.5)	4,170 (57.5)
50				2,760 (21.5)	2,770 (36.5)	2,770 (47.5)	2,770 (53.5)
55					1,840 (31)	1,840 (42)	1,840 (49.5)
60					1,290 (20)	1,290 (36)	1,290 (45)

Since the crane will be working with a maximum of 35 foot radius, refer to the column labeled **RADIUS IN FEET** and row labeled **35 feet**. Trace the main boom length of 50 feet.

The highest listed gross capacity using a boom length of 50 feet is 8,220 pounds.

GENERAL CRANE SAFETY STUDENT GUIDE

EXERCISE LIFT 4 – DEDUCTIONS

Deductions are found in the load chart package and include:

Extension weighing 846 pounds, auxiliary boom nose weighing 143 pounds, main hook block weighing 895 pounds, and whip ball weighing 338 pounds. Total deductions equal to 2,222 pounds.

Deductions

Extensions	-----	<u>846 lbs.</u>
Aux. Boom Nose	---	<u>143 lbs.</u>
Main Hook Block	---	<u>895 lbs.</u>
Whip Ball	-----	<u>338 lbs.</u>
Other Deductions	---	<u>0 lbs.</u>
Total Deductions	---	<u>2,222 lbs.</u>

EXERCISE LIFT 4 - WORKSHEET

Is there enough capacity to make the lift?

Gross capacity is 8,220 pounds. We subtract deductions of 2,222 pounds. The net capacity is 5,998 pounds.

What is the total weight to be lifted?

Load weight including all rigging gear is 5,440 pounds.

Can this lift be safely made?

Yes, the net capacity of the crane is greater than the load on the hook.

This lift exceeds 80% of the lifting capacity; therefore, it is a complex lift.

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CHART MODULE FOUR EXAM

1. Use the Grove RT - 740 Rough Terrain Load Chart to answer this question.

Crane Configuration:

The Grove RT740 is equipped with a stowed Tele-offsettable boom extension. The whip line with a 10 ton headache ball is reeved over the auxiliary boom nose. **No main block is used.**

The Lift:

To lift a generator from a trailer to a roof top using a Grove RT 740. The working radius will be 68 feet with a 95 foot boom.

Which radius would you refer to on the load chart to determine capacity?

- A. 70 feet
- B. 68 feet
- C. 80 feet
- D. 95 feet

2. Use the Grove RT - 740 Rough Terrain Load Chart to answer the following question.

Crane Configuration:

The Grove RT740 is equipped with a stowed Tele-offsettable boom extension. The whip line with a 10 ton headache ball is reeved over the auxiliary boom nose. **No main block is used.**

The Lift:

To lift a generator from a trailer to a roof top using a Grove RT 740. The working radius will be 68 feet with a 95 foot boom.

Which length on the load chart would you choose to determine capacity?

- A. 100 feet
- B. 85 feet
- C. 95 feet
- D. 90 feet

GENERAL CRANE SAFETY STUDENT GUIDE

3. Use the Grove RT - 740 Rough Terrain Load Chart to answer the following question.

Crane Configuration:

The Grove RT740 is equipped with a stowed Tele-offsettable boom extension. The whip line with a 10 ton headache ball is reeved over the auxiliary boom nose. **No main block is used.**

The Lift:

To lift a generator from a trailer to a roof top using a Grove RT 740. The working radius will be 68 feet with a 95 foot boom.

The gross capacity at 68 foot radius with 95 feet of boom is _____

- A. 5,100 lbs.
- B. 4,740 lbs.
- C. 4,650 lbs.
- D. 5,880 lbs

4. Use the Grove RT - 740 Rough Terrain Load Chart to answer the following question.

Crane Configuration:

The Grove RT740 is equipped with a stowed Tele-offsettable boom extension. The whip line with a 10 ton headache ball is reeved over the auxiliary boom nose. **No main block is used.**

The Lift:

To lift a generator from a trailer to a roof top using a Grove RT 740. The working radius will be 68 feet with a 95 foot boom.

Total deductions for the crane as equipped are: _____

- A. 1,549 lbs.
- B. 1,041 lbs
- C. 560 lbs.
- D. 1,406 lbs.

GENERAL CRANE SAFETY STUDENT GUIDE

5. Use the Grove RT - 740 Rough Terrain Load Chart to answer the following question.

Crane Configuration:

The Grove RT740 is equipped with a stowed Tele-offsettable boom extension. The whip line with a 10 ton headache ball is reeved over the auxiliary boom nose. **No main block is used.**

The Lift:

To lift a generator from a trailer to a roof top using a Grove RT 740. The working radius will be 68 feet with a 95 foot boom.

The net capacity of this crane is _____.

- A. 4,041 lbs.
- B. 2,878 lbs.
- C. 3,551 lbs.
- D. 5,100 lbs.

6. Use the Grove RT - 740 Rough Terrain Load Chart to answer the following question.

Crane Configuration:

The Grove RT740 is equipped with a stowed Tele-offsettable boom extension. The whip line with a 10 ton headache ball is reeved over the auxiliary boom nose. **No main block is used.**

The Lift:

To lift a generator from a trailer to a roof top using a Grove RT 740. The working radius will be 68 feet with a 95 foot boom.

You are lifting a generator weighing 2,698 pounds. The rigging gear weighs 150 pounds. The total load will be _____.

- A. 2,848 lbs.
- B. 2,698 lbs.
- C. 3,288 lbs.
- D. 3,488 lbs.

GENERAL CRANE SAFETY STUDENT GUIDE

7. Use the Grove RT - 740 Rough Terrain Load Chart to answer the following question.

Crane Configuration:

The Grove RT740 is equipped with a stowed Tele-offsettable boom extension. The whip line with a 10 ton headache ball is reeved over the auxiliary boom nose.

The 40 ton 4 sheave main hook block is used.

The Lift:

To lift a generator from a trailer to a roof top using a Grove RT 740. The working radius will be 68 feet with a 95 foot boom.

If the 40 ton main hook were used with cheek plates instead of without cheek plates what would the consequence be?

- A. Increased deductions would reduce the margin between load and capacity
- B. Capacity would increase using the block with cheek plates
- C. Either block could be used equally safely
- D. The load could not be lifted safely

8. Use the Grove RT - 740 Rough Terrain Load Chart to answer the following question.

Crane Configuration:

The Grove RT740 is equipped with a stowed Tele-offsettable boom extension. The whip line with a 10 ton headache ball is reeved over the auxiliary boom nose. **No main block is used.**

The Lift:

To lift a generator from a trailer to a roof top using a Grove RT 740. The working radius will be 68 feet with a 95 foot boom.

The gross capacity of the crane is 5,590 lbs. The deductions total 1,549 pounds. The load weighs 2,848 lbs. Based on the information provided, is this a complex lift?

- A. Yes
- B. No

NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

GENERAL CRANE SAFETY STUDENT GUIDE

LOAD CHARTS MODULE 5

LOAD CHARTS MODULE 5 EXERCISE 1

Grove RT 740 rough terrain hydraulic crane, 35' to 110' power boom, reeved with 6 parts of line with a permissible line pull of 12,920, a 45 ton 3-sheave hook block with cheek plates, a 32-foot normally stowed extension and a 7 1/2 ton headache ball reeved over the auxiliary boom nose.

[Click Here for References](#)

1. What is the gross capacity for this crane as configured on outriggers with the boom fully retracted at minimum radius?

- 77,520 pounds.
- 80,000 pounds.
- 67,400 pounds.
- 56,500 pounds.

Grove RT 740 rough terrain hydraulic crane, 35' to 110' power boom, reeved with 6 parts of line with a permissible line pull of 12,920, a 45 ton 3-sheave hook block with cheek plates, a 32-foot normally stowed extension and a 7 1/2 ton headache ball reeved over the auxiliary boom nose.

[Click Here for References](#)

2. What is the net capacity with a fully extended boom at minimum radius in the current configuration?

- 18,500 pounds.
- 16,253 pounds.
- 16,919 pounds.
- 16,391 pounds.

Grove RT 740 rough terrain hydraulic crane, 35' to 110' power boom, reeved with 6 parts of line with a permissible line pull of 12,920, a 45 ton 3-sheave hook block with cheek plates, a 32-foot normally stowed extension and a 7 1/2 ton headache ball reeved over the auxiliary boom nose.

[Click Here for References](#)

3. Choose the maximum net load that can be lifted safely at maximum usable radius.

- 1,790 pounds @ 100 feet.
- 2,170 pounds @ 95 feet.
- 2,740 pounds @ 90 feet.
- 493 pounds @ 90 feet.

GENERAL CRANE SAFETY STUDENT GUIDE

Grove RT 740 rough terrain hydraulic crane, 35' to 110' power boom, reeved with 6 parts of line with a permissible line pull of 12,920, a 45 ton 3-sheave hook block with cheek plates, a 32-foot normally stowed extension and a 7 1/2 ton headache ball reeved over the auxiliary boom nose.

[Click Here for References](#)

4. When lifting on rubber, what is the maximum load you can pick and carry on the hook with a fully retracted boom at a 15 foot radius?

- 27,300 pounds.
- 25,191 pounds.
- 25,053 pounds.
- 24,878 pounds.

Grove RT 740 rough terrain hydraulic crane, 35' to 110' power boom, reeved with 6 parts of line with a permissible line pull of 12,920, a 45 ton 3-sheave hook block with cheek plates, a 32-foot normally stowed extension and a 7 1/2 ton headache ball reeved over the auxiliary boom nose.

[Click Here for References](#)

5. What is the maximum pick and carry net capacity for a 90' boom length?

- 7,903 pounds
- 5,778 pounds
- 6,878 pounds
- 10,150 pounds

LOAD CHARTS MODULE 5 EXERCISE 2

(Use the 638E2 Capacities Chart found in references to answer these questions)

[Click Here for References](#)

1. What is the Maximum Gross Capacity for this crane as configured?

- 28,550 lbs
- 10,850 lbs
- 40,000 lbs
- 39,650 lbs

GENERAL CRANE SAFETY STUDENT GUIDE

(Use the 638E2 Capacities Chart found in references to answer these questions)

[Click Here for References](#)

2. When lifting a load with a category 4 crane, what is the maximum gross capacity at a 28 foot radius?

- 7,645 pounds
- 6,150 pounds
- 8,350 pounds
- 7,995 pounds

(Use the 638E2 Capacities Chart found in references to answer these questions)

[Click Here for References](#)

3. What is the net capacity for this crane using 27 feet of boom at a 21 foot radius with a one sheave block?

- 12,900 pounds
- 10,150 pounds
- 9,950 pounds
- 12,750 pounds

(Use the 638E2 Capacities Chart found in references to answer these questions)

[Click Here for References](#)

4. What is the maximum weight that can be lifted safely with the boom extended to 38 feet using the two sheave block?

- 25,750 pounds
- 3,850 pounds
- 25,395 pounds
- 27,500 pounds

NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

CRANE COMMUNICATIONS MODULE

COMMUNICATIONS - RADIO AND HAND SIGNALS

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.

Radio communications are well suited for blind and complex lifts.

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

HAND SIGNALS

Hand signals are most widely used method of communication between signalers and crane operators.

Hand signals like those found in the American Society of Mechanical Engineers, A.S.M.E. B30 standards must be posted in the crane in clear view of the operator.

Your activity may approve local signals in addition to these standard signals.



COMMUNICATIONS - SIGNALERS

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.

COMMUNICATION - RADIO

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



Radio guidelines

- Use an isolated channel
- Clear the line of other traffic
- Limit background noise

Radio work practices

- Identify the crane and yourself
- Allow time between commands
- Verify the command

Follow the guidelines and work practices shown below when using radios.

GENERAL CRANE SAFETY STUDENT GUIDE

HOOK AND TROLLEY SIGNALS

AUXILIARY HOIST OR WHIP LINE SIGNAL

- The elbow is tapped with the opposite hand to indicate auxiliary hoist
- Followed up with standard hook signals



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 TROLLEYS

- One finger up for the number “1” hook or trolley
- Two fingers up for the number “2” hook or trolley
- Each followed with standard signals to indicate the desired motion



HOIST HAND 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.

GENERAL CRANE SAFETY STUDENT GUIDE

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



RAISE BOOM

The signal to raise the boom, or boom up, is given with:

- an extended arm,
- fingers closed and thumb pointing upward.

LOWER BOOM

The signal to lower the boom, or boom down, is given with:

- an extended arm,
- fingers closed and thumb pointing downward.



RAISE BOOM / LOWER LOAD

The signal to raise the boom and lower the load is given with an:

- extended arm,
- thumb pointing upward and
- fingers flexing in and out.

LOWER BOOM/ RAISE LOAD

The signal to lower the boom and raise the load is given with an:

- extended arm,
- thumb pointing downward and
- fingers flexing in and out.



GENERAL CRANE SAFETY STUDENT GUIDE

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.



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.



RETRACT BOOM ONE HANDED

The one handed retract signal is made with:

- one fist in front of the chest, and the
- thumb pointing outward, with a tapping motion.

DIRECTIONAL SIGNALS

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

GENERAL CRANE SAFETY STUDENT GUIDE

TRAVEL

The signal for crane or bridge travel is made with:

- an extended arm,
- hand open with palm facing outward, and
- the hand moving horizontally in the desired direction of travel.



TROLLEY TRAVEL

The signal for trolley travel is made with:

- a palm up and fingers closed and
- the thumb moving in the desired direction of travel.

SWING

The signal for swing or rotate is:

- an extended arm
- the index pointed in the desired direction of rotation.



MAGNET SIGNALS

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



MAGNET DISCONNECT

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 extend arms
- palms up and fingers open.

GENERAL CRANE SAFETY STUDENT GUIDE

STOP SIGNALS

Stop and emergency stop signals can be given by anyone.

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

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

STOP

The stop signal is:

- an extended arm,
- palm down
- moving back and forth horizontally.



EMERGENCY STOP

The signal for an emergency stop is:

- both arms extended
- with palms down
- moving them back and forth horizontally.

DOG EVERYTHING

When all operations must be secured, set the brakes, pawls, and dogs.

The signal to dog everything is:

- clasped hands in front of the body.



GENERAL CRANE SAFETY STUDENT GUIDE

CRANE COMMUNICATION EXAM

1. A universal language understood by everyone involved with weight handling is:
 - A. direct voice commands.
 - B. hand signals.
 - C. signal flags.
 - D. spoken word.

2. Direct voice should only be used when:
 - A. the operator and the rigger are working in close proximity and ambient noise is high.
 - B. the operator and rigger are working in close proximity and ambient noise is low.
 - C. the rigger has not learned hand signals.
 - D. no other form of communications is available and ambient noise is high.

3. In the crane cab, the crane operator must have a clear view of the...
 - A. crane maintenance records.
 - B. ASME Hand Signal Chart.
 - C. crane lift history.
 - D. EOM.

4. Any additional hand signals must be
 - A. approved by the ASME.
 - B. approved by OSHA
 - C. approved by NOSH.
 - D. approved by the activity.

5. Another form of communications, other than hand signals, must be used if:
 - A. the signaler is not in clear view of the crane operator
 - B. ambient noise is greater than the lack of visibility
 - C. the signaler is in clear view of the rigger in charge
 - D. activities designates alternative methods

GENERAL CRANE SAFETY STUDENT GUIDE

6. For multiple crane lifts, _____ will communicate with the crane operators.

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

7. This signal indicates:

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



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

- A. lower the boom.
- B. raise the load - lower the boom.
- C. stop activities.
- D. lower the hoist.



9. This signal indicates to:

- A. forward.
- B. extend the boom.
- C. raise the load.
- D. stop.



10. This signal indicates to:

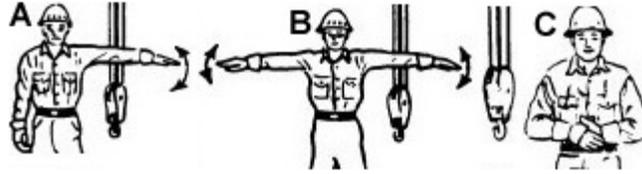
- A. lower the load.
- B. separate the load.
- C. retract the boom.
- D. move closer.



GENERAL CRANE SAFETY STUDENT GUIDE

11. Which signal is used to indicate shutting down everything - commonly known as dog everything?

- A. A
- B. B
- C. C



12. This signal indicates:

- A. swing
- B. stop
- C. emergency stop
- D. travel back



13. This signal indicates:

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



14. This signal indicates:

- A. lower the load
- B. emergency stop
- C. dog everything
- D. retract boom



15. This signal indicates:

- A. Emergency stop
- B. Magnet disconnected



NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

CRANE TEAM CONCEPT MODULE

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: crane riggers, and a crane walker.

The rigging supervisor assigns the crane team members depending on the complexity and scope of work. Either the rigging supervisor or rigger-in-charge may conduct team briefings.

CRANE TEAM SHARED RESPONSIBILITIES

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

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

PRE-JOB BRIEFING

A pre-job briefing for complex lifts is conducted by the rigging supervisor, operator supervisor or the working leader and shall be conducted to ensure that all crane team personnel understand the requirements of the lift.

CRANE TEAM COMMUNICATIONS

Communications during the lift are just as important as the pre-lift brief. All team members must be made aware of any problems that are discovered.

CRANE TEAM SAFETY

Stop crane operations before personnel board the crane. Cranes should be positioned to allow safe boarding.

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

Have problems resolved before resuming operations.

GENERAL CRANE SAFETY STUDENT GUIDE

Knowledge Check

1. What is the purpose of the crane team concept? The crane team concept:

- A. helps ensure crane operations without injury to personnel and without damage to property and equipment.
- B. ensures members follow all procedures and adhere to all

CRANE OPERATOR RESPONSIBILITY

The crane operator is responsible for performing the pre-use check as well as the safe operation of the crane.

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

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

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

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.

RIGGER-IN-CHARGE RESPONSIBILITY

The rigger-in-charge has overall responsibility for the safety, planning, and control of the lift.

The Rigger-In-Charge ensures that each load is rigged properly and the crane envelope is kept clear. He or she also signals the crane operator or designates other personnel to provide signals and coordinates the activities of the crane team members.

The rigger-in-charge plans all aspects of each lift. He or she determines the load weight and center of gravity of each load and then selects the proper rigging.

Next, the load path is determined and the method of communication is planned.

CRANE RIGGER RESPONSIBILITY

A crane rigger is responsible for carrying out assignments from the rigger-in-charge or the rigging supervisor.

These duties include assisting the crane operator with the pre-use check, selection and inspection of rigging gear, safely rigging the loads and keeping the rigger-in-charge informed.

GENERAL CRANE SAFETY STUDENT GUIDE

The crane rigger selects and inspects crane rigging gear, and establishes proper attachment points as directed by the rigger-in-charge.

A crane rigger keeps the rigger-in-charge informed of questionable or unsafe conditions and changes that may affect the operation.

CRANE WALKER RESPONSIBILITY

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.

A crane walker assists the crane rigger and crane operator in performing the pre-use check of the crane.

The crane walker ensures the crane's travel path is clear by watching for potential obstructions and checking the proper alignment of the crane track switches.

Crane walkers stay near the emergency stop button to communicate the stop signals to the crane operator.



SUPERVISOR RESPONSIBILITY

The supervisor is familiar with NAVFAC P-307 and supports the crane team concept.

The supervisor reviews onsite conditions for all complex lifts.

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

A supervisor oversees lifts exceeding 80% of hook capacity, 50% for barge mounted mobile cranes.

If the lifts are repetitive in nature, the supervisor shall be present during the first evolution of the lift for each rigging crew.

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

A supervisor shall review on-site conditions for complex lifts and perform a pre-job briefing with all crane team personnel.

A supervisor shall personally oversee all lifts exceeding 80% of the certified capacity of the crane's hoist or 50% for mobile cranes mounted on barges.

GENERAL CRANE SAFETY STUDENT GUIDE

CRANE TEAM EXAM

1. 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. 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, Rigger Supervisor, and Crane Rigger
 - D. The Crane Operator, Crane Walker, and Crane Rigger

3. Additional crane team members may be assigned by
 - A. the crane operator as required.
 - B. the supervisor as required.
 - C. the EOM designation.
 - D. the crane rigger as required.

4. 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.

GENERAL CRANE SAFETY STUDENT GUIDE

5. The crane operator is responsible for the safe _____ of the crane.
- A. condition
 - B. return
 - C. repair
 - D. inspection
 - E. operation
6. The crane operator moves the crane only as directed by the:
- A. signaler
 - B. rigger
 - C. crane walker
7. When rigging your own loads, you are responsible for _____
- A. determining the load weight.
 - B. selecting and inspecting the rigging gear.
 - C. calculating the Center of Gravity of the load.
 - D. hooking up the load.
 - E. all of the above actions.
8. Crane operators are responsible for all of the following **EXCEPT**:
- A. moving the crane only when signaled.
 - B. doing a thorough ODCL inspection.
 - C. slowing down when signals are unclear.
 - D. maintaining communication with signaler.
 - E. lifting and landing all loads safely.
9. Securing the crane envelope is the
- A. combined responsibility of all team members.
 - B. combined responsibility of the crane operator and the crane supervisor.
 - C. sole responsibility of the crane operator.
 - D. sole responsibility of the rigging supervisor.

GENERAL CRANE SAFETY STUDENT GUIDE

10. If you feel safety is in jeopardy during the performance of your task, you should:

- A. stop work and have the problem resolved.
- B. use the OEM manual to solve the problem.
- C. call your supervisor for clarification.
- D. evaluate the lift plan.

11. The crane operator must immediately stop operations when

- A. any time a stop signal is given.
- B. operations have exceeded allowed time.
- C. communications are lost during a blind or complex lift.
- D. the operating envelope is penetrated.
- E. the weather forecast is not good.

12. Planning the lift route is the responsibility of the:

- A. crane rigger.
- B. crane operator.
- C. crane supervisor.
- D. rigger in charge.

13. Coordinating the activities of the crane team is the responsibility of the:

- A. crane rigger.
- B. crane supervisor.
- C. activities.
- D. crane operator.
- E. rigger in charge.

14. A _____ may be assigned by the rigger in charge to assist the operator with the pre-use check, select and inspect rigging gear, and rig loads.

- A. crane rigger
- B. crane supervisor
- C. crane engineer
- D. crane operator

GENERAL CRANE SAFETY STUDENT GUIDE

15. If an accident is reported, the preliminary investigation will be performed by the:

- A. crane rigger.
- B. crane operator.
- C. supervisor
- D. rigger in charge.

NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

SAFE OPERATIONS 1

CRANE ACCIDENTS

Most crane accidents can be avoided by consistently practicing basic safety procedures.

Team members are often to blame for crane accidents, due to inattention, poor judgment, overconfidence, or haste.

Understanding the crane is the operator's first responsibility. Crane operators at naval activities must often operate a variety of cranes. They must be familiar with each type of crane they are qualified to operate.

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, the operator performs a mandatory daily crane inspection using the ***Operator's Daily Checklist***.

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.

GENERAL CRANE SAFETY STUDENT GUIDE

LIFTS NEAR PERSONNEL

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

NEVER RIDE LOADS

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

OVERHEAD LINES

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

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

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

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

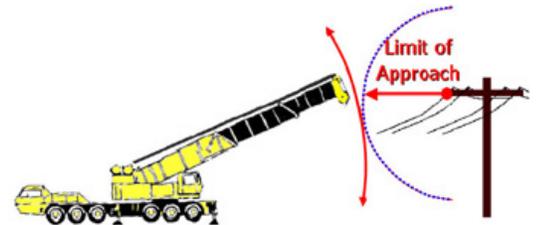
ABSOLUTE LIMIT OF APPROACH

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.

50,000 Volts or less

- Minimum 10' from any part of crane
- No part of crane or load can enter limit
- Greater voltages increase distance

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.

Never leave a suspended load unattended.

GENERAL CRANE SAFETY STUDENT GUIDE

LIFTING LOADS

When lifting loads, position the freely suspended hook directly over the load for vertical lifting. This prevents side loads and prevents load shifting at lift-off.

Take the slack out of rigging gradually and watch for hook movement that indicates the need to reposition the crane before lifting.

Stop when the load lifts a few inches off the ground and check the hoist brake. Accelerate smoothly to reduce dynamic loading.

LANDING LOADS

When lowering loads, be sure the surface that you plan to land on will support the load.

Slow the load down as you approach the landing surface.

To land heavy loads softly, stop the load a few inches off the ground and allow the load to settle before touching down.

SECURING THE CRANE

When securing cranes remove gear from the hook, place all controls in the neutral position and engage all brakes and locks.

Stow hooks near, but not in, the upper limit switches.

For cranes located out doors, secure the crane against wind movement and chock the wheels as necessary.

Knowledge Check

1. The first step in the procedure for lifting loads is to:

- A. hoist slowly and remove slack.
- B. hoist at one speed until load lifts.
- C. hoist slowly until load lifts.

2. The second step for lifting loads is to:

- A. lift until completely suspended and stop.
- B. lift until desired height and stop.
- C. lift until load clears all obstacles and stop.

GENERAL CRANE SAFETY STUDENT GUIDE

TRAVELING

When traveling cranes with loads, stow unused hooks, follow OEM requirements and keep loads close to the ground while avoiding obstructions.

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.

SAFE OPERATIONS 1 EXAM

1. When operating cranes, the operator's PRIMARY responsibility is to:
 - A. Do pre-use checks.
 - B. Operate safely.
 - C. Use the shortest boom length possible.
 - D. Keep the crane clean.

2. 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. What information should be posted, clearly understandable, and readily available to the operator.
 - A. Certification Information
 - B. Crane Operator's license number
 - C. Travel speed through congested areas

4. What information should be posted, clearly understandable, and readily available to the operator.
 - A. ODCL Checks
 - B. Operators License Number
 - C. Labeled controls for each function

GENERAL CRANE SAFETY STUDENT GUIDE

5. Which of the following operator responsibilities is considered the basis for ensuring a safe and reliable crane?

- A. Proper set-up on outriggers
- B. Periodic lubrication and servicing
- C. Properly inflated tires without damage
- D. Firm and level supporting surface
- E. Operator Daily Checks (ODCL)

6. When lifting loads with a crane, which of the following is the FIRST thing an operator should do?

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

7. 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. Tell his supervisor at the end of the shift.
- C. Proceed slowly with caution.
- D. Note the incident on the back of the ODCL card.

8. Side loading a crane boom by dragging loads or lifting a load with a non-vertical hoist is not permitted due to:

- A. destructive stresses placed on the boom & sheaves.
- B. possible overload due to Swing-out of the load after liftoff.
- C. uncontrolled movement of load due to shifting.
- D. any of the listed factors.

9. 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.

NOTES

GENERAL CRANE SAFETY STUDENT GUIDE

SAFE OPERATIONS 2

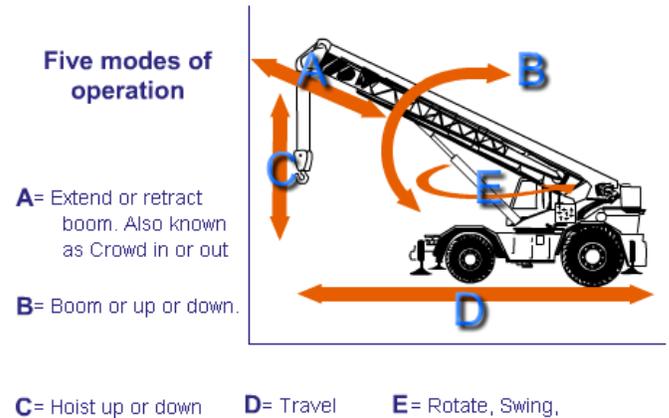
MOBILE CRANE OPERATING TERMS

There are five common modes of operation for a typical mobile crane: booming up or down, rotating, traveling, hoisting up or down, and extending and retracting the boom. Raising or lowering the boom is also known as booming or luffing.

Rotate sometimes called swing or slew, causes the upper-works of the crane to revolve on the carrier.

Travel mode allows the operator to move the entire crane on wheels, tires or crawler tracks.

Hoist mode is used to raise and lower the hooks.



For extendible boom cranes, like the one shown, the **extend or retract boom mode** sometimes referred to as crowding is used to lengthen or shorten the boom.

MOBILE CRANES - TRAVELING

When traveling a truck, cruiser, or crawler crane to and from job sites, secure the hook and block to the carrier frame to prevent them from swinging into the boom.

To secure the hook block to the crane, use a weak link such as nylon rope. The breaking strength of the weak link shall be less than the rated capacity of the hook block's wire rope as reeved.

When securing the hook blocks for highway travel add a back up tie-back to prevent free swinging in the event of weak link failure. Tension the hoist just enough to take up the slack.

Do not over tighten. Check for adequate clearances between hook blocks and boom tip.

Follow all the OEM instructions for traveling the crane. You may need to disengage hydraulic pumps, remove optional counterweights, or even disassemble the boom.

OPERATING

When lifting and landing heavy loads with mobile cranes adjust the boom position as necessary to compensate for deflection.

The signal person should assist in keeping the boom tip directly over the load.

GENERAL CRANE SAFETY STUDENT GUIDE

Use the shortest boom length practical for maximum stability and strength.
Use power lowering for positive load control.

LIFTING ON TIRES

Lift on rubber only when necessary and allowed. Cranes are much less stable on rubber than when on outriggers. Lift only on level surfaces.

You must keep the crane level when operating on outriggers or on tires.
Remember, greater deflection and radius increase can be expected when making lifts on tires.

Check all tires for condition and inflation to OEM specifications.

Axle lockouts must be tested according to OEM instructions to ensure proper operation.

USING EXTENSIONS ON TIRES

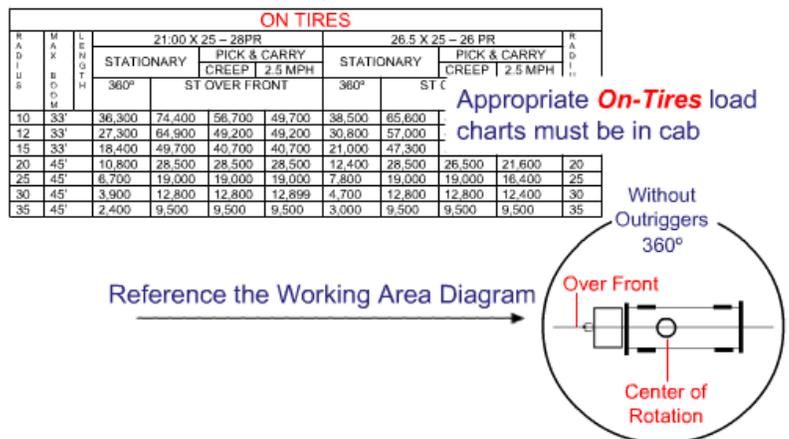
Check the crane's manual and load chart information before using a jib or extension.

Lifting from jibs or boom extensions while on rubber is prohibited by most manufacturers.

ON-RUBBER LOAD CHART

When lifting on rubber is permitted at your activity, you must use the appropriate on-rubber load charts.

This chart shows gross capacities when working on tires.



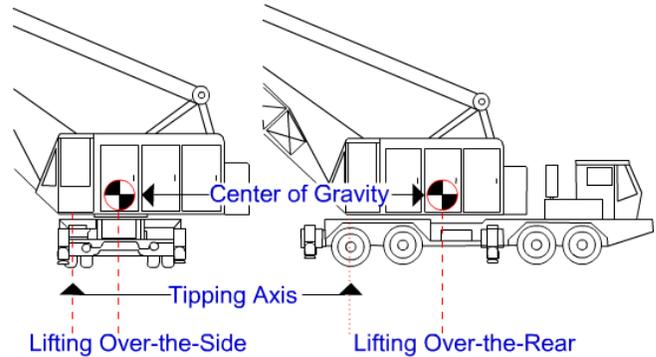
The OEM may provide on rubber charts for stationary 360 degrees, locked over-the-front, defined arc over-the-front and pick & carry.

Check the working area diagram before lifting on tires.

GENERAL CRANE SAFETY STUDENT GUIDE

CRANE CENTER OF GRAVITY

It is important for operators to understand how the center of gravity affects the capacity of the crane when moving from one quadrant to another.



The illustration shows a crane on-rubber positioned for lifting over the side and over the rear. The symbol on each crane represents the center of gravity of the entire crane including the carrier. The tipping axis for the crane in each position is the centerline of the outer tires.

A crane becomes less stable with the same load applied, whenever the center of gravity of the crane moves closer to the tipping axis. This is why most mobile cranes have a higher over-the-rear capacity than over-the-side.

MOBILE CRANES – TRAVELING WITH LOADS

Travel with suspended loads only when permitted by the OEM and the local activity.

Cranes must have appropriate *Pick and Carry Load Charts* in the operator's cab.

Set the rotate lock and travel with the load directly over the end inline with the carrier as required by the OEM. Generally this means carrying over the front with RT cranes and over the rear with truck cranes.

Rotate brakes are normally used for holding operating position when the crane is not in line with the crane carrier.

When practical and as permitted by the OEM, extend the outriggers and keep the outrigger pads a few inches off the ground.

Always check that the automatic or manual axle lock-outs, when equipped are released.

Be sure the ground which the crane will travel over can support the machine.

EXTENDIBLE BOOM CRANES - OPERATING

Lower the hoist block when extending the boom to prevent the block from raising into the limit as the boom is extended.

This could result in two-blocking and break the hoist wire rope, dropping the load.

GENERAL CRANE SAFETY STUDENT GUIDE

Remember that anti two-block devices are operational aids that can fail and must not be relied upon to stop the movement of the hoist.

Extend boom sections equally as required by OEM load charts.

Extend counterweights as required on cranes equipped with them.

On hydraulic truck cranes, set the front stabilizer float, when equipped.

Check the operator's manual and load chart notes for instructions on setting the stabilizer float. In many cases, it must be set regardless of the quadrants of operation.

EXTENDABLE BOOM CRANES - SECURING

When securing a truck crane with a hydraulic boom retract the boom fully and place it in the cradle.

For rough terrain cranes place the boom in a nearly horizontal position.

Requirements for mobile extendible boom cranes may vary from manufacturer to manufacturer.

Always consult OEM instructions for securing requirements for each crane.

MOBILE LATTICE-BOOM CRANES - OPERATING

When operating mobile lattice-boom crane lower the hoist blocks to allow boom tip clearance before lowering the boom.

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

On many lattice-boom truck cranes, you must also set the front float when equipped for on-outrigger operation.

For friction machines, set hoist-drum pawls, when the hoist is not in use.

When the crane is equipped with automatic hoist-drum pawls, they should be checked regularly.

MOBILE LATTICE-BOOM CRANES – SECURING

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

GENERAL CRANE SAFETY STUDENT GUIDE

FLOATING CRANES – OPERATING

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

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

FLOATING CRANES – SECURING

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

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

FLOATING CRANE BARGE – SECURING

Secure the floating crane barge as required.

Set the gangway when the crane is moored pier-side. Clean and secure the deck. Store or secure loose cargo. Stow unused rigging gear, mooring lines, & ropes. Check mooring line tension to allow for tidal changes.

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

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

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

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

PORTAL CRANES - OPERATING

Travel with caution, especially in congested work areas and when approaching curves, intersections, building entrances, and access to ladders leading into dry docks.

It is a good practice to stop before crossing rail switches to verify correct alignment.

When possible, the operator should position the boom in the direction of travel. If the crane rigger gives a signal to travel back and disappears from sight, **the crane operator must stop traveling** until communication is re-established.

Clearance lines painted along crane tracks are a guide to keep all materials and vehicles away from crane travel trucks.

GENERAL CRANE SAFETY STUDENT GUIDE

Operators shall stop crane travel when materials or vehicles are inside crane clearance lines, until they are moved.

PORTAL CRANES - SECURING

When securing portal cranes, follow OEM recommendations.
Park away from fire-lanes, gangways, and pedestrian walkways.

When required connect to shore using the proper electrical safety procedures.

LOCOMOTIVE CRANES - OPERATING

When operating a locomotive crane, use tilt-blocks or bed-stabilizing wedges according to OEM instructions to provide over-the-side stability for heavy lifts.

Use outriggers when making lifts exceeding the free-rated capacity of locomotive cranes.

LOCOMOTIVE CRANES - TRAVELING

Disengage tilt-blocks or bed-wedges when traveling and lifting over the side at the same time. Failure to do so may result in derailing the crane because of the decreased ability for the axle assemblies to pivot on the carrier when rounding corners.

When traveling around corners, carry loads in the center of the tracks. When this is not possible, carry the load or counterweight, whichever is heavier, to the outside of the curved track. This will prevent the tapered travel wheels from climbing the rail and derailing the crane.

Have the signal person flag traffic at street crossings. Sound the horn when approaching intersections or blind corners and use warning bells while backing up.

When traveling without loads, set the boom to approximately 45 degrees.

LOCOMOTIVE CRANES – MOVING CARS

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

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

Locomotive cranes are not usually designed to charge the braking systems of additional cars or to move several cars at a time.

GENERAL CRANE SAFETY STUDENT GUIDE

LOCOMOTIVE CRANES – SECURING

When securing locomotive cranes, set the boom at about a 45 degree angle. If equipped with a magnet, clam-shell, or other lifting attachment, lower it to the ground.

Set the car-body brake or place wheel wedges against the inner set of travel wheels.

OVERHEAD ELECTRIC TRAVELING (OET) AND GANTRY CRANES - OPERATIONS

The bridge travel function is used to travel the crane in the selected direction along the length of the runway rails. This allows the operator to move the entire crane along its supporting rail structure, in the selected direction.

The trolley function is used to move the hoisting machinery in the selected direction along the trolley rails.

The hoist function is used to raise and lower the hooks.

OVERHEAD ELECTRIC TRAVELING (OET) AND GANTRY CRANES - OPERATING

Overhead electric traveling cranes are generally operated indoors so congestion is often an issue. Watch for changes in the work area that may cause interference. Storage racks with material stacked too high are a common problem.

Operators should always check for trolley and bridge drift before operating the crane.

Lift loads vertically. Side pulls can cause uneven or overlapped spooling of the hoist wire and may cause the wire rope to be cut or severely damaged.

Avoid sudden starts and stops with the bridge. This can result in skidding and uneven wear on the wheels.

A sudden start with a heavy load on one end of the bridge may cause a crane to skew. Skewing means that the bridge and trucks are out of alignment with the rails, often resulting in wheel chatter from flange contact with the sides of the rail head.

Always board cab-operated cranes at designated places. Access the crane cab or bridge walkway using fixed ladders, stairs, or platforms.

Remain aware of other cranes working on the same rail system.

For gantry cranes, watch travel truck clearances. For cab-operated gantry cranes, this may require additional personnel to ensure a clear travel path.

Use radio controls according to the manufacturer's instruction. Turn off power to the radio controller and properly store when finished operating.

GENERAL CRANE SAFETY STUDENT GUIDE

OVERHEAD ELECTRIC TRAVELING (OET) AND GANTRY CRANES - SECURING

Move cab-operated cranes to a boarding platform or ladder. Never attempt to walk the rails to enter or exit an OET crane.

Secure main power switch, usually located on the bridge, for cab-operated cranes only.

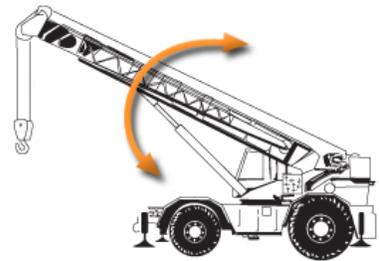
When necessary for OET or gantry cranes located out of doors, secure the crane against movement by the wind.

Chock the wheels as necessary for travel trucks.

SAFE OPERATIONS MODULE 2 EXAM

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

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



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

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



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

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



GENERAL CRANE SAFETY STUDENT GUIDE

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

- A. hooks
- B. jacks
- C. jib
- D. rigging gear
- E. oiler

5. When lifting heavy loads with mobile cranes, operators must keep in mind what specific pre-caution?

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

6. When landing heavy loads with mobile cranes, operators must keep in mind what specific pre-caution?

- A. Remove stowed jib to lighten boom.
- B. Use both hooks for added capacity.
- C. Use power lowering whenever possible.

7. Extending the boom on a typical hydraulic crane will cause the hook(s) to _____.

- A. lower
- B. raise
- C. spin

8. Anti two-block devices are operational aids that can fail and must not be relied upon to stop the movement of the hoist.

- A. True
- B. False

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

- A. True
- B. False

GENERAL CRANE SAFETY STUDENT GUIDE

10. Hydraulic booms can fail with little or no warning when subjected to

- A. side loads
- B. over loads
- C. Both A and B are correct

11. When securing rough terrain cranes, the boom should be in a near _____ position.

- A. safe
- B. vertical
- C. horizontal

12. Lowering a fixed boom with the load block close to the boom-tip sheaves may result in two-blocking.

- A. True
- B. False

13. All of the following steps apply to securing lattice-boom cranes EXCEPT:

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

14. When operating floating cranes you must start swinging or rotating quickly and stop abruptly.

- A. True
- B. False

15. **Select the best answer.** Lifting heavy loads with floating cranes will cause the barge to _____.

- A. sink
- B. drift
- C. list
- D. skew
- E. rotate

GENERAL CRANE SAFETY STUDENT GUIDE

16. Portal crane operators shall stop crane travel if materials or vehicles are inside crane clearance lines.

- A. True
- B. False

17. When making heavy lifts with locomotive cranes, the use of tilt-blocks or bed-wedges will increase _____ stability.

- A. over-the-side
- B. on outriggers
- C. on rubber
- D. over the end

18. Failure to disengage tilt-blocks or bed wedges for locomotive crane travel may result in: _____

- A. overheating brakes.
- B. overloading the crane.
- C. loss of stability.
- D. derailling the crane.

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

- A. Luff
- B. Hoist
- C. Skew

20. Which of the following is a mode of operation for a typical OET or gantry crane?

- A. Luff
- B. Swing
- C. Trolley Bridge

GENERAL CRANE SAFETY STUDENT GUIDE

21. Which of the following is a mode of operation for a typical OET or gantry crane?

- A. Rotate
- B. Bridge
- C. Extend

22. Which of the following is a mode of operation for a typical OET or gantry crane?

- A. Travel
- B. Extend
- C. Rotate

NOTES

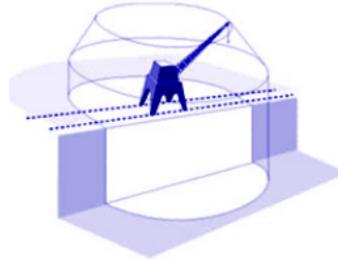
GENERAL CRANE SAFETY STUDENT GUIDE

CRANE AND RIGGING GEAR ACCIDENTS

CRANE OPERATING ENVELOPE

In order to define a crane accident, you must first understand the crane operating envelope.

The operating envelope includes the crane, the operator, the riggers, and the crane walkers, other personnel, the rigging gear between the hook and the load, the load itself, the supporting structures, such as the rails or the ground, and the lift procedure.



Includes:

- crane
- operator
- riggers and personnel
- other personnel
- rigging gear
- load
- supporting structure
- procedure

RIGGING GEAR ENVELOPE

The rigging gear operating envelope contains the rigging gear and miscellaneous equipment covered by NAVFAC P-307 section 14, the user of the gear, the load itself, other personnel involved in the operation, the structure supporting the gear, the load rigging path, and the rigging procedure.

CRANE ACCIDENT DEFINITION

A crane accident occurs when any of the elements in the operating envelope fail to perform correctly during operations, including operations during maintenance or testing, resulting in the following: personnel injury or death, material or equipment damage, dropped load, derailment, two-blocking, overload or collision.

RIGGING GEAR ACCIDENT DEFINITION

Rigging gear accidents occur when any of the elements in the operating envelope fails to perform correctly during weight handling operations resulting in the following: personnel injury or death, material or equipment damage, dropped load, two blocking, or overload.

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

Component failure such as motor burnout, gear tooth breakage, bearing failure, etc. is not considered an accident just because damage to equipment occurred, unless the component failure causes other damage such as a dropped boom or dropped load.

GENERAL CRANE SAFETY STUDENT GUIDE

ACCIDENT CAUSES

In most cases, crane accidents are due to inattention to the task, poor judgment, team members having too much confidence in their abilities or operating the crane too fast.

OPERATOR RESPONSIBILITIES

The operator can play a significant role in eliminating human error and accidents. Drugs and alcohol can affect a person's capability to think, reason, or react in normal situations and can certainly lead to serious accidents.

Operators must always consult their physicians regarding effects of prescription drugs before operating equipment, and recognize that medications often affect people differently.

An operator is responsible for evaluating his or her physical and emotional fitness.

ACCIDENT REPORTING PROCEDURES

If you have an accident with a crane or you find damage and suspect an accident has happened, you must stop operations as soon as safely possible. Call emergency services if anyone is injured. Secure the crane and power as required. Notify supervision immediately and preserve the accident scene to aid the investigation.

The activity responsible for the weight handling operation at the time of the accident shall initiate and submit the accident report

ACCIDENT REPORTING - CONTRACTOR

The contractor shall notify the contracting officer as soon as practical but no later than four hours after any WHE accident. Secure the accident site and protect evidence until released by the contracting officer. Conduct an accident investigation to establish the root cause(s) of any WHE accident.

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

Contractors shall provide to the contracting officer, within thirty days of any accident, a Crane and Rigging Gear Accident Report using the form provided in NAVFAC P-307 Section 12 consisting of a summary of circumstances, an explanation of cause or causes, photographs (if available), and corrective actions taken.

GENERAL CRANE SAFETY STUDENT GUIDE

ACCIDENT REPORTING - CONTRACTING OFFICER

The contracting officer shall notify the host activity of any WHE accident upon notification by the contractor and provide the Navy Crane Center and the host activity a copy of every accident report, regardless of severity, upon receipt from the contractor.

The contracting officer shall notify the Navy Crane Center of any accident involving a fatality, in-patient hospitalization, overturned crane, collapsed boom, or any other major damage to the crane, load, or adjacent property as soon as possible, preferably within twenty four hours of notification by the contractor.

When the contracting officer is not in the local area, the contracting officer shall designate a local representative to ensure compliance with the above noted requirements. The above requirements are in addition to those promulgated by OPNAVINST 5100.23 and related local instructions.

CRANE AND RIGGING GEAR ACCIDENTS EXAM

1. 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. The rigging gear operating envelope contains the rigging gear and miscellaneous equipment covered by P-307 section 14, the load itself and
 - A. load rigging path.
 - B. the gear or equipment's supporting structure.
 - C. the user of the gear or equipment

3. During maintenance the rigging gear between the crane hook and the load fails and results in equipment damage. This is reported as a (an)
 - A. rigging gear deficiency.
 - B. rigger error
 - C. operator error.
 - D. crane accident.

GENERAL CRANE SAFETY STUDENT GUIDE

4. 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 (an)

- A. operator error
- B. crane accident
- C. load configuration error
- D. crane walker's error

5. When rigging gear covered by P-307 Section 14 fails while suspended from a structure and drops the load it is a:

- A. crane accident.
- B. load configuration error.
- C. rigging gear accident.
- D. rigging error.

6. If component failure occurs, such as motor burnout, and does not result in damage, the component failure is considered:

- A. a crane accident
- B. crane maintenance's responsibility
- C. a non accident
- D. a rigging accident

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

- A. personnel error
- B. riggers or signalmen
- C. equipment failure
- D. weather conditions
- E. crane operators

8. 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. operating the crane too fast
- B. engineering lift specifications
- C. the crane operating envelope
- D. inattention to the task

GENERAL CRANE SAFETY STUDENT GUIDE

9. Who is primarily responsible for evaluating a crane operator's physical and emotional fitness?

- A. The Crane Operator
- B. The Crane Supervisor
- C. The activity Medical Officer
- D. The Dispatcher
- E. All listed personnel

10. If you have an accident with a crane or you find damage and suspect an accident has happened, your first step is to:

- A. notify your supervisor immediately.
- B. secure the crane and power as required.
- C. call emergency services if anyone is injured.
- D. stop operations as soon as safely possible.

NOTES



GENERAL CRANE SAFETY EVALUATION

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					
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?

List other training topics in which you are interested: _____

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