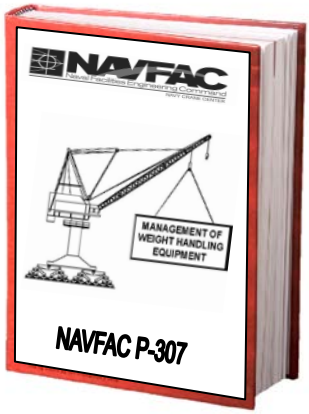
Navy Crane Center



NAVFAC P-307 Training

GENERAL CRANE SAFETY

WEB BASED TRAINING STUDENT GUIDE

NCC-GCS-03

Naval Facilities Engineering Command
Navy Crane Center
Norfolk Naval Shipyard, Bldg. 491
Portsmouth, VA 23709-5000
Comm. Phone: 757.967.3803, DSN: 387
Fax: 757.967.3808
http://www.navfac.navy.mil/ncc

TABLE OF CONTENTS

INTRODUCTION

Welcome

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

The following topics will be discussed during this training: NAVFAC P-307, Crane Components, Operator's Daily Checklist (ODCL), Complex and Non-Complex Lifts, Determining Load Weight and Load Weight Distribution, Sling Angle Stress and D/d Ratio, Rigging Gear Marking and Record Requirements, Rigging Gear Use, Load Charts, Crane Communications, and Crane Team Concept, Safe Operations; and Crane and Rigging Gear Accidents.

Course Objectives

Upon successful completion of this course you will be able to: understand the requirements of NAVFAC P-307, identify crane component types, complete an Operator's Daily Checklist (ODCL), determine load weights, load weight distribution, and sling angle stress, identify proper selection and use of rigging gear, explain the crane team concept, identify proper crane communication methods, and identify crane and rigging gear accidents.

NAVFAC P-307

Welcome
Welcome to the NAVFAC P-307 module.

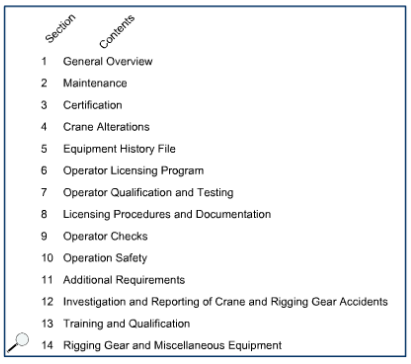
Objectives
Upon successful completion of this module, you will be able to state the purpose of NAVFAC P-307, identify covered equipment, describe the training and qualification requirements of NAVFAC P-307, and determine which types of cranes require licenses for operation.

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 training and qualification standards for all personnel involved with maintenance, inspection, test, certification, engineering, rigging, and operation of Weight Handling Equipment, or WHE, and ensure the safe lifting and controlling capability of WHE and promote safe operating practices. Weight Handling Equipment includes both cranes and the rigging gear used for lifting operations.

Applicability
NAVFAC P-307 applies to naval shore activities, including Navy activities on joint bases of other military services and agencies; Naval Construction Forces, including the Naval Construction Training Centers, and naval special operating units. Also included are Navy fleet activities and detachments that operate shore based WHE. NAVFAC P-307 meets, or exceeds, all OSHA requirements for maintenance, inspection, testing, certification, repair, alteration, and operation of equipment.

NAVFAC P-307 Table of Contents
For an overview of NAVFAC P-307, review this table of contents.

NAVFAC P-307 Table of Contents



Section	Contents
1	General Overview
2	Maintenance
3	Certification
4	Crane Alterations
5	Equipment History File
6	Operator Licensing Program
7	Operator Qualification and Testing
8	Licensing Procedures and Documentation
9	Operator Checks
10	Operation Safety
11	Additional Requirements
12	Investigation and Reporting of Crane and Rigging Gear Accidents
13	Training and Qualification
14	Rigging Gear and Miscellaneous Equipment

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.

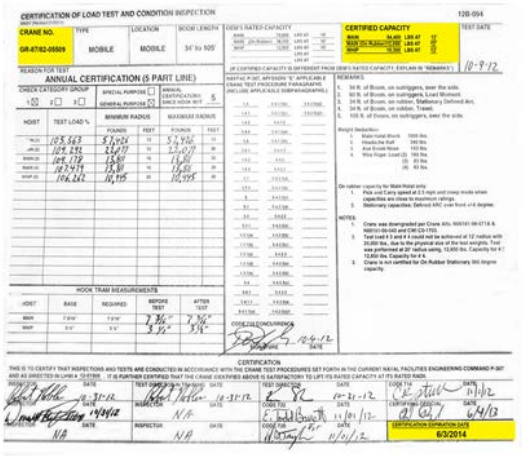
Maintenance and Inspection Requirements

NAVFAC P-307 provides requirements for documentation of maintenance and inspection, including: types and frequency of inspection; deficiencies to load bearing parts, load controlling parts, and operational safety devices; repairs and alterations made to cranes; and minimum requirements for record keeping.

Posting of Certification Information

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.

Posting of Certification Information



Types of Equipment Covered

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. Rigging gear is covered in Section 14.

Knowledge Check

1. Select the best answer. NAVFAC P-307 uses the term Weight Handling Equipment to refer to:
   a) All cranes and rigging gear
   b) Anything within the crane envelope
   c) Cranes, crane gear, rigging gear, and all equipment
   d) Only rigging gear

2. True or False. NAVFAC P-307 provides guidance to shore based naval activities for management of weight handling equipment.
   a) True
   b) False

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.

Category 1 Cranes

This is a list of 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.

Crane Components

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

The boom is defined as an inclined spar, strut, or other long structural member that supports the hoisting tackle (blocks and hooks). A jib is an extension that may be attached to the main boom when lifting light loads to a higher elevation than that permitted by the main boom. Boom length is the distance from the boom "heel" or "foot" pins to the center of the boom tip sheave.

The machinery house normally contains the diesel engine and generator, batteries, clutches, brakes, motors, and drums.

The rotate bearing is a large, precision machined ring bearing connecting the stationary and rotating portions cranes.

The supporting structure consists of the carrier frame, rotate base, and gantry.
The travel system may include wheels, tires, tracks, travel motors, clutches, and brakes.

Category 1 Crane Examples

These are examples of Category 1 cranes.

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
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

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

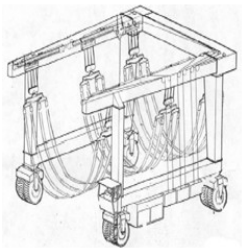
Typically:
- boom may rotate 90° or more between the mast supports or "stiff legs" or members capable of resisting both tensile and compressive forces

Load movement:
- toward the mast by raising the boom
- away from the mast by lowering the the boom

Derrick

Mobile Boat Hoist

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

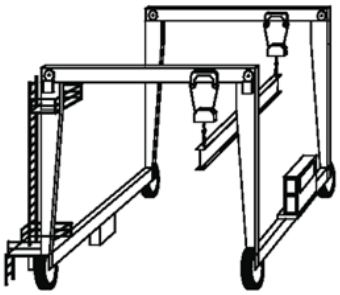


Landing Craft Retrieval Unit (LCRU)

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

The rubber tire gantry crane shown is a category 1 crane as described in NAVFAC P-307.



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

Category 2 and 3 Cranes

Category 2 and Category 3 cranes include: Overhead traveling cranes; Gantry cranes; Wall cranes; Jib cranes; Davits; Pillar cranes; Pillar jib cranes; Monorails and associated hoists; Fixed overhead hoists, including fixed manual and powered hoists; Portable A-frames and portable gantries with permanently installed hoists; and Pedestal mounted commercial boom assemblies attached to stake trucks, trailers, flatbeds, or railcars, or stationary mounted to piers, etc., with certified capacities less than 2,000 pounds.

Portable manual and powered hoists are covered in Section 14 of the NAVFAC P-307 (they are defined in Section 1). The activity may, however, treat them as Category 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

Trolly 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

Trolly Mounted Overhead Hoist

Knowledge Check 2

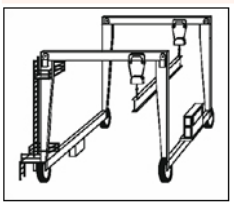
1. Select the best answer. Category 2 and Category 3 cranes are separated by:

a) Licensing requirements
b) Boom capacity and length
c) Certification date
d) Certified capacity

2. True or False. Boom length is the distance from the boom “heel” or “foot” pins to the center of the boom tip sheave.

a) True
b) False

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



a) Category 1
b) Category 2
c) Category 3
d) Category 4

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

a) Category 1
b) Category 2
c) Category 3
d) Category 4

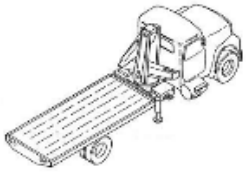
5. Select the best answer. What is the category of this crane?

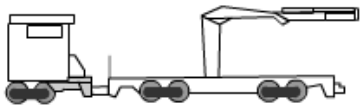
a) Category 1
b) Category 2
c) Category 3
d) Category 4

Category 4 Cranes

Mounts

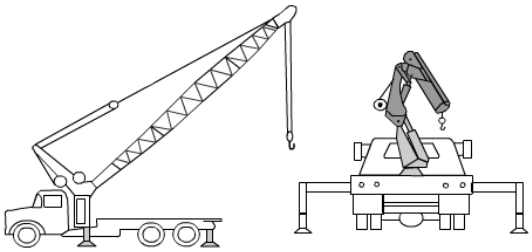
Category 4 cranes may be attached to stake beds, trailers, flat bed trucks, rail cars, or may be stationary mounted on piers, barges, etc.





Booms

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



Pedestal Mounted

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.

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 Examples

These are examples of Category 4 cranes.

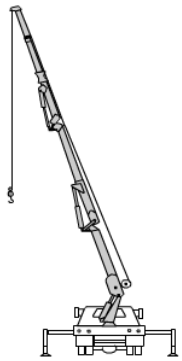
Category 4 Cranes

Boom Assemblies

- Non-Telescoping
- Articulating
- Telescoping

Mounted on:

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



Truck Mounted
Commercial Boom Assembly

Hydraulic Boom Crane
- Commercial
- Truck- Mounted
- Standard Ground Control

Structure:
- carrier, usually a flatbed truck
- independently operated crane

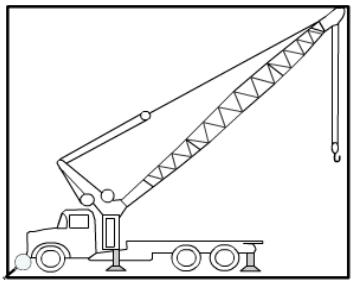
Power:
Power to operate may be from the truck's engine by way of a power take off unit

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.

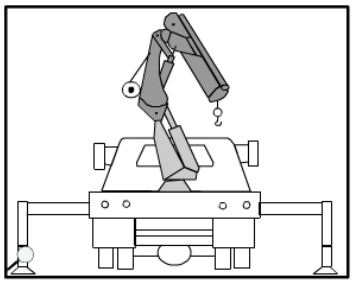


Non-Telescoping Boom

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

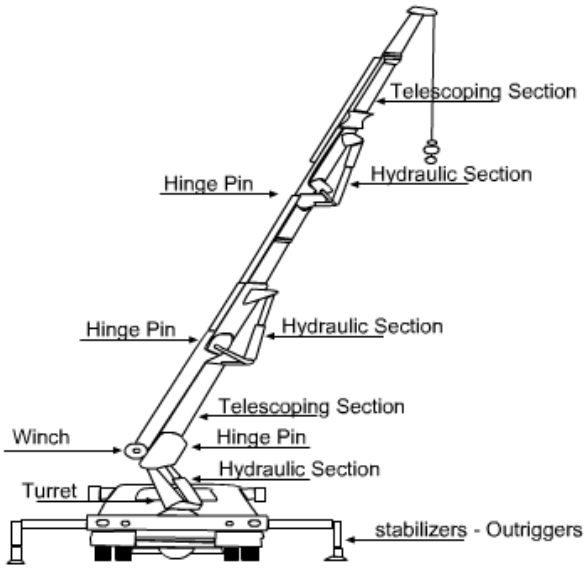
Hydraulic Extendible Boom

Hydraulic Extendible Boom

Truck Mounted Articulating Boom

Articulating Boom Crane
Truck Mounted

Category 4 Crane Components



Category 4 Cranes

All Category 4 cranes require a licensed operator.

Maintenance, Certification, and Alterations (Sections 2, 3, and 4)

NAVFAC P-307 Section 2 (Maintenance) provides maintenance inspection frequencies and details. Personnel performing maintenance inspections shall be trained and qualified as inspectors per section 13.
Section 3 (Certification) provides crane certification requirements.
Section 4 (Alterations) provides crane alteration requirements.

Licensing (Sections 6, 7, and 8)

NAVFAC P-307 provides uniform standards for crane operator licensing. 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.

Operator Training

Prior to taking any performance test, the license candidate shall be thoroughly trained on the operation of the type of crane for which a license is to be issued.

The candidate shall operate that type of crane only under the direct observation of a licensed operator. The licensed operator shall retain full responsibility for the safe operation of the crane.

The supervisor shall approve lifting of loads based upon the candidate's demonstration of knowledge of the equipment and operation without loads. The candidate shall not perform complex lifts.

Operator Checks (Section 9)

A complete check of the crane shall be performed by the operator prior to the first use of the crane each day (whether the crane is used in production, maintenance, testing, or being relocated).
NAVFAC P-307 Section 9 covers pre-use check and documentation requirements, procedure requirements, specific instructions, and deficiency reporting and requirements.

Operation Safety and Additional Requirements (Sections 10 and 11)

NAVFAC P-307 Section 10 includes crane operation safety procedures, crane team responsibilities and lifting and crane operation requirements.
Section 11 provides additional crane requirements.

NAVFAC P-307 Section 12: Crane and Rigging Gear 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 and 5100.23.
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

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

Training (Section 13)

Section 13 of NAVFAC P-307 provides training and qualification requirements for personnel involved in the operation, maintenance, inspection, and testing of Navy Weight Handling Equipment.

Rigging Gear and Miscellaneous Equipment (Section 14)

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. True or False. Non-cab Operated Category 3 cranes require a license to operate.

a) True
b) False

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

a) Category 1 cranes
b) Category 2 cranes
c) Cab-Operated Category 3 cranes
d) Category 4 cranes

NOTES

CRANE COMPONENTS

Welcome
Welcome to Crane Components.

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

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

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

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

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


Wire rope, Hooks, & Blocks


Sheaves

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

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

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

Examples of load-controlling components are foot-controlled brakes used as secondary brakes for hoist speed control, travel gear assemblies, rotate gear assemblies, and rotate locks. Appendix F of NAVFAC P-307 lists examples of load-controlling parts.

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.

Knowledge Check

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

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

2. Select the best answer. Load - _____ parts are those that restrain position or control the movement of the load.
a) Lifting
b) Controlling
c) Operation
d) Handling
e) Bearing

3. Select the best answer. A hook is what type of component?
a) Operational Safety Device
b) General Safety Device
c) Load-Controlling Part
d) Load-Bearing Part

4. Select the best answer. Hydraulic foot brakes are what type or group of components?
a) Load-Controlling Parts
b) General Safety Device
c) Load-Bearing Parts
d) Operational Safety Device

5. Select the best answer. Load - _____ parts are those that support the load.
a) Bearing
b) Lifting
c) Handling
d) Operational
e) Controlling

6. Select the best answer. How is electrical current conveyed from the revolving portion of the crane to the lower crane structure?
a) Through the collector ring system
b) Through the electrical panels
c) Through transistors
d) Through the main circuit board

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.

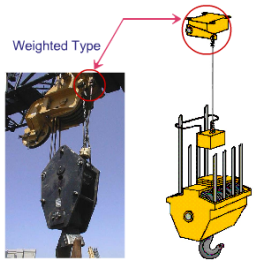
Load Indicators

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.

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

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

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

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

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

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.

Knowledge Check

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

a) Universal
b) General
c) Load bearing
d) Operational

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

a) Load bearing
b) Operational
c) Universal
d) General

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

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

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

a) General Safety Device
b) Operational Safety Devices
c) Load Controlling Part
d) Load Bearing Part

NOTES

OPERATOR'S DAILY CHECKLIST (ODCL)

Welcome
Welcome to Operator's Daily Checklist.

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

Introduction
An Operators Daily Checklist or ODCL is a safety checklist 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
The daily inspection conducted by the operator is a general check by sight, sound, and touch. It helps the operator identify conditions that may render the crane unsafe to operate and enhances crane reliability.

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

Sections
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.

Knowledge Check

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

a. Complex lifts only
b. Moving the crane to a new location
c. Securing the crane each day
d. The first use of the crane each day

2. Select the best answer. The ODCL is used to identify:
a. Members of the current crane team
b. Conditions that may render the crane unsafe
c. Who is licensed to operate the crane
d. Necessary and missing paperwork

3. Select all that apply. What are the four sections of a properly performed pre-operational check?
a. Machinery check
b. No-load operational check
c. Walk around check
d. Electrical function check
e. Operator's cab check
f. Stability check

4. Select the best answer. What method of inspection is used in the operator's daily check of the crane?
a. Sight, sound and touch
b. Observing the crane in operation
c. Review of OEM manual
d. CCI Inspection

Warning Tags

Look for warning tags during your walk around visual check. You may find warning tags posted with the certification card. Warning tags are generally hung on the pendant controller or other types of crane controls. They may also be found at the power source of the crane.

Warning – do not operate any crane which has evidence that a tag was on the crane, such as a tie wrap, wire band, empty pouch, etc. If warning tags are posted on any component of the crane you must investigate the tag before continuing with operation.

Danger Tags

The red danger tag prohibits operation by anyone. If you find one, never energize a crane with a danger tag attached! Energizing equipment with a danger tag attached may result in personnel injury or equipment damage. Inform your supervisor if you find the crane has a danger tag attached.

Caution Tags

The yellow caution tag generally gives some type of warning, precaution, or special instructions to the operator of the crane. Most caution tags inform of hazardous conditions such as rail stops, swing interference, crane clearance problems, etc.

Always read and follow the written instructions on the reverse side of this tag before operating the crane. If you do not understand the instructions, ask your supervisor for clarification.
Occasionally a yellow caution tag will state “No Production Lifts.”

Out of Service Tags

Another tag you may find is an “Out of Service” tag. These may vary in color and makeup from one activity to another. An Out of Service tag is installed to perform maintenance, testing, or inspection. Only crane maintenance personnel, or the person who hung the tag, are authorized to remove an Out of Service tag. When you find this tag, do not use the crane.

Lock Out Tags

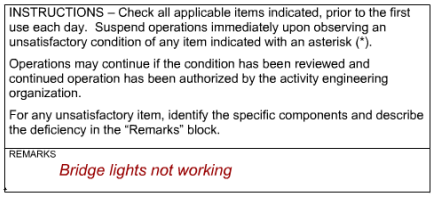
Another tag you may see is a “Lockout” tag. These may vary in color and makeup from one activity to another. A Lockout Tag is installed to inform you that energy has been locked out because personnel are working on the crane. Only the person who hung the tag is authorized to remove a Lockout Tag. When you find this type of tag, do not energize the crane.

Who Can Remove Warning Tags?

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

Critical Components

The ODCL identifies components that are critical to the safe operation of the crane. Critical components are load-bearing parts, load-controlling parts, and operational safety devices. They are identified by an asterisk (*) next to the item. Any deficiency to a critical component or safety hazard must be reported to your supervisor immediately.



Unsatisfactory Conditions

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

Recording Results 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.

Knowledge Check

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

a. Letter color: red for critical – yellow for cautionary
b. Ampersand (&)
c. Bold letters
d. Asterisks (*)

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

a. Batteries
b. Emergency Stop Button
c. Windlocks, Stops and Bumpers

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

a. Report the situation to crane maintenance
b. Stop, secure the crane and notify your supervisor
c. Resolve the situation before continuing
d. Report the situation to crane inspection

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

a. Described in the “Remarks” block of the ODCL worksheet
b. Delivered to maintenance and engineering for action

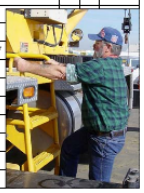
5. Select the best answer. Each item on the ODCL shall be marked:

a. Serviceable, unserviceable, or not applicable
b. Stable, unstable, or not applicable
c. Correct, incorrect, not applicable
d. Satisfactory, unsatisfactory, or not applicable

Walk Around Check

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

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



Safety Guards and Plates

Check for missing safety guards and plates.

General Hardware

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

Wire Rope and Reeving

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

Block and Hook

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

Sheaves or Sprockets

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

Boom and Jib

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

Gantry, Pendants, and Boom Stops

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

Walkways, Ladders and Handrails

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

Windlocks, Stops, and Bumpers

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

Tires, Wheels, and Tracks

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

Leaks

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

Outriggers and Stabilizers

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

Load Chain

Check for damaged or deteriorated links.

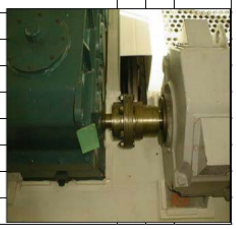
Area Safety

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

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

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

Diesel Engine and Generator

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

Leaks

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

Lubrication

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

Battery, Lights, and Glass

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

Clutches and Brakes

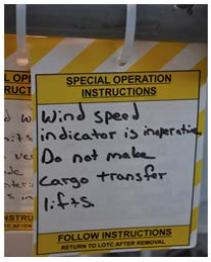
Check accessible portions of clutches and brakes for evidence of excessive heat, wear, or grease and oil on the linings. Check for evidence of loose fasteners and for missing or broken parts.
If a brake is equipped with a manual release mechanism, check to ensure the mechanism is not in the released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

Electric Motors

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

Auxiliary Engine and Compressor

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



Danger/Caution Tags

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

Fire Extinguishers

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

Hoist Drum Pawls and Ratchets

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

Knowledge Check

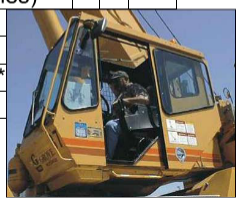
1. Select the best answer. Discoloration of the brake drum is usually caused by:
a. Overheating
b. Normal operations
c. Overloading the crane
d. Lubrication

2. Select the best answer. During inspection, cracked or flaking paint may indicate:
a. Latex paint over alkyd primer
b. Structural damage or loose bolts
c. Poor quality paint
d. Aluminum paint on steel components

ODCL Operator Cab Checks

This is a typical Operator's Cab Check section from an ODCL.
The operator should enter the cab and ensure all controls are in the neutral or off position prior to starting the engine. Start the engine and check the items in the Operator Cab Check section.

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



Gauges, Indicator and Warning Lights

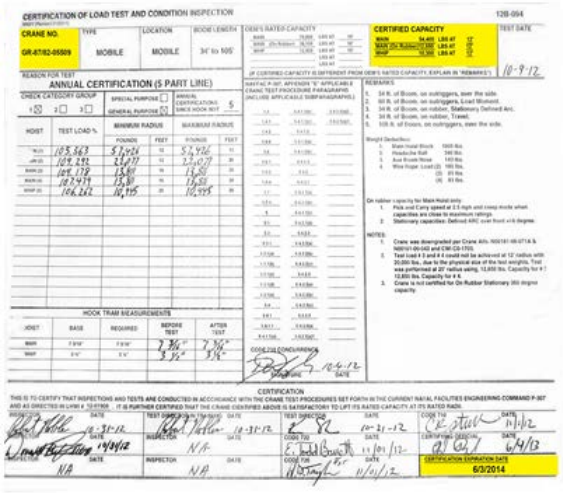
Check gauges to ensure none are broken or missing and that they are operating normally.
Check indicator and warning lights to ensure none are broken or missing and that applicable indicator and warning lights are lit.

Visibility and Glass

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

Load Rating Charts

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


CERTIFICATION OF LOAD TEST AND CONDITION INSPECTION

ANNUAL CERTIFICATION (5 PART LINE)

CERTIFIED CAPACITY

6/3/2014

List and Trim Indicator

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

Boom Angle/Radius Indicator

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

Fire Extinguishers

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

Level Indicator

On mobile cranes, check the level indicator for damage.

Danger/Caution Tags

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

OPERATIONAL CHECK

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

The final check before placing the crane in service is the “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.

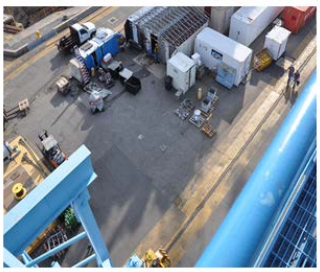
When performing the operational check portion of the ODCL in cold weather or icy conditions, the operator should raise the blocks and boom before lowering them, to avoid damage when sheaves may be frozen.

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

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

Area Safety

Check the work area and ensure that the exact locations of obstacles or hazards are knows.
Ensure ground conditions are sufficiently firm to support a loaded crane.



Outriggers and Stabilizers

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

Unusual Noises

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

Control Action

Check controls through a range sufficient to ensure that they operate freely and that the corresponding component actuates properly when controls are activated.
Check hoist controls through the full speed range.

Wire Rope or Chain

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

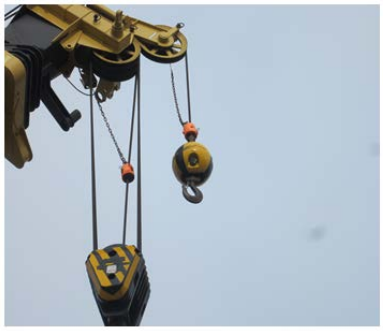
Brakes and Clutches

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

Boom Angle/Radius Indicator

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

Limit Switches



Checking of limit switches shall be performed at slow speed and include each upper hook hoist primary limit switch and the upper and lower boom hoist primary limit switches. (Verifying the operation of the upper and lower boom hoist limit switches is required only during the initial check of the crane each day.)

Checking of hook hoist lower limit switches is not required if the hook can be lowered to its lowest possible position (e.g., bottom of dry dock being worked at minimum radius) while still maintaining a minimum of two wraps of rope on the hoist drum (three wraps for un-grooved drums).

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

For cranes without hoist upper limit switches, do not check hoist overload clutches if so equipped. (See NAVFAC P-307, section 10 for specific precautions for these hoists.)

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

Emergency Stop

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

Other Operational Safety Devices

Check any other operational safety devices as directed by the activity engineering organization. An example would be dead-man controls.
These pictures show two types of dead-man controls. A foot switch and a push-button thumb switch on top of the controller.

General Safety Devices

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

Fleeting Sheaves

Check operation of fleeting sheaves, where visible, to ensure they travel freely on the shaft.

Knowledge Check

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

a. In the operator's manual
b. Posted on the crane
c. In the load lift review
d. In the EOM
e. Posted in the crane maintenance area

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

a. Compensate for slow operator response
b. Stop operations when released
c. Push your hand away from the handle when the crane stops
d. Change operational speeds to suit conditions

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

a. Under no circumstances operate this piece of equipment
b. Review the special instructions and operate accordingly
c. Verify the tag was from previous work
d. Fix the problem and operate the equipment
e. Remove the tag and continue operations

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

a. Remove the tag and continue operations
b. Review the special instructions and operate accordingly
c. Under no circumstances operate this piece of equipment
d. Verify the tag was from previous work
e. Fix the problem and operate the equipment

NOTES

COMPLEX AND NON-COMPLEX LIFTS

Welcome
Welcome to the Complex and Non-complex Lifts module

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

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

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

Complex Lift Categories
Complex lifts include:

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

Procedures
A supervisor or working leader must review on-site conditions and conduct a pre-job briefing for all complex lifts.
A supervisor or working leader must supervise lifts over 80% (except for category 3 cranes), multiple hook lifts when the weight exceeds 80% of any hoist, and lifts of ordnance involving the use of tilt fixtures.
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.

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

Knowledge Check

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

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

2. Select the best answer. For all complex lifts, a supervisor or working leader must review on-site conditions and …

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

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

a. Evaluated according to the complex lift requirements
b. Routine lifts because they are not complex shapes
c. Included in the complex lift requirements
d. Excluded from the complex lift requirements

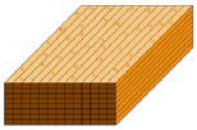
4. Select the best answer. A crane with a capacity of 100,000 pounds is performing a lift of 40,000 pounds. This is a(n):

a. Complex lift
b. Overload lift
c. Non-complex lift
d. Hazardous lift

Hazardous Materials

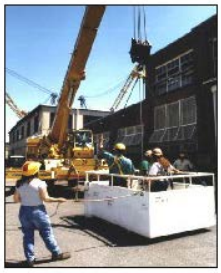
Lifting hazardous materials with a crane is a complex lift. Materials such as oxygen, acetylene, propane or gasoline in bottles, cans or tanks that are properly secured in racks designed for lifting by a crane are excluded**.**

Large Complex Geometric Shapes



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

Personnel Lifts



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

Lifts Over 80% Capacity

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

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.

Knowledge Check

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

a. Usual and unusual
b. Complex and non-complex
c. Critical and non-critical
d. Common and non-common
e. None of these

2. Select the best answer. Personnel lifts are …

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

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

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

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

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

NOTES

CRANE SET-UP

Welcome
Welcome to Mobile Crane Set-up.

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

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.

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.

Knowledge Check

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

a. Number of riggers required
b. Trained and qualified driver
c. Engineering documentation

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

a. Security clearance
b. Union requirements for drivers
c. Pre-use checks performed

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

a. Check route
b. Number of riggers required
c. Tire sizes

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

a. Disengaged
b. Engaged
c. Rotated
d. Optimized for travel

Site Conditions

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

Clearance

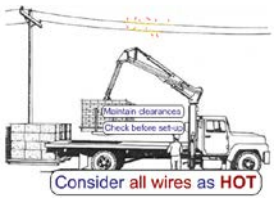
Pay particular attention to counterweight clearance. No part of the crane rotate structure may be closer than 2 feet from an obstruction.

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.

Barricading

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

Knowledge Check

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

a) 12 inches
b) Whatever the crane operator feels is safe
c) 6 feet
d) 18 inches
e) 2 feet

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

a) Erect barricades
b) Rotate slowly and cautiously
c) Turn on headlights
d) Sound the horn to warn personnel in the area
e) Designate a team member to guard the area when rotating

Set-Up Conditions

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 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.

Outriggers Properly Extended

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

Tires Off The Ground

When a crane is set up on outriggers, the weight of the crane must be off the carrier tires in order for the crane to pick 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 to 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.

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.

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.

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.

Plumb Bob

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

Pads Pinned

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

Locking Beams

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

Knowledge Check

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

a) A crane walker
b) A firm supporting surface
c) A valid driver's license
d) Jack stands

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

a) Locked
b) Rotated

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

a) Firmly set for stability
b) Depressurized
c) Just clear of the ground
d) Rotated for flexibility

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

a) Placed according to engineering specifications
b) Properly extended
c) Retracted on the down side
d) Extended as far as possible

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

a) True
b) False

NOTES

DETERMINING LOAD WEIGHT

Welcome
Welcome to Determining Load Weight.

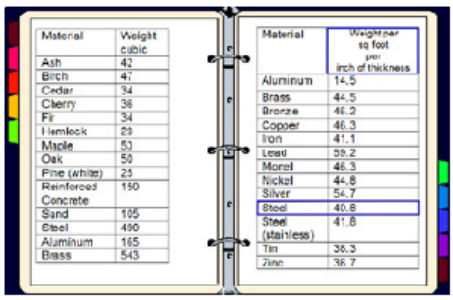
Objectives
Upon successful completion of this module you will be able to identify the importance of knowing the weight of an item, choose acceptable ways to obtain weight information, calculate area and volume of basic objects and determine the weight of basic shapes.

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

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

Unacceptable Methods
Never take word of mouth to establish load weight. Word of mouth may be used as a starting point for sizing the crane and rigging gear so the component can be weighed with a load indicating device, but never shall it be used as the final determination of load weight. To avoid overloading any equipment used in a crane lift, the rigger-in-charge shall know or have a reasonable estimate of the weight to be lifted. If the weight is estimated to exceed 50% of the capacity of the hoist or 80% of the capacity of the rigging gear, platform/skid, below-the-hook lifting device, etc., the weight shall be verified by performing an engineering evaluation or using a local procedure approved by the certifying official or activity engineering organization. Alternatively, a load indicating device shall be used.

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



Material	Weight cubic
Ash	42
Birch	41
Cedar	34
Cherry	36
Fir	34
Hemlock	28
Maple	53
Oak	50
Pine (white)	25
Reinforced Concrete	150
Sand	105
Steel	490
Aluminum	165
Brass	543

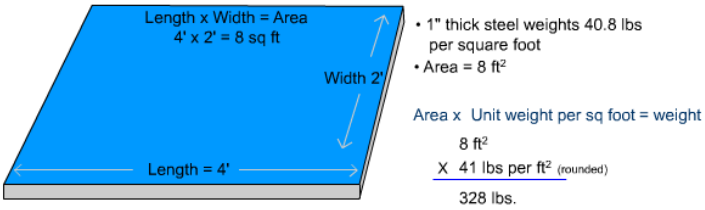
Material	Weight per sq foot per inch of thickness
Aluminum	14.5
Brass	44.5
Bronze	46.2
Copper	46.3
Iron	41.1
Lead	59.2
Monel	46.3
Nickel	44.8
Silver	54.7
Steel	40.8
Steel (stainless)	41.8
Tin	36.3
Zinc	36.7

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

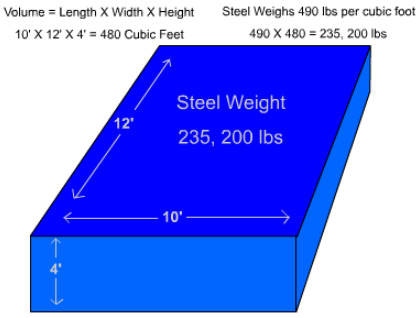
Finding Weight

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

Weight by Area



To calculate the weight of this plate, we must find the area and multiply it by the material weight per square foot. Here, we have a steel plate, 4 feet by 2 feet by 1 inch thick. The area is 8 square feet. To calculate the weight, we need to find the unit weight, or weight per square foot for the material. Using the standard material weight chart, we find steel weighs 40.8 pounds per square foot per inch of thickness. The math can be simplified by rounding to 41 pounds. Multiplying 8 square feet by 41 pounds per square foot gives us 328 pounds.

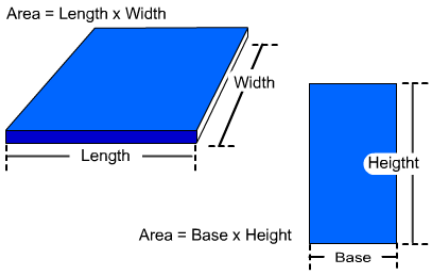


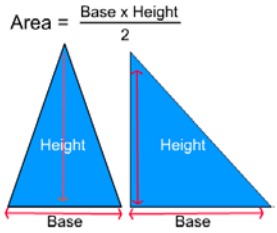
Weight by Volume

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

Calculating Area

The area of a square or rectangular shaped object is determined by multiplying length times width or base times height. It is always expressed in units of square feet or square inches.



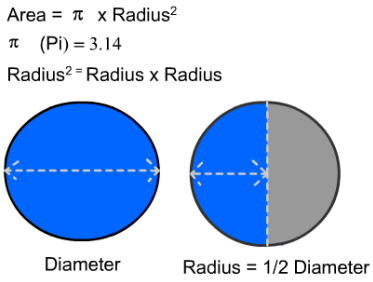


Triangle Area

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

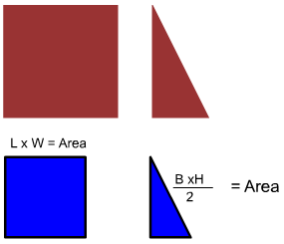
Circle Area

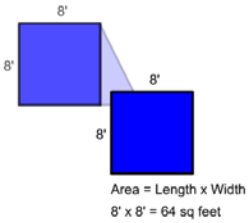
To calculate the area of a circle, multiply Pi, which is 3.14, by the radius squared. Find the radius of the circle by dividing its diameter in half. To square the radius, multiply the radius by itself. For example, if a circle has a diameter of 3 feet, the radius will be 1.5 feet. 1.5 feet times 1.5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



Area of a Complex Shape

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



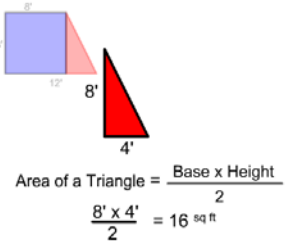


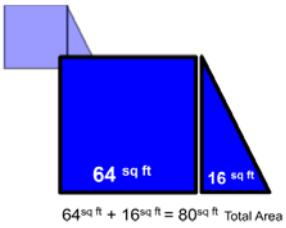
Area of First Part

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

Area of Second Part

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



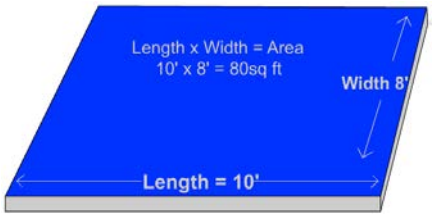


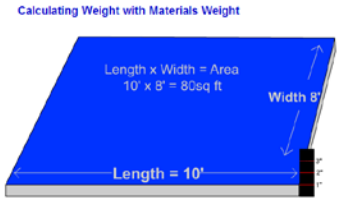
Adding Areas

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

Calculating Area and Materials Weight Step One

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

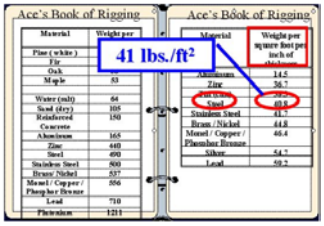




Calculating Area and Materials Weight Step Two

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

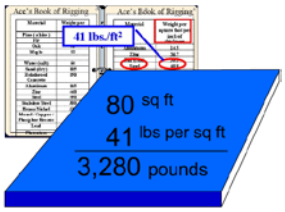
Calculating Area and Materials Weight Step Three

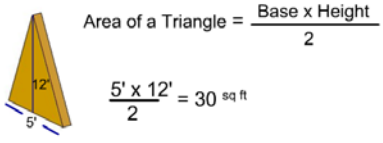


We can find the weight of common materials listed in several reference books available from various industry sources. Here, in "Ace's Book of Rigging", we find these tables. Material weight per cubic foot is in the left table. In the right table, unit weights are listed by weight per square foot, per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

Calculating Area and Materials Weight Step Four

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

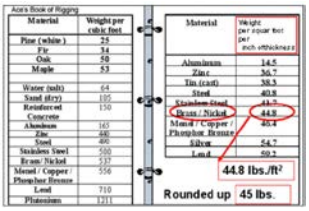




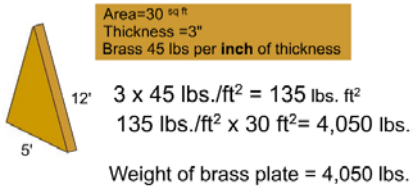
Calculating Weight of a Triangle Step One

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

Calculating Weight of a Triangle Step Two



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



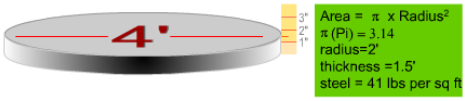
Calculating Weight of a Triangle Step Three

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

Calculating the Area of a Circle Steps

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

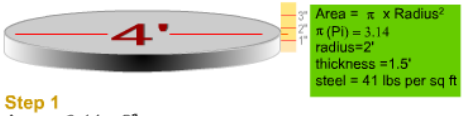
Calculating Weight - Circle



Step 1
Area = 3.14 x 2²
Area = 12.56 ft

Step 2
Thickness x pounds per 1" thickness weight
1.5 x 41 = 61.5 lbs / ft2

Step 3
Area x lbs per sq. ft = Weight of plate
12.56 ft² x 61.5 lbs = 772.44 lbs



Step 1
Area = 3.14 x 2²
Rounded Area = 13 ft²

Step 2
Thickness x pounds per 1" thickness weight
1.5 x 41 = *Rounded* 62 lbs / ft²

Step 3
Rounded Area 13 ft² X *Rounded* lbs/ft² x 62 lbs/ft² = Weight of plate = 806 lbs

Rounding

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

Knowledge Check

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

a) Square feet times material weight per square foot based on a specified thickness
b) Cubic feet times material weight per cubic foot

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

a) 1,500 feet
b) 150 feet
c) 75 square feet
d) 1,500 square feet

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

a) 22 square feet
b) 22 feet
c) 39 square feet
d) 7 square feet

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

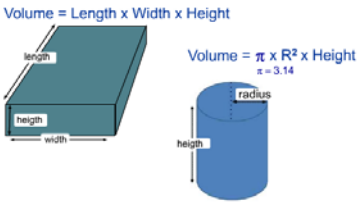
a) 1,100 lbs.
b) 1,300 lbs.
c) 1,000 lbs.
d) 1,200 lbs.

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

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

Calculating Volume

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



Load Weight by Volume

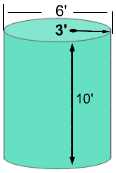
To calculate weight, by volume, we need to find the unit weight, or weight per cubic foot for the material. We go back to the tables to find the weight for a cubic foot of fir wood. This time we will use the table on the left since the material weights listed here are based on the weight per cubic foot of material. Using the standard material weight chart, we

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

Volume of a Cylinder

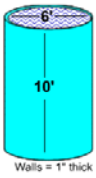
What is the formula for finding the volume of a cylinder? To calculate the volume we must first find the area of the circular end. The formula for area is Pi times radius squared. Once we know the area, we simply multiply it times the height or length. So the formula we use to find the volume of a solid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

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



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

Calculating the Volume of a Cylinder



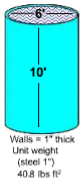
Dimensions:
Height=10'
Diameter = 6' Radius = 3'

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

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

Cylinder Weight

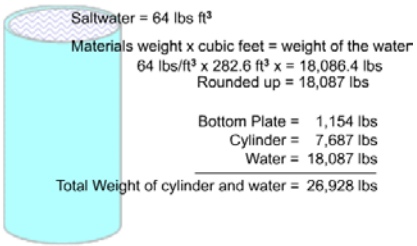
One inch steel plate weighs 40.8 pounds per square foot. The bottom plate is 6 feet in diameter, so the radius is 3 feet. 3 feet squared equals 9 square feet. We multiply 9 square feet by 3.14. This gives us the area, 28.26 square feet. We multiply this by the unit weight for steel plate of 40.8 pounds per square foot. The bottom plate weighs 1,154 pounds. Calculate the cylinder wall weight as a flat plate. Multiply Pi, (3.14) times the diameter, 6 feet, times the height, 10 feet. 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 weight = π x $Radius^2$ x 40.8 lbs ft^2
Step 1 3'x3' = 9 ft^2
Step 2 3.14 x 9ft^2 = 28.26 ft^2
Step 3 28.26 ft^2 X 40.8 = 1,154 lbs.

Cylinder wall weight = π x diameter x Height ft x weight of materials
Step 1 3.14 x 6' x 10' = 1,884 ft^2
Step 2 1,884 ft^2 x 40.8 = 7,687 lbs.

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



Cylinder Weight Salt Water

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

feet to find the weight of the water in the cylinder. 282.6 cubic feet times 64 pounds per cubic foot equals 18,086.4 pounds. Now we will add up the weights. 1,154 pounds for the bottom plate, 7,687 pounds for the cylinder wall; and 18,087 pounds of water, for a total load of 26,928 pounds.

Knowledge Check

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

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

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

a) 204 cubic feet
b) 7,687 cubic feet
c) 204 square feet
d) 1,922 cubic feet

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

a) 10,000 lbs.
b) 10,362 lbs.
c) 12,532 lbs.
d) 10, 532 lbs.

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

a) 2,880 cubic feet
b) 2,900 feet
c) 2,880 square feet
d) 2,400 square feet

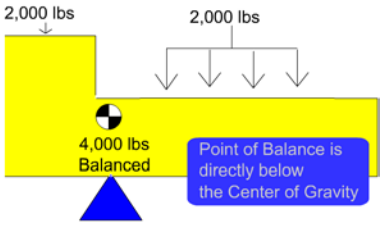
NOTES

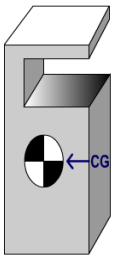
LOAD WEIGHT DISTRIBUTION

Welcome
Welcome to the Load Weight Distribution Module.

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

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

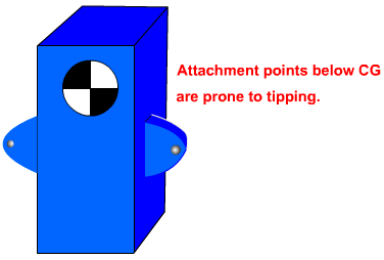


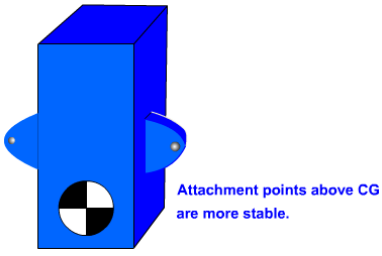


Center of Gravity
The center of gravity is the point where the entire weight of the object would balance in any direction, as if all the weight were concentrated in that one point. It is a fixed point and does not change unless the shape of the object is altered. Center of gravity is generally located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

The hook must be centered over the CG before lifting.

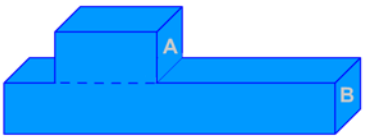
Why Find the Center of Gravity
The location of the center of gravity will affect an object's reaction to movement. If the attachment points are below the center of gravity, the object will tip over more easily when moved. If the attachment points are above the center of gravity, the object is not likely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





Finding the Center of Balance Step 1

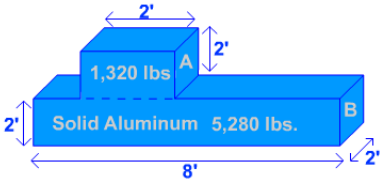
The balance point of a symmetrical object will be directly under its center. To find the balance point of a complex shape, we must first break the object into symmetrical sections or components.



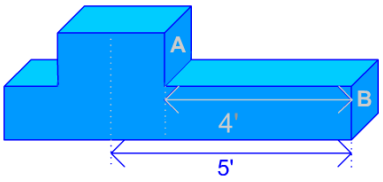
Finding the Center of Balance - Step 2

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

Determine the weight of each section or component.
Aluminum weighs 165 lbs per cu. ft.
Part A = 2' X 2' X 2' = 8 cu. ft X 165 lbs = 1,320 lbs
Part B = 2' X 8' X 2' = 32 cu. ft X 165 lbs = 5,280 lbs
Add the sections: 1,320 + 5,280 = 6,600 lbs



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



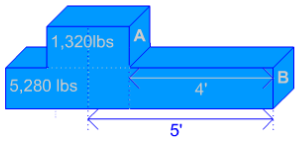
Finding the Center of Balance Step 3

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

Finding the Center of Balance Step 4

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

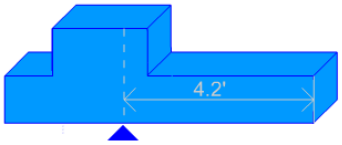
Multiply the weight of each section by the distance from the reference end to the center of each section.
Moment of Section A = 1,320 lbs X 5' = 6,600 ft lbs
Moment of Section B = 5,280 lbs X 4' = 21,120 ft lbs



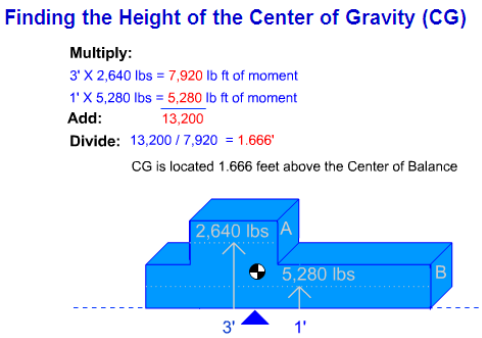
Finding the Center of Balance Step 5

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

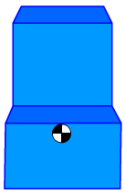
Add the moments of each section (from step 4)
Divide by the total weight (from step 2)
Moment: 6,600 ft lbs + 21,120 ft lbs = 27,720 ft lbs
Weight: 1,320 lbs + 5,280 lbs = 6,600 lbs
27,720 ft lbs / 6,600 lbs = 4.2'



Pinpointing the Center of Gravity – CG Height



In this example the weight of section A is 2,640 pounds. The weight of section B is 5,280 pounds. Measure the distance from the reference end to the center of each section. Multiply the weight of each section by the distance from the reference end to the center of the section to obtain the moment. The distance from the reference line to the center of section A is 3 feet and the distance from the reference line to the center of section B is one foot. The moment for section A is 7,920 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.



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.

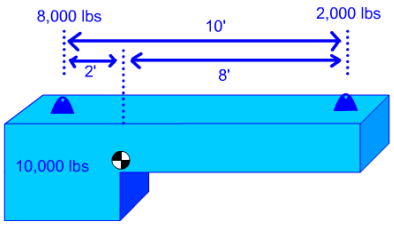
Center of Gravity Pinpointed

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.

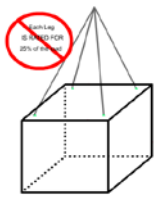
CG Review

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



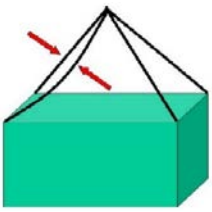
The center of gravity provides a quick reference for how the weight is distributed throughout a load. However, before planning the lift it is necessary to refine how the load weight is distributed. Weight distribution determines what each attachment point will have to carry. This information insures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



A Wrong Assumption

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

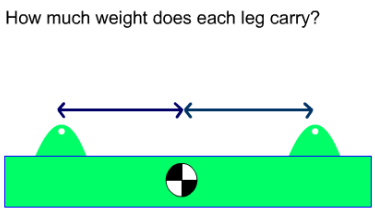
How Many Legs Really Carry the Load?



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

A Safe Assumption

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

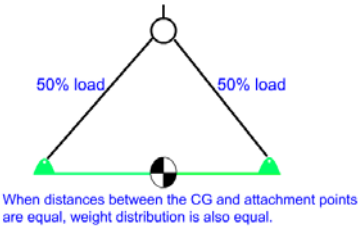


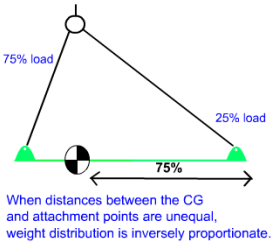
Determining Leg Weight

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

Equal Leg Weight

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





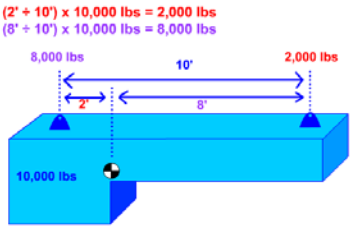
Unequal Leg Weight

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

Calculating Distribution

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

Weight Distribution Example



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

Knowledge Check

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

a) 25%, 75%
b) 50%, 50%
c) 33%, 66%
d) 75%, 25%

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

a) Where all the weight is concentrated
b) Where the item balances
c) Always in the center of an object

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

a) True
b) False

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

a) True
b) False

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

a) 3 divided by 6 multiplied by 10,000 (3 / 6 x 10,000)
b) 9 divided by 3 multiplied by 10,000 (9 / 3 x 10,000)
c) 3 divided by 9 multiplied by 10,000 (3 / 9 x 10,000)
d) 6 divided by 3 multiplied by 10,000 (6 / 3 x 10,000)

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

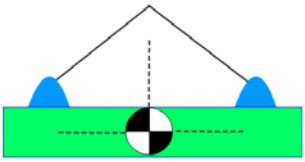
a) True
b) False

NOTES

SLING ANGLE STRESS

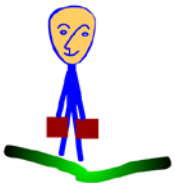
Welcome
Welcome to Sling Angle Stress.

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



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

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

90° Example


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

45° Example


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

30° Example

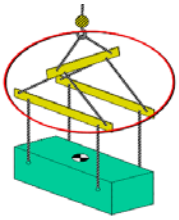

At a 30° angle, the amount of stress in Ace's arms increases further. The stress increase at 30° is 100% of the weight he's holding. Now Ace feels like he's holding 100 pounds in each arm even though the weight is still actually 50 pounds.

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

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

Sling Angle Stress Affects

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



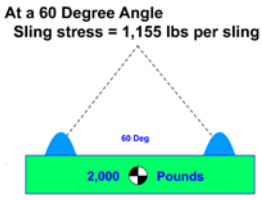
Minimizing Sling Angle Stress

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

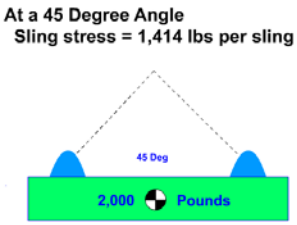
Summary

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

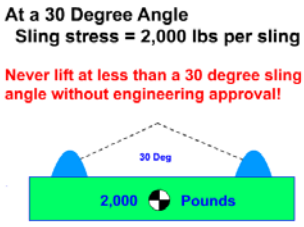
Examples



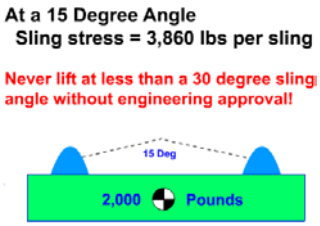
At a 60° angle the load on the rigging has increased to 1,155 pounds. Keep in mind each leg has 1,155 pounds of stress even though only one leg is shown. 60° is the preferred angle!



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



At a 30° angle the stress has increased to 2,000 pounds Each sling now has a load equal to the weight of the object! That is a 100% increase. Never lift with less than a 30° angle without engineering approval!



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

Accounting for Sling Angle Stress

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

Selecting Minimum Rated Capacity

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

Determine Minimum Rated Capacity

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

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

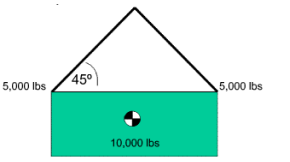
Using an Angle Factor Chart

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

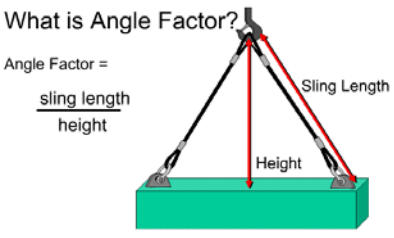
Angle Factor Chart Example

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

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

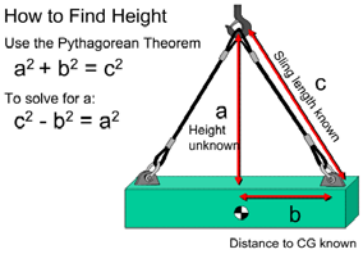


1.414 x 5,000 lbs.=7,070 lbs. in each leg.



What is Angle Factor?

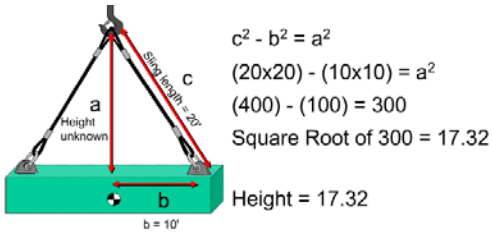
Remember the lift triangle? Now the whole triangle idea really comes into play. The sling angle factor is a ratio of the side of the lift triangle, which in this case is the sling, and the height of the triangle. To find it, divide the sling length by the height of the lift triangle. The height is the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

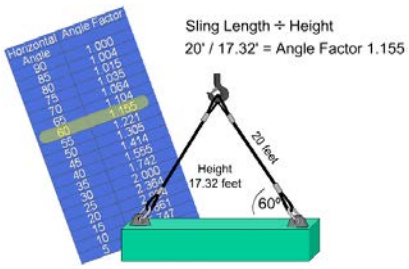


How to Find Height

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

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



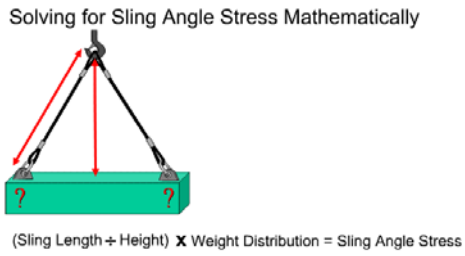


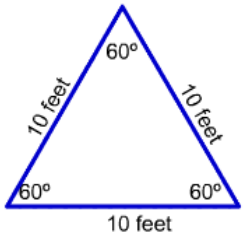
Finding Angle Factor

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

Solving 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.



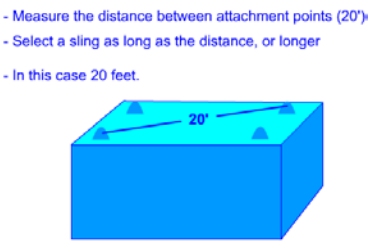


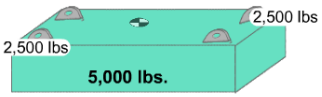
60° Sling Angle

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

60° Sling Length

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





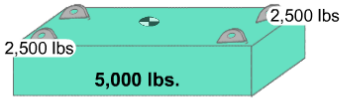
60° angle Factor of **1.155**
1.155 x 2,500 lbs. = 2,888 lbs. Stress
Minimum capacity sling and rigging gear require 2,888 lbs.

60° Minimum Capacity

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!

30° Minimum Capacity

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



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

Unequal Distance

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

Knowledge Check

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

a) True
b) False

2. Select the best answer. An object has a length of 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 degrees or greater?

a) 3 feet
b) 6 feet
c) 5 feet
d) 4 feet

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

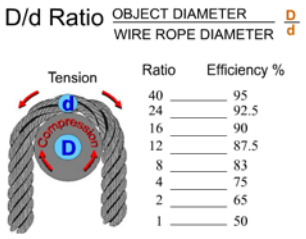
a) Multiply the weight in the attachment point times the height of the lift triangle
b) Multiply the weight of the item times rated capacity of the gear
c) Multiply the weight in the attachment point times the angle factor
d) Multiply the weight of the item times the distance between attachment points

NOTES

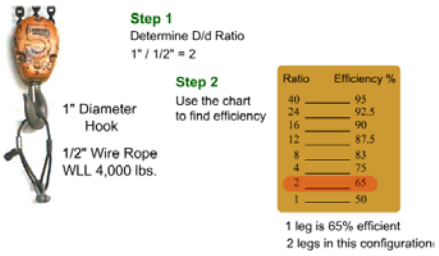
D/d RATIO

Welcome
Welcome to the D to d Ratio module.

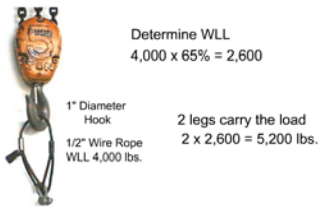
Objectives
Upon successful completion of this module you will be able to explain the concept of "D" to "d" ratio, determine a sling's D/d ratio in a given application, determine sling efficiency, and determine the sling's rated load.

D/D Ratio


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

D/d Efficiency


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



D/d Using Efficiency
Now that we know the efficiency, let's figure out the maximum weight that could be lifted in this configuration. First, we must determine the rated load of each leg. We multiply the rated load by the efficiency; 4,000 times .65, or 65%, equals 2,600. 2,600 pounds is the rated load for one leg. When we double a sling over an object, we effectively create two legs. Since two legs are carrying the load, we multiply the rated load by 2. 2,600 times 2 equals 5,200. This is the rated load of the doubled sling. Whenever we bend a wire rope around an object, or double our wire rope slings, this D/d ratio must be calculated. For D/d ratios that fall between the values shown, use the lower efficiency.

D/d Calculations
The D/d principle also applies to slings bent around corners. In this case, the diameter of the curvature of the sling as it bends around the corner of the object to be lifted must be determined. For many applications, special fittings such as pipe sections are placed on the

corners of the object to ensure a large enough diameter of curvature for the sling so as not to reduce the sling efficiency too greatly.

NOTES

RIGGING GEAR MARKING AND RECORD REQUIREMENTS

Welcome
Welcome to the Rigging Gear Marking and Record Requirements module.

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

NAVFAC P-307 Section 14
Let's look at the section of NAVFAC P-307 that deals with rigging, Section 14. Section 14 provides 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.
These requirements also apply to covered equipment used with multi-purpose machines, material handling equipment (e.g., forklifts), and equipment covered by NAVFAC P-300.
Except for BOS contracts, these requirements do not apply to contractor owned equipment used with contractor owned cranes, forklifts, backhoes, excavators, and front-end loaders.

Test and Inspection Program
NAVFAC P-307 requires each activity to establish a program that includes initial visual inspection and load test of 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.

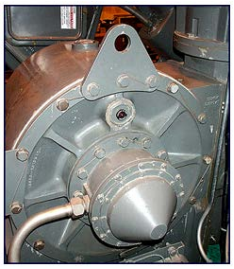
Why Test and Inspection?
Why do we need a test and inspection program? The primary goal is to prevent personnel injury! The test and inspection program is designed to identify sub-standard, defective, damaged, or worn equipment, and remove unsafe equipment from service.

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.

Additional Covered Equipment

Equipment covered also includes manually operated hoists as identified in ASME B30.16 and B30.21 which include chain hoists and lever operated hoists.
Equipment covered also includes miscellaneous equipment, including below the hook lifting devices as identified in ASME B30.20, such as spreader beams, plate clamps, magnet lifters, pallet lifters, tongs, container spreaders, personnel platforms, portable gantry/A-frames, and portable floor cranes used for general lifting, and cranes and hoists procured with, integral to, and used solely in support of larger machine systems.

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.
Where OEM provided specialized rigging equipment is used, the activity shall ensure that the equipment is in good condition and that personnel using the equipment know how it is to be used.

Knowledge Check

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

a) Prevent personnel injury
b) Identify sub-standard equipment
c) Remove unsafe equipment

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

a) Authorized for use
b) In an inspection program
c) Not damaged
d) New to the activity

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

a) OEM installed integral attachments
b) Cranes and hoists integral to larger machines
c) Container spreaders
d) Personnel platforms

Equipment Markings

Markings on each piece of equipment are the most apparent way for you, the user, to know the requirements of NAVFAC P-307 have been met. Each piece of equipment must be clearly marked, tagged or engraved with the rated load of the equipment, an indication of the re-inspection due date, and a unique serial number that will allow it to be traced to its test and inspection

documentation.
Below the hook lifting devices weighing more than 100 pounds shall be marked with the weight of the device.
Markings must be done in a manner that will not affect the strength of the component. Vibra-etch methods and low stress dot faced stamps are generally acceptable methods for marking equipment. Contact the OEM for guidance on where and how to mark equipment.

Roundslings

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.

Wire Rope Endless Slings

In non-specific use applications endless slings shall have a marked rated load based on a D/d efficiency of 50 percent and may be used over various size pins at loads not exceeding the marked rated load.
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.

Chain Slings

In accordance with CFR 29 1915.112 and 29 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.
Chain slings not used in ship repair, shipbreaking, or cargo transfer require a 2-year periodic inspection frequency.

Lashing

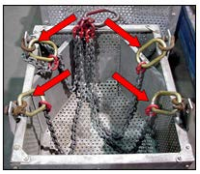
Lashing must be marked to identify it to the spool or reel from which it came. The rated load must be marked on each piece as well as the re-inspection due date.

Multiple Part Equipment

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.

Multi-leg Slings

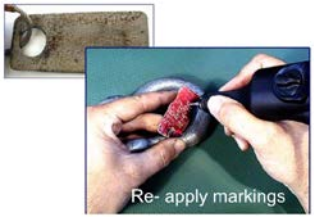
Multi-leg slings assemblies shall be marked with the rated load of each leg, the rated load of the entire assembly, and the sling angle upon which the rated load is based.



Multi-Part Wire Rope Slings

NAVFAC P-307 requires that multi-part slings (sometimes referred to as braided slings) shall have the OEM's marking re-marked at 70% of the OEM's rated load unless destructive tests are conducted on sample slings. The documentation is reviewed by the Navy Crane Center.

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

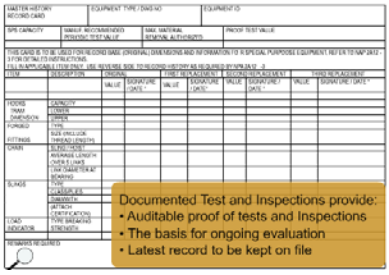


Illegible/Missing Markings

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

Required Records

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



Record Information

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

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

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

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

Matching Gear to Record

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

Gear Marking Example

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

Knowledge Check

1. Select all that apply. Markings on lashing must identify:

a) The spool or reel
b) The re-inspection due date
c) Size
d) Rated load
e) Serial number

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

a) Identification of individual components
b) Dates of tests and inspections
c) Latest test inspection results
d) All of the data listed above

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

a) Chain slings with permanent attachments
b) Rope or chain-sling bridle assemblies
c) Components that can be separated
d) All rigging equipment
e) End fittings on slings

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

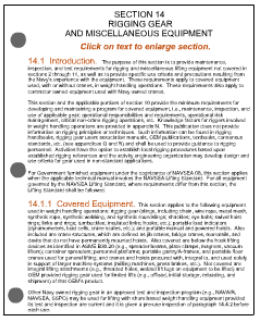
a) For 1 year
b) Until replaced by a more current record
c) For 6 months
d) For 3 years

NOTES

RIGGING GEAR GENERAL USE

Welcome
Welcome to the Rigging Gear General Use module.

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


SECTION 14
RIGGING GEAR
AND MISCELLANEOUS EQUIPMENT
Click on text to enlarge section.
14.1 Introduction.
14.1.1 Covered Equipment.

NAVFAC P-307 Section 14
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 shop made equipment unless it has been approved by engineering and certified for use in weight handling operations!

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

Selecting Rigging Gear (continued)

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

Rigging Gear Hazards

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

Hazards (continued)

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

Hazards – Sharp Edges

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

Hazards – Electrical

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

Protective Materials

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.

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

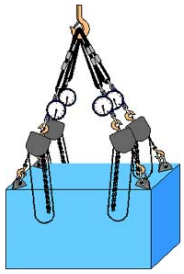
Portable floor cranes, portable a-frames, portable gantries, and cranes integral to larger machine systems must be operated in accordance with applicable ASME B30 criteria and OEM recommendations. Chain Hoists and portable hoists must be operated in accordance with ASME B30.16 and OEM recommendations. 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.

Hoists and Crane Usage

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

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.



Usage Do's

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

Usage Don'ts

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

Below the Hook Lifting Devices

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

Knowledge Check

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

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

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

a) True
b) False

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

a) Never use damaged gear
b) Consider height restrictions when selecting sling lengths
c) Never use gear past its inspection due date
d) Base rigging gear on the total stress, not just the weight of the load
e) Follow all of the above

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

a) Chafing gear
b) Your hand
c) Metal spacers

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

a) True
b) False

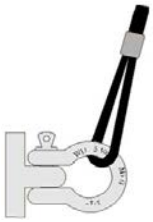
NOTES

RIGGING HARDWARE

Welcome
Welcome to the Rigging Hardware module.

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

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

Side Loading Shackles


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

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.

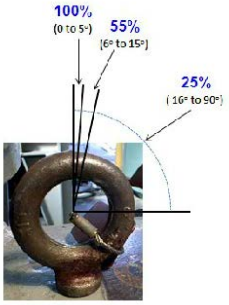
Non-shouldered Eyebolts


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 Eyebolts

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.

The rated load of the eyebolt shall be reduced in accordance with table 14-5 of NAVFAC P-307 or OEM recommendations.



Installing Shouldered Eyebolts

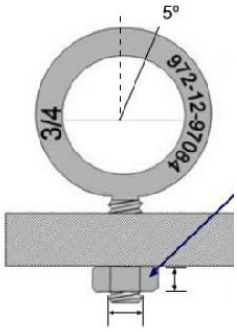
When loading shouldered eyebolts at an angle in the plane of the eye, the eyebolts must be installed with the shoulder seated flush against the mounting surface.

Engaging Hole

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

Minimum Thread Engagement

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



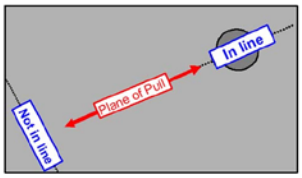
Backing Nuts

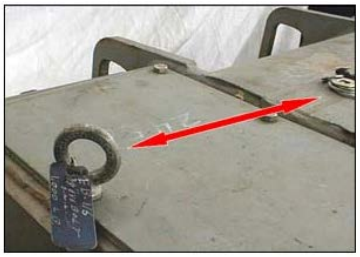
When eyebolts are used with backing nuts, the backing nut must be at least SAE J995 grade 5 and fully engaged with at least 1 full thread exposed.

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

Eye Alignment

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

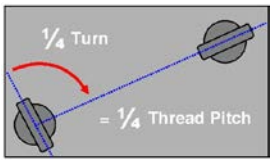




Shim Use Overview

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

Determining 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 Usage

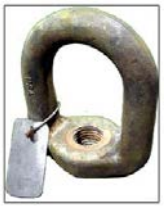
This is an example of shims being used incorrectly. Do you see the problem with this eyebolt installation? The total shim thickness is more than the thread pitch.

Side Pulls

Side pulls on eyebolts are very dangerous and may cause the eyebolt to fail. Side pulls result from loading outside the plane of the eye. Never install a sling though two separate eyebolts; the result will be side pulls on both eyebolts and damage to the sling.

Eye-nuts

Eyenuts must be used in accordance with OEM instructions. They must have full thread engagement. This means the shank or stud they are attached to must be long enough to allow complete engagement of the eyenut. Eyenuts must be used for vertical applications only.



Swivel Hoist Rings

Angular pulls do not reduce the rated load of a swivel hoist ring. When using swivel hoist rings, they must be installed with the shoulder flush with the mounting surface.
The minimum thread engagement shall be 1 and ½ times the diameter of the bolt for steel (or threads fully engaged for swivel hoist rings with thread projections less than 1 and ½ times the diameter of the bolt).
They must be tightened with a calibrated torque wrench in accordance with OEM requirements. Check the OEM instructions prior to installing any shims. Most manufacturers do not allow the use of shims with swivel hoist rings.

Swivel Hoist Rings (continued)

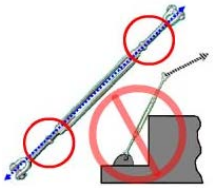
Swivel hoist rings must be used in accordance with OEM specifications. They must be tightened to the OEM specified torque – and the torque is normally marked on the hoist ring. Before using backing nuts on hoist rings, check the OEM specification to see if it is allowed.

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.

Turnbuckles (continued)

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



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

a) True
b) False

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

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

3. True or False. An angular pull of 45^{o} is allowed on non-shoulder type eyebolts.
a) True
b) False

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

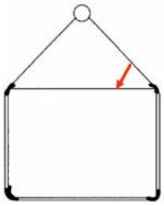
NOTES

SLING USE

Welcome
Welcome to the Sling Use Module.

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

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



Wire Rope Sling Use (Continued)
For loads with a non-circular cross section the bend diameter is derived from the minimum bend diameter of the wire rope around the corner of the load. For slings bent around corners, the corners must be rounded to provide the minimum D/d efficiency. Chafing protection is used to protect the load and sling from damage.

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

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

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.

When a chain sling is used in a choker hitch, the capacity shall be reduced to reflect the efficiency percentages shown in table 14-4 of NAVFAC P-307.

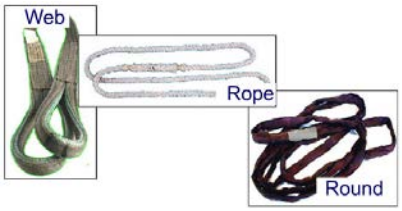
Chain Sling Temperature Restrictions

For use in temperatures below minus 40 (-40) or above 400 degrees Fahrenheit (F), follow OEM recommendations for rated load reduction.

Metal Mesh Sling Temperature Restrictions

Metal mesh slings are often used in abrasive or high temperature environments that would damage slings. Do not use bare metal mesh slings when temperatures are below -20° or above 550° Fahrenheit. Do not use elastomer coated slings when temperatures are below 0° or above 200° Fahrenheit. Always follow OEM recommendations.

Types of Synthetic Slings



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

Use

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.
Always follow OEM requirements when using synthetic slings.

Web Sling Use

Synthetic webbing slings shall be used in accordance with OEM recommendations.
Where a synthetic webbing sling is used in a choker hitch, the total capacity shall be reduced to reflect the efficiency percentages shown in table 14-4 of NAVFAC P-307.
Web slings must be installed flat around the load without kinks or twists. Kinks and twists reduce friction on the load and can cause the sling to roll or slide out of position. These slings are not affected by D-to-d ratio. Eye length in relation to the diameter of the hook is critical. The eyes of webbing slings are stitched and the stitching can be damaged if the eye is spread excessively.

Web Slings and Shackles

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 194° Fahrenheit or OEM recommendations, whichever is more restrictive.

Synthetic Rope Use

Stranded synthetic rope slings shall not be used in a single part vertical hitch, unless a method is used to prevent unlaying of the rope.
When making single point lifts with eye to eye synthetic rope slings, use two slings or double up a single sling. If they are allowed to spin, the splice could come undone and drop the load! The minimum D-to-d ratio is 1 to 1. This means a one half-inch diameter synthetic rope sling cannot bent around any object that is smaller than one half-inch.

Synthetic Rope Sling Temperature Restrictions

Nylon or polyester slings shall not be exposed to temperatures above 194° Fahrenheit (140 degrees Fahrenheit for polypropylene slings) or OEM recommendations, whichever is more restrictive.

Round Sling Use

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

For new roundslings, a certificate of proof test shall be retained in the history file for the life of the sling.
Roundslings constructed of yarns other than nylon or polyester shall be used only with the following additional restrictions: (1) The certificate of proof test shall include the diameter of pin used during actual proof test. (2) Alternate yarn roundslings shall not be used over a hook, pin, or shackle that is smaller than the diameter of the pin used during the sling proof test.

Round Sling Temperature Restrictions

Follow OEM recommendations when using roundslings in extreme temperatures.

Sling Use Considerations

Slings must not be used at angles less than 30° from horizontal unless specifically authorized by an engineering work document. Never use a sling that has been knotted. 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 and Hook Considerations

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

8 inches, this can stress the eye and can cause the swage or stitches to fail. Never place the eye of a wire rope sling around an object which has a diameter greater than 1/2 the length of the eye. Never place the eye of a synthetic web or rope sling around an object which has a diameter greater than 1/3 the length of the eye. If the hook diameter is too large, a shackle can be used to connect the slings to the hook, thereby reducing the diameter over which the sling eyes are placed.

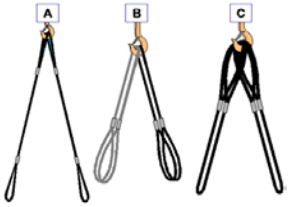
Attaching Gear to Hooks

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

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

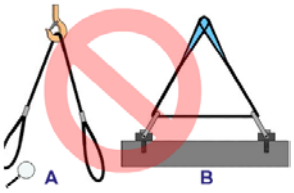
Correct use

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



Incorrect Use of Slings on Hooks

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

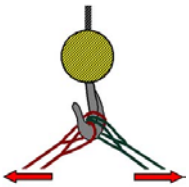


Included Angle

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

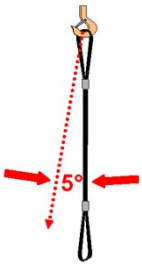
Inside and Outside Slings

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.



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.

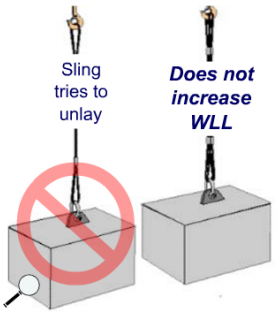


Vertical Load

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.

Vertical Hitch and 2 Legs

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.

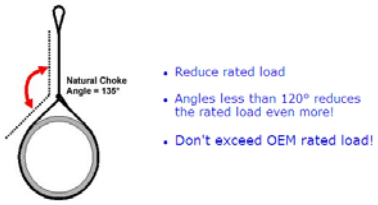


Choker Hitches

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 the sling from rotating the pin of the shackle as it passes over it. Never set the choker so the running part of the sling passes against the shackle pin.

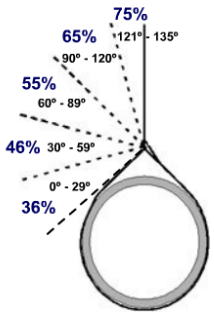
Choker Loads

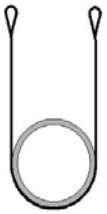
Whenever a chokier hitch is used, the sling's rated load is reduced. The natural choke angle is 135 degrees - if a choker hitch is allowed to tighten itself as the load is lifted. When choke angles are less than 120 degrees, the rated load must be reduced further.



Choker Hitch Efficiency

This chart shows the efficiency of the sling's capacity when choking with a wire rope or synthetic rope sling. Refer to NAVFAC P-307 Table 14-4 for choker efficiencies of other slings. For angles 121° to 135° the rated load is reduced to 75% of the vertical capacity (80% for synthetic web and round slings). This does not apply to braided multi-part wire rope slings.





Basket Hitches

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

Knowledge Check

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

a) 1:1
b) 2:1
c) 3:1
d) 4:1

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

a) True
b) False

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

a) True
b) False

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

a) 1:1
b) 2:1
c) 3:1
d) 4:1

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

a) 75%
b) 100%
c) 150%
d) 200%

NOTES

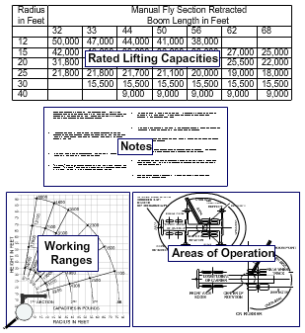
LOAD CHARTS MODULE 1

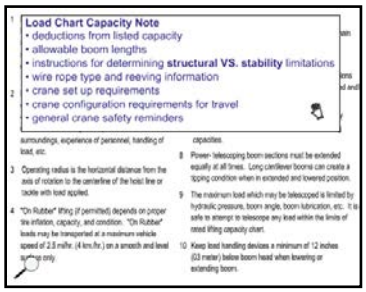
Welcome
Welcome to Load Charts Module 1.

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

Introduction to Load Charts
A good working knowledge of the OEM load chart is necessary to calculate safe lifting capacities. Generally, load charts list the maximum rated capacity of the crane for every permissible configuration, specify the crane's operational limitations, and set-up requirements for safe operation. Load charts also show configuration variables affecting the capacity of the crane at the time of the lift and identify factors influencing the crane's capacity, such as boom angle, boom length, load radius, deductions from gross capacity, configuration of the crane, and quadrants of operation.

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





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

Capacity Chart
The rated capacity chart is that part of the load chart that we reference to determine the crane's gross capacities. Gross capacities are listed for various boom lengths and load radii. The bold line, running between the listed capacities, separates capacities based on strength of materials where overload may cause structural failure and capacities based

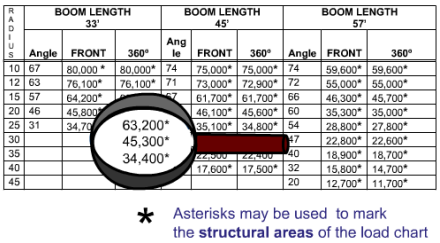
Radius in Feet	Manual Fly Section Retracted Boom Length in Feet								Manual Fly Extd. *92
	32	33	44	50	56	62	68	71	
12	50,000	47,000	44,000	41,000	38,000				
15	42,000	40,000	39,000	36,000	33,000	27,000	25,000		
20	31,800	31,400	31,000	29,500	28,000	25,500	22,000	20,000	12,000
25	21,800	21,800	21,700	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.

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.

Asterisks

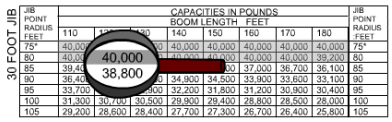
Some manufacturers use asterisks to mark the structural areas of the load chart.



RADIUS	BOOM LENGTH 33'			BOOM LENGTH 45'			BOOM LENGTH 57'		
	Angle	FRONT	360°	Angle	FRONT	360°	Angle	FRONT	360°
10	67	80,000 *	80,000*	74	75,000*	75,000*	74	59,600*	59,600*
12	63	76,100*	76,100*	71	73,000*	72,900*	72	55,000*	55,000*
15	57	64,200*		67	61,700*	61,700*	66	46,300*	45,700*
20	46	45,800*		60	46,100*	45,600*	60	35,300*	35,000*
25	31	34,70		52	35,100*	34,800*	54	28,800*	27,800*
30							47	22,800*	22,600*
35							40	18,900*	18,700*
40							32	15,800*	14,700*
45							20	12,700*	11,700*

63,200*
45,300*
34,400*

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

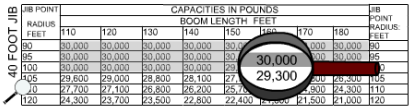


30 FOOT JIB

JIB POINT RADIUS FEET	CAPACITIES IN POUNDS BOOM LENGTH FEET 110	120	130	140	150	160	170	180	JIB POINT RADIUS FEET
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	40,000	39,200	80
85	39,4				00	37,000	36,700	36,100	85
90	36,40		00	34,900	34,500	33,900	33,600	33,100	90
95	33,700	33,400	00	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

40,000
38,800

Shaded areas indicate
structural or strength of materials lifting areas



40 FOOT JIB

JIB POINT RADIUS FEET	CAPACITIES IN POUNDS BOOM LENGTH FEET 110	120	130	140	150	160	170	180	JIB POINT RADIUS FEET
90	30,000	30,000	30,000	30,000	30,0		00	30,000	90
95	30,000	30,000	30,000	30,000	30		00	30,000	95
100	30,000	30,000	30,000	30,000	29				0
105	29,600	29,000	28,800	28,100	27,		00	26,300	105
10	27,700	27,100	26,800	26,200	25,7		00	24,300	110
120	24,300	23,700	23,500	22,800	22,400		21,500	21,000	120

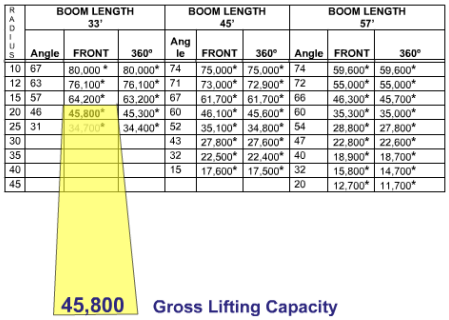
30,000
29,300

Shaded Areas

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

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.



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

45,800 Gross Lifting Capacity

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.

Deductions

The weight of attachments, such as swing away jibs, stowed or erected, and the weight of auxiliary boom heads and rooster sheaves, must be deducted from gross capacity. The weight of the hooks, blocks and overhaul ball are also deducted from the gross capacity. The crane may be equipped with standard or optional hook blocks having different weights.

Hook block weights and capacities should be stamped on each hook block. Be aware that some manufacturers require the weight of excess wire rope, not necessary for a lift, to be deducted.

Knowledge Check

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

a) Working Area Diagram
b) Range Diagram
c) Rated Lifting Capacities
d) Notes

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

a) Working Area Diagram
b) Rated Lifting Capacities
c) Notes
d) Range Diagram

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

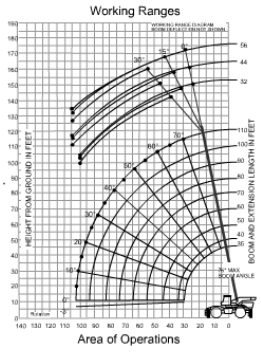
a) Rated Lifting Capacities
b) Range Diagram
c) Working Area Diagram
d) Notes

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

a) Reduced Capacities
b) Gross Capacities
c) Net Capacities
d) Safety Margins

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

a) Range Diagram
b) Rated Lifting Capacities
c) Working Area Diagram
d) Notes

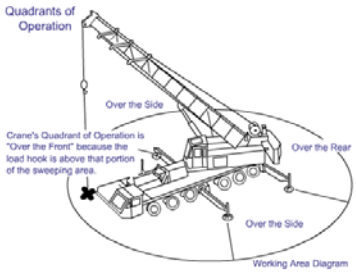


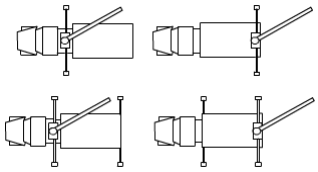
Range Diagram

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





Quadrants of Operations

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.

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.

Guessing

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

Structural Failure

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.

Knowledge Check

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

a) Notes
b) Range Diagram
c) Rated Lifting Capacities
d) Working Area Diagram

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

a) Working Area Diagram and Rated Lifting Capacities Chart
b) Rated Lifting Capacities Chart and Notes Pages
c) Range Diagram and Working Area Diagram
d) Notes Pages and Range Diagram

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

a) Notes
b) Working Area Diagram
c) Rated Lifting Capacities
d) Range Diagram

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

a) Range Diagram
b) Notes
c) Working Area Diagram
d) Rated Lifting Capacities

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

a) Notes
b) Rated Lifting Capacities
c) Range Diagram
d) Working Area Diagram

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

a) Damaged Wire Rope
b) Tipping (Loss of Stability)
c) Boom Failure
d) Overturning
e) All of the consequences listed above

NOTES

LOAD CHARTS MODULE 2

Welcome

Welcome to Load Charts Module 2.

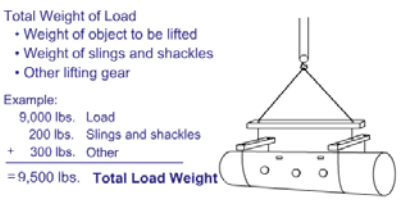
Objectives

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

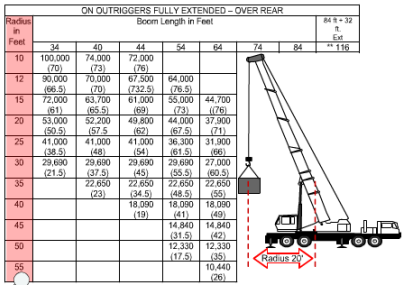
Pre-planning mobile crane lifts

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

Total Load Weight



Determining the total weight of the load begins with finding the weight of the object to be lifted. In this example lift, the object weight is 9,000 pounds. The total weight of the load includes the weight of the object to be lifted and the weight of the rigging gear. In the example the object weight is 9,000 pounds. 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.



ON OUTRIGGERS FULLY EXTENDED – OVER REAR

Radius in Feet	Boom Length in Feet							84 ft + 32 ft Ext ** 116
	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 (732.5)	64,000 (76.5)				
15	72,000 (61)	63,700 (65.5)	61,000 (69)	55,000 (73)	44,700 ((76)			
20	53,000 (50.5)	52,200 (57.5	49,800 (62)	44,000 (67.5)	37,900 (71)			
25	41,000 (38.5)	41,000 (48)	41,000 (54)	36,300 (61.5)	31,900 (66)			
30	29,600 (21.5)	29,600 (37.5)	29,600 (45)	29,600 (55.5)	27,000 (60.5)			
35		22,650 (23)	22,650 (34.5)	22,650 (48.5)	22,650 (55)			
40			18,090 (19)	18,090 (41)	18,090 (49)			
45				14,840 (31.5)	14,840 (42)			
50				12,330 (17.5)	12,330 (35)			
55					10,440 (26)			

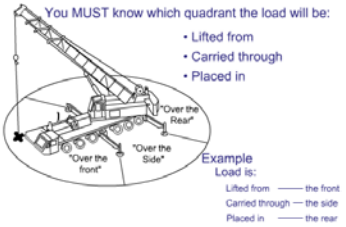
Load Radius

The load radius is the horizontal distance measured from the center of rotation of the crane center pin, to the center of the hook. Load radius can be established by centering the hook over the load and referring to the crane's radius indicator. For fixed boom lengths, radius can be calculated using boom angle and a load chart. On telescoping boom cranes, boom deflection can increase the radius. On critical lifts the radius should be measured. Monitor the radius throughout the lift.

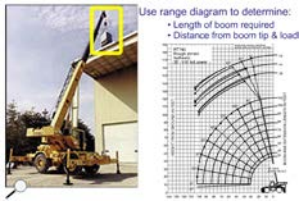
Measuring Radius

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.



Lift Height Considerations

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

Job Site Considerations

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

Crane Selection

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

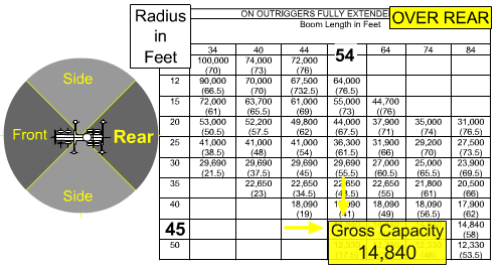
Requirements

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

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

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.



Radius in Feet	ON OUTRIGGERS FULLY EXTENDED Boom Length in Feet			OVER REAR			
	34	40	44	54	64	74	84
	100,000 (70)	74,000 (73)	72,000 (76)				
12	90,000 (66.5)	70,000 (70)	67,500 (732.5)	64,000 (76.5)			
15	72,000 (61)	63,700 (65.5)	61,000 (69)	55,000 (73)	44,700 (76)		
20	53,000 (50.5)	52,200 (57.5	49,800 (62)	44,000 (67.5)	37,900 (71)	35,000 (74)	31,000 (76.5)
25	41,000 (38.5)	41,000 (48)	41,000 (54)	36,300 (61.5)	31,900 (66)	29,200 (70)	27,500 (73.5)
30	29,690 (21.5)	29,690 (37.5)	29,690 (45)	29,690 (55.5)	27,000 (60.5)	25,000 (65.5)	23,900 (69.5)
35		22,650 (23)	22,650 (34.5)	22,650 (51.5)	22,650 (55)	21,800 (61)	20,500 (66)
40			18,090 (19)	18,090 (41)	18,090 (49)	18,090 (56.5)	17,900 (62)
45				Gross Capacity 14,840			14,840 (58)
50							12,330 (53.5)

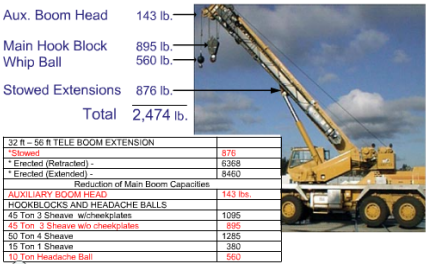
Gross Capacity

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*.

Over the side capacity

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

Radius in Feet	ON OUTRIGGERS FULLY EXTENDED Boom Length in Feet			OVER SIDE			
	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 (46.5)	20,280 (55)	20,280 (61)	20,280 (66)
40			15,950 (19)	15,950 (41)	15,950 (49)	15,950 (56.5)	15,950 (62)
45				Gross Capacity 12,840		12,840 (51.5)	12,840 (58)



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

Deductions

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

Calculations

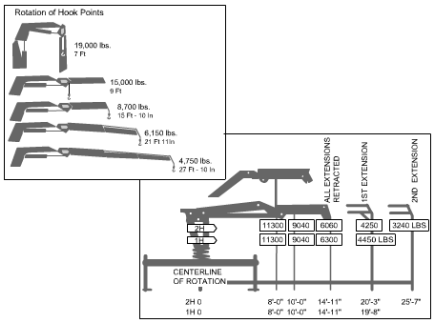
In this example you must determine net capacities for two working quadrants. Gross capacity over-the-rear is 14,840 pounds. Deductions add up to 2,474 pounds. Gross capacity less deductions results in a net capacity of 12,366 pounds over the rear. Gross capacity over-the-side is 12,840 pounds. Gross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

Final Checks

For this example, compare the net capacities with the total weight of the load. Over-the-rear net capacity at 45 foot radius is 12,366 pounds. Over-the-side net capacity at 45 foot is 10,366 pounds. The total weight of the lift is 9,500 pounds. Since the net capacity in both over-the-rear and over-the-side quadrants exceeds the total weight of the lift, you know this lift can be safely made. Since the over-the-side lift exceeds 90% of the cranes capacity at

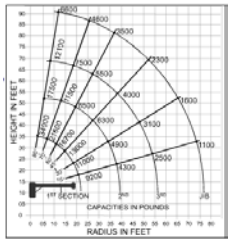
this radius, this lift requires the crane team to follow procedures for a complex lift. If practical, the operator might try shortening the radius by booming up and/or using a shorter boom before swinging over-the-side.

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, ensure that the load does not exceed the rated load of the wire rope.

Category 4 Capacity Chart



In this load chart for a telescoping boom Category 4 crane, the manufacturer placed the capacity values on the range diagram. Capacities are based on boom angle and boom section in use. When extending the boom, the listed capacity is reduced. For example, extending the boom beyond minimum length would require the operator to refer to the capacity listed for the next section.
This holds true for each additional section. When adjusting the boom angle, the operator must be aware of the changes in capacity. When working between boom angles the operator will always use the capacity listed for the next lower angle.

Knowledge Check

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

a) Radius
b) Distance
c) Speed

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

a) Industrial area
b) Quadrants
c) Route

3. Select the best answer. When pre-planning mobile crane lifts the crane operator must know the _____ conditions where the lift is to be made.
a) Weather
b) Site

4. Select the best answer. Which of the following is most critical to maintain crane capacity?
a) Hook radius
b) Hoisting speed
c) Boom tip height
d) Boom angle

5. Select the best answer. When setting up mobile cranes at the job site, which of the following job site conditions should be considered?
a) Ground conditions
b) Traffic
c) Proximity to power lines
d) Room to maneuver and set up crane
e) All of the conditions listed

6. Select the best answer. The range diagram can be used to determine the required boom length.
a) True
b) False

7. Select the best answer. The values listed in the manufacturer's capacity charts for most mobile cranes are _____.
a) Suggested guidelines
b) Maximum radii
c) Net capacities
d) Gross capacities

8. Select the best answer. Calculating _____ capacity requires subtracting the total of all deductions from crane capacity.
a) Deductions
b) Gross
c) Crane
d) Net
e) Boom

9. Select the best answer. The total weight of the load includes _____.
a) The load and all rigging gear
b) Only the load

NOTES

LOAD CHARTS MODULE 3

Welcome
Welcome to Load Charts Module 3.

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

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

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

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	80	150,000	69	90,000	76	83,000		
15	54	120,000	65	86,000	71	80,000	75	74,000
20	42	90,000	58	74,000	66	67,000	71	60,000
25	25	66,000						50,000
30								43,000
35								37,000

25 Ft. = Next longer radius

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	80							
15	54	45 Ft. = Next LOWER CAPACITY						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

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

Between Values for Two Variables

Sometimes you must determine gross capacity for values between those listed for both boom length and radius. For a 24-foot radius, choose the row for the 25 foot radius. For a 36-foot boom length, read down the column for the 45-foot boom length. Following this procedure, the gross capacity for both radius and boom length is 62,000 pounds.

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

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

Gross Capacity = 62,000 lbs.

Remember, when working between values shown on a capacity chart, **always choose the lower values listed on the load chart to determine safe capacity.**

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	105
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	17,979	84
80	41	14,270	14,270	74

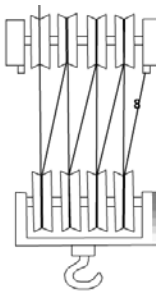
55° is between 56° and 49°
Next lower = 49°

Boom Angle between Values

When the boom angle falls between the values listed in the capacity chart refer to the boom angle with 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 lower capacity shown on the chart. In this example the correct reference boom angle is 49º.

Capacity Limiting Factors – Hook Block

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 the side of the 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.

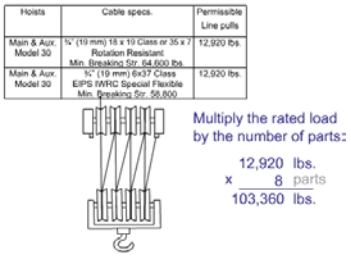
Wire Rope Capacity

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	¾" (19 mm) 18 x19 Class or 35x7 Rotation Resistant Min. Breaking Str. 64,600 lbs.	12,920 lbs.
Main & Aux. Model 30	¾" (19 mm) 6 x 37 Class EIPS IWRC Special Flexible Min. Breaking Str. 58,800	12,920 lbs.

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.



Knowledge Check

1. Select the best answer. The crane lifting capacity may be limited by the rated load of the hook and block installed on your crane.

a) True
b) False

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

a) For the maximum radius defined on the chart
b) For the next shorter radius chart listing
c) For the next longer radius chart listing

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

a) Highest value for the two listed values
b) Maximum value listed
c) Lower value listed

4. Select the best answer. Wire rope capacity is determined by multiplying the number of parts of line by the rated load of the wire rope.

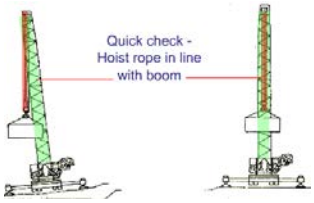
a) True
b) False

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

a) On the ODCL Checklist
b) On the Crane History Card
c) On the side of the block

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

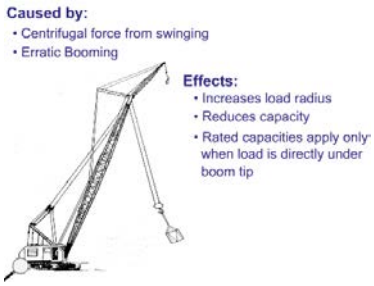
Capacities shown on the load chart for each crane are based on the crane being perfectly level. A crane that is three degrees out of level can reduce capacity by as much as 50%. A crane that is out of level can tip more easily. A quick way to check for level is to sight along the hoist rope. It should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

Outrigger Positions

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

Side-Loading

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



Load Swing

Load swing affects the capacity and sometimes the stability of cranes. Load swing can be caused by the centrifugal force from rotating a crane too fast. Load swing can also be caused from booming the crane up or down in an erratic manner. Load swing increases the effective radius resulting in reduced capacity and may cause the crane to tip. Load chart ratings apply only when 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 cannot control ground conditions but must compensate to ensure adequate support for the crane. When soft ground cannot be avoided use adequate blocking under all floats or pads and re-check the level of the crane frequently.

Wind

Follow OEM guidance for operating in windy conditions. Both the crane and load are affected by wind. Loss of control of the load and crane may result even though the weight of the load is within the normal capacity of the crane.

Knowledge Check

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

a) 2^{o}
b) 3^{o}
c) 5^{o}
d) 10^{o}
e) None

2. When making a lift, rapid starting and stopping could cause _____.

a) Side-loading
b) Traffic tickets
c) Lack of outrigger stability

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

a) Reduced capacity and possible overloading
b) More effective use of capacity charts
c) More effective load radius

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

a) Use blocking or cribbing under the outriggers
b) Reduce the capacity by 50%
c) Use bricks and cement blocks for stability
d) Do not make the lift

NOTES

LOAD CHARTS MODULE 4

Welcome

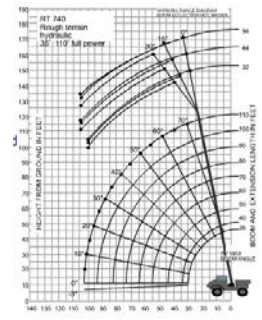
Welcome to Load Charts Module 4.

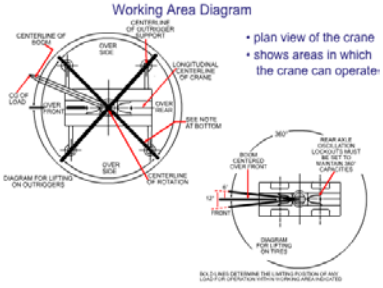
Objectives

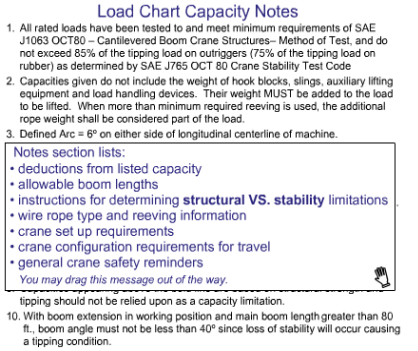
Upon successful completion of this module, you will be able to determine crane lifting capacities for more complicated lifting scenarios, use range diagrams for pre-planning critical or unusual lift situations, identify crane configuration options which may increase capacity and calculate percentage of lift capacity, based on the weight of the load and capacity of the crane.

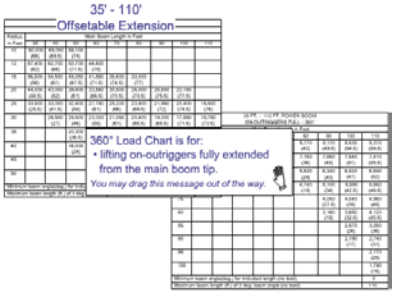
Load Chart Package

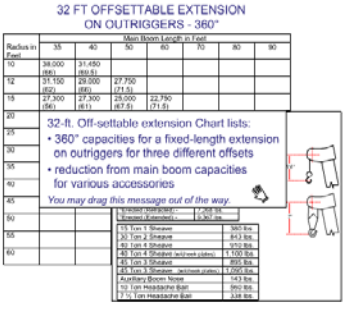
A load chart is a collection of diagrams, tables and notes showing operating quadrants, listing possible crane configurations, describing the lift configurations in which a crane can safely perform, and listing capacities associated with each quadrant and configuration. Parts of the load chart are used in various combinations, depending on crane configuration and lift complexity. This sample load chart package is for a Grove Rough Terrain crane.

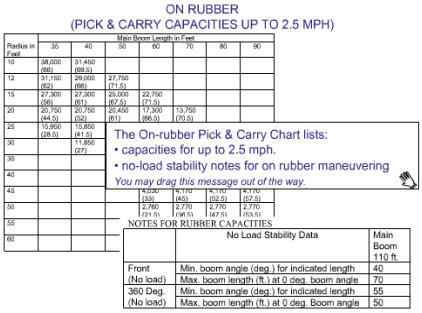


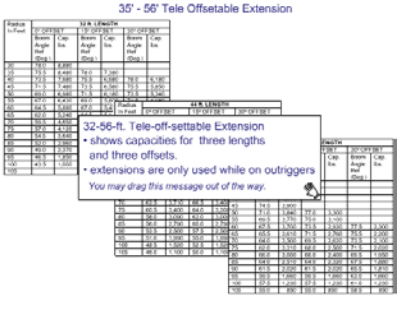


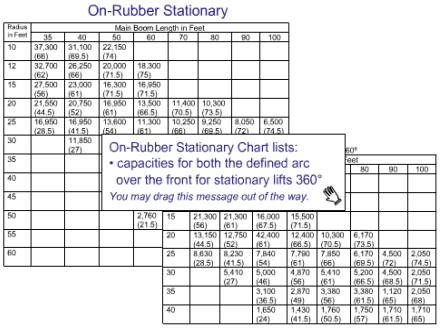










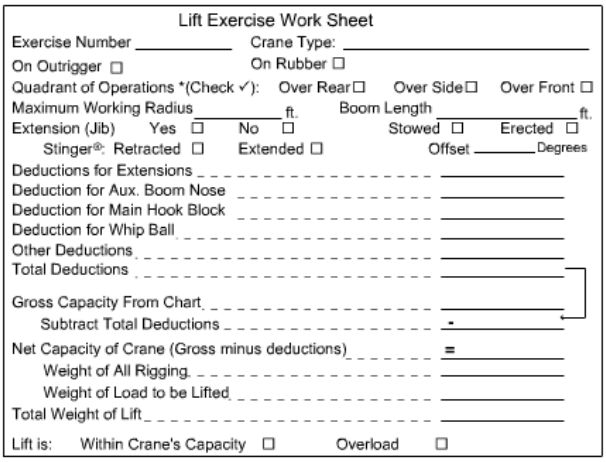


Worksheet Overview

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 ☐ 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 _____

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 _____

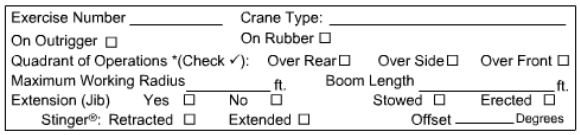
Total Weight of Lift _____

Lift is: Within Crane's Capacity ☐ Overload ☐

Top section of worksheet

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 ☐ On Rubber ☐

Quadrant of Operations *(Check ✓): Over Rear ☐ Over Side ☐ Over Front ☐

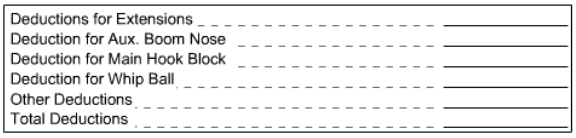
Maximum Working Radius _____ ft. Boom Length _____ ft.

Extension (Jib) Yes ☐ No ☐ Stowed ☐ Erected ☐

Stinger®: Retracted ☐ Extended ☐ Offset _____ Degrees

Middle section of worksheet

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 _____

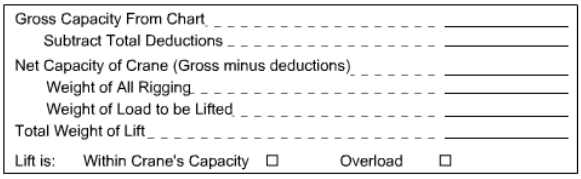
Other Deductions _____

Total Deductions _____

Bottom section of worksheet

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 ☐ Overload ☐

Process Overview

Can a lift be safely made? Ask and answer three questions.

What is the net lifting capacity of the crane?

Net Weight
- Net lifting capacity = gross capacity - all deductions
- Gross lifting capacity is listed on the crane's lifting capacity chart

What is the total load weight?

Total weight of the load
Total of:
- the weight of the load itself
- the weight of all rigging gear

Is the net lifting capacity of the crane greater than the total weight of the load?

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

Load Chart Exercise Overview

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
40Ton 4 Sheave (w/3 hook plates)	1,100 lbs.
45 Ton 3 Sheaves	895 lbs.
45 Ton 3 Sheaves (w/4 hook plates)	1,095 lbs.
Auxiliary Boom Nose	143 lbs.
10 Ton Headache Bait	560 lbs.
7 ½ 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.

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

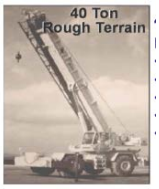
Deductions for Extensions	843
Deduction for Aux. Boom Nose	143
Deduction for Main Hook Block	0
D	0
C	0
T	986 lbs.
Gross Capacity From Chart	39,400
Subtract Total Deductions	- 986 lbs.
Net Capacity of Crane (Gross minus deductions)	= *38,414 lbs.*
Weight of All Rigging	90 lbs.
Weight of Load to be Lifted	3,700 lbs.
Total Weight of Lift	*3,790 lbs.*

Completed Load Chart Exercise Worksheet. Review the process until you understand where the data comes from.

Lift is: **Within Crane's Capacity** ☒ Overload ☐

EXERCISE LIFT 1

Crane Configuration



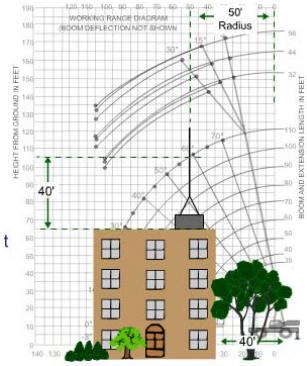
The crane for this lift is configured as follows. A 40 ton rough terrain (RT) crane equipped with: a 35' to 110' boom, a stowed 32' to 56' tele-offsettable boom extension, an auxiliary boom nose, a fully reeved 3-sheave main hook block and a 7.5 ton headache or overhaul ball. Assume the safe working load for the wire rope on each hoist is 10,000 pounds per part.

Lift and Load

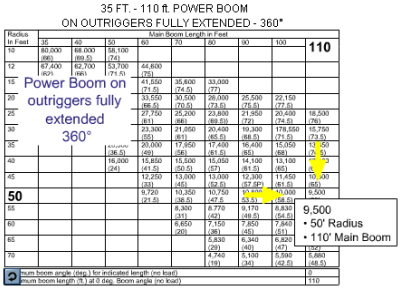
Lift: You are assigned to remove a large air conditioning unit from a 60 foot high building, 10 feet in from the edge and place it on a truck bed.

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

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.

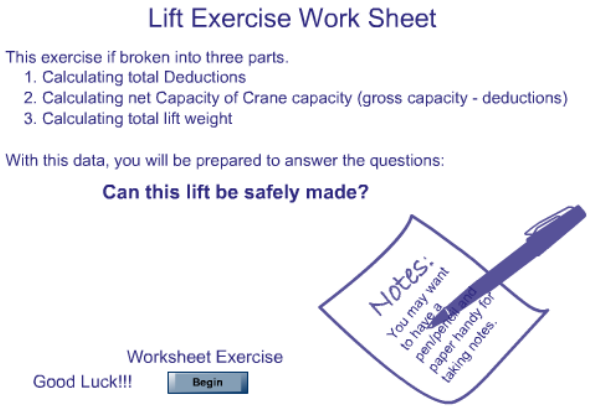


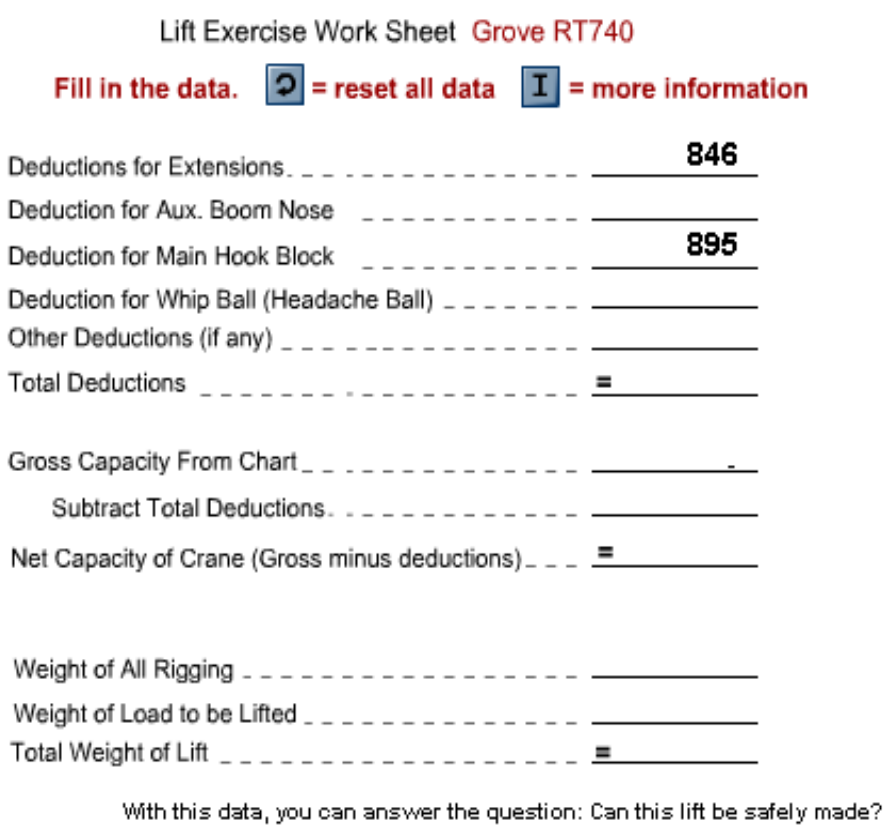
Capacity

What is the gross capacity for a fully extended boom at a 50 foot radius? It is 9,500 pounds.

Exercise Worksheet

This exercise gives you the opportunity to use the load and lift information to determine if this lift can be safely made.





Exercise Lift 1 Status
Can this lift be made safely?

Is the lift within the capacity of the crane?

Exercise Lift 1 Radius Change
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								
	35	40	50	60	70	80	90	100	110
10	80,000 (66)	68,000 (69.5)	58,100 (74)						
12	67,400 (62)	62,700 (66)	53,700 (71.5)	44,600 (75)					
15	56,500 (56)	54,500 (61)	48,050 (67.5)	41,550 (71.5)	35,600 (74.5)	33,000 (77)			
20				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 (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 (35.5)	20,000 (49)	17,950 (56)	17,400 (61.5)	16,400 (65)	15,050 (68)	13,650 (70.5)
40			16,000 (24)	15,850 (41.5)	15,500 (50.5)	15,050 (57)	14,100 (61.5)	13,100 (65)	12,000 (6
45				12,250 (33)	13,000 (45)	13,000 (52.5)	12,300 (57.5)	11,450 (61.5)	10,500
50				9,720 (21.5)	10,350 (36.5)	10,750 (47.5)	10,800 (53.5)	10,000 (58.5)	9,1
55					8,300 (31)	8,770 (42)	9,170	8,830	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)	
	mum boom angle (deg.) for indicated length (no load)								0
	mum boom length (ft.) at 0 deg. Boom angle (no load)								110

8,370
• 55' Radius
• 110' Main Boom

For a 55-foot radius, the gross capacity is 8,370 pounds.

Exercise Lift 1 Radius Change - 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	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?

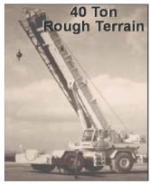
Can this lift still be made safely?

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. 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.



EXERCISE LIFT 2

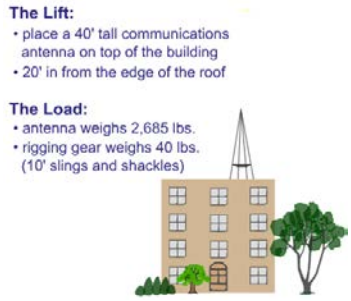
Crane Configuration

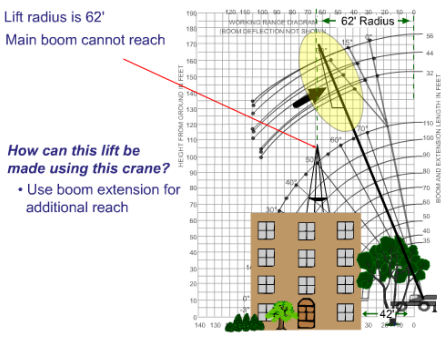
The crane configuration for this lift is a 40 ton rough terrain (RT) crane equipped with a 35' to 110' boom, a 32' to 56' tele-offsettable boom extension, an auxiliary boom nose, a fully reeved 45-ton, 3-sheave main hook block, and a 7.5-ton headache or overhaul ball. Assume the rated load for the wire rope on each hoist is 10,000 lbs. per part.

Lift and Load

Lift: Place a 40 foot tall communications antenna on top of an apartment complex 20 feet in from the edge of the roof.

Load: The communications antenna weighs 2,685 pounds. The rigging gear, 10 foot slings and shackles, weigh 40 pounds.



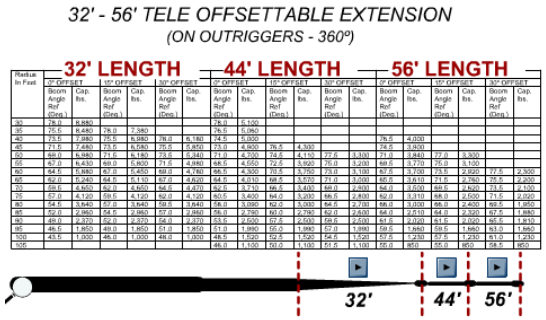


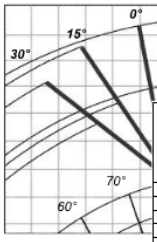
Considerations

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. 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?

Capacity

The tele-offsettable Extension capacity chart is used to find the gross capacity for this lift. Notice that this capacity chart shows three different extension lengths. 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.





Radius In Feet	32 ft. LENGTH					
	0° OFFSET		15° OFFSET		30° OFFSET	
	Boom Angle Ref (Deg.)	Cap. lbs.	Boom Angle Ref (Deg.)	Cap. lbs.	Boom Angle Ref (Deg.)	Cap. lbs.
30	78.0	8,500				
35	75.5	8,100	78.0	7,000		
40	73.5	7,600	75.5	6,600	78.0	5,800
45	71.5	7,100	73.5	6,200	76.0	5,470
50	69.0	6,700	71.5	5,800	73.5	4,960
55	67.0	6,250	69.0	5,420	71.5	4,600
60	64.5	5,700	67.0	5,070	69.0	4,240
65	62.5	4,860	64.5	5,110	67.0	4,620
70	59.5					
75	57.0					
80	54.5	3,260	57.0	3,260	59.5	2,580
85	52.0	2,580	54.5	2,960	57.0	2,960
90	49.0	1,990	52.0	2,580	54.0	1,990
95	46.5	1,470	49.0	1,470	51.0	1,470
100	43.5	1,000	46.0	1,000	48.0	1,000
105						

Gross Capacity = 4,860 lbs.

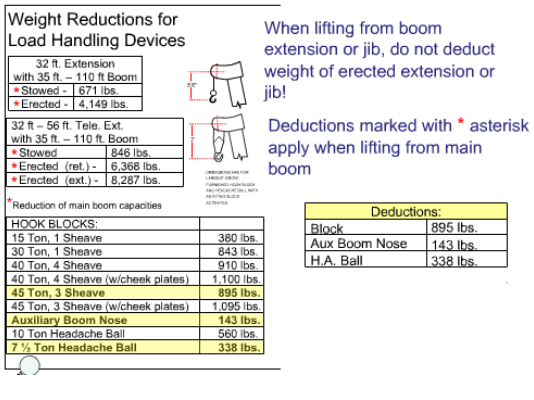
Offset

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 to 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.

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.



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 if 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!!! Begin

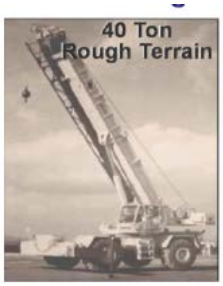
Lift Exercise Work Sheet Grove 740 RT

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.

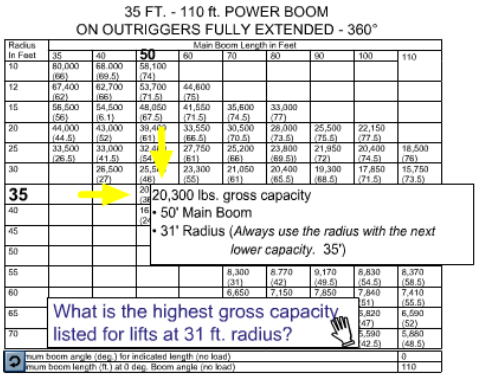
Lift and Load

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.

Can this lift be safely made?

Follow through the steps to answer this question.

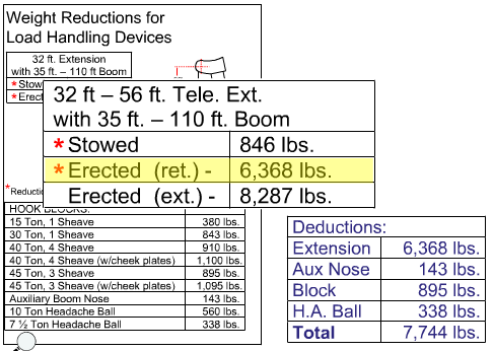


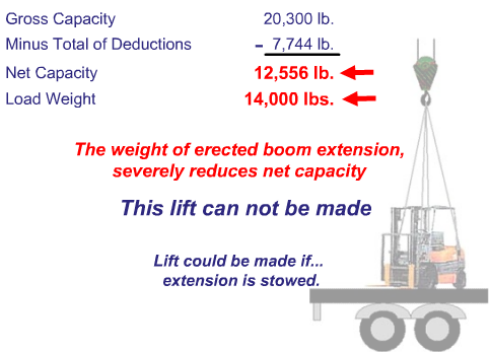
Gross Capacity

Refer to the load chart. What is the highest gross capacity listed for a lift at 31-foot radius? Using a 50-foot boom at 35-foot radius, the gross capacity is 20,300 pounds.

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. Add the deductions for the auxiliary boom nose, main hook block, and headache ball. Deductions total 7,744 pounds.



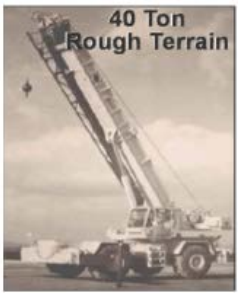


Worksheet

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.

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.

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.

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			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,[illegible]50 ([illegible]4)	13,400 (61)	11,000 (66)	11,000 (69.5)	10,150 (72)
30		11,850 (27)	11,[illegible]00 (46)	10,600 (55)	9,300 (61)	9,300 (66.5)	9,300 (68.5)
35			8,220	7,910	8,200 [illegible]6)	8,200 (61.5)	8,200 (65)
40					[illegible]980 [illegible]0.5)	5,980 (57)	5,980 (61.5)
45					4,170 [illegible]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)
					1,290 (20)	1,290 (36)	1,290 (45)

New radius?
New gross?

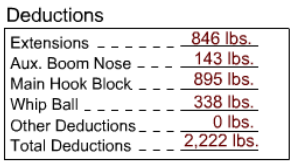
8,220
• 35' Radius
• 50" Main Boom

Gross Capacity

Use the chart ON RUBBER - PICK AND CARRY. 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.

Deductions

Deductions are found in the load chart package and include: an 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.



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.

Knowledge Check

Reference

The following questions require the use of the Grove RT-740 Rough Terrain Crane load chart package. Please obtain this package before answering the questions.
Use the course Reference button and follow the links to the load chart package. It is a PDF document and once opened can be printed.

1. Select the best answer.
   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 RT740. The working radius will be 68 feet with a 95 foot boom.

   Use the Grove RT-740 Rough Terrain Load Chart to answer the following question.

   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. Select the best answer.
   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 RT740. The working radius will be 68 feet with a 95 foot boom.
   Use the Grove RT-740 Rough Terrain Load Chart to answer the following question.

   Which length on the load chart would you choose to determine capacity?
   a) 100 feet
   b) 85 feet
   c) 95 feet
   d) 90 feet

3. Select the best answer.
   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 RT740. The working radius will be 68 feet with a 95 foot boom.
   Use the Grove RT-740 Rough Terrain Load Chart to answer the following question.

   The gross capacity at 68 foot radius with 95 feet of boom is _____.
   a) 3,551 lbs.
   b) 5,590 lbs.
   c) 4,740 lbs.
   d) 5,100 lbs.

4. Select the best answer.
   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 RT740. The working radius will be 68 feet with a 95 foot boom.
   Use the Grove RT-740 Rough Terrain Load Chart to answer the following question.

   Total deductions for the crane as equipped are: _____.
   a) 1,549 lbs.
   b) 1,041 lbs.
   c) 560 lbs.
   d) 1,406 lbs.

5. Select the best answer.
   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 RT740. The working radius will be 68 feet with a 95 foot boom.
   Use the Grove RT-740 Rough Terrain Load Chart to answer the following question.

   The net capacity of this crane is _____.
   a) 4,041 lbs.
   b) 2,878 lbs.
   c) 4,740 lbs.
   d) 3,551 lbs.

6. Select the best answer.
   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 RT740. The working radius will be 68 feet with a 95 foot boom.
   Use the Grove RT-740 Rough Terrain Load Chart to answer the following question.

   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.

7. Select the best answer.
   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 RT740. The working radius will be 68 feet with a 95 foot boom.
   Use the Grove RT-740 Rough Terrain Load Chart to answer the following question.

   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. Select the best answer.
   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 RT740. The working radius will be 68 feet with a 95 foot boom.
   Use the Grove RT-740 Rough Terrain Load Chart to answer the following question.

   The gross capacity of the crane is 5,100 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

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.

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 Capacites 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

(Use the 638E2 Capacites 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 Capacites 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 Capacites 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

CRANE COMMUNICATIONS

Welcome
Welcome to Crane Communications.

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

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.
When making lifts where hand signals are not feasible (such as when the operator cannot see the signal person), the rigger giving the signals shall remain in constant voice communication with the operator. The operator shall stop the crane at any time and in any situation judged to be unsafe or when communication is lost or unclear. If communication is lost, the operator shall stop operation until communication is reestablished.
Radio communications are well suited for blind and complex lifts. As a general rule, direct voice should only be used when the operator and rigger are working in close proximity and ambient noise is not a factor.

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

Hand Signal Rules
Signalers must remain in clear view of the crane operator. If the crane operator can't see you, another method of communication must be used. Only one signaler communicates with the crane operator at a time.

Radio

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

Knowledge Check

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

a) The 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) No other form of communication is available and ambient noise is high
d) The rigger has not learned hand signals

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

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

3. Select the best answer. For multiple crane lifts, _____ will communicate with the crane operators.

a) No signalers unless directed by the rigger-in-charge
b) One signaler for each crane involved
c) Up to three signalers
d) One signaler at a time

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

a) Signal flags
b) Spoken word
c) Hand signals
d) Direct voice commands

5. Select the best answer. Any additional hand signals must be …
a) Approved by OSHA
b) Approved by the activity
c) Approved by NOSH
d) Approved by the ASME

6. Select the best answer. Another form of communication, other than hand signals, must be used if ….
a) The signaler is in clear view of the rigger-in-charge
b) The signaler is not in clear view of the crane operator
c) Activities designate alternative methods
d) Ambient noise is greater than the lack of visibility

Hook and Trolley Signals

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

Auxiliary Hoist or Whip Line

When calling for the whip line or auxiliary hoist:
The elbow is tapped with the opposite hand and 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 Hook and Trolleys

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

- One finger up for the number “1” hook or trolley
- Two fingers up for the number “2” hook or trolley
- Each followed with standard signals to indicate the desired motion

Hoist Signals

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

Hoist

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

Lower

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

Move Slowly

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

Boom Signals

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

Raise Boom

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

Lower Boom

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

Raise Boom / Lower Load

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

Lower Boom/ Raise Load

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

Extend Boom

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

Extend Boom One Handed

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

Retract Boom

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

Retract Boom One Handed

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

Directional Signals

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

Travel

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

Trolley Travel

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

Swing

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

Stop Signals

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

Stop

The stop signal is: an extended arm, palm down and 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.

Magnet Signals Overview

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

Magnet Disconnected

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

Knowledge Check

1. Select the best answer. This signal indicates:
a) Auxiliary hoist
b) Travel
c) Raise hoist
d) Main hoist

2. Select the best answer. When the signalers fingers are flexing in and out, this signal indicates:
a) Stop activities
b) Lower the boom
c) Raise the load – lower the boom
d) Lower the hoist

3. Select the best answer. This signal indicates to:
a) Forward
b) Stop
c) Raise the load
d) Extend the boom

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

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

5. Select the best answer. This signal indicates:

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

6. Select the best answer. This signal indicates:

a) Swing
b) Magnet disconnected
c) Emergency stop
d) Stop

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

a) Magnet disconnected
b) Emergency stop

8. Select the best answer. This signal indicates:

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

NOTES

CRANE TEAM CONCEPT

Welcome
Welcome to Crane Team Concept.

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

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

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.

Knowledge Check

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

a) Injury to personnel
b) Damage to property
c) Damage to equipment
d) All of the above

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

a) The Crane Operator, Crane Supervisor, and Crane Rigger
b) The Crane Operator, Rigger Supervisor, and Crane Rigger
c) The Crane Operator and Rigger-in-Charge
d) The Crane Operator, Crane Walker, and Crane Rigger

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

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

Shared Responsibilities

While each member of the crane team has individual responsibilities, all team members share some common responsibility, including participation in pre-job briefings, watching for potential problems and making other team members aware of them. All team members are responsible for keeping non-essential personnel away from the crane's operating envelope during lifting evolutions.

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.

Communications

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

Safety

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

Crane Operator Responsibilities

The crane operator must ensure that his or her license is not expired, and that the certification of the crane is not expired prior to operation. These are the two expiration dates that are of particular importance to crane operators.
The crane operator is responsible for performing the pre-use check of the crane and the operators main concern during crane operation is operating safely.
The crane operator must have a full understanding of each lift prior to execution and moves only when directed by the signal person.

Pre-Use Check

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

Full Understanding

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

Stop for Safety

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

Knowledge Check

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

a) Support the Goal of safe crane operation
b) Attend the pre-lift briefing. Any new members who replace another team member must be briefed as well.
c) Keep the Rigger-in-Charge well informed of conditions affecting personnel or the equipment during lifts.
d) Keep non-essential personnel out of the operating area
e) Stop operations whenever safety is in question
f) Perform all of the listed actions above

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

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

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

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

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

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

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

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

Rigger-in-Charge Responsibilities

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.

Lift Planning

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 Responsibilities

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.

Assisting with the ODCL

The crane rigger assists the operator in performing the pre-use check of the crane and work area.

Selecting and Inspecting Rigging Gear

The crane rigger selects and inspects crane rigging gear, and establishes proper attachment points as directed by the rigger-in-charge.

Communicating

A crane rigger keeps the rigger-in-charge informed of questionable or unsafe conditions and changes that may affect the operation.

Crane Walker Responsibilities

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

Pre-Use Check

A crane walker assists the crane rigger and crane operator in performing the pre-use check of the crane.

Safe Travel

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.

Communicating Stop

Crane walkers stay near the emergency stop button to communicate the stop signals to the crane operator.

Supervisor Responsibilities

The supervisor is familiar with NAVFAC P-307 and supports the crane team concept.

Site Conditions

The supervisor reviews onsite conditions for all complex lifts.

Power Lines

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

Complex Lifts

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 (except for lifts using pillar, pillar jib, fixed overhead hoists, or monorail cranes) or 50% for mobile cranes mounted on barges.
A supervisor shall also supervise multiple hook lifts when the weight exceeds 80% capacity of any hoist, and lifts of ordnance involving the use of tilt fixtures.

Accidents

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

Knowledge Check

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

a) Supervisor
b) Crane rigger
c) Crane operator
d) Rigger-in-Charge

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

a) Crane rigger
b) Rigger-in-Charge
c) Crane operator
d) Crane supervisor

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

a) Crane supervisor
b) Activities
c) Crane operator
d) Crane rigger
e) Rigger-in-Charge

NOTES

SAFE OPERATIONS MODULE 1

Welcome
Welcome to Safe Operations.

Objectives
Upon successful completion of this module you will be able to explain operator responsibilities, describe proper methods to lift and land loads, identify safe operating procedures, and state securing procedures for cranes.

Understanding the Crane
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.
When performing the operational check portion of the ODCL in cold weather or icy conditions, the operator should raise the blocks and boom before lowering them to avoid damage when sheaves may be frozen.
Operators should inform rigging personnel to stand clear of the area below the blocks and boom prior to operation.
The operator should hoist up slowly, in small increments, to break any ice and/or snow free, and monitor the sheaves to ensure proper movement and operation of the sheaves and wire rope.
This should also be performed periodically throughout the day to ensure proper operation during cold weather or icy conditions.

Knowledge Check

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

a) Do pre-use checks
b) Operate safely
c) Keep the crane clean
d) Use the shortest boom length possible

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

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

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

a) Travel speed through congested areas
b) Crane operator's license number
c) Certification information

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

a) Periodic lubrication and servicing
b) Proper set-up on outriggers
c) Operator's Daily Checklist (ODCL)
d) Firm and level supporting surface

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

a) Labels for each control function
b) ODCL checks
c) Operator's License Number

Operator Awareness

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

Unsafe Conditions

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

Lifts Near Personnel

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

Riding Loads

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

Overhead 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 signaler shall be assigned.

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

Required clearance for normal voltage in operation near high voltage power lines and operation in transit with no load and boom or mast lowered.

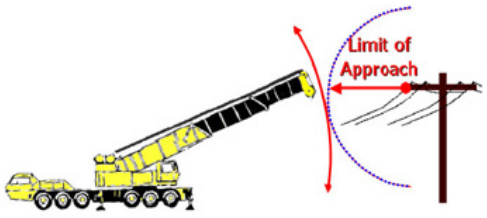
NORMAL VOLTAGE, KV (PHASE TO PHASE)	MINIMUM REQUIRED CLEARANCE, FT (M)
Operation Near High Voltage Power Lines	
0 to 50	20 (6.10)
Over 50 to 200	20 (6.10)
Over 200 to 350	20 (6.10)
Over 350 to 500	50 (15.24)
Over 500 to 750	50 (15.24)
Over 750 to 1000	50 (15.24)
Operation in Transit with No Load and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

Follow the requirements of NAVFAC P-307 paragraphs 10.11.1 through 10.11.1.6 for crane operations near or below overhead electrical transmission lines, operation near communication towers, and travelling below power lines.

Limit of Approach

When operating in the vicinity of overhead transmission lines, for 50,000 volts or less, the minimum clearance is 20 feet.

When operating in the vicinity of overhead transmission lines, the best crane set up is one in which no part of the crane or load can enter the clearance limit.



Even boom failure should not allow the crane, load line, or load to enter the limit.

Operating Practices

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

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

Lifting Loads

Prior to lifting, position the freely suspended hook directly over the loads center of gravity when attaching the load. This prevents side loading the boom or crane and prevents dragging or shifting of the load as it is picked up.

Sufficient tag lines shall be used to minimize load swing and rotation unless their use creates a hazard.

Take the slack out of rigging gradually and watch for hook movement that indicates the need to reposition the crane before lifting.

When lifting a load, stop hoisting when the load lifts a few inches off the ground and check to ensure there is no slippage of the hoist brake. Accelerate smoothly to reduce dynamic loading.

Extreme caution shall be used when making lifts out of water. When the load comes out of the water, buoyancy is lost and the load on the crane may increase. Also, just as the load leaves the water, the surface tension (suction) can increase the load on the crane momentarily. Water held inside the object may also increase the load weight.

Landing Loads

When lowering loads, be sure the surface that you plan to land on will support the load.

When landing load: slowly lower the load as you approach the landing surface, stop the load a few inches off the ground or landing surface, then slowly lower the rest of the way.

Securing the Crane

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

Traveling

When traveling cranes with loads, stow unused hooks, follow OEM requirements and keep loads close to the ground while avoiding obstructions. 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.

Knowledge Check

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

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

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

a) Hoist at one speed until the load lifts
b) Hoist slowly until the load lifts
c) Hoist slowly and remove slack from the rigging gear

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

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

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

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

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

a) Destructive stresses placed on the boom and sheaves
b) Possible overload due to swinging of the load after lifting
c) Uncontrolled movement of the load due to shifting
d) Any of the listed factors above

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

a) Keep loads just high enough to clear obstacles
b) Start slowly and increase speeds gradually
c) Avoid sudden stops
d) Slow or secure unused hooks
e) Perform all of the listed actions above

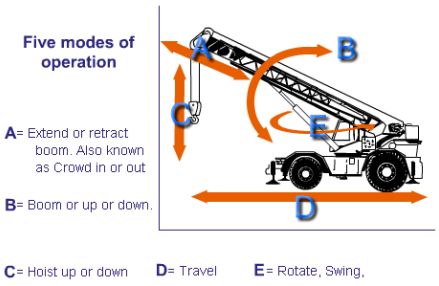
NOTES

SAFE OPERATIONS MODULE 2

Welcome
Welcome to Safe Operations Module 2.

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

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



Rotate sometimes called swing or slew, causes the upper-works of the crane to revolve on the carrier.
Travel mode allows the operator to move the entire crane on wheels, tires or crawler tracks.
Hoist mode is used to raise and lower the hooks.

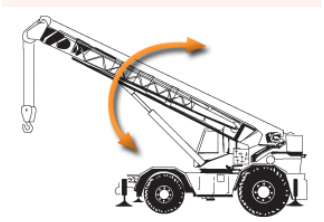
Mobile Cranes - Traveling
When traveling a truck, cruiser, or crawler crane to and from job sites, secure the hook and block to the carrier frame to prevent them from swinging into the boom. To secure the hook block to the crane, use a weak link such as nylon rope. The breaking strength of the weak link 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. Use the shortest boom length practical for maximum stability and strength. Use power lowering for positive load control.

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

Knowledge Check

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



a) Extend or Retract boom
b) Rotate
c) Hoist up or down
d) Booming up or down

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

a) Hoist up or down
b) Extend or retract boom
c) Booming up or down
d) Rotate

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

a) Rotate
b) Booming up or down
c) Hoist up or down
d) Extend or retract boom

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

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

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

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

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

a) Use both hooks for added capacity
b) Remove stowed jib to lighten boom
c) Use power lowering whenever possible

Lifting on Tires

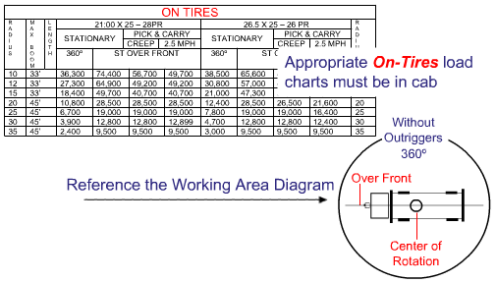
Lift on rubber only when necessary and allowed. Cranes are much less stable on rubber than when on outriggers. Lift only on level surfaces. You must keep the crane level when operating on outriggers or on tires. Remember, greater deflection and radius increase can be expected when making lifts on tires.

Issues

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

Boom Extensions

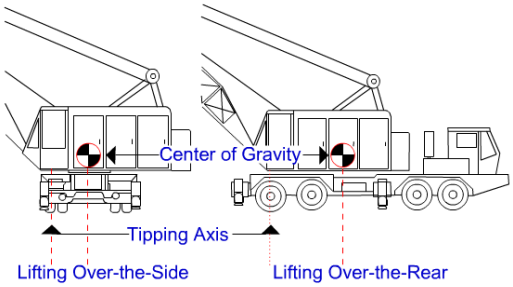
Check the crane's manual and load chart information before using a jib or extension. Lifting from jibs or boom extensions while on rubber is prohibited by most manufacturers.



On-Rubber Load Chart

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

Crane Center of Gravity



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

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.

Extendable Boom Cranes - Operating

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

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

Mobile Lattice-boom Cranes – Securing

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

Knowledge Check

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

a) Raise
b) Spin
c) Lower

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

a) True
b) False

3. Select the best answer. Hydraulic booms can fail with little or no warning when subjected to:
a) Side loads
b) Over loads
c) Both a and b are correct

4. Select the best answer. When securing rough terrain cranes, the boom should be in a near _____ position.
a) Horizontal
b) Safe
c) Vertical

5. Select the best answer. All of the following steps apply to securing lattice-boom cranes except:
a) Retract boom
b) Place the boom at approximately 45 degrees
c) Engage all drum pawls
d) Disengage master clutch
e) Lock down all foot brakes

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

Floating Cranes – Operating

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

Floating Cranes – Securing

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

Floating Crane Barge – Securing

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

Portal Cranes - Operating

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

Portal Cranes – Securing

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

Locomotive Cranes - Operating

When operating a locomotive crane, use tilt-blocks or bed-stabilizing wedges according to OEM instructions to provide over-the-side stability for heavy lifts. Use outriggers when making lifts exceeding the free-rated capacity of locomotive cranes.

Locomotive Cranes - Traveling

Disengage tilt-blocks or bed-wedges when traveling and lifting over the side at the same time. Failure to do so may result in derailing the crane because of the decreased ability for the axle assemblies to pivot on the carrier when rounding corners. When traveling around corners, carry loads in the center of the tracks. When this is not possible, carry the load or counterweight, whichever is heavier, to the outside of the curved track. This will prevent the tapered travel wheels from climbing the rail and derailing the crane. Have the signal person flag traffic at street crossings. Sound the horn when approaching intersections or blind corners and use warning bells while backing up. When traveling without loads, set the boom to approximately 45 degrees.

Locomotive Cranes – Moving Cars

If you need to move rail cars using a locomotive crane use caution when coupling or disconnecting cars. The crane crew shall make sure that no one is working in, on, or under the car**,** and that nothing will prevent its safe movement. Crews shall uncouple cars only when brakes are set and wheels are properly chocked. Limit the number of cars moved at one time, loaded or unloaded, to the number recommended by the crane manufacturer or by local policy. Locomotive cranes are not usually designed to charge the braking systems of additional cars or to move several cars at a time.

Locomotive Cranes – Securing

When securing locomotive cranes, set the boom at about a 45 degree angle. If equipped with a magnet, clam-shell, or other lifting attachment, lower it to the ground. Set the car-body brake or place wheel wedges against the inner set of travel wheels.

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 travel 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.

Overhead Electric Traveling (OET) and Gantry Cranes – Operating (continued)

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.

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 outside, secure the crane against movement by the wind. Chock the wheels as necessary for travel trucks.

Knowledge Check

1. True or False. When operating floating cranes you must start swinging or rotating quickly and stop abruptly.

a) True
b) False

2. Select the best answer. Lifting heavy loads with floating cranes will cause the barge to _____.
a) Sink
b) List
c) Rotate
d) Drift
e) Skew

3. True or False. Portal crane operators shall stop crane travel if materials or vehicles are inside crane clearance lines.
a) True
b) False

4. Select the best answer. When making heavy lifts with locomotive cranes, the use of tilt-blocks or bed-wedges will increase _____ stability.
a) Over the side
b) On rubber
c) On outriggers
d) Over the end

5. Select the best answer. Failure to disengage tilt-blocks or bed-wedges for locomotive crane travel may result in _____.
a) Derailing the crane
b) Overloading the crane
c) Loss of stability
d) Overheating brakes

6. Select the best answer. Which of the following is a mode of operation for a typical OET or gantry crane?
a) Luff
b) Hoist
c) Skew

7. Select the best answer. Which of the following is a mode of operation for a typical OET or gantry crane?
a) Swing
b) Trolley
c) Luff

8. Select the best answer. Which of the following is a mode of operation for a typical OET or gantry crane?
a) Bridge
b) Extend
c) Rotate

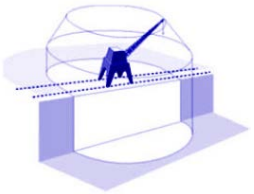
NOTES

CRANE AND RIGGING GEAR ACCIDENTS

Welcome
Welcome to Crane and Rigging Gear Accidents.

Objectives
Upon successful completion of this module you will be able to identify the elements in the crane and rigging gear operating envelopes, define a crane accident, define a rigging gear accident, identify the primary causes of accidents and explain the procedures to follow when an accident happens.

Accident Categories
There are two general categories of weight handling accidents: Crane Accidents and Rigging Gear Accidents.
Crane Accidents are those that occur during operation of Category 1, 2, 3, or 4 cranes.
Rigging Gear Accidents are those that occur when gear covered by NAVFAC P-307 Section 14 is used by itself in a weight handling operation, i.e., without a crane. Or, when covered gear is used with multi-purpose machines, material handling equipment (forklifts), and with equipment covered by NAVFAC P-300 in a weight handling operation.



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.

Rigging Gear Operating 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.

Knowledge Check

1. Select all that apply. The crane operating envelope includes the crane, the operator, the riggers, the crane walkers, and …

a) The load
b) Any supporting structures
c) Rigging gear between the hook and the load
d) The area where the load will be landed

2. Select all that apply. The rigging gear operating envelope contains the rigging gear and miscellaneous equipment covered by NAVFAC P-307 section 14, the load itself and …

a) Other personnel involved in the operation
b) The gear or equipment's supporting structure
c) The load rigging path
d) The crane removal procedure
e) The rigging procedure
f) The user of the gear or equipment

Near Misses

A near miss is a situation where an accident was avoided by mere chance or where intervention prevented an ongoing sequence of events that would have resulted in an accident.

Near misses and other unplanned occurrences with lessons to be learned that do not fall under the crane and rigging gear accident definitions, shall be reported using NAVFAC P-307, Section 12, Figure 12-2 (Near Miss Report). This report must be e-mailed to the Navy Crane Center (Code 06) within 30 days of the occurrence.

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 (this includes load tests when the test load tolerance is exceeded), 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.

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 a crane accident occurs, personnel must take the following actions:
Stop operations as soon as possible, however don't stop at the expense of safety.
In some circumstances, for example, if a crane is involved in a collision as a load is being lowered, the operator should first land the load, then follow the accident response procedure.
Don't try to correct the problem unless life or limb is in danger.
Call, or have someone call 911 if an injury occurs.
Secure the crane.
Secure power as required.
If danger exists to the crane or personnel, place the crane and load in a safe position. Notify supervision as soon as safely possible.
Ensure that the accident scene is preserved to aid the investigation.

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.

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.

Knowledge Check

1. Select the best answer. During maintenance the rigging gear between the crane hook and the load fails and results in equipment damage. This is reported as a:

a) Operator error
b) Crane accident
c) Rigging gear deficiency
d) Rigger error

2. Select the best answer. During crane operations the load shifts. The operator reacts quickly and saves the load but causes the crane to derail. This is reported as a:

a) Load configuration error
b) Operator error
c) Crane accident
d) Crane walker's error

3. Select the best answer. When rigging gear covered by NAVFAC P-307 Section 14 fails while suspended from a structure and drops the load it is a:

a) Crane accident
b) Rigging error
c) Rigging gear accident
d) Load configuration error

4. Select the best answer. If component failure occurs, such as motor burnout, and does not result in damage, the component failure is considered:

a) A rigging gear accident
b) A crane accident
c) A non-accident
d) Crane maintenance's responsibility

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

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

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

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

7. Select the best answer. If you have an accident with a crane or you find damage and suspect an accident has happened, your first step is to:

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

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_____