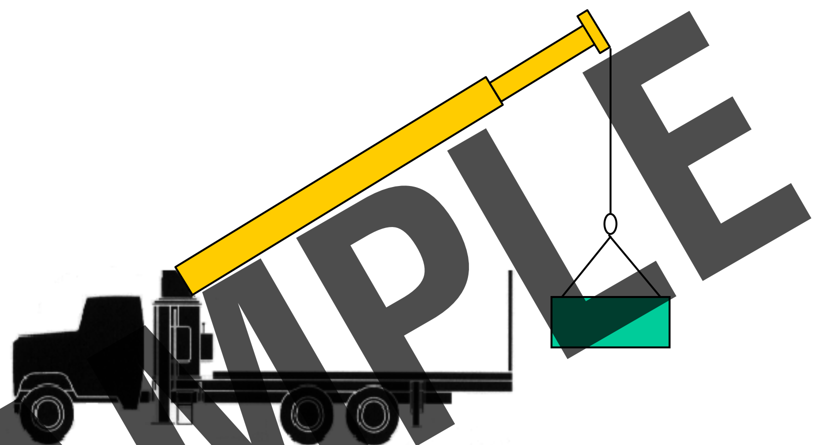
INTRODUCTION

Boom trucks are versatile machines, which can be used for many job applications from loading and unloading materials to placing those materials or personnel up to heights of 170 feet. Mounted on a truck bed these cranes can move between job sites at highway speeds carrying payloads in excess of 15,000 lbs. As with all cranes, significant training is needed to ensure safe operation and productivity.



The ultimate responsibility for each lift lies with the boom truck operator. To operate the boom truck safely and effectively, the operator must understand all the aspects of the machine, including: control locations and functions; crane movements; capacities, load charts and related data; operation speeds; signals, both visual and audible. He is also responsible for the inspection of all components and hardware on the truck and crane and have a practical knowledge of rigging and rigging hardware and be able to assess loads and situations that might present a hazard.

1. **Training can reduce the risk of accidents to you and those you work with.**

2. **Training can also reduce the operating costs of your company by avoiding damage to the truck, property and product.**

Training makes sense.

INTRODUCTION

BEING A PROFESSIONAL

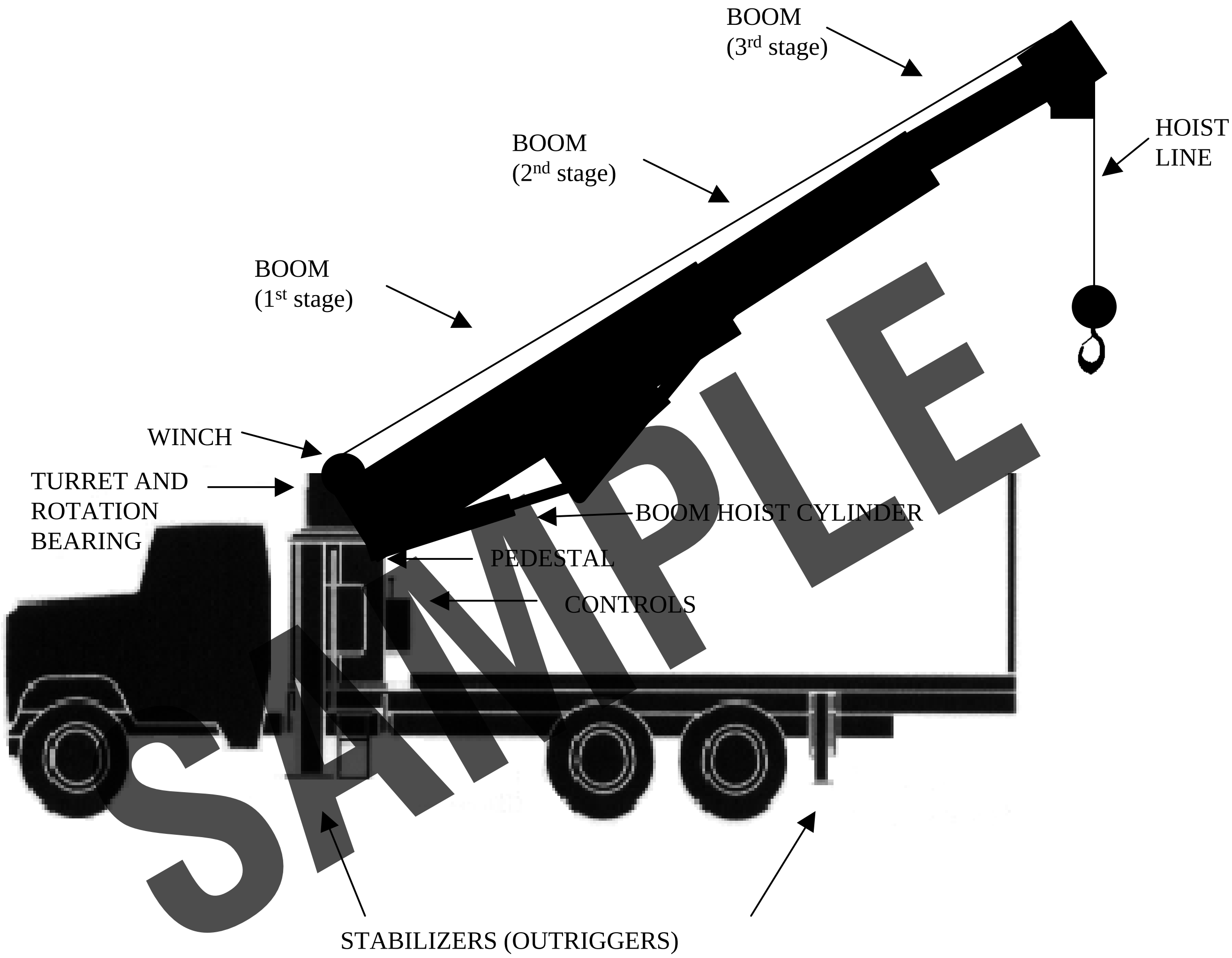
- **ATTITUDE**
- **TEAM MEMBER**

A professional boom truck operator:

- Is responsible.
- Is on time.
- Is rested, alert and physically prepared.
- Is knowledgeable about safe operating procedures and company rules.
- Wears protective clothing and equipment.
- Never stops learning about his profession.
- Is a skilled operator and continues to improve upon those skills.
- Keeps the vehicle under control at all times.

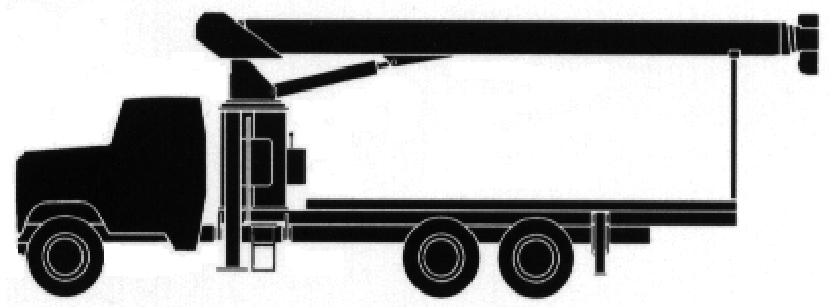
NEVER RUSHES A JOB

BOOM COMPONENTS



Federal regulations require that a written, dated and signed inspection report log be maintained for all cranes in active service.

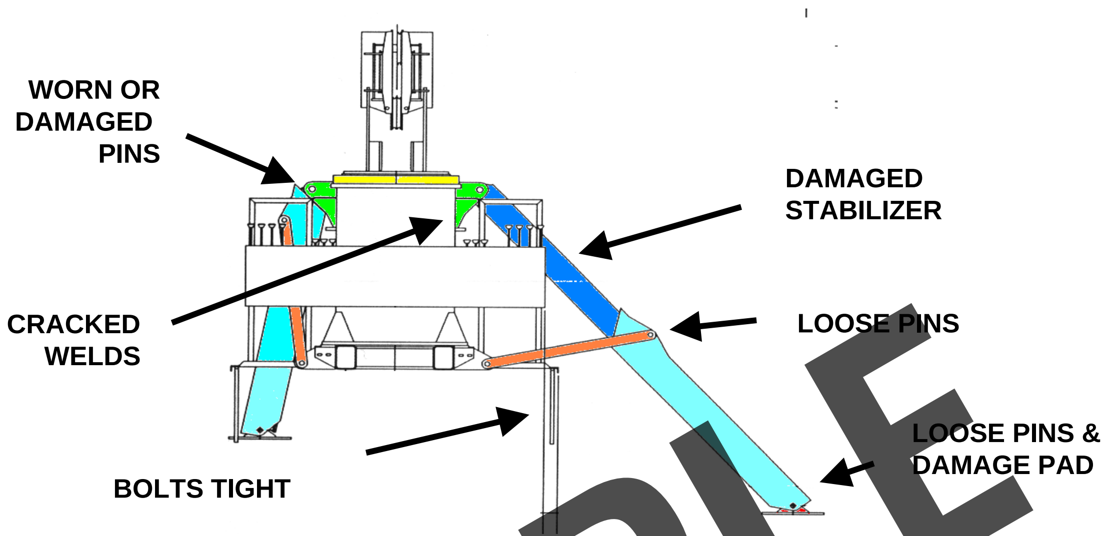
BOOM TRUCK INSPECTION



BOOM TRUCK INSPECTION CHECK LIST

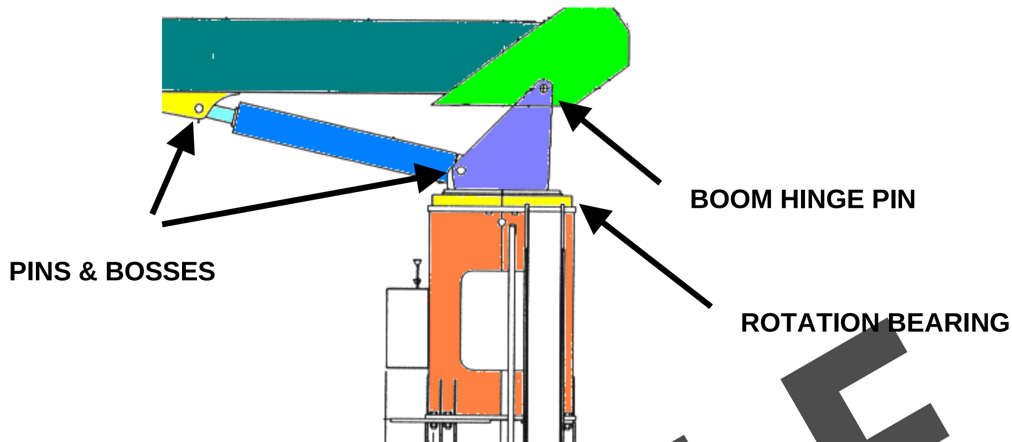
INSPECTION AREA	INSPECTION RESULTS			
	Sat.	Unsat.	N/A	Comments
Carrier				
Engine Oil				
Radiator				
Suspension				
Tires				
Wheels				
Rotation System				
Outriggers				
Mounting Bolts & Welds				
Hydraulic Fluid Levels				
Carrier Structure				
Oper. Station & Turret				
Guages				
Controls & Labels				
Hydraulic Cylinders				
Hydraulic Hoses				
Warning Alarms				
Service Brakes				
Swing Brakes				
Electrical System				
Safety Equipment				
Boom				
Sheaves				
Wire Rope				
Hook & Swivel				
Boom Angle Indicator				
Load Indicators				
Anti-Two-Block System				
Winch				
Slide Pads				
Deformations, Cracks				
Boom Extention				
Load Block				

BOOM TRUCK INSPECTION



- ❑ Stabilizers should deploy smoothly.
- ❑ Check for deformities or dents in the box tubes.
- ❑ The pads should not be bent up at the corners and should move smoothly. Check to see that the pin keepers are present and that there is no excessive play in that area.
- ❑ Check the upper hinge pin and bushing by lowering the stabilizer within a few inches of the ground and moving it back and forth. Some movement is normal, but excessive play will allow the crane to move back and forth causing further damage.
- ❑ All welds need to be checked for cracks.
- ❑ Check attachment of crane to truck chassis. If bolted, check around the bolt heads and washer area to see if there is cracked paint or dirt which could indicate movement.

BOOM TRUCK INSPECTION

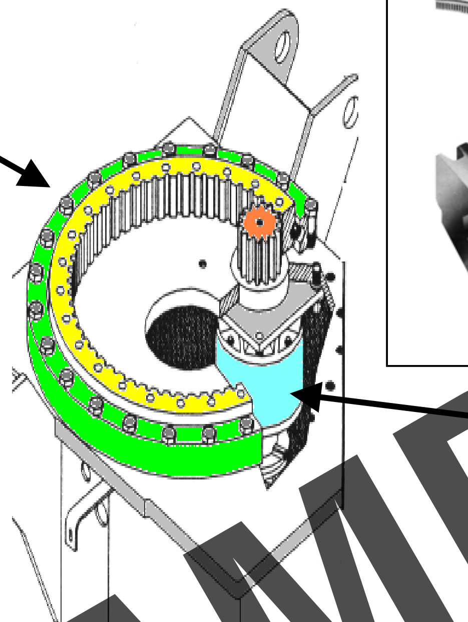


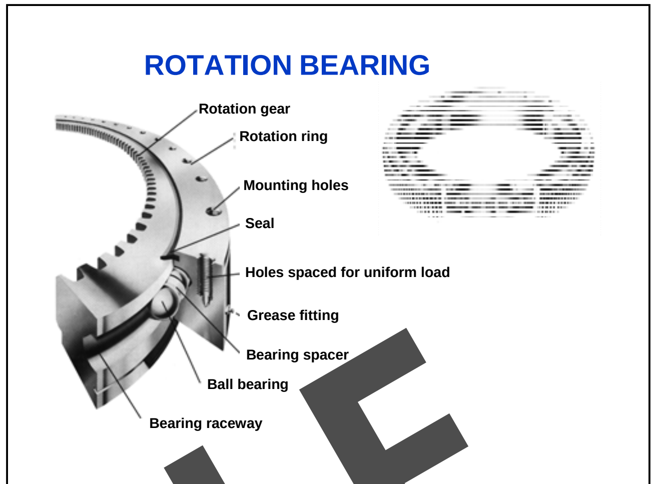
The four areas in the slide can be checked by performing the following test:

- Set up the crane on level ground with the stabilizers fully extended.
- Retract the boom fully and raise it to its most vertical position and extend the hoist wire about 10 feet.
- Abruptly lower the boom momentarily which will result in the turret and boom component rocking. Observe the movements in the rotation bearing, boom hinge pin and bushing, and the lift cylinder pins and bushings. CAUTION: WHEN SHAKING THE CRANE, OBSERVE THE HOOK AND STOP ANY BOOM MOVEMENT IF IT CAN SWING INTO THE BOOM.
- Any excessive movement must be noted and evaluated per the manufacturer's specifications.
- Check the turret area for cracked welds and any deformed components.

BOOM TRUCK INSPECTION

ROTATION BEARING & DRIVE

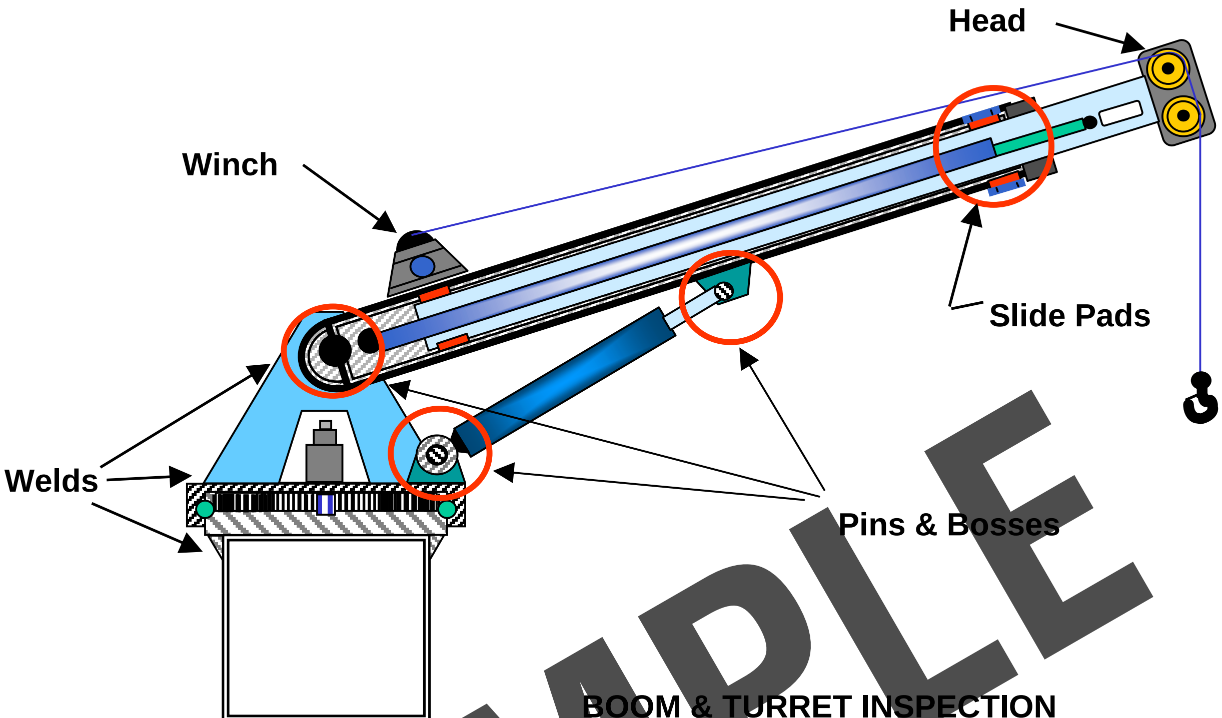




The only thing that keeps the boom from detaching from the pedestal is the rotation bearing. If they fail, the boom comes down.

- The rotation bearing should be greased on a regular basis per the manufacturer maintenance manual.
- The rotation bearing is attached to the pedestal by bolts. These need to be checked for tightness. The turret is also attached to the bearing with bolts and they also need to be checked.
- The rotation drive motor is typically mounted up in the pedestal and the mounting bolts need to be checked.
- Check the ring and pinion gears for grease.

BOOM TRUCK INSPECTION

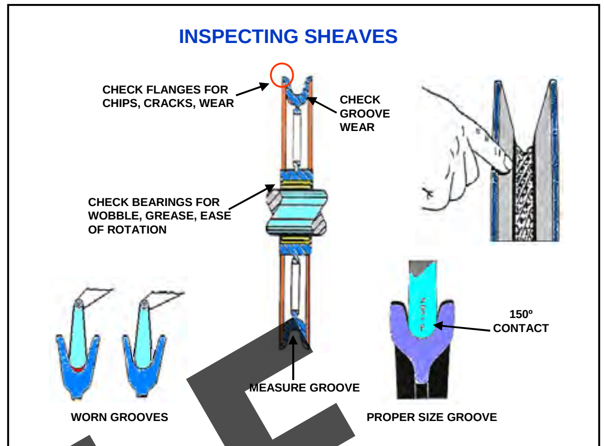


BOOM & TURRET INSPECTION

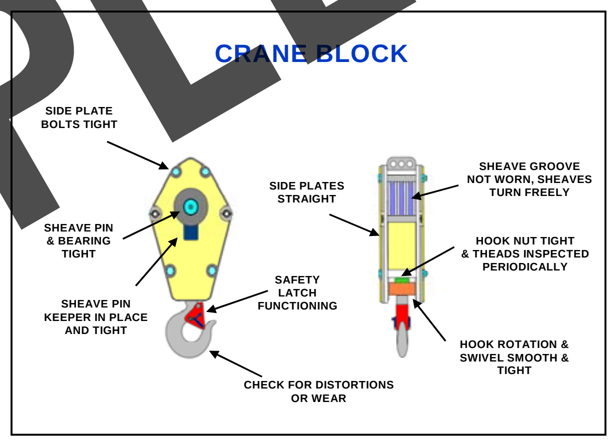
- The boom needs to be extended and checked for smoothness of operation. Any binding or difficulty in extending could be the result of damaged boom sections.
- All welds need to be checked for cracks.
- Any hydraulic leaks need to be investigated and repaired. Check the hoses for chaffing and wear.
- The slide pads can be checked for proper alignment by extending the boom completely and lowering the tip toward the ground. Move the boom tip back and forth by pushing on it and observe how much the boom sections move inside each other. Excessive movement will require the slide pads to be adjusted or replaced.
- The boom tip needs to be checked for deformation and twisting.
- The winch should be checked for proper reeving. The most common cause of damage to wire rope is crushing due to crossed wraps on the winch drum.

BOOM TRUCK INSPECTION

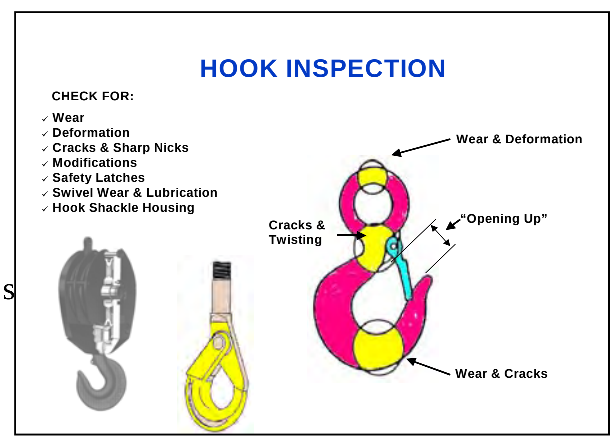
- Check sheaves for bearing wear and lubrication.
- Check the flanges and treads. Use a sheave gauge.
- Sheaves can only be repaired per manufacturer's procedures.



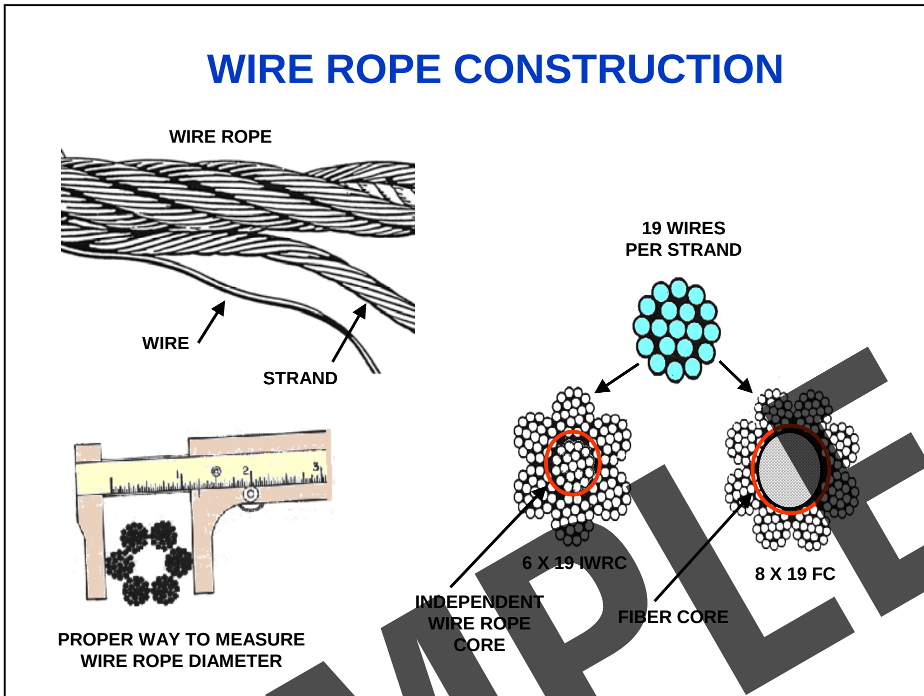
- The sheaves and bearings need to be checked on crane blocks.
- Check the side plates and any additional weights attached to the sides need to be checked for loose or missing bolts or fasteners.
- The hook and shank nut should be separated periodically and the threads inspected for corrosion and other damage.
- The safety latch must be in place and functioning properly.
- The hook should rotate freely on the swivel bearing. Check for excessive movement.



- Wear in excess of 5% in the neck of the hook and 10% in other areas is cause for removal.
- An increase in the hook throat opening of more than 15% is cause for removal
- Any twist in the hook of more than 10% is cause for removal.
- Hooks can only be repaired per manufacturer's procedures.



WIRE ROPE



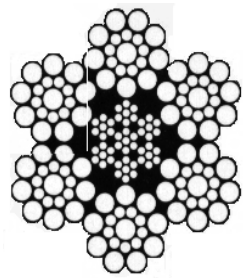
Wire rope is made of steel **wires** laid together to form a **strand.** These strands are laid together to form a rope, usually around a central core of either fiber or wire, as indicated above. **IWRC** is the abbreviation for **independent wire rope core.** This wire core, which is actually another strand, has several advantages over fiber core. It adds about 7 ½% in strength and helps to resist rope crushing.
Fiber core is impregnated with lubricant which is released during use. Fiber core also helps to cushion the strands during use. **Fiber core wire rope should not be used For hoisting or rigging.**
Most wire rope is made from preformed strands. The preforming gives the the stands a better load distribution, and it prevents unraveling when the rope is cut.
The number of strands, number of wires per strand, type of material and nature of the core will depend on the intended purpose of the wire rope.

Wire Rope Lays:

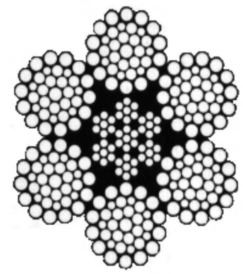
The lay refers to the direction of the winding of the wires in the strands and to the strands in the rope. This term refers to two basic lays. **Regular Lay** and **Lang Lay.**
Regular Lay: The wires in the strands are laid in one direction while the strands in the rope are laid in the opposite direction. The wires are able to withstand considerable crushing and distortion due to the short length of the exposed wires.
Lang Lay: The wires in the strands and the strands in the rope are laid in the same direction. Lang Lay rope should not be used for single part hoisting due to its tendency to untwist. Its biggest advantage is its resistance to abrasion.

WIRE ROPE

Wire rope, with many smaller wires and strands, is **more flexible** than rope with large diameter wires and fewer strands.



ABRASION RESISTANCE
Increases with larger wires
Decreases with smaller wires



FATIGUE RESISTANCE
Decreases with fewer wires
Increases with more wires

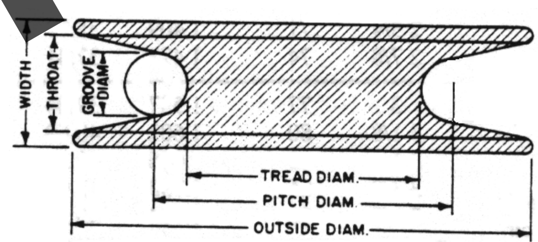
Any time a wire rope goes over a sheave it bends, which causes fatigue in the rope. The more wires the rope has, the more flexible it becomes and less fatigue occurs. The larger the sheave, the less the rope has to bend. The diameter of the sheave must be considered in relation to the type of rope needed for the job.

STANDARDS FOR SHEAVE & DRUM RATIOS

D = Diameter of drum or pitch diameter of the sheave.
d = Diameter of wire rope
ratio = **D / d**

ASNE/B30.5 "MOBILE CRANES"
Minimum Ratios

	Drum	*Sheave*
Load Hoist	**18**	**18**
Boom Hoist	**15**	**15**
Load Block		**16**



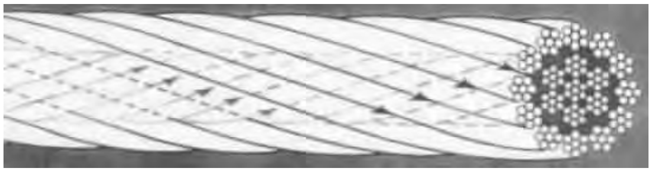
The larger the sheave is in diameter as compared to the wire rope, the less bending the rope has to do to go over it.

LESS BENDING MEANS LONGER LIFE

Manufactures of wire rope have even more stringent standards. Here is what one manufacturer recommends for some types of wire rope:

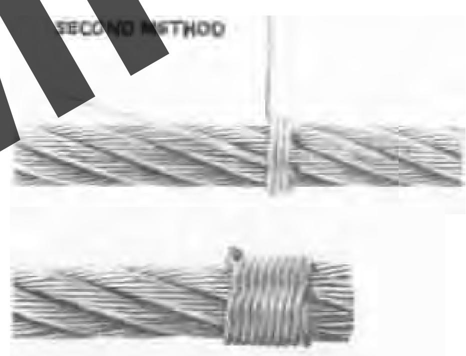
Type	**max**	**min**
6 x 7	72:1	42:1
19 x 7	51:1	34:1
6 x 19	51:1	34:1
6 x 25	45:1	30:1

ROTATION RESISTANT WIRE ROPE



The non-rotating characteristic is secured by building into the rope two layers of strands, one having Right Lay and the other Left Lay. The tendency of one layer of strands to rotate in one direction is counteracted by the tendency of the other layer of strands to rotate in the opposite direction.

Rotation Resistant wire rope requires very careful handling prior to, during and after installation. When a non-rotating rope is cut, bent around a thimble or wedge socket, or is attached to any fitting, care must be taken to prevent **core slippage.**
Core slippage can happen quite easily. When the rope is twisted in one direction, one layer of strands will tighten up and shorten, while the other layer of strands loosens, or becomes longer. As a result the shorter layers of strands carry the majority of the load. To ensure that core slippage does not take place, always apply **wire seizings** to bind the inner and outer cores together before the rope is cut or attached to any fitting.



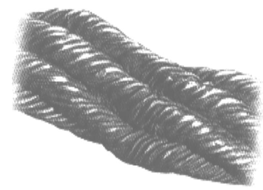
The use of a **swivel** at the load hook or in the termination for a rotation resistant rope can result in unpredictable service. This practice, or any other which allows the rope to rotate while in service, can lead to unbalanced loading between inner and outer layers of strands, which may result in core failure. *If any significant change in diameter is found in a short length of an operating rope, or if there is an unevenness of outer strands,* ***the rope should be replaced.***

Since rotation rope is special, applicable industry standards list separate design, maintenance, inspection and removal criteria for them. The minimum safety factor for rotation resistant rope is usually 5:1, and there are some who list it as 8:1. When hoisting personnel, it is 10:1.

WIRE ROPE INSPECTION

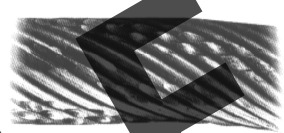
Kinks are a permanent distortion. After a wire rope is kinked it is impossible to straighten the rope enough to return it to its original strength. The rope must be replaced. Causes: crossed lines on drum, improper handling and installation, and uncoiling.

KINKED WIRE ROPE

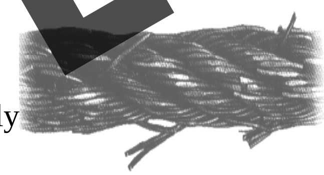


Strand Nicking is due to continued operation under a high load which results in core failure.

STRAND NICKING

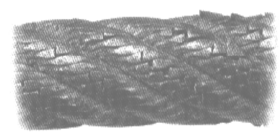


FATIGUE FAILURE

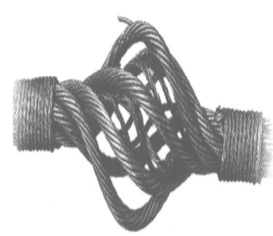


Metal Fatigue is usually caused by bending stress from repeated passes over sheaves, or from vibration such as crane pendants. **Fatigue Breaks** can be either external or internal. They also can be caused by wobbly sheaves, tight grooves, poor end terminations. In the absence of all these causes, remember that all wire rope will eventually fail from fatigue.

FATIGUE BREAKS



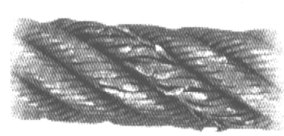
BIRDCAGE



Bird Caging is a result of mistreatment such as sudden stops, wound on too tight of drum, or pulling through tight sheaves. The strands will not return to their original position

High Stranding is a condition caused when overloading and crushing take place and the other strands become overloaded.

HIGH STRAND

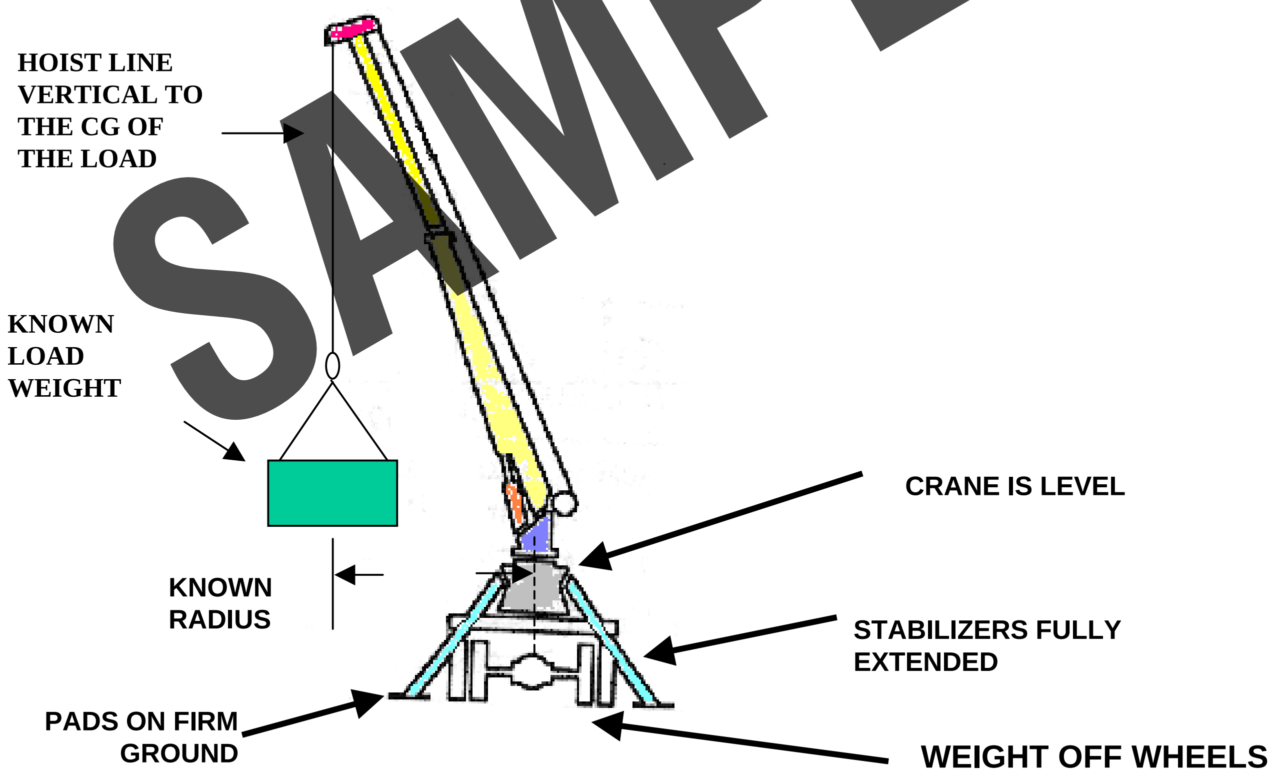


BOOM TRUCK SETUP

Picking a suitable location is the foundation to a safe lift. The quality of the surface is your first consideration. Is it level? Can all stabilizers be extended fully? Will the soil or surface hold up under the weight of the lift?

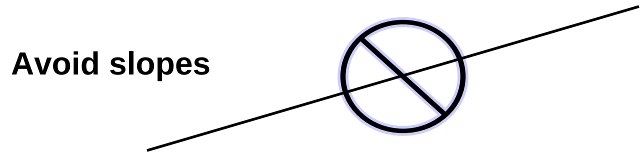
You should know the following:

- Load weight
- Radius of the pick
- Can crane be leveled
- How high load must be lifted
- Are there power lines nearby
- Any other structures
- Pedestrians or traffic
- Plan for making the lift

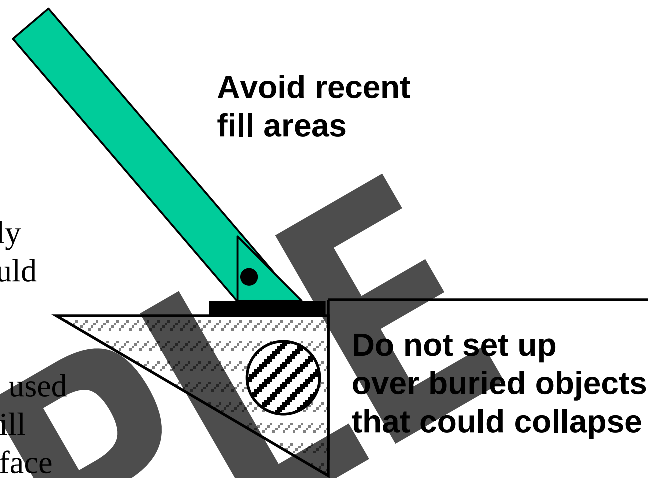


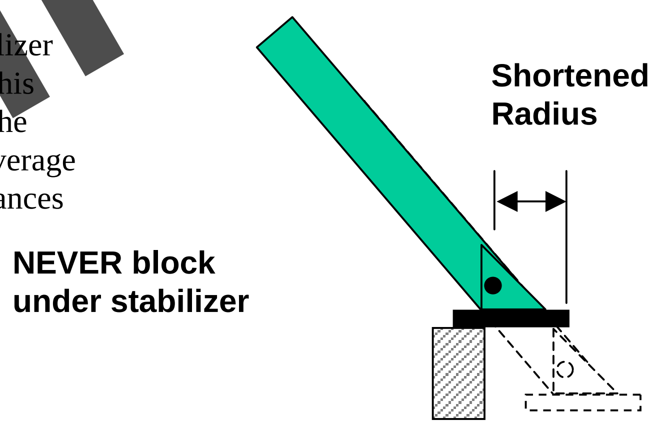
*On some boom trucks, the stabilizers will not take all the weight off the tires.

STABILIZER SET UP

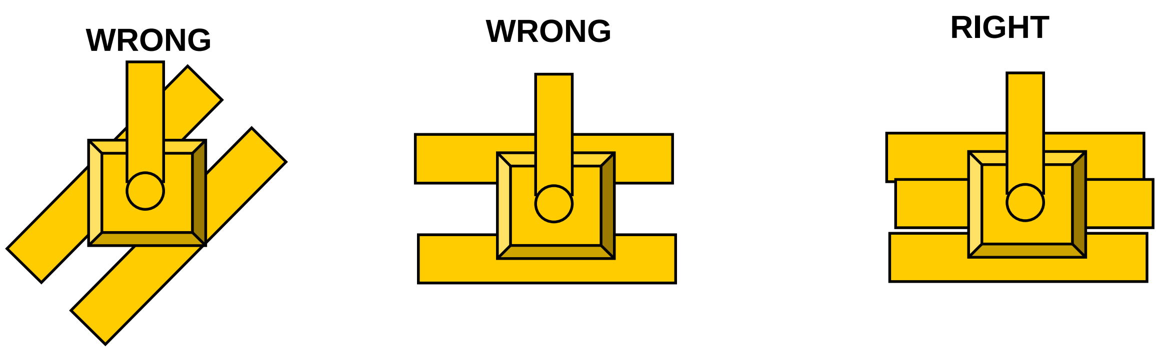


- Always extend all stabilizers.
- Avoid setting up on a slope.
- Soils along foundations may be poorly compacted or conceal objects that could collapse.
- Floats of at least 24” x 24” should be used under each stabilizer. These floats will reduce the lbs. per sq. inch on the surface and help the stabilizer from sinking.
- Blocking under the A-frame type stabilizer will prevent it from fully deploying. This will shorten the distance of the pad to the center of rotation which reduces the leverage of the boom truck and increases the chances of a tip over.





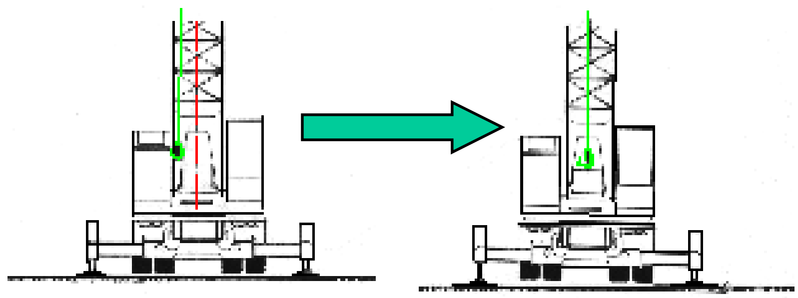
FLOATS UNDER PADS



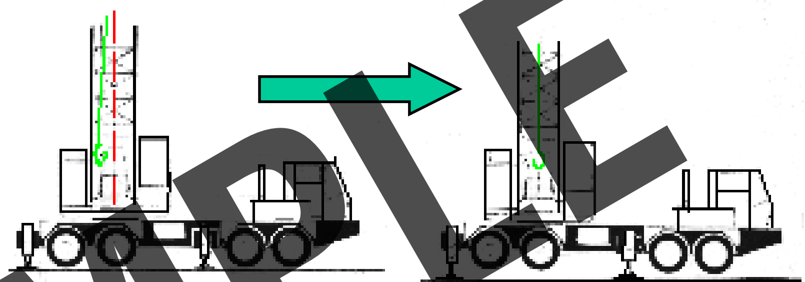
LEVELING THE CRANE

LEVELING THE CRANE USING HOIST LINE AND BOOM

SWING BOOM
OVER REAR
& LEVEL CRANE
UNTIL HOIST
WIRE IS PLUMB
WITH BOOM



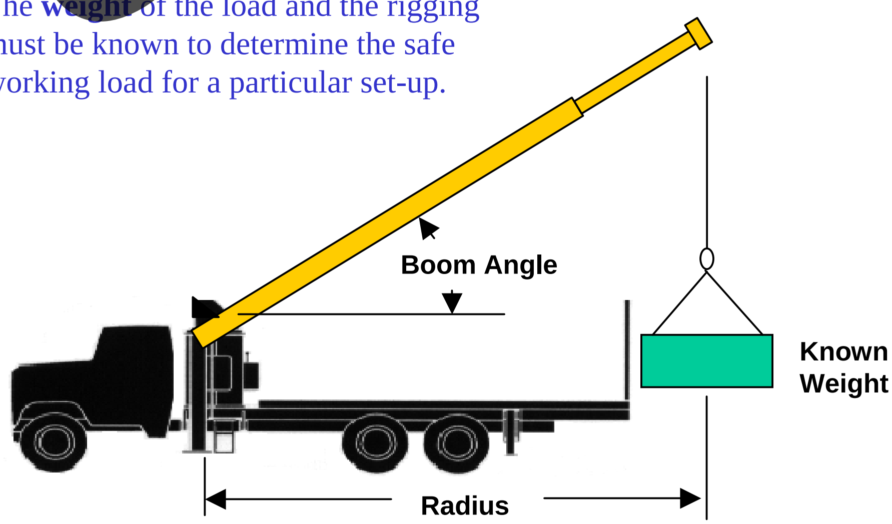
SWING BOOM
OVER SIDE
& LEVEL CRANE
UNTIL HOIST
WIRE IS PLUMB
WITH BOOM



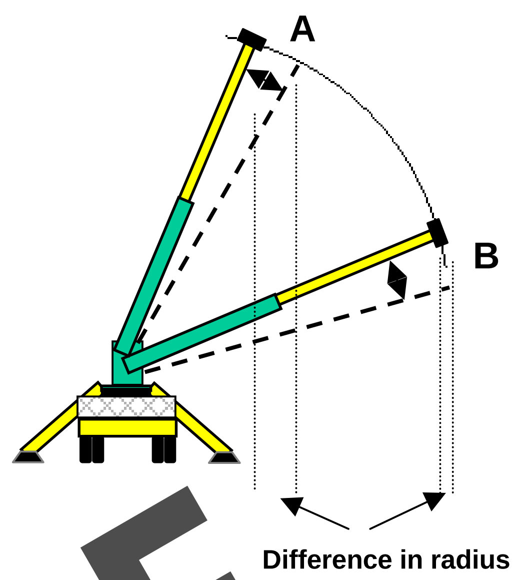
LOAD RADIUS AND BOOM ANGLE

The **radius** for the load is measured from the center of the rotation of the crane to directly under the vertically hanging hook. The **boom angle** is measured from a horizontal line to the center of the boom.

The **weight** of the load and the rigging must be known to determine the safe working load for a particular set-up.



LEVELING THE CRANE



ESTIMATED OUT OF LEVEL

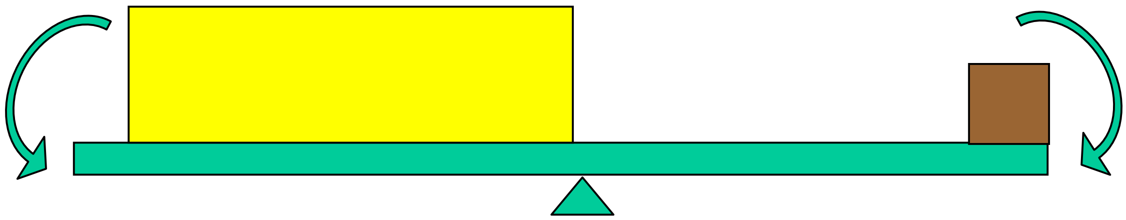
CAPACITY REDUCTIONS

BOOM LENGTH AND RADIUS	CAPACITY REDUCTION WHEN OUT OF LEVEL(Deg)		
	1	2	3
Short Boom, Minimum Radius	10%	20%	30%
Short Boom, Maximum Radius	8%	15%	20%
Long Boom, Minimum Radius	30%	41%	50%
Long Boom, Maximum Radius	5%	10%	15%

MAXIMUM RADIUS CHANGES LESS PER DEGREE THAN MINUMUM RADIUS

Note that the percentage of reduction is less when the boom is at maximum radius than when the boom is at minimum radius. Even though the change in the angle for both A and B is the same, the resulting change is much greater when the boom is raised high than when it is low.

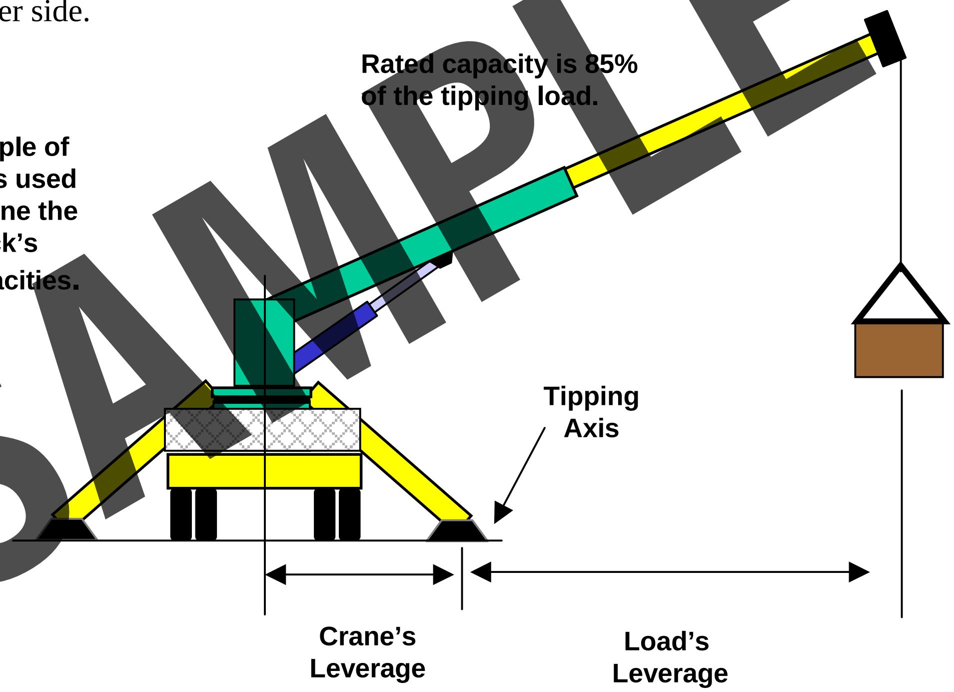
BOOM TRUCK STABILITY



Boom truck stability is based on the concept of balance and leverage

The concept of the teeter-totter is something that most people are familiar with and is a good way to explain stability. When a teeter-totter is in perfect balance, the torque created by the weight times length of the lever arm on one side of the pivot point must equal the torque created by the weight times the lever arm length on the other side.

The principle of leverage is used to determine the boom truck's rated capacities.

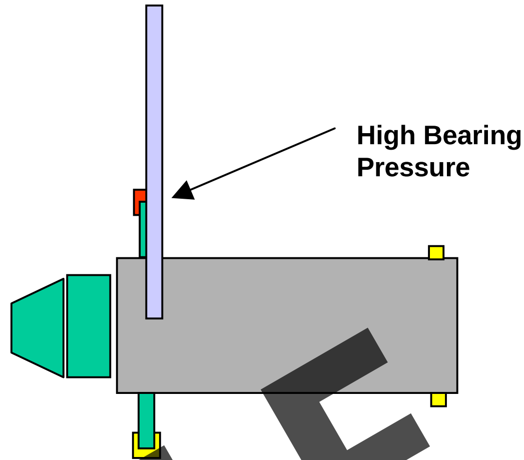


For all cranes, the torque on the side of the crane always must be greater or otherwise the crane will tip over. The crane's torque or leverage is the effective weight of the crane times the distance from the cranes center of gravity to the stabilizer. Leverage for the load is the weight of the load and that portion of the boom that is beyond the stabilizer pad times the distance from the stabilizer pad to the center of the load.

Note that the total weight of the load, boom, and a portion of the truck weight is on the stabilizer(s) over which the boom is working.

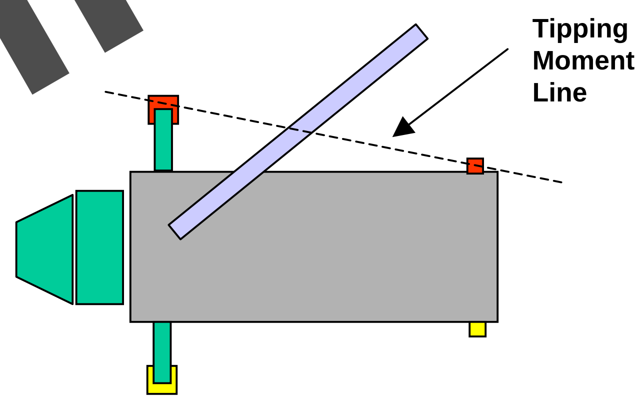
BOOM TRUCK STABILITY

When the boom is located directly over the stabilizer, the pressure applied to the ground is the greatest because the stabilizer is supporting most of the load.



Most boom pads are 12” x 16” which equals 192 sq. in. of surface pressing on the ground. The load placed on this pad can be upwards of 20,000 lbs. This would result in a ground bearing pressure of 100 lbs. per sq. inch.

For this pressure, the ground would need to be hard pan or compacted gravel soil. For many sites, the soil conditions are poor and may be only able to support 40 lbs. per sq. inch. A 24” x 24” float placed under the stabilizer will increase the surface area to 576 lbs. per sq inch. This will yield a ground bearing pressure for the above situation of 34 lbs. per sq. inch. This is a much improved situation.



As the boom moves from the forward stabilizer toward the back of the truck, the pressure on the ground is shared by the two stabilizers.
The distance from the cranes center to the tipping moment line has increased so the leverage for the truck has increased making the boom truck more stable
The danger here is doing the opposite. When a load is picked up from the rear of the truck and brought over the side, the boom truck may initially be very stable, but as the load is swung over the side, the boom truck’s leverage decreases, making it less stable. Many operators are deceived by this condition and it results in a tip over. That’s why it is important for the operator to take the time to plan every lift.

LIFT REQUIREMENTS

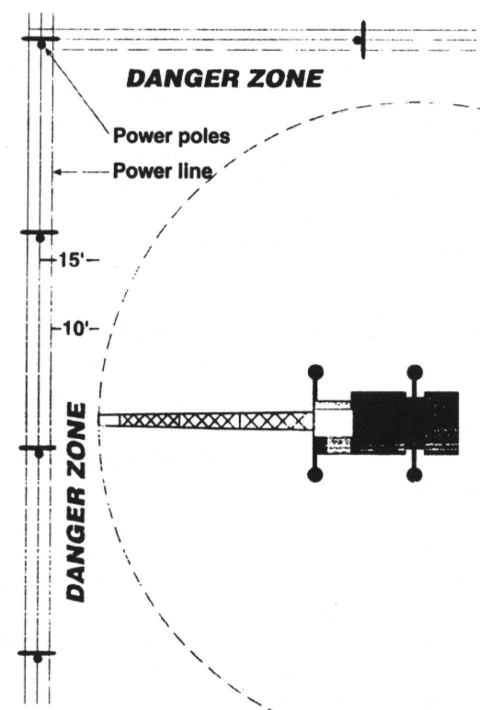
The operator should take a moment to study the area in which he will be working. Look for power lines, obstructions, vehicle and pedestrian traffic, ground conditions and other potential areas to avoid in the set-up. When assessing the load, the operator must know the weight, the load's center of gravity and its structural strength in order to rig properly. Using the same rigging technique for every lift often is not wise. In order to properly situate the truck you must know where the load will be picked from and where it needs to be placed.

- **The Big Picture**
- **Assessing the Load**
- **Rigging Requirements**
- **Assessing the Pick Area**
- **Assessing the Placement Area**

- **Calculate the gross load**
- **Determine the maximum radius**
- **Determine the maximum height**
- **Refer to load chart to determine if lift will be within the boom truck's capacity.**

Required Clearances

50kV	**10 ft**
50 to 200kV	**15 ft**
200 to 350kV	**20 ft**



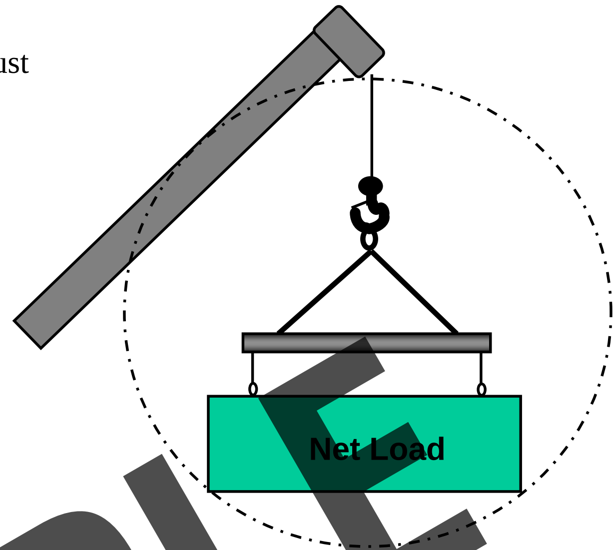
POWER LINES:

Electrocution is the number one cause of death involving cranes. Always observe the minimum clearance distances. If for some reason you must get closer, you should use a spotter to watch the crane boom to ensure that it does not enter into the danger zone. Tag lines should not be used close to electrical lines.

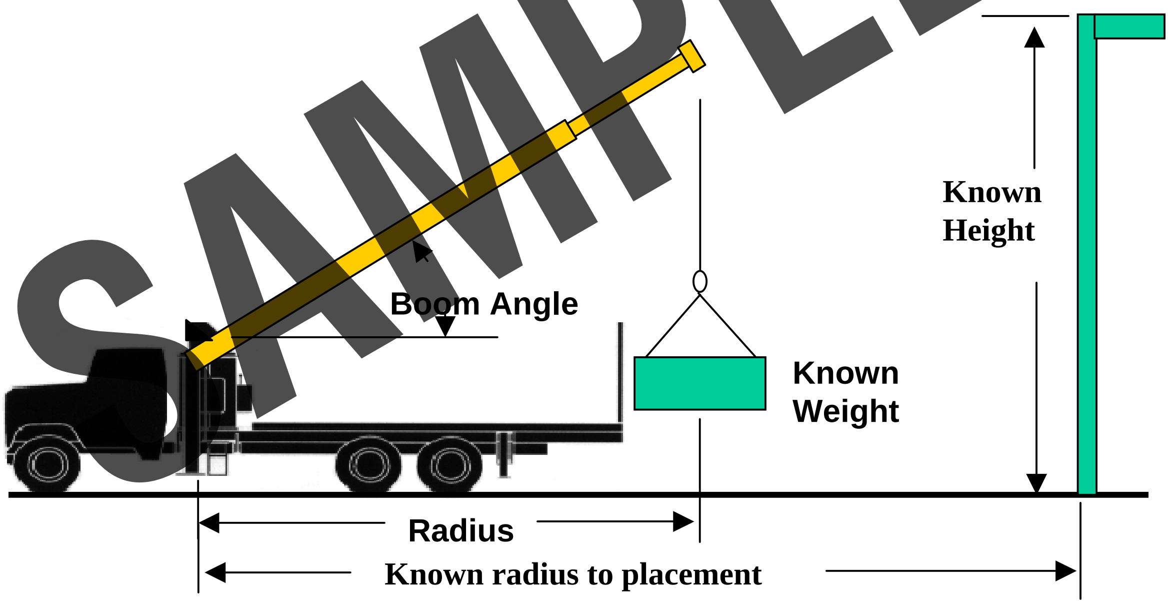
LIFT REQUIREMENTS

GROSS LOAD

When assessing the load the operator must know the weight. The gross load would include everything below the boom tip.



Gross Load =
- **Net Load +**
- **Rigging +**
- **Wire Rope +**
- **Block +**
- **Boom Attachments**

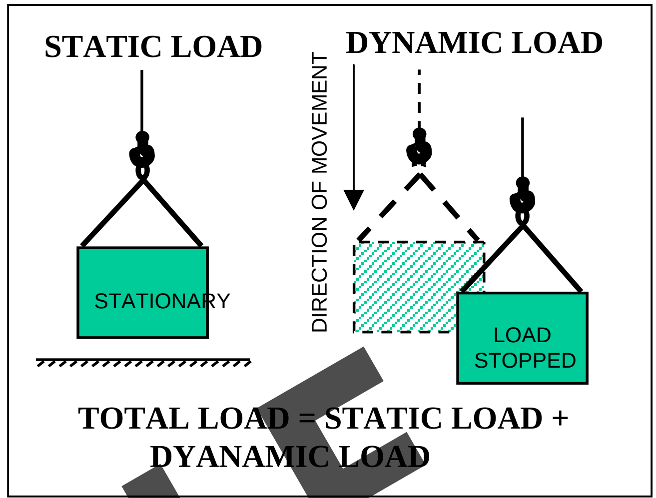


The load radius is the horizontal distance measured from the center of rotation of the crane to the load hook while the boom is under load. The operator may need to make a few measurements if the lifting requirements are close to the maximum capacity for a certain configuration. When placing loads at elevated heights, the operator must know these heights to determine if his boom truck is capable of making the pick. Guessing at the height or the radius may result in a tip over if wrong. Once those distances are known, then the operator can refer to the load chart.

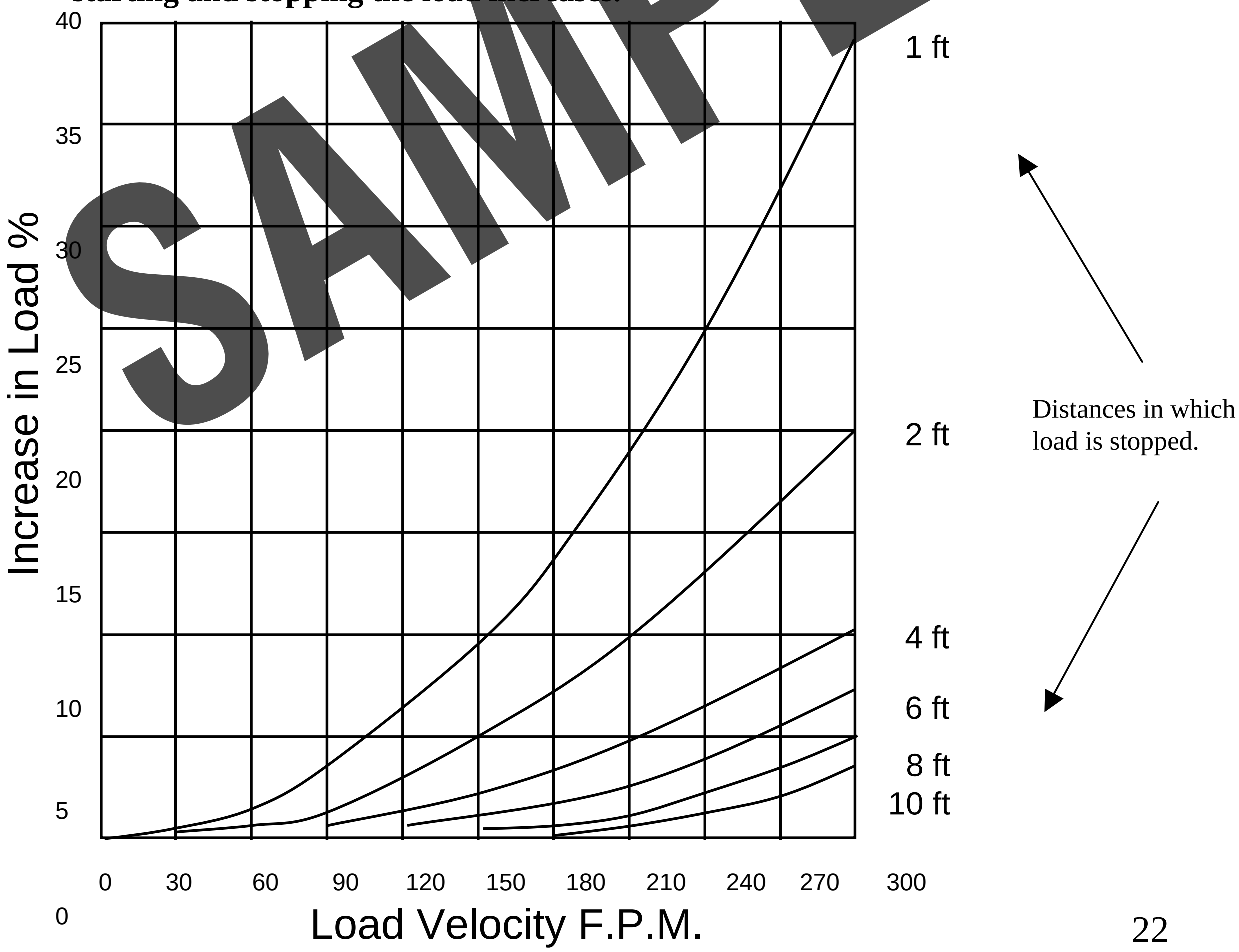
DYNAMIC LOADING

IMPACT OF DYNAMIC LOADING

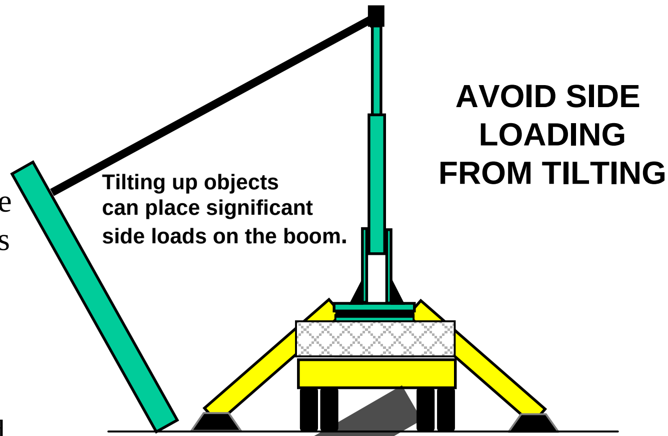
When a load is moved, additional stresses are imposed on the crane's structure. To start a load moving either by hoisting, booming or swinging, the crane will have to exert an additional force. How much additional force is dependent on the weight of the load and how fast it has started moving. Loads started slowly and stopped slowly will not exert as much stress on the crane as those which are move rapidly.



The below chart shows how the dynamic load increases as the rate of starting and stopping the load increases.



BOOM TRUCK STABILITY

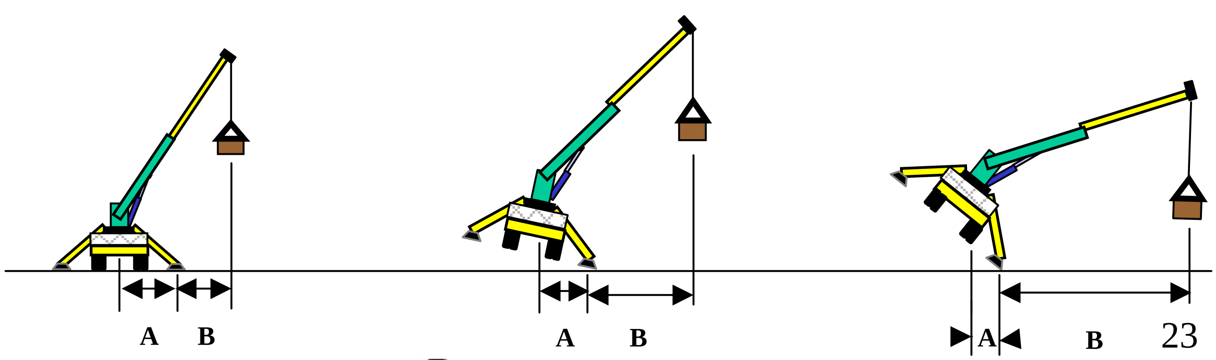


The boom is very susceptible to side loading damage and needs to be above the load at all times. Tilting up panels are a common cause of side loading. When tilting up a panel, the hoist line must remain vertical at all times.

Although it is not very apparent, wind can cause excessive stresses on the crane. Wind on the boom itself, especially when fully extended, can contribute to a tip over. The operator must stop operations when the wind becomes a significant factor. When to stop is left up to the judgment of the operator. According to OSHA, lifting of personnel shall not be done in winds in excess of 15 mph.

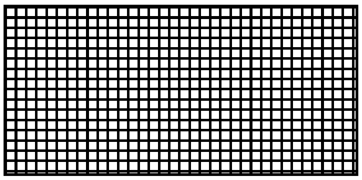
The wind pressure on the load can also add side loading to the boom as well as losing control of the load. Tag lines may be necessary to help control the load, but should never be used to pull the load around.

Rate of tipping: In a stable situation, the boom truck leverage is greater than the load leverage. As the boom truck begins to tip, distance A becomes shorter and distance B increases. This results in a decrease in leverage for the truck and increase in leverage for the load. If the truck continues to tip, the rate increases and unless the operator is able to land the load immediately, it may be impossible to stop.

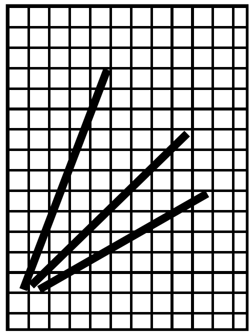


LOAD CHART

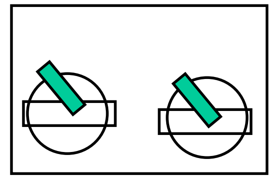
Most load charts have at least 4 areas of information.



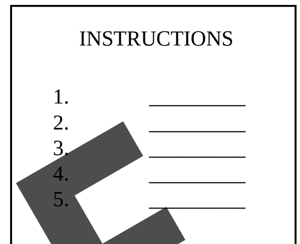
CAPACITY CHART



RANGE CHART



OPERATING AREA CHART



NOTES TO OPERATOR

Below is an example of a boom truck load chart:

LOAD CAPACITY CHART

AREA OF OPERATION

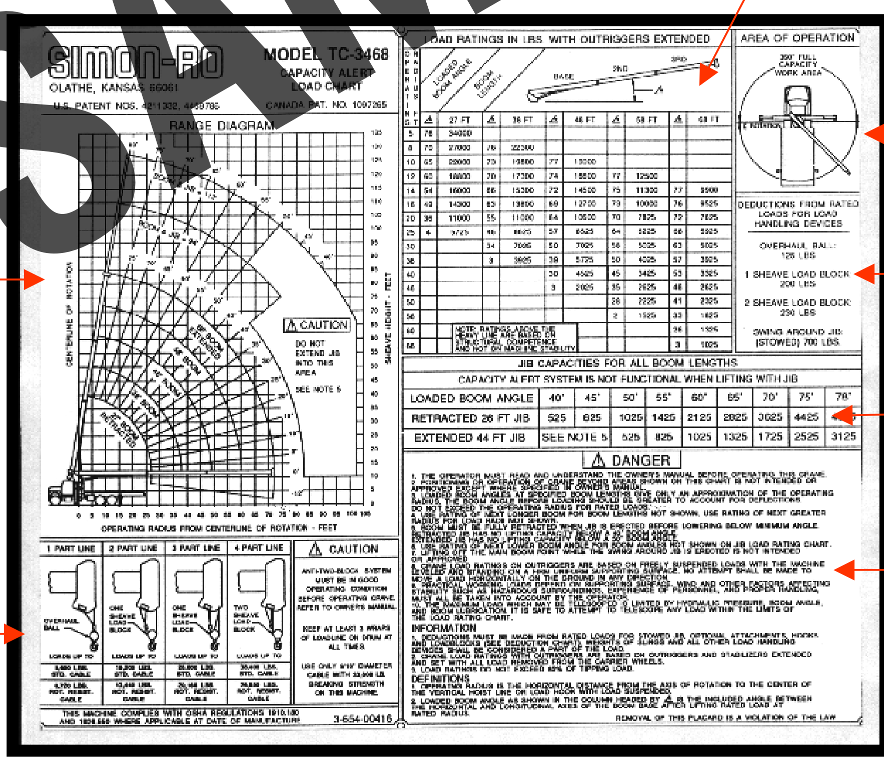
RANGE DIAGRAM

LOAD DEDUCTIONS

JIB LOAD CAPACITY CHART

LINE CAPACITY AND REEVING SET-UPS

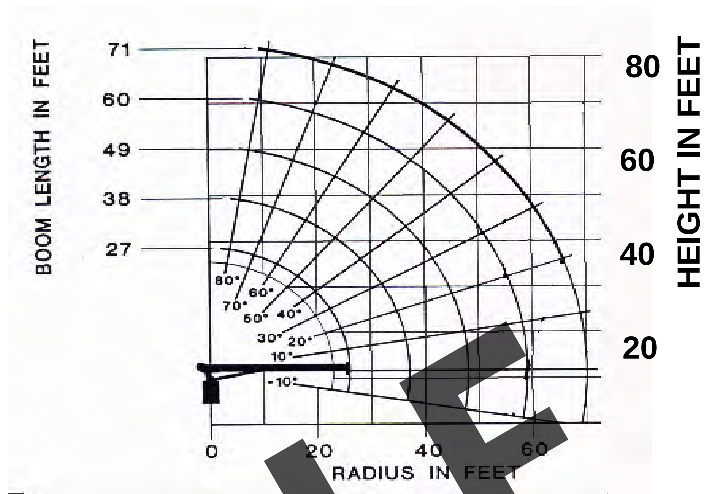
NOTES TO OPERATOR



LOAD CHART

RANGE DIAGRAM

The range diagram shows the various boom tip heights based on boom length and radius. This chart will help to determine if this crane is able to make a certain lift. using this diagram in pre-planning can prevent the boom truck from being sent to a site and not be adequate for the job.



RATED LOAD CAPACITY CHART

LOAD RADIUS (FEET)	LOADED BOOM ANGLE	27FT BOOM (LBS)	LOADED BOOM ANGLE	38FT BOOM (LBS)	LOADED BOOM ANGLE	49FT BOOM (LBS)	LOADED BOOM ANGLE	60FT BOOM (LBS)	LOADED BOOM ANGLE	71FT BOOM (LBS)	RATED LOAD DEDUCTIONS
10	67	***17,900***	74.5	***16,100***	78.5	***14,900***					(LBS)
12	62.5	***15,400***	71.5	***13,900***	76	***12,800***	79	***11,800***			DOWNHAUL
14	57	***13,700***	68	***12,200***	73.5	***11,200***	77	***10,400***	79.5	***10,000***	WEIGHT = 150
16	52	***12,300***	64.5	***10,900***	71	***9,900***	75	***9,200***	77.5	***8,800***	
20	39.5	***10,000***	57	***9,000***	66	***8,200***	71.5	***7,600***	70.5	***7,200***	ONE SHEAVE
25	17	***7,600***	49	***7,500***	60	***6,800***	66.5	***6,200***	70.5	***5,800***	BLOCK = 200
30			37.5	***6,300***	53	***5,700***	61	***5,200***	66	***4,900***	
35			21	***5,000***	44.5	***4,900***	55	***4,500***	61.5	***4,200***	TWO SHEAVE
40					35	***4,200***	49	***3,900***	56.5	***3,600***	BLOCK = 355
45					22	***3,500***	42	***3,300***	51.5	***3,150***	
50							34	***2,900***	46	***2,750***	STOWED
55							23	***2,500***	40	***2,400***	JIB = 500
60									33	***2,100***	
65									23.5	***1,750***	
70									4	***1,100***	
	0	***6,000***	0	***3,800***	0	***2,400***	0	***1,550***	0	***950***	

The load capacity section of the load chart states the lifting capacity of the boom truck for a given radius and boom length. A typical chart will show the radius in the left hand column and the corresponding boom angle and length on top. If the desired radius falls between two figures on the chart, the longer of the two must be used with their corresponding angles and capacities. Never try to "split the difference." The boom angles on the chart are for **loaded** booms. When pre-determining where the boom angle is to be used as a means for establishing the radius, 2 degrees should be added to the load chart number. As the boom is loaded, it will tend to drop a few degrees, so the 2 degrees should compensate for that.

LOAD CHART

AREA OF OPERATION: Typically the load chart will have a section showing the area of operation or will make a statement concerning it in the notes section.

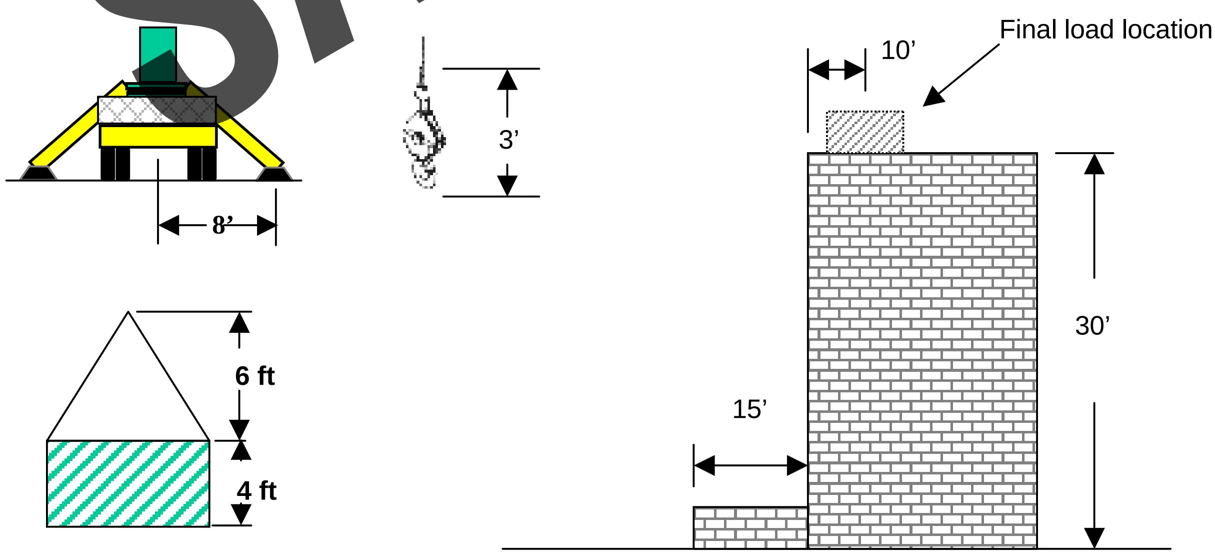
LOAD DEDUCTIONS: This section of the chart is very important to understand because these must be taken into consideration in determining how big of a net load the crane can safely lift.

JIB LOAD CAPACITY: If the crane is fitted with a jib, it will have a load chart showing the capacity for various distances.

NOTES: The operator is required to read and understand the information presented in the “notes to operator” section.

LINE CAPACITY AND REEVING CONFIGURATIONS: This section tells how much can be lifted for the different hoist line reeving configurations. Even though the load chart may indicate a certain lifting capacity, lifts need to be restricted to the capacity for the wire rope reeving configuration.

RANGE DIAGRAM EXERCISE



(Not to scale)

RANGE DIAGRAM EXERCISE

Step One: Calculate the total gross load including deductions

Load	= 4000 lbs
Load Deductions	= 700lbs

(1 sheave block, 200 lbs; stowed jib, 500 lbs; rigging and load line negligible)

Total gross load	=4700 lbs

Step Two: Minimum boom tip height for this lift.

Building height		= 30 ft
Load & rigging height	= 10 ft	
Hook height	= 3 ft	
Minimum free line		= 5 ft
Minimum boom tip height	= 48 ft	

Step Three: Minimum radius for this lift.

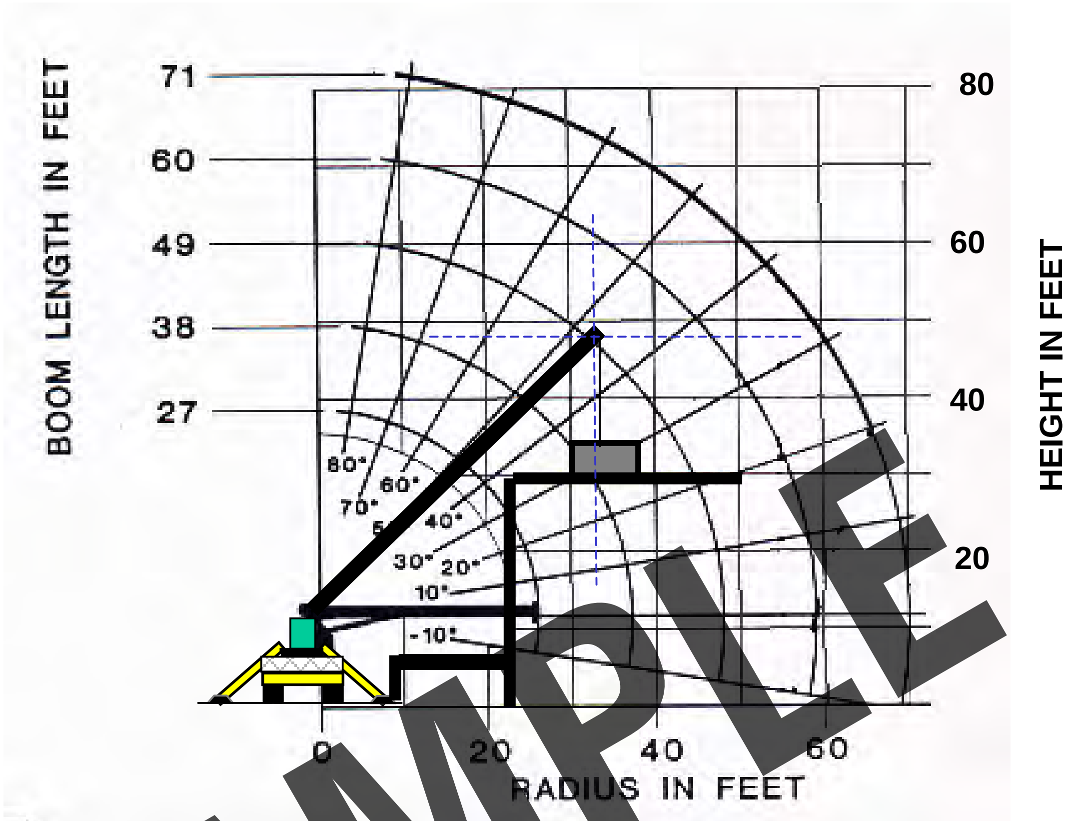
Center of rotation to stabilizer	= 8 ft
Stabilizer to edge of building	= 15 ft
Edge of building to load center	= 10 ft
Minimum radius	= 33 ft

Step 4: Sketch the building and load placement on the range diagram

Sketching it on the diagram:

- First, draw a horizontal line at 30 feet high, (the height of the building).
- Next, draw a vertical line at 23 feet of radius, (the distance to the side of the building). the intersection of these two lines represents the building corner.
- At 33 feet of radius, draw a vertical line form the top of the building upward. This represents the center of the load on top of the building.
- At 48 feet of height from the ground, draw a horizontal line that intersects the vertical line representing the hoist line. The intersection of these two lines represents the lowest point the boom tip can be placed and still be able to make the lift.
- A line drawn from the boom hinge to the boom tip will show the minimum boom angle and will also show how much clearance the boom had from the edge of the building.
- The next thing to be determined is the length of boom required. This is determined from the boom length arcs. In this case the 49 foot boom will barely meet the requirements. Checking the load chart for a 49 foot boom and 35 foot radius shows a lifting capacity of 4,700 lbs and therefore the lift can be made but it will be considered a critical lift which will require that all of the conditions be checked and verified.

RANGE DIAGRAM EXERCISE



Step 5: Draw a vertical line through the load center, intersecting the boom tip arcs. Identify the shortest boom length which provides the minimum boom tip height and provides sufficient clearance from the boom to the building.

Step 6: Knowing the boom length and the minimum radius, locate on the load capacity chart the load capacity for this particular set-up.

LOAD RADIUS (FEET)	LOADED BOOM ANGLE	27FT BOOM (LBS)	LOADED BOOM ANGLE	38FT BOOM (LBS)	LOADED BOOM ANGLE	49FT BOOM (LBS)	LOADED BOOM ANGLE	60FT BOOM (LBS)	LOADED BOOM ANGLE	71FT BOOM (LBS)	RATED LOAD DEDUCTIONS
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25	17	***7,600***	49	***7,500***	60	***6,800***	66.5	***6,200***	70.5	***5,800***	BLOCK = 200
30			37.5	***6,300***	53	***5,700***	61	***5,200***	66	***4,900***	
35			21	***5,000***	44.5	***4,900***	55	***4,500***	61.5	***4,200***	TWO SHEAVE
40					35	***4,200***	49	***3,900***	56.5	***3,600***	BLOCK = 355
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50							34	***2,900***	46	***2,750***	STOWED
55							23	***2,500***	40	***2,400***	JIM = 500
60									33	***2,100***	
65									23.5	***1,750***	
70									4	***1,100***	
	0	***6,000***	0	***3,800***	0	***2,400***	0	***1,550***	0	***950***	

CRANE SAFETY

- Do not leave the crane with a suspended load
- Rig the crane with sufficient parts of line for the load
- Avoid two-blocking the crane
- Always have a minimum of three wraps of cable on the drum
- Monitor the winch to make sure that it is spooling correcting
- Do not lift loads over personnel
- Lift one load at a time
- Maintain correct electrical clearance

MAKING THE LIFT

Review the lift scenario with the operator, riggers and signal person

Attach taglines when necessary

Position signal person within visibility of the load and operator

Begin by lifting the load *slowly*

Re-check the boom angle indicator to assess radius increase

Keep load as low as possible when moving it

Swing *slowly* to avoid swing out.

Avoid erratic booming

Follow signal and stop operation when uncertain

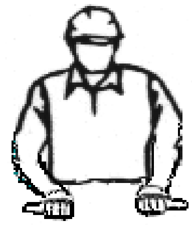
Lower load *slowly*

SIGNALS

- Only one person should be designated as the signal person.
- The emergency stop signal can be given by anyone on the site.
- The signals must be clear and precise.
- The crane operator should never respond to a signal that is not clearly understood.

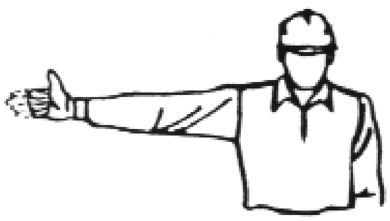
SIGNALS

DOG EVERYTHING



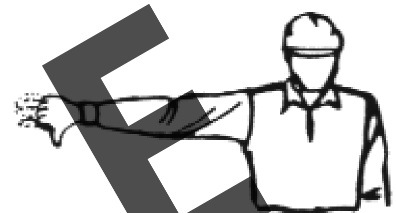
EXTEND BOOM

EMERGENCY STOP



LOWER THE LOAD
RAISE THE BOOM

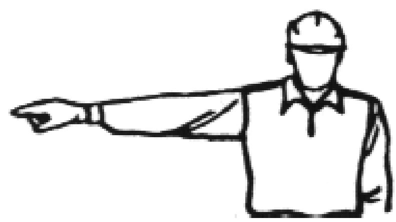
RETRACT BOOM



RAISE THE LOAD
LOWER THE BOOM

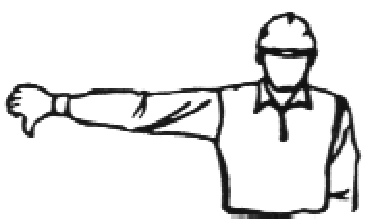
RAISE THE LOAD

RAISE THE BOOM



SWING

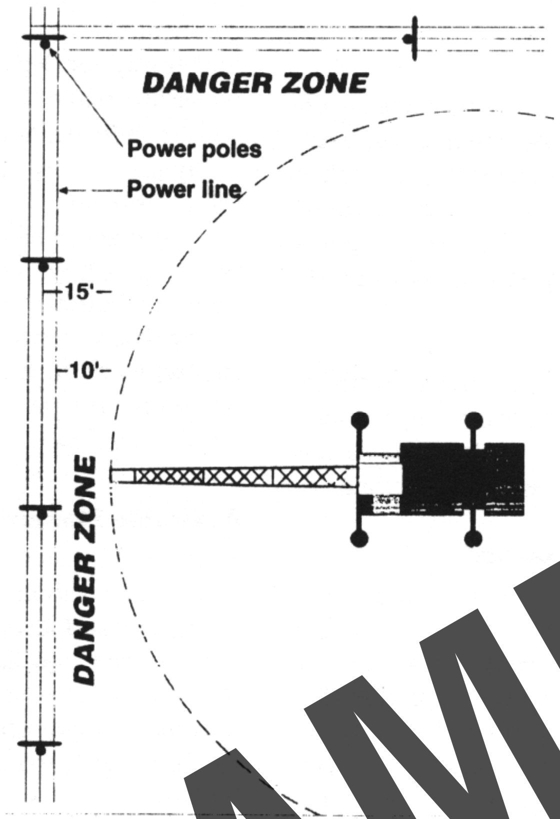
LOWER THE
LOAD



LOWER THE BOOM

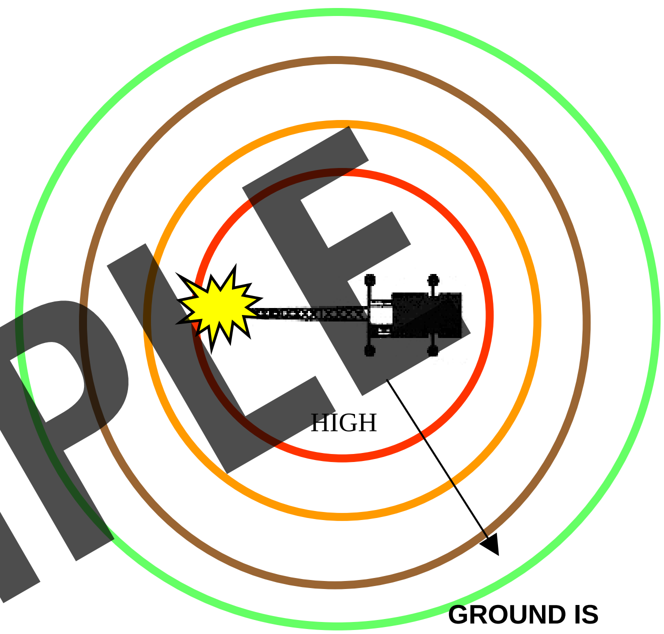
STOP

POWERLINE CONTACT



Required Clearances

50kV	10 ft
50 to 200kV	15 ft
200 to 350kV	20 ft

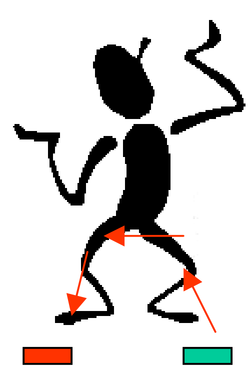


ELECTROCUTION IS THE #1 CAUSE OF DEATH INVOLVING CRANES. If contact is made….

1. The operator should remain with the crane if possible until the utility company indicates it is safe.

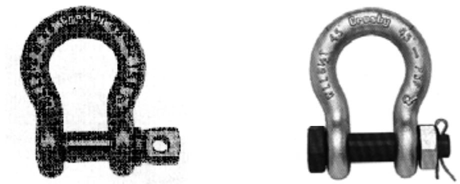
2. No one should be allowed to approach the machine or touch it. If the operator is unconscious, no attempt should be made to rescue him until it is safe.

3. If the operator must leave the machine due to fire, he should stand up carefully without touching anything and carefully jump to the ground landing on both feet. Once on the ground, he should shuffle away from the machine.



VOLTAGE PATH

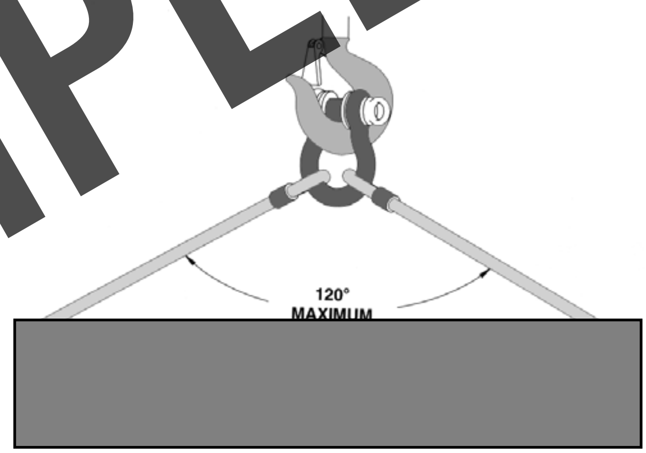
SHACKLE INSPECTION



The working load limit (WLL) must be printed on the shackle or it must be taken out of service. This WLL is for vertical lifts only.

Only two types of shackles are to be used in rigging for lifts. The screw pin type and the bolt type shackle.

Shackles that are deformed or damaged must be removed from service.



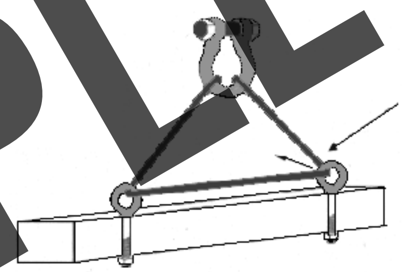
Side Loading Reduction Chart For Screw Pin & Bolt Type Shackles Only†	
Angle of Side Load	***Adjusted Working Load Limit***
0° In-Line	**100% of Rated Working Load Limit**
45° from In-Line	**70% of Rated Working Load Limit**
90° from In-Line	**50% of Rated Working Load Limit**

† DO NOT SIDE LOAD ROUND PIN SHACKLES

EYE BOLTS

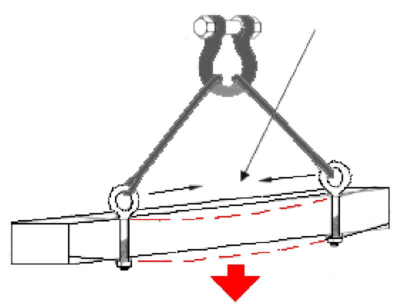
Eye bolts should always be inspected before use. Look for signs of wear and damage. Look to see if shank is bent or elongated. Make sure the threads on the shank and the receiving hole are clean.

DIRECTION OF PULL	ADJUSTED WORKING LOAD
In-Line	Full Rated Working Load
45 Degrees	30% of Rated Working Load
60 Degrees	60% of Rated Working Load



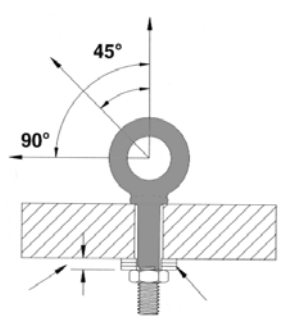
WRONG!

- Always use Shouldered Eye Bolts for angular lifts.
- For angular lifts, reduce working load according to chart.
- Never exceed load limits.
- Always screw eye bolt down completely for proper seating.
- Always tighten nuts securely against the load.
- Always stand clear of load when lifting.
- Always lift load with steady, even pull- do not jerk.
- Do not reeve slings from one eye bolt to another.
- Never machine, grind or cut the eye bolt.



CAUTION

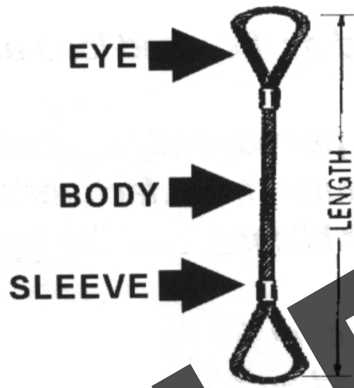
STRUCTURE MAY BUCKLE FROM COMPRESSION FORCES



Shoulder Nut
Eye Bolt

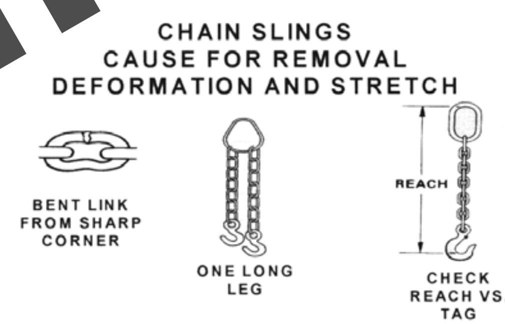
WIRE ROPE SLING INSPECTION

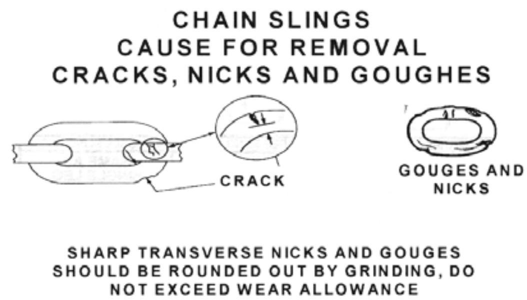
KINKING
CRUSHING
UNSTRANDING
BIRDCAGING
STRAND DISPLACEMENT
CORE PROTRUSION
CORROSION
BROKEN OR CUT
STRANDS
BROKEN WIRES



Wire rope slings need to be inspected in the same way wire rope is and a **record kept of those inspections**. All slings must have a tag on them indicating the capacity or they must be taken out of service.

Chain slings are to be inspected regularly and a record kept of these inspections also. Again, if there is no capacity tag, it must be taken out of service.
Chain slings are often used to hold steel while it is being welded. Always check to make sure heat damage has not occurred. Heat damage can be detected by discolored metal.



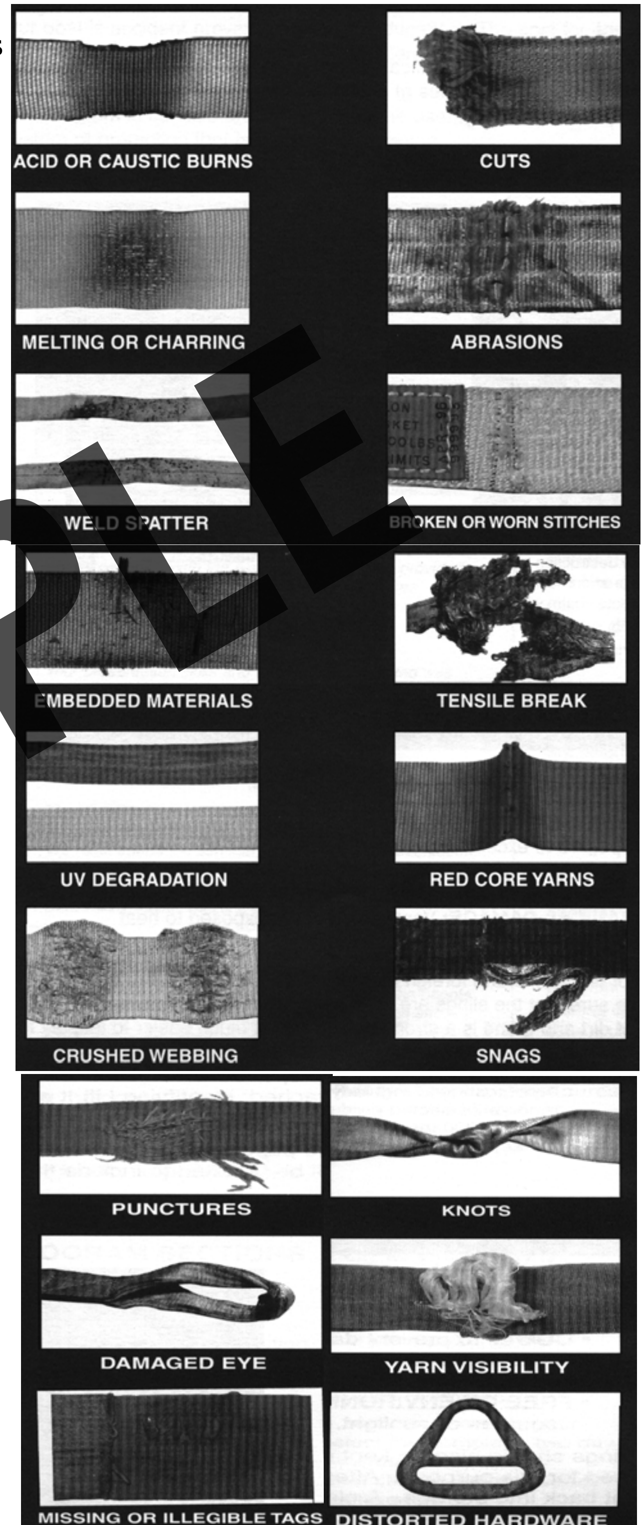


SYNTHETIC SLING INSPECTION

Far too many web slings have to be discarded prematurely simply because abusive or careless work habits caused irreparable damage.

To the right are some examples of damaged slings.

Regardless of whether a sling shows damage from abuse or regular wear, the overriding rule in all cases is that the sling eyes should be cut, and the sling discarded immediately whenever damage is detected.

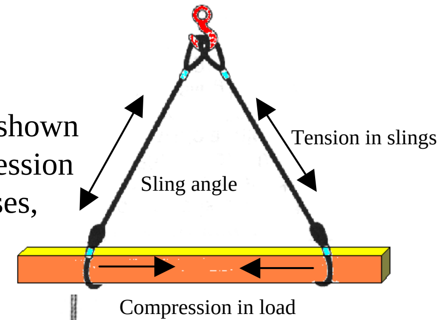


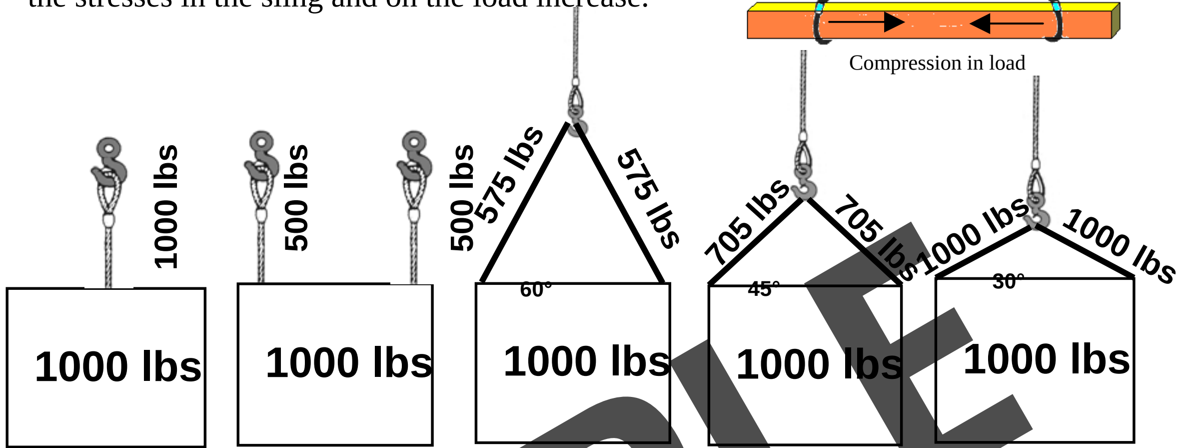
When using synthetic slings, remember:

- Slings without a capacity tag should be discarded. That tag should have the following information:
  - -Name and trademark of manufacturer.
  - -Manufacturer's code or stock number.
  - -Rated loads (rated capacities) for the type of hitches used.
  - -Type of synthetic material.
- Use wear pads on corners to protect the sling from cuts, or abrasions.
- Do not pull the sling out from under the load if caught under it.
- Take into consideration the sling angles when calculating the capacity of the sling to handle the load.

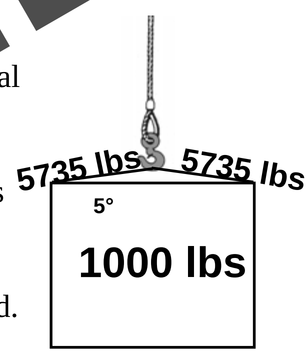
SLING ANGLES

When slings are brought together and form a hitch, as shown at right, the stresses in the slings increase and a compression force on the load is created. As the sling angle decreases, the stresses in the sling and on the load increase.





Sling angles of 60 degrees are the best to use because of the minimal increase of stress in the slings. When required to use smaller sling angles, slings need to be selected based on the increased stress and not on the weight of the load. The compression in the load also has to be considered. When the sling angle is 30 degrees for a 1000 lb load, the compression which is crushing the load will be 866 lbs. Depending on the structural strength of the load, it may be damaged.

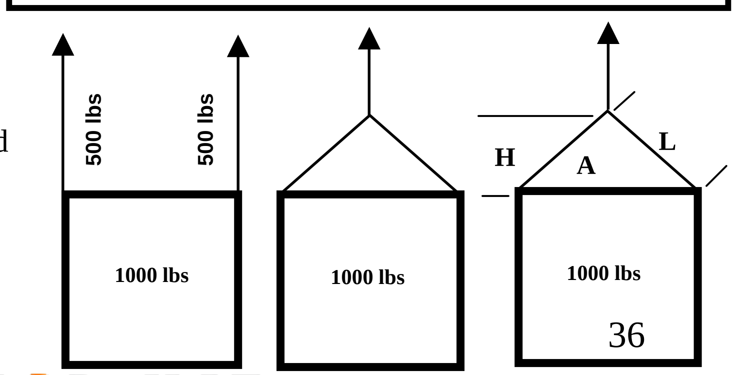


All that is needed to calculate the stress in a sling is the weight of the object and a measuring tape.

Sling Angle Degree (A)	Load Angle Factor = L/H
90	1.000
60	1.155
50	1.305
45	1.414
30	2.000
Load On Each Leg Of Sling = (Load/2 x Load Angle Factor	

Example: **Load in each sling = 500 x Load Angle Factor**

If the sling was 8' long and the height (H) was 4', then 8 divided by 4 equals 2 which equals the **Load Angle Factor**. So, if the load is 1000lbs, each sling is required to support 500lbs. The stress in the sling is equal to 500lbs x the load angle factor of 2 or 1000lbs.



CALCULATING LOAD WEIGHT

Importance of load weights

The weight of the load to be lifted must be known to prevent overloading of the boom truck. Without the weight the load chart cannot be referred to and guessing the weight can be dangerous.

You must know the weight of the load to prevent tipovers!

If you must estimate, never boom out to a point where the estimated weight would exceed 50% of the capacity of that load zone. In other words, make the best estimate you can and then multiply it by 2 to determine the safest load zone you can operate in.

Acceptable methods of determining weight

You may find the weight from:

- Data on manufacturing label plates.
- Manufacturer documentation.
- Blueprints or drawings.
- Shipping receipts.
- Weigh the item.
- Bill of lading (be careful)
- Stamped or written on the load
- Approved calculations

Never use word of mouth to establish the weight of an item!

CALCULATING LOAD WEIGHT

To find the weight of any item you need to know its volume and unit weight.

- Volume x Unit weight = Load weight
- Unit weight is the density of the material

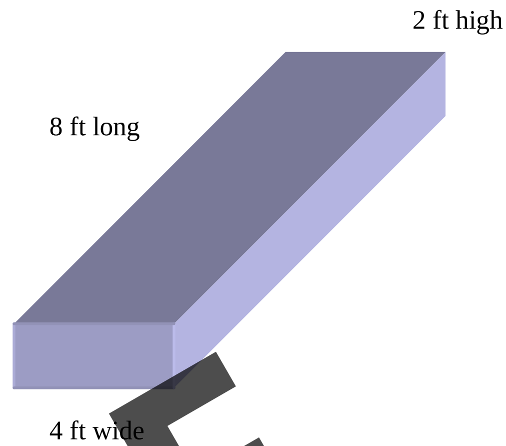
Here are some examples of common materials and their unit weight:

WEIGHTS OF MATERIALS BASED ON VOLUME (lbs. Per cubic ft.)

MATERIAL	UNIT WEIGHT	MATERIAL	UNIT WEIGHT
METALS		**TIMBER**	
Aluminum	165	Cedar	34
Brass	535	Cherry	36
Bronze	500	Fir, seasoned	34
Copper	560	Fir, wet	50
Iron	480	Hemlock	30
Lead	710	Maple	53
Steel	490	Oak	62
Tin	460	Pine	30
MASONARY		Poplar	30
Ashlar masonry	160	Spruce	28
Brick, soft	110	White pine	25
Brick, pressed	140	Railroad ties	50
Clay tile	60	**LIQUIDS**	
Rubble masonry	155	Diesel	52
Concrete, cinder, haydite	110	Gasoline	45
Concrete, slag	130	Water	64
Concrete, stone	144	**EARTH**	
Concrete, reinforced	150	Earth, wet	100
MISC.		Earth, dry	75
Asphalt	80	Sand and gravel, wet	120
Glass	160	Sand and gravel, dry	105

CALCULATING LOAD WEIGHT

CALCULATING VOLUME



Volume of a cube

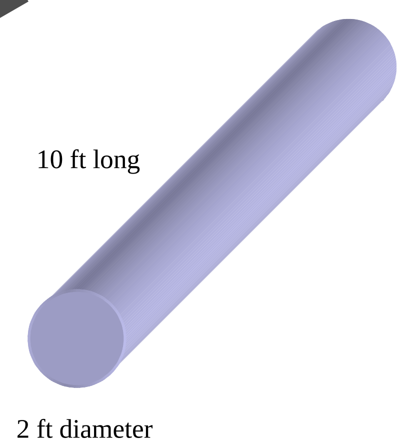
Length x Width x Height = Volume

8 ft x 4 ft x 2 ft = 64 cubic feet

If the material was **cedar**, then all we need to do to determine it's weight would be to multiply the unit weight of cedar x 64.

Unit weight x Volume = Weight

34 lbs per cubic foot X 64 cubic ft. = 2,176 lbs.



Volume of a cylinder

Pi (π) x Radius Squared x Length = Volume

π = 3.14

3.14 x 1^2 ft x 10 ft = 31.4 cubic ft

If the material was **reinforced concrete,** then all we need to do to determine it's weight would be to multiply the unit weight of reinforced concrete x 31.4.

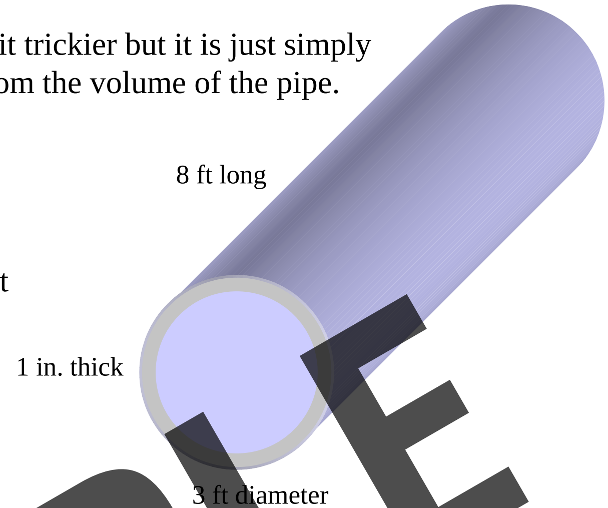
150 lbs per cubic foot x 31.4 cubic ft. = 4,710 lbs.

CALCULATING LOAD WEIGHT

Volume of pipe

Calculating the volume of pipe is a bit trickier but it is just simply subtracting the volume of the hole from the volume of the pipe.

If the pipe were one inch thick, three feet in diameter and 8 feet long, then we would figure the volume of the entire pipe and subtract the volume of the hole to get the the volume of the material.



3.14 x (1 ½ ft.)² x 8 feet = total volume of pipe (56.52 ft³)

3.14 x (1ft 5 in.)² x 8 feet = volume of hole (50.41 ft³)

56.52 ft³ – 50.41 ft³ = 6.11 ft³

Volume of material x unit weight = total weight

If this pipe were **steel** then the unit weight would be 490 lbs.

6.11 x 490 lbs = 2,994 lbs.

For thin pipe a quick way to ***ESTIMATE** the volume is to split the pipe open and calculate the volume like a cube. The formula would be:

π x diameter = width, so:

π x diameter x length x thickness x unit weight = weight of object

3.14 x 3 ft x 8 ft x 1/12 ft (or .008 ft) x 490 lbs = *3,077.2 lbs

CALCULATING LOAD WEIGHT

WEIGHT TABLES

Weight tables are an excellent way to calculate load weight.
If you are handling certain materials often, then having a chart that gives you the weight per cubic foot, cubic yard, square foot, linear foot or per gallon is handy. Here are a few examples:

METAL PLATES

1 INCH STEEL PLATE weighs approximately 40 lbs per sq. ft.
1/2 inch steel plate would then be about 20 lbs. per sq. ft.

A steel plate measuring 8 ft. x 10 ft. x 1inch would then weigh about 3,200 lbs. (8 x 10 x 40 lbs = 3,200 lbs.)

BEAMS

Beams come in all kinds of materials and shapes and lengths. STEEL I-BEAMS weigh approximately 40 lbs a linear ft. at 1/2 inch thick and 8 inches x 8 inches. If it were 1 inch thick then it would be 80 lbs a linear ft. If it were 20 feet long at 1 inch thick then it would weigh about 1,600 lbs. (20 ft. x 80 lbs. = 1,600lbs.)

There are weight tables for everything from creosoted pine poles to Steel coils. Take advantage of these. But, if you don't know for sure the weight of a load and there are no other resources available to help you, don't hesitate to do the calculations yourself.

CALCULATING WEIGHT REVIEW

USING THE FORMULAS AND WEIGHT TABLES FROM THE PREVIOUS PAGES, CALCULATE THE WEIGHT OF THE FOLLOWING OBJECTS:

1. A load of cedar 4” x 4” x 8’. The stack is 3’ high and 4’ wide.

   a. 6,528 lbs.
   b. 3,264 lbs.
   c. 1,632 lbs.
   d. not enough information was given.

2. A concrete pipe 1’ thick, 4’ in diameter and 12’ long.

   a. 33,930 lbs.
   b. 8,482 lbs.
   c. 16,965lbs.
   d. 1,696.5 lbs.

3. A steel plate that is 1” thick x 8’ x 12’.

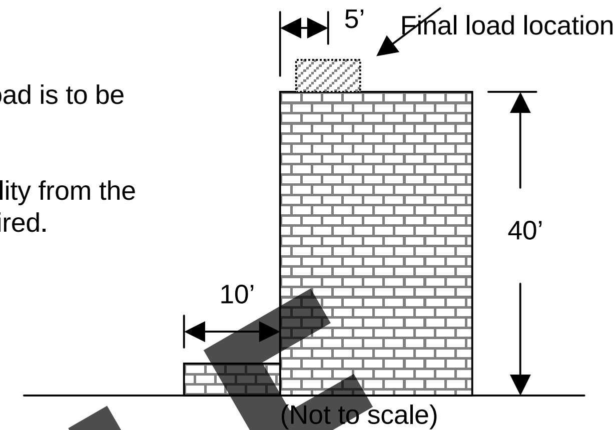
   a. 3,840 lbs.
   b. 6,550 lbs.
   c. 1,920 lbs.
   d. none of the above.

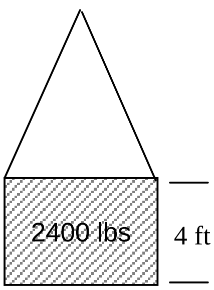
4. A one inch I-beam that is 8” x 8” x 12 ft long.

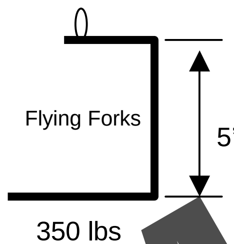
   a. 9,600 lbs.
   b. 6,300 lbs.
   c. 1,820 lbs.
   d. 960 lbs.

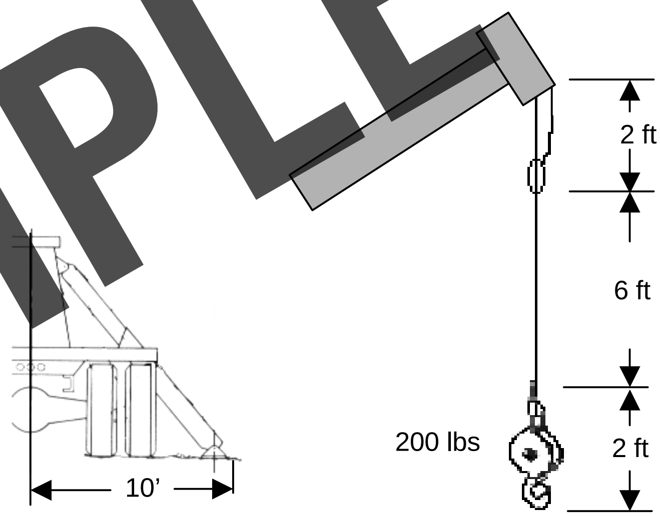
LOAD CHART EXERCISE

- A 2400 pound load is to be placed on the top of a roof using a set of flying forks.
- The adjacent diagram shows the building configuration and the position of where the load is to be placed.
- A minimum of 6 feet vertical operating flexibility from the boom tip to the anti-two-block cut out is required.









GROSS LOAD

Weight of load: ________lbs

Weight of forks: ________lbs

Weight of block: ________lbs

Gross load weight:________lbs

BOOM TIP HEIGHT

Building height: ________ft

Load & rigging height ________ft

Hook height: ________ft

Free line: ________ft

Minimum boom tip height:________ft

RADIUS

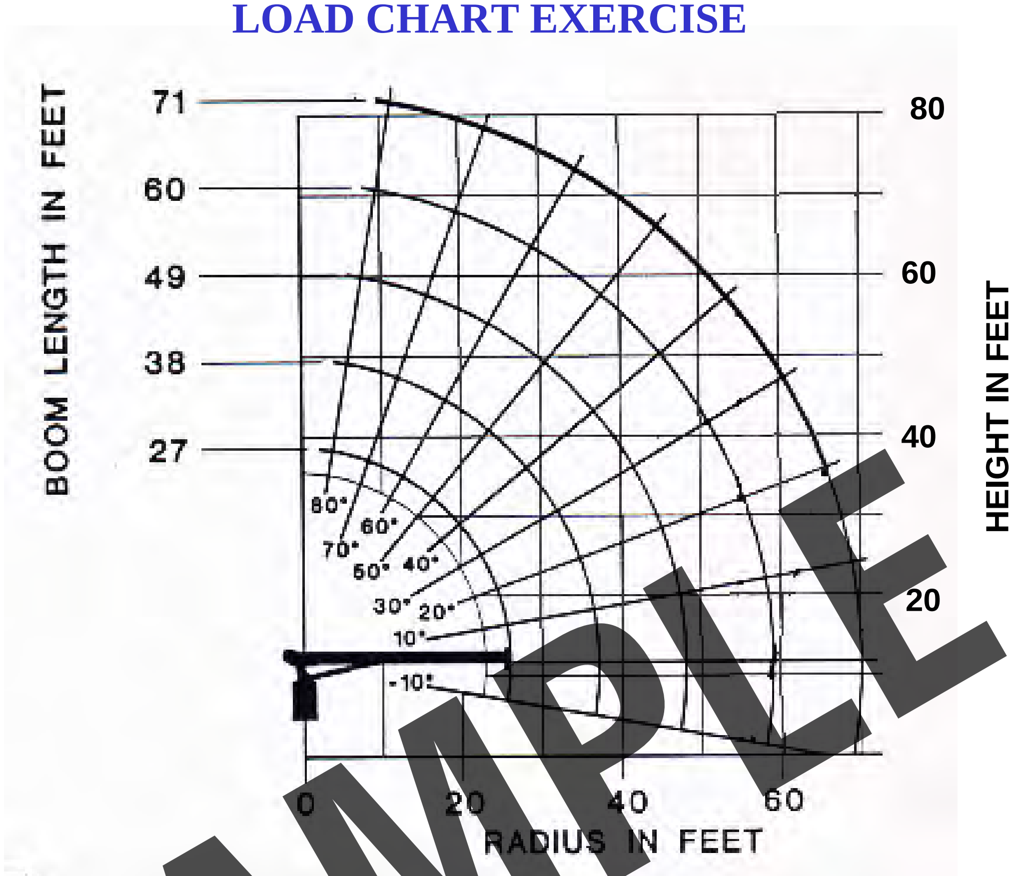
Center of rotation to stabilizer: ______ft

Stabilizer to edge of building: ______ft

Edge of building to center of load:______ft

Minimum radius: ______ft

LOAD CHART EXERCISE



Use the above diagram to sketch the problem from the previous page.

According to the chart below, can the crane make this lift safely?

LOAD RADIUS (FEET)	LOADED BOOM ANGLE	27FT BOOM (LBS)	LOADED BOOM ANGLE	38FT BOOM (LBS)	LOADED BOOM ANGLE	49FT BOOM (LBS)	LOADED BOOM ANGLE	60FT BOOM (LBS)	LOADED BOOM ANGLE	71FT BOOM (LBS)	RATED LOAD DEDUCTIONS
10	67	***17,900***	74.5	***16,100***	78.5	***14,900***					(LBS)
12	62.5	***15,400***	71.5	***13,900***	76	***12,800***	79	***11,800***			DOWNHAUL
14	57	***13,700***	68	***12,200***	73.5	***11,200***	77	***10,400***	79.5	***10,000***	WEIGHT = 150
16	52	***12,300***	64.5	***10,900***	71	***9,900***	75	***9,200***	77.5	***8,800***	
20	39.5	***10,000***	57	***9,000***	66	***8,200***	71.5	***7,600***	70.5	***7,200***	ONE SHEAVE
25	17	***7,600***	49	***7,500***	60	***6,800***	66.5	***6,200***	70.5	***5,800***	BLOCK = 200
30			37.5	***6,300***	53	***5,700***	61	***5,200***	66	***4,900***	
35			21	***5,000***	44.5	***4,900***	55	***4,500***	61.5	***4,200***	TWO SHEAVE
40					35	***4,200***	49	***3,900***	56.5	***3,600***	BLOCK = 355
45					22	***3,500***	42	***3,300***	51.5	***3,150***	
50							34	***2,900***	46	***2,750***	STOWED
55							23	***2,500***	40	***2,400***	JIB = 500
60									33	***2,100***	
65									23.5	***1,750***	
70									4	***1,100***	
	0	***6,000***	0	***3,800***	0	***2,400***	0	***1,550***	0	***950***	

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