ROUGH TERRAIN CRANE SAFETY TRAINING

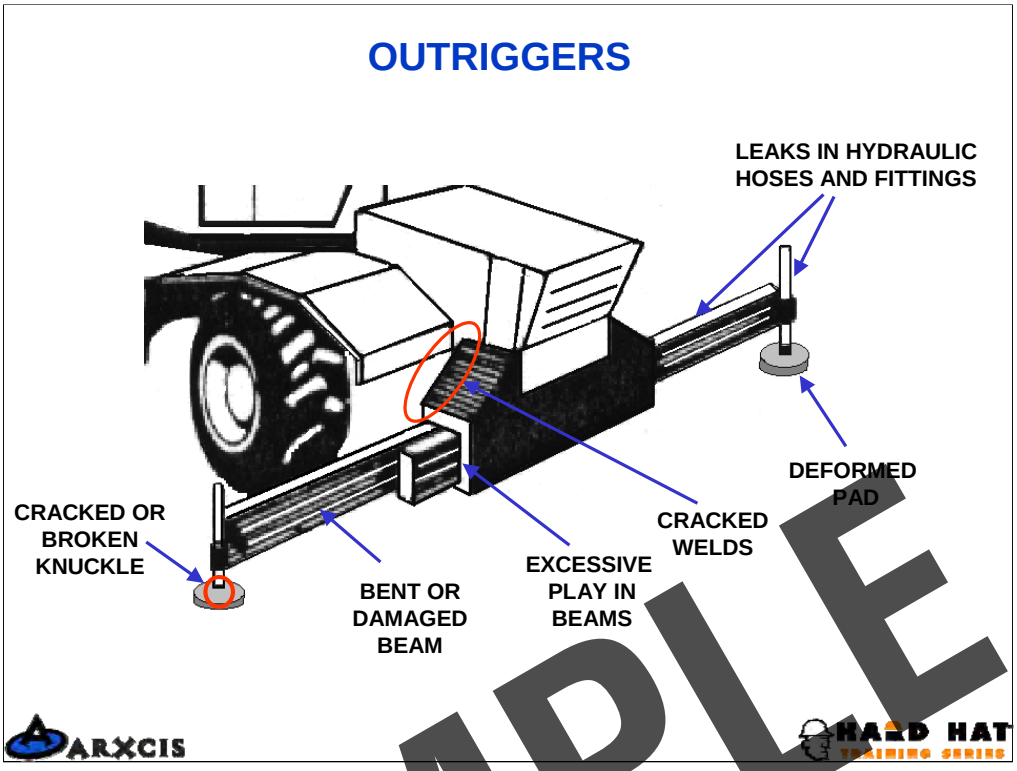
ARXCIS

HARD HAT TRAINING SERIES

Objective: To present the inspection checklist to students.

1. The inspection checklist is introduced now so that students can refer to it during discussions regarding the mechanical structure of a crane.

2. Review briefly the items on the checklist but do not go into any detail at this time.



Objective: To review the inspection of the outrigger section of the crane.

The crane outriggers need to be inspected prior to a crane being used. Check for the following items and any other that the manufacturer may recommend:

Cracked Welds – Check the area where the outrigger beam box attaches to the crane's frame. There are several areas which require crawling under the machine. Check other areas such as the beams and where the vertical stabilizers attach to the ends of the outrigger beams.

Stabilizer Pads – Check for bent or damaged pads. In order for the pads to evenly distribute the load placed on them, they need to be flat. Also check the knuckle where the pad attaches to the vertical stabilizer.

Hydraulic System – Check all of the hydraulic hoses, pipes, fittings and cylinders for leaks and damaged components. Look for excessive hydraulic fluid on the vertical stabilizer cylinder rods which may indicate the cylinder needs repair.

Outrigger Beam – Check the outrigger beam for dents, bends or cracks. Any damage needs to be investigated to determine its impact on safety.

CRACKED STRUCTURAL WELD

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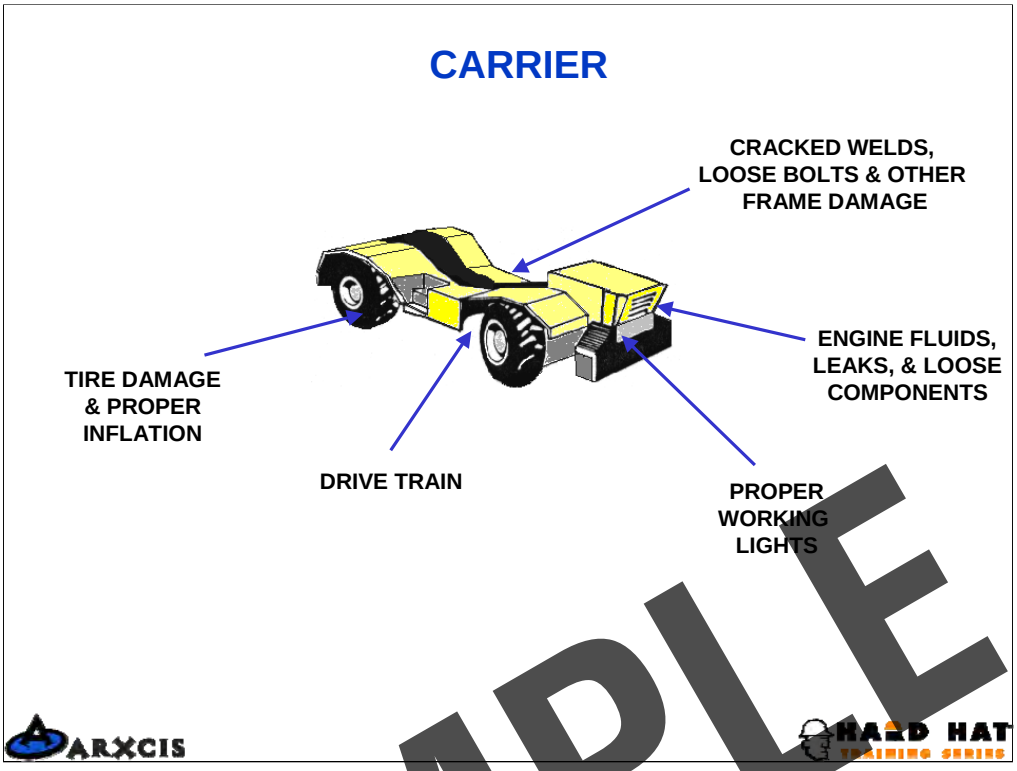
Objective: To review inspection of the outrigger section of the crane.

This slide is used to show how cracks in welds can occur and what they will look like.



Objective: To review the inspection of the carrier section of the crane.

The carrier section of the crane includes the frame, power train, engine and associated components.

INSPECTING THE UNDER-CARRIAGE

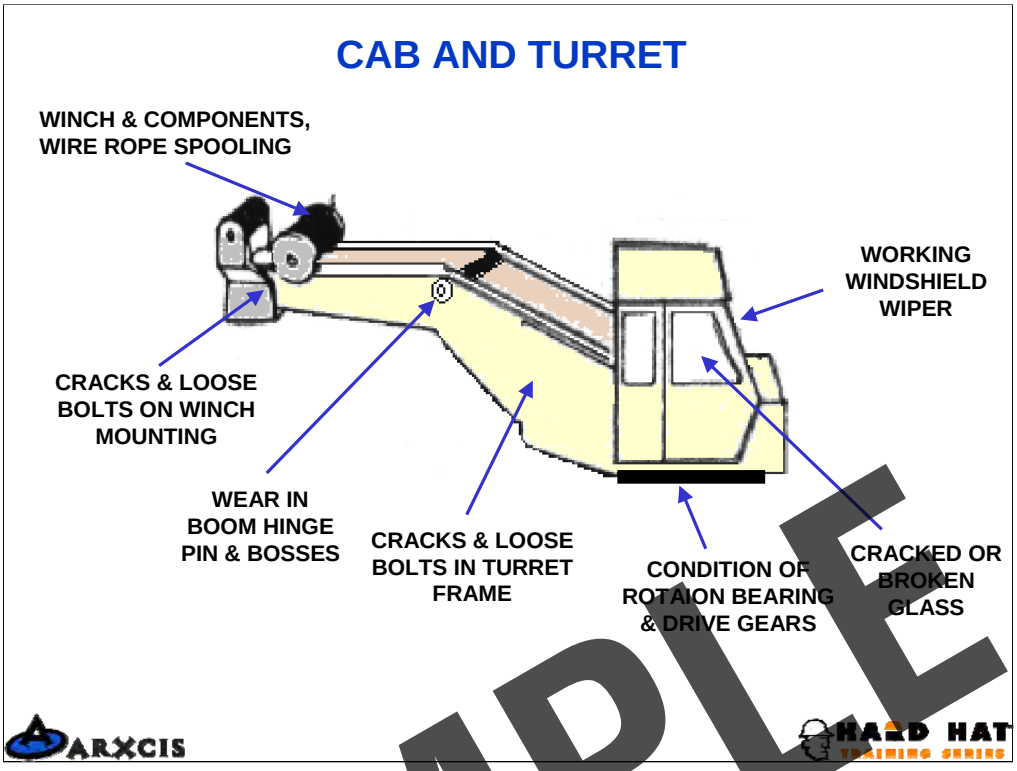
DRIVE TRAIN COMPONENTS

CHECK HOSES, FITTINGS AND OTHER HYDRAULIC COMPONENTS

Objective: To review the inspection of the carrier section of the crane.

The underside of the crane needs to be inspected on a regular basis. An inspection of the undercarriage should include the following:

- Check the frame for cracks and loose bolts.
- Check all hydraulic hoses for leaking hydraulic fluid and damage. On older machines, hydraulic hose fasteners tend to come loose, allowing them to chafe on the frame.
- Check all electrical wiring for damage.
- Check the power train for loose bolts and leaking fluids.
- Check the inside of the tire walls for damage.



Objective: To review the inspection of the cab and turret section of the crane.

The general inspection of the cab and turret section of the crane will include the following:

• All glass in the cab must be free of cracks, scratches and other damage which would obstruct the vision of the operator.

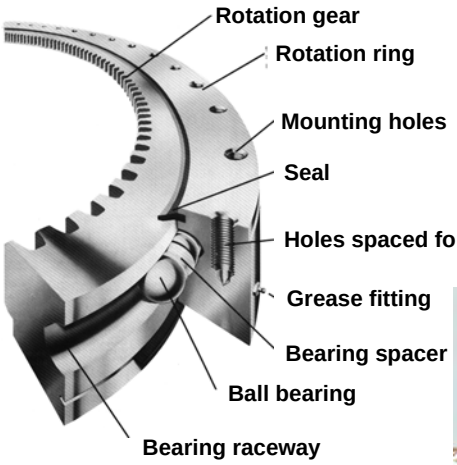
• All controls in the cab need to be clearly labeled with their function and direction of movement.

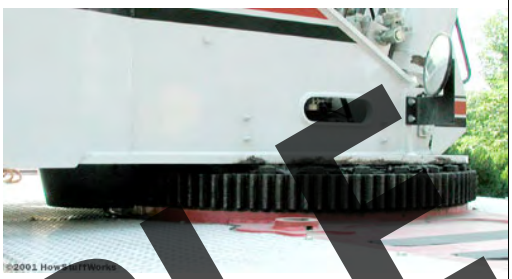
• A fire extinguisher is required to be in the cab.

• The turret frame must be checked for cracks and broken welds.

Additional inspection areas are covered in the following slides:

ROTATION BEARING





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Objective: To show the students how the rotation bearing is assembled and the importance of inspection and maintenance.

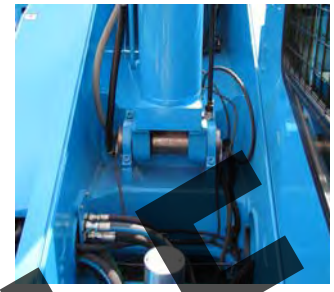
The rotation bearing is what attaches the turret to the carrier. The design of the bearing may differ slightly depending on the manufacturer. The major difference in design is whether the rotation gear is on the inside or outside. Review the different parts of the bearing.

Point out that the turret which is attached to one half of the bearing is held in place by the ball bearings only. If the bearing fails, there are no safety devices to prevent the turret from falling from the crane.

The rotation bearing needs to be lubricated on a regular basis to prevent wear and failure. Refer to the operator's and maintenance manuals for directions.

TURRET INSPECTION

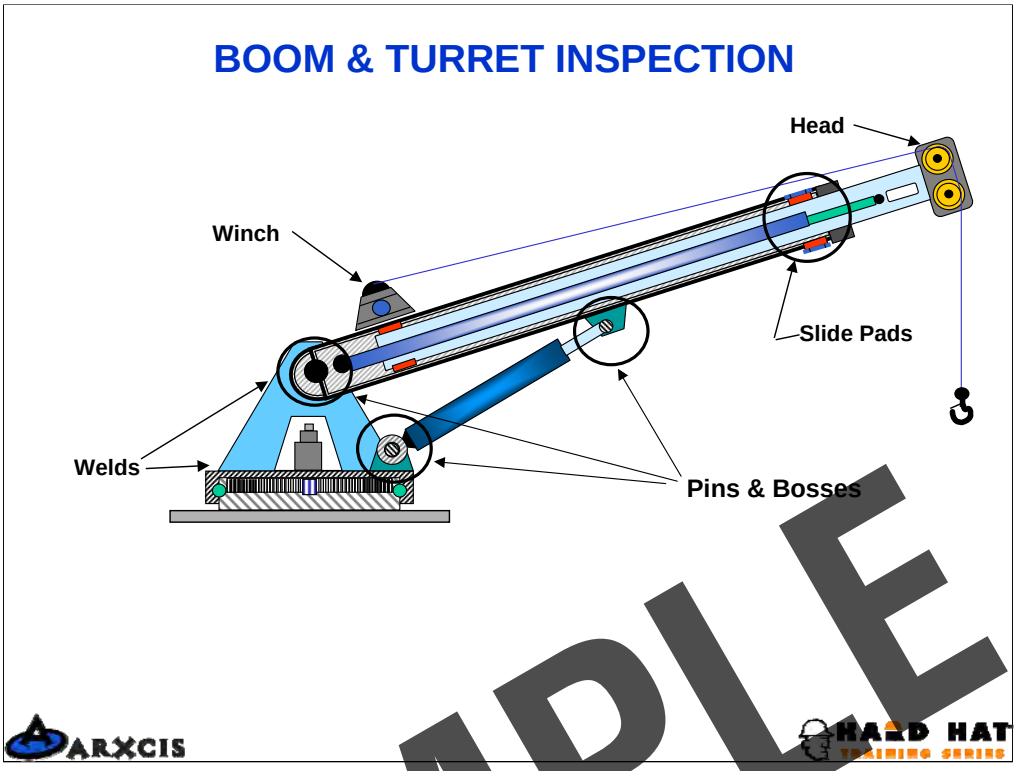
INSPECT THE CONDITION OF HYDRAULIC AND ELECTRICAL COMPONENTS IN THE TURRET AREA.



Objective: To review the inspection of the turret section of the crane.

There is a multitude of hydraulic hoses and electrical wires in the base of the turret section. Inspect these components for wear and damage. Any leaking fluid needs to be investigated.

Check the boom hinge pin and bushing for wear and for sufficient lubrication.



Objective: To review the inspection of the boom and turret section of the crane.

When inspecting the boom and turret section, check the following:

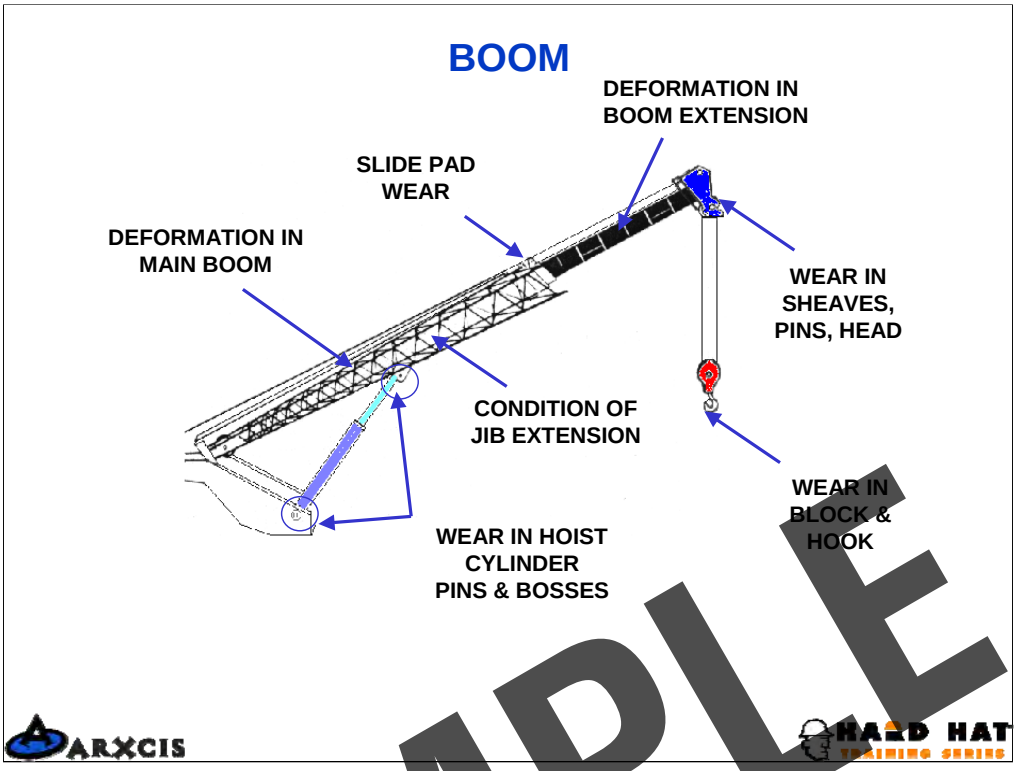
• All welds for cracks.

• Boom extension for smoothness of operation. Any binding or difficulty in extending the boom could be the result of damaged boom sections.

• The boom lift cylinders and extension cylinders for hydraulic leaks. Check the hoses for chafing and damage.

• Boom section slide pads for proper alignment. These can be checked by extending the boom completely and lowering the tip toward the ground. Move the boom tip back and forth by pushing on it and observing how much the boom sections move inside each other. Excessive movement requires the slide pads to be adjusted or replaced.

• The boom tip for deformation and twisting.

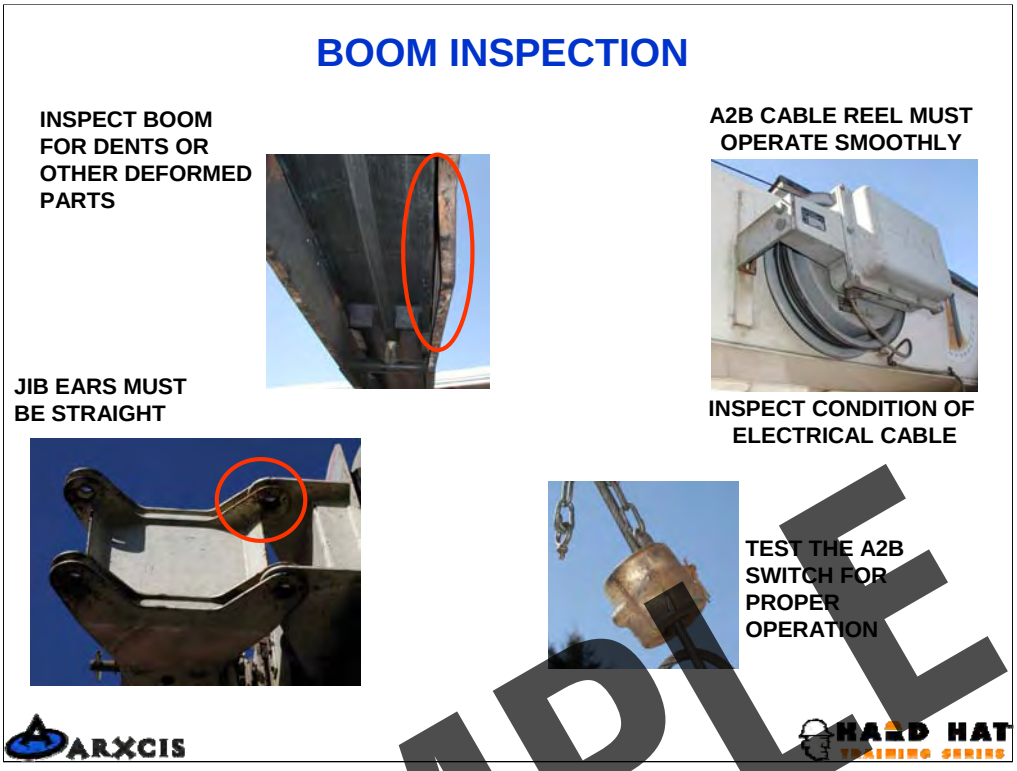


Objective: To review the inspection of the boom section of the crane.

When inspecting the boom section, check the following:

• Damage to the boom. Any dents, cracks or other damage to the boom needs immediate investigation. Because of the extreme stress experienced by the boom, such defects can lead to catastrophic failure.

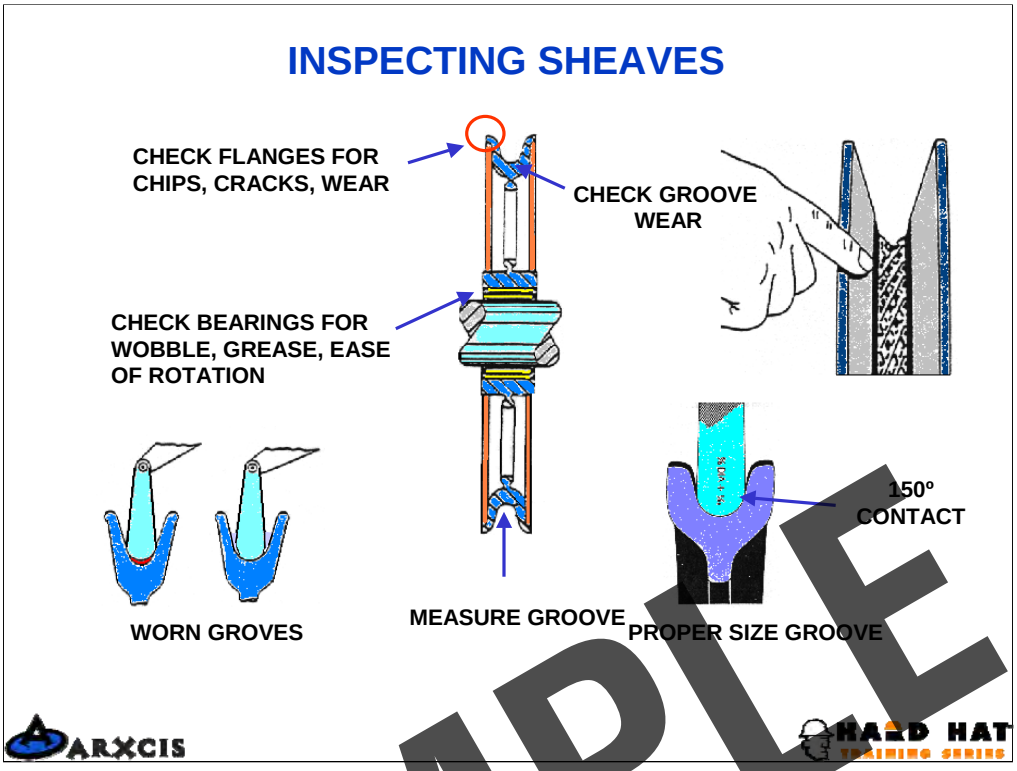
• Damage to the jib extension. If the jib extension is a lattice boom design, check the chords and lacings for dents and bends. Any damage found here needs to be immediately investigated to prevent catastrophic failure.



Objective: To review the inspection of the boom section and crane components.

For cranes with swing-away jib extensions, check the jib ears for damage. These ears need to be straight to allow the jib to swing around smoothly.

Cranes equipped with an anti-two-block, A2B, device often have an electrical cable reel attached to the side of the boom. This reel needs to be inspected regularly to ensure that it is rotating freely. Also, the condition of the electrical cable needs to be evaluated. The A2B switch mounted at the end of the boom should be tested to ensure that it will disable the boom extension and hoist up functions. The chain that suspends the weight from the A2B switch should be inspected for damage to all links and fasteners.



Objective: To review the inspection of the sheaves.

When inspecting the sheaves, check for the following:

• Bearing wear and adequate lubrication.

• Flange and groove damage. Newer cranes are equipped with plastic sheaves that are more susceptible to flange wear and damage. A sheave gauge can be used to determine the amount of wear to the groove of the sheave.

Sheaves that are damaged can only be repaired per manufacturer's procedures.

HOOK AND OVERHAUL BALL

THE WEIGHT & CAPACITY OF THE BALL NEEDS TO BE CLEARLY DISPLAYED

INSPECT THE CONDITION OF THE HOOK FASTENERS

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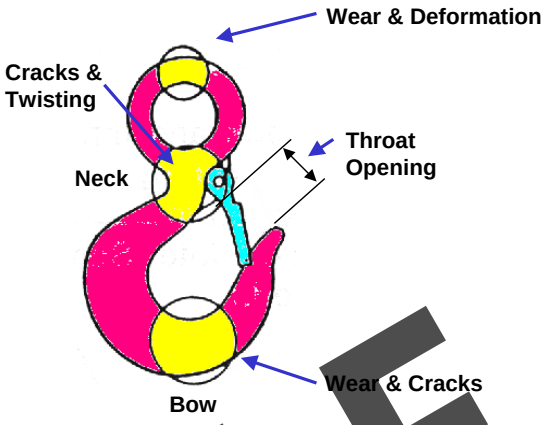
Objective: To review the inspection of the hook and overhaul ball.

Cranes that are equipped with an auxiliary winch and a single part of hoist wire normally use a combined hook and overhaul ball arrangement. The weight of the ball should be marked on the ball. The swivel that is located inside the ball must rotate freely and not have excessive wear. Some swivels have permanently lubricated bearings while others require regular greasing. The fasteners which attach the ball to the wire rope and the hook to the ball need to be load-rated and inspected for damage and wear.

HOOK INSPECTION

CHECK FOR:

- Wear
- Deformation
- Cracks & Sharp Nicks
- Modifications
- Safety Latches
- Swivel Wear & Lubrication
- Hook Shackle Mousing



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HARD HAT TRAINING SERIES

Objective: To review the inspection of the hook.

Hooks need to be inspected regularly for wear and damage. Hooks can only be repaired per manufacturer's procedures.

Wear in excess of 5% in the neck of the hook and 10% in other areas including the bow of the hook 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.

The hook safety latch must function properly and not be removed.

CRANE BLOCK

WEIGHT & CAPACITY OF HOOK BLOCK NEEDS TO BE CLEARLY DISPLAYED

WHEN NOT IN USE, HOOK BLOCKS REQUIRE PROPER STORAGE

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Objective: To review the inspection criteria for hook blocks.

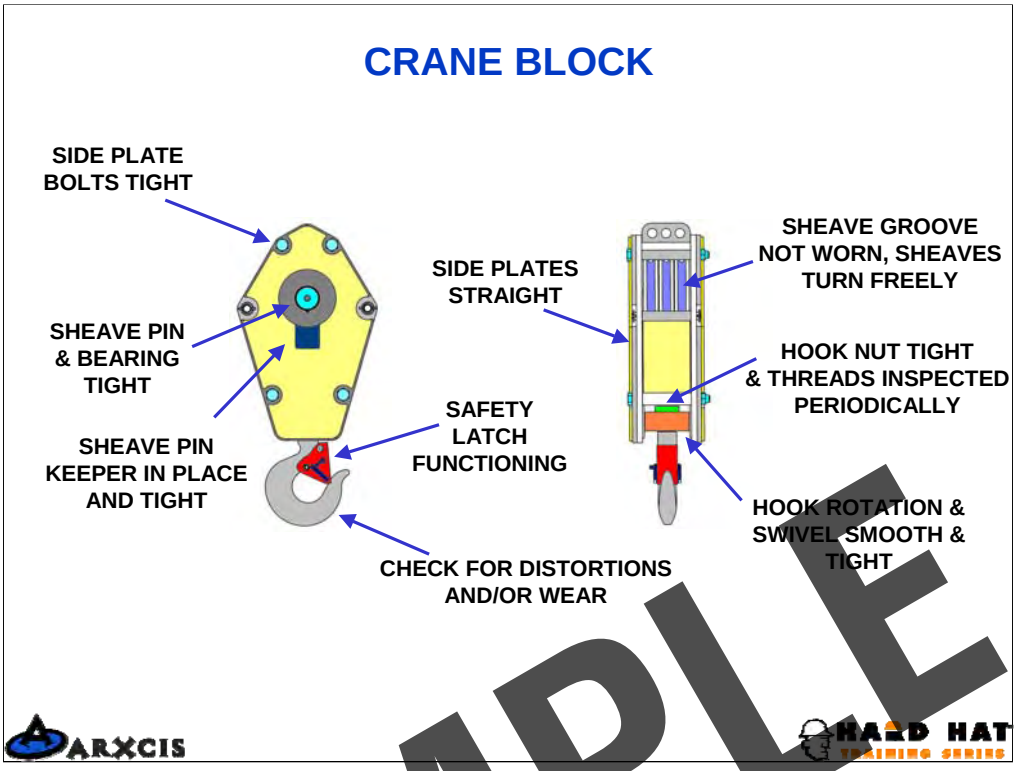
Sheaves and bearings need to be inspected as discussed earlier.

Side plates and any additional weights attached to their sides need to be inspected for loose or missing bolts or other fasteners.

The hook should rotate freely on the swivel bearing. Check for excessive movement.

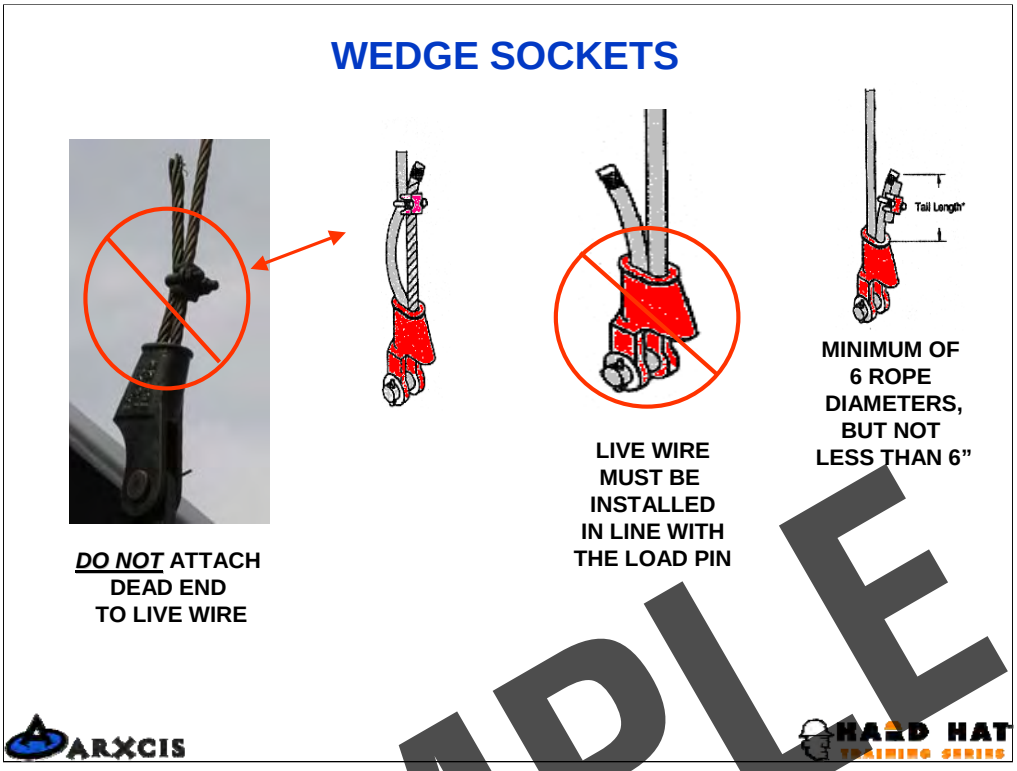
The hook shank and nut should be separated periodically and the threads inspected for corrosion and other damage. The loss of more than 20% of the threaded area due to corrosion is cause for removal.

The safety latch must be in place and functioning properly.



Objective: To review the inspection criteria for hook blocks

Continuation of the previous slide

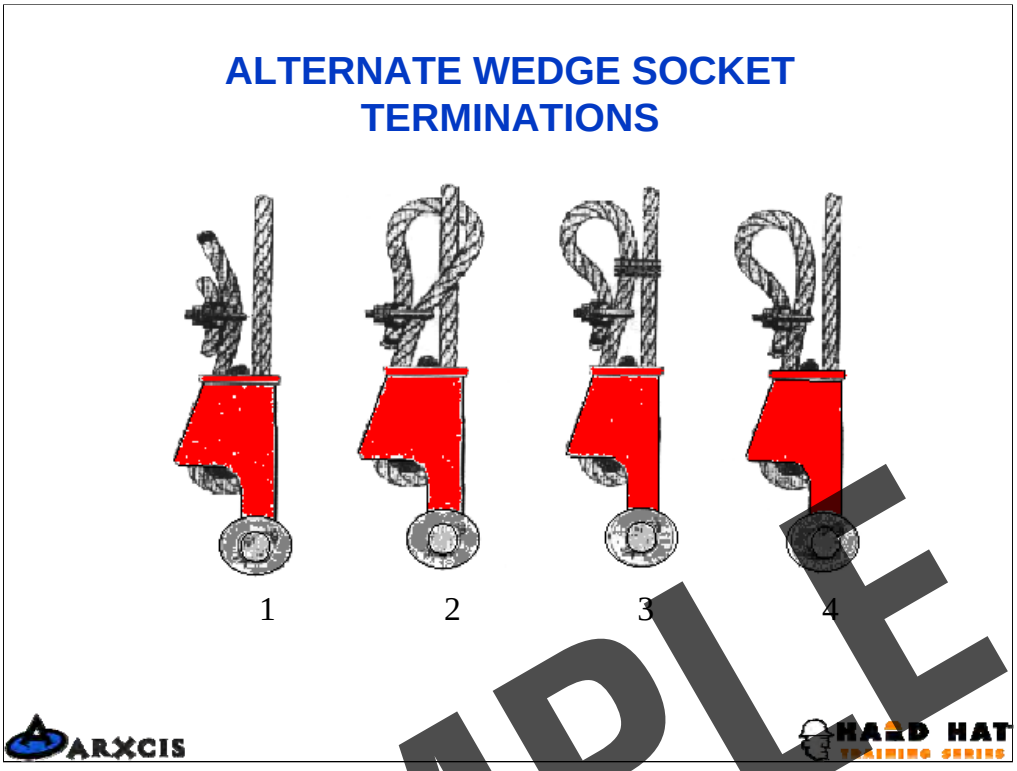


Objective: To demonstrate the proper use of the wedge socket.

Wedge sockets are often used to provide an end fitting on hoist wire rope. The socket must be installed according to manufacturer’s directions. When inspecting a wedge socket, look for the following:

• The live load wire rope feeding into the wedge socket must be in line with the load pin on the socket.

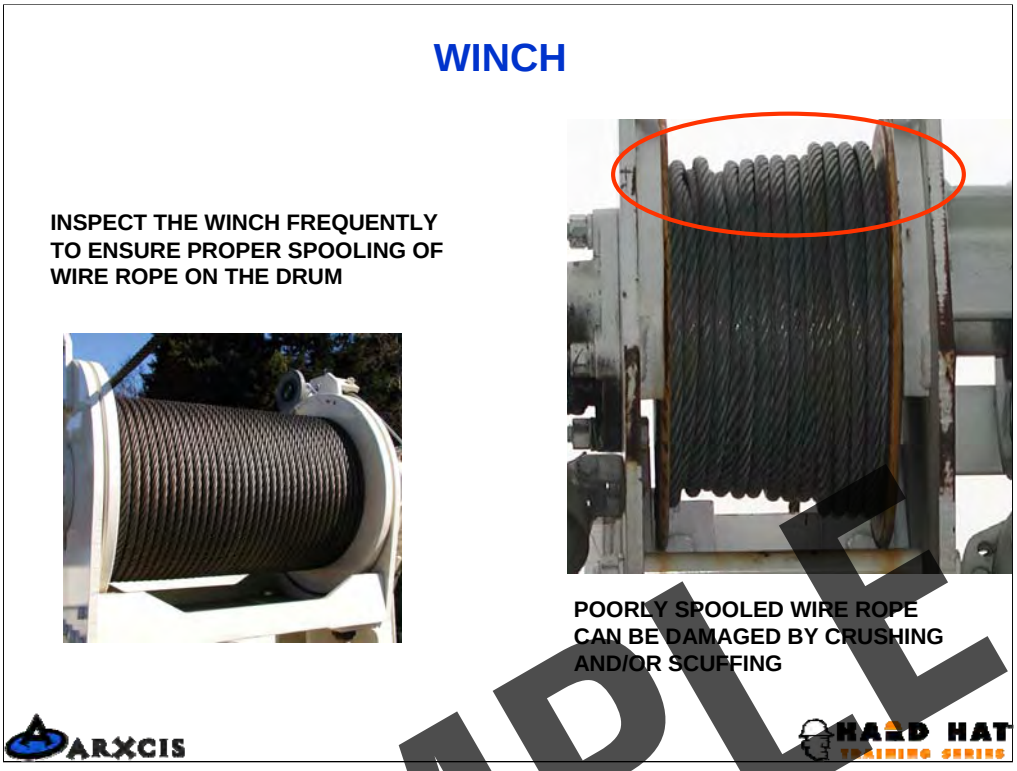
• The dead-end tail coming out of the socket must not be connected back to the live load line.



Objective: Show the proper way to terminate the dead end of the wire rope.

The above slide shows various ways the dead end of the hoist wire rope can be properly terminated.

The most common termination for rough terrain cranes is number 2. This type of termination tends to prevent fouling the A2B weight.



Objective: To emphasize the importance of proper wire rope spooling on a winch drum.

The spooling of wire rope on a winch needs be regularly monitored to prevent damage.

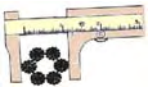
Crushing, from spooling problems is one of the most common causes of damaged wire rope on a crane.

The operator needs to monitor the winch to prevent wraps from loosening and allowing the wire rope to cross over itself.

Loosely wrapped wire rope needs to be unspooled and then properly respooled on the winch to prevent damage.

WIRE ROPE INSPECTION

MEASURE WIRE ROPE
TO CHECK FOR WEAR



PROPER WAY TO MEASURE
WIRE ROPE DIAMETER

CRUCHED WIRE ROPE

Poor Spooling On Winch

SCUFFING

Poor Spooling On Winch

ARXCIS

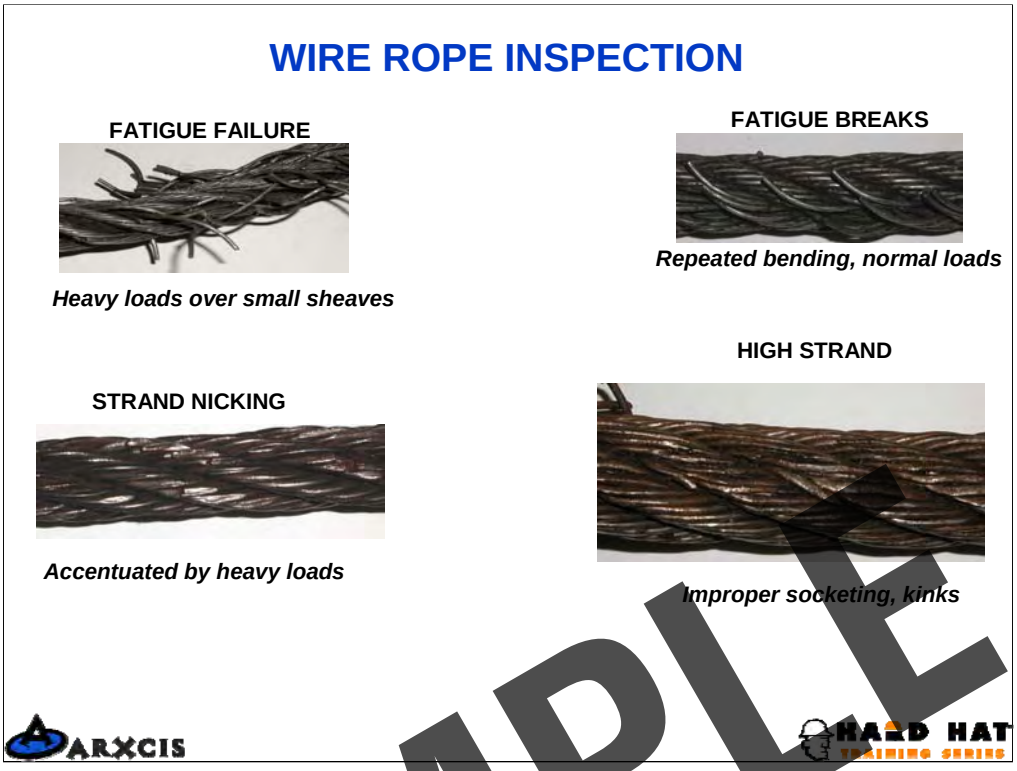
HARD HAT TRAINING SERIES

Objectives: Review what to look for when inspecting wire rope.

The diameter of a wire rope should regularly be measured. When the diameter is less than the nominal value for the wire rope, its manufacturer should be consulted to determine the minimum allowable number.

One of the primary causes for wire rope removal is crushing. Wire rope which has been crushed causing permanent deformation needs to be replaced.

Poorly spooled wire rope, which has valleys between the wraps, will cause subsequent wraps to fall into these valleys, resulting in scuffing. Scuffing normally causes the outer wires in the strands to break.



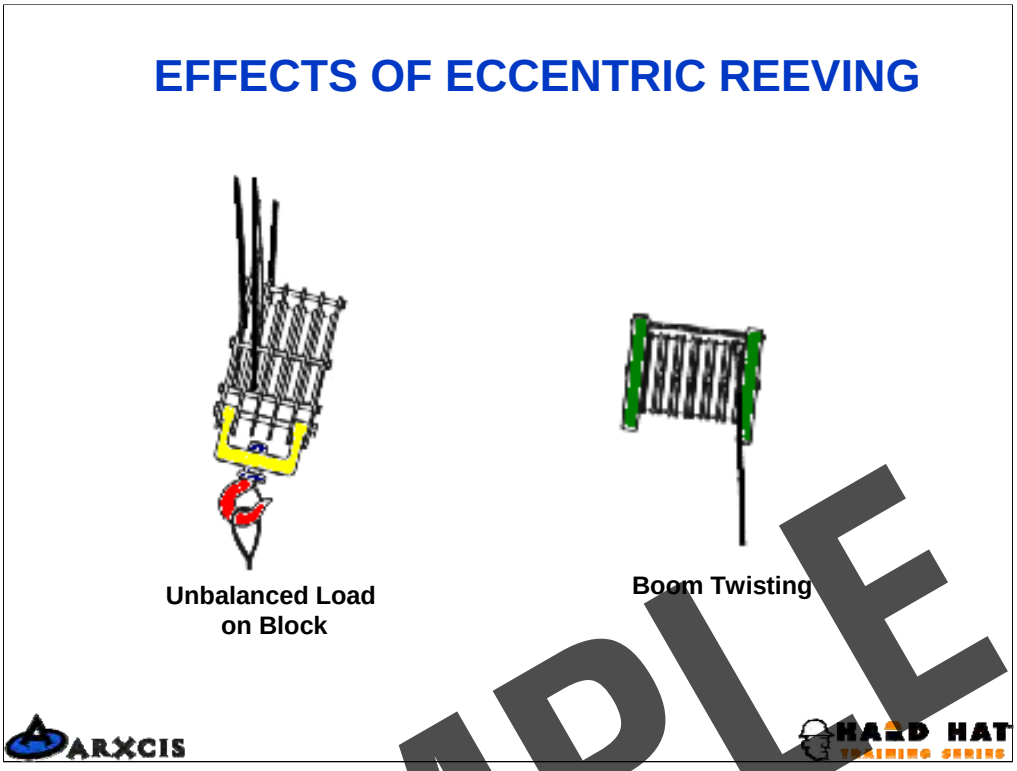
Objectives: Review what to look for when inspecting wire rope.

Wire rope that is lifting heavy loads over small sheaves fatigues prematurely and results in broken wires in the strands.

All wire rope that is repeatedly bent over sheaves and winch drums will eventually break due to fatigue.

Strand nicking can be a result of lifting loads in excess of the wire rope's rated capacity. This nicking occurs when wire rope is spooled onto a winch drum.

High stranding occurs when a strand in the wire rope loosens. This is often a result of not setting the wedge socket properly. If high stranding is noticed, the rope may need to be replaced.

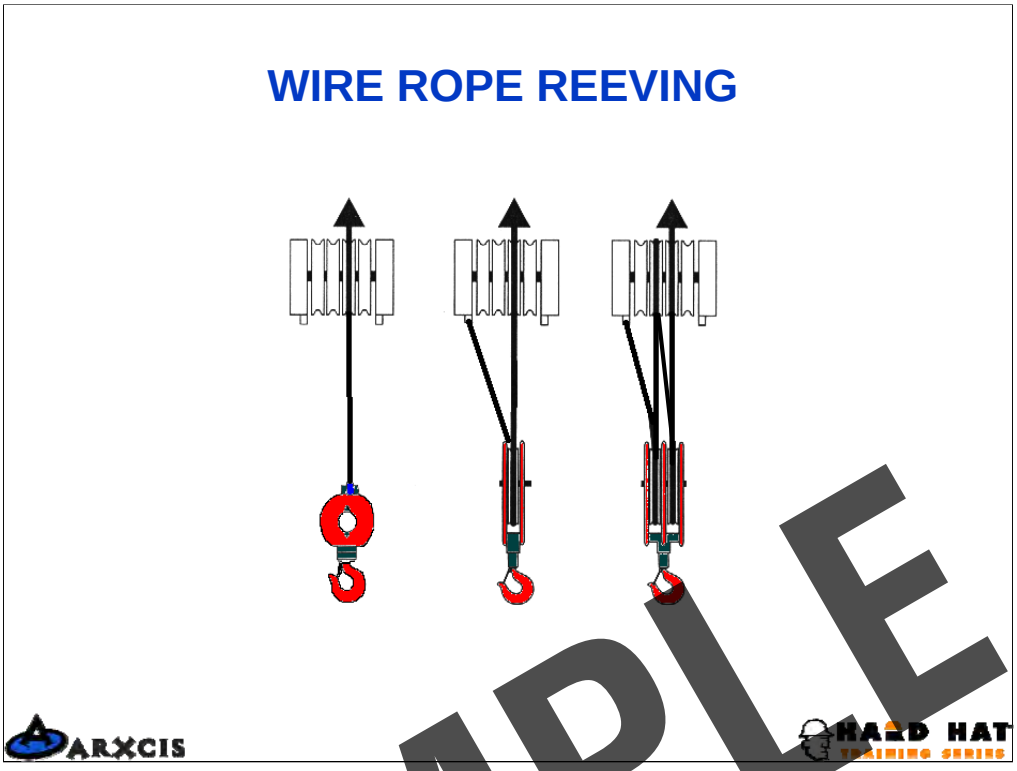


Objectives: To illustrate the effects of eccentric reeving.

When reconfiguring the reeving on the load block, the parts of line need to be evenly spaced on both sides of the hook to prevent the block from tilting when picking up a load. Flange damage to the sheaves can result from operating like this.

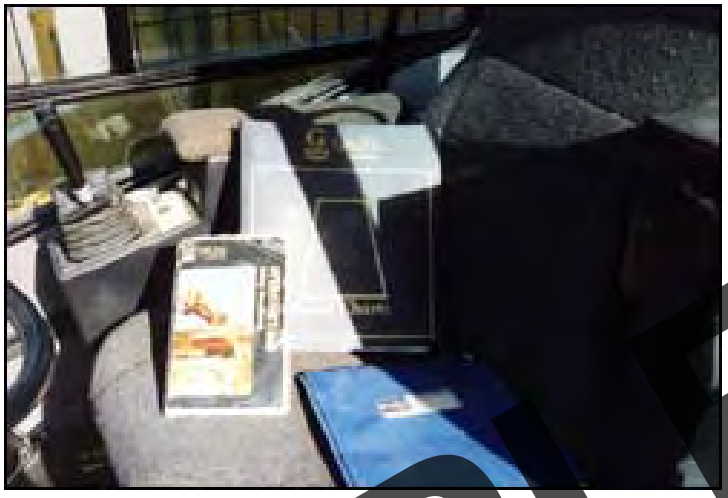
The improperly reeved wire rope on the boom tip can cause the boom to twist. Evenly space the wire rope to prevent boom twisting.

WIRE ROPE REEVING



Objectives: To illustrate proper reeving.

OPERATOR MANUAL & DOCUMENTATION



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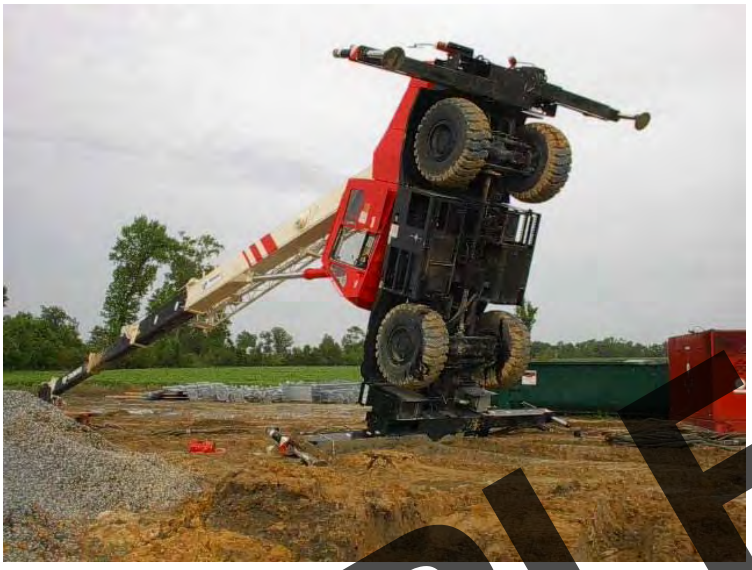
Objective: To review the documentation that should be on a crane.

The operator's manual is required to be with the crane at all times. Along with this manual, load capacity charts must be in the cab for the operator to refer to. Additional documentation includes wire rope certificates for all hoist lines and manuals for special hardware.

CRANE STABILITY



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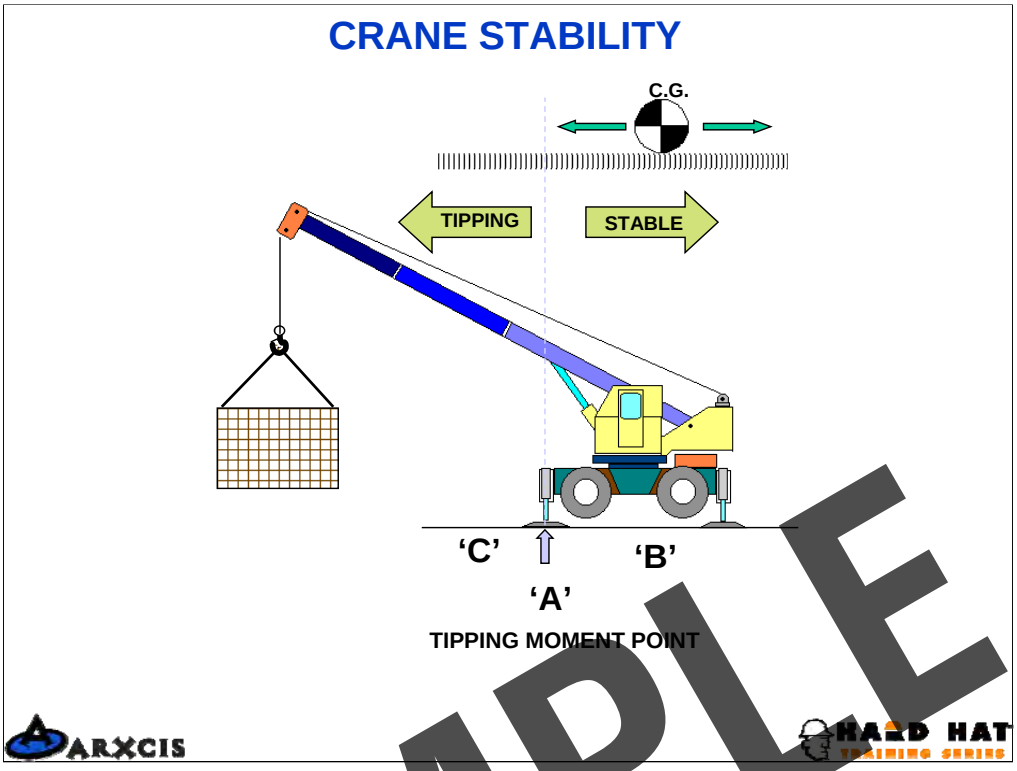
Objective: To introduce the next set of slides which discuss issues of stability and setup.

A major cause of crane accidents is the crane tipping over. The principles governing crane stability need to be clearly understood by the operator. Causes of tipover accidents are:

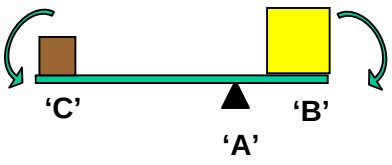
- Poor ground conditions
- Crane not set up per manufacturer's specifications
- Not adhering to load capacity charts

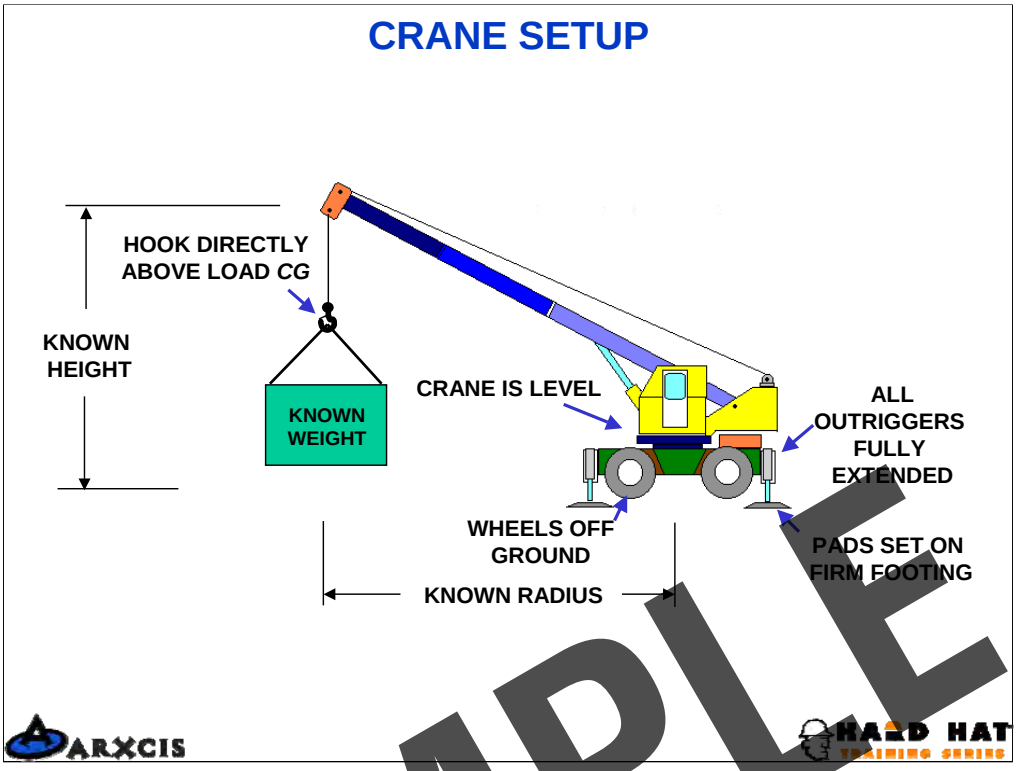
Each of these points will be discussed in detail.



Objectives: To show how stability of a crane is based on the principle of leverage.

Crane stability is based on the principle of leverage. The crane can be viewed as a teeter-totter. The fulcrum, point A, is similar to the outrigger or tire over which the load is being lifted. When the leverage on side B is greater that the leverage on side C, the crane remains stable. When the leverage on side C becomes greater than on side B, the crane tips over. The leverage on side B basically depends on whether the crane is operating on rubber or with outriggers extended. When operating on rubber, the leverage is much less than when operating with outriggers extended. The *amount* the outriggers are extended also affects the amount of leverage generated. The leverage on side C depends on the horizontal distance the load is from point A and the weight of the load. Increasing the horizontal distance and/or increasing the weight of the load increases the leverage on side C. The horizontal distance from point A to the load can be increased by lowering the boom and/or extending the boom.





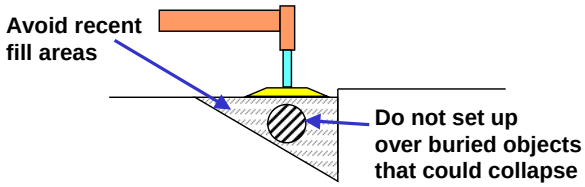
Objectives: To review basic requirements for proper crane setup.

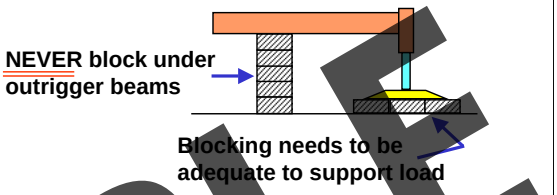
When setting up the crane, the operator should refer to the operator's manual for specific directions. Consider the following:

- When operating on rubber, follow the setup procedure and limitations specified by the crane manufacturer.
- When operating on outriggers, extend them per the load chart requirement.
- When operating on outriggers, crane wheels need to be off the ground.
- The outrigger pads need to be set on firm footings.
- The crane needs to be level.
- The weight of the load and the distance the load will be from the crane must be known.
- The height at which the load is to be placed needs to be known.

CRANE SETUP

Selecting a Suitable Site





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Objective: To consider requirements for safe crane setup.

1. The first consideration is the quality of the surface the crane will be set up on.
2. Soils along the foundation of buildings are often poorly compacted and may contain drain pipe and other voids. Avoid setting up in such areas if possible. If such setup is necessary, use additional floats.
3. Floats larger than the outrigger pads should be used under each outrigger regardless of the type of surface being set up on. Float use will reduce the pounds per square inch loading on the surface which helps prevent the outrigger from sinking.
4. Blocking under the outrigger beam prevents full leverage of the outrigger being utilized. Such blocking increases potential for a tipover.
5. Always extend all outriggers. Not doing so can result in the crane tipping over.

POOR SETUP CAN END LIKE THIS

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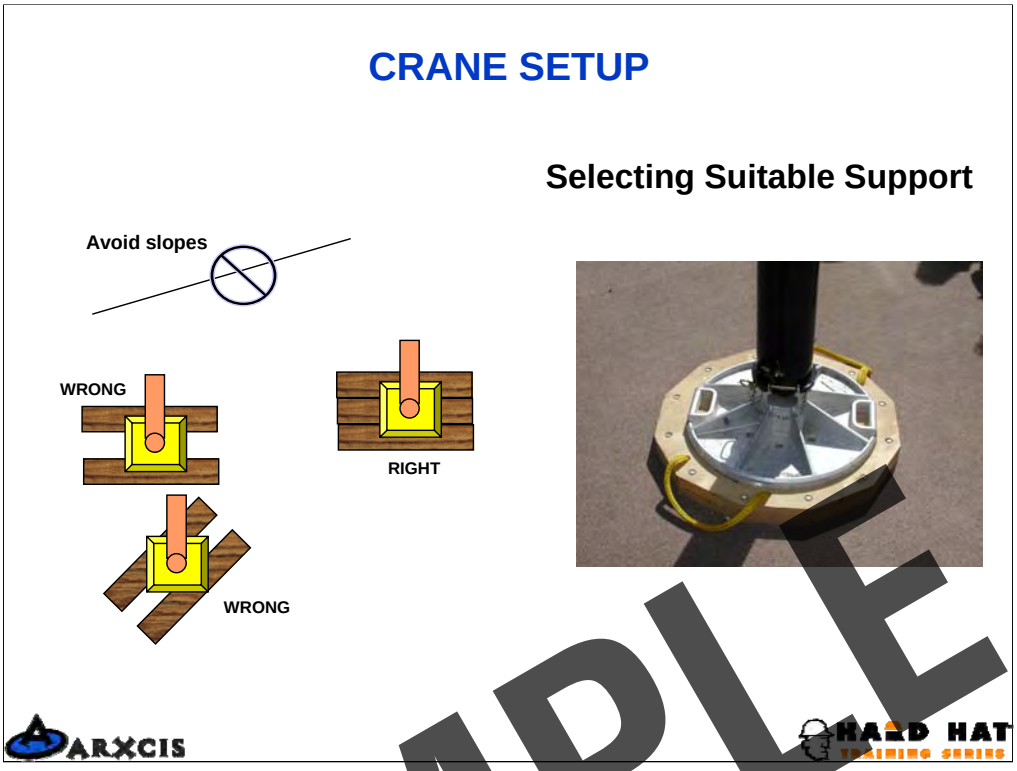
Objective: To illustrate how improper setup may result in an accident.

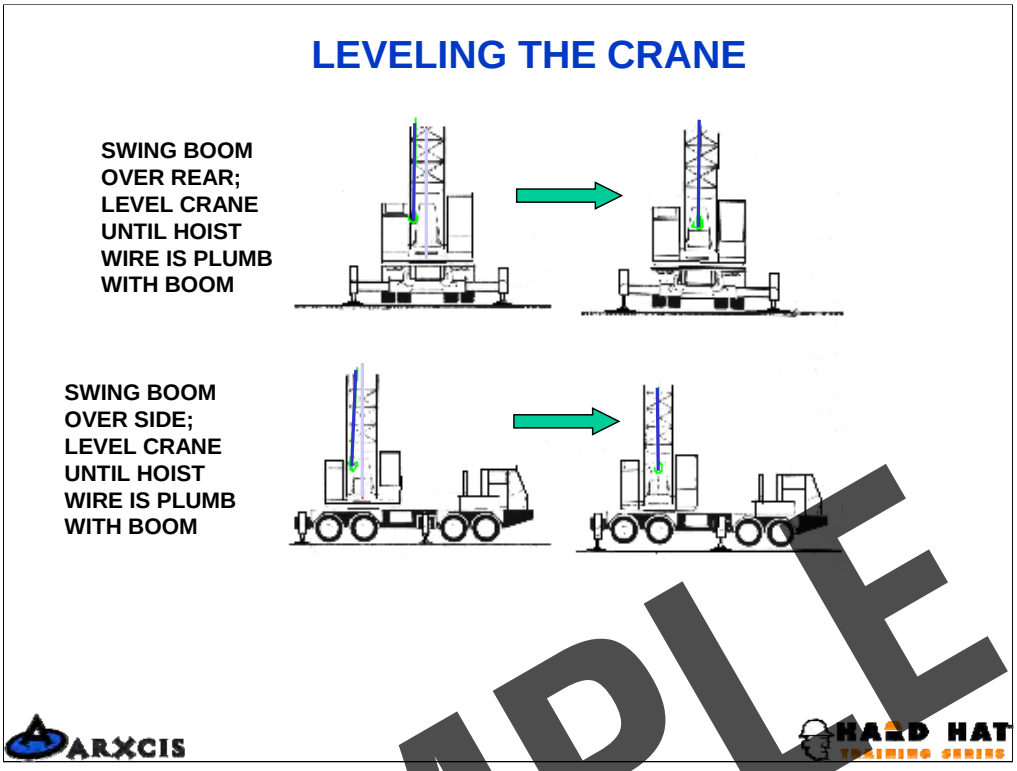
Outriggers on rough terrain cranes need to be extended per the manufacturer's requirements. Some cranes allow the outriggers to be partially extended and provide a load capacity chart for that particular setup. Other cranes, especially older ones, do not allow partially extensions. Operating with partial extended outriggers without corresponding load capacity charts can result in an accident.



Objective: To discuss the use of floats under outrigger pads.

The use of floats under outrigger pads greatly increases the safety of an operation. By increasing the size of the footprint, the concentrated load on the ground decreases thus decreasing the potential for a tipover.

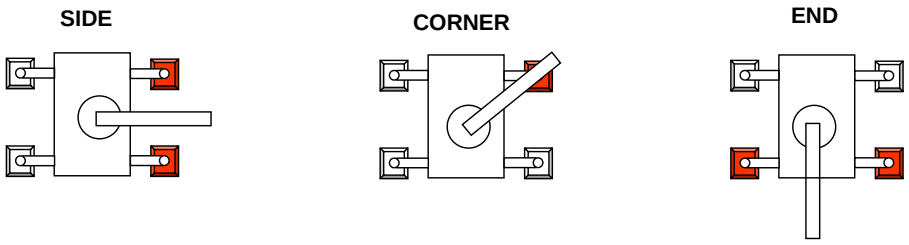
The size of the float varies according to the soil bearing strength of the ground. Floats need to be strong enough to withstand the load.



Objective: To show how a crane can be leveled using the hoist line and boom.

1. Leveling may take a few minutes, but is very important.
2. Rough terrain cranes typically have a bubble level mounted in the cab to use for leveling the crane.
3. In the absence of a bubble level, a carpenter's level can be placed on the turret for leveling purposes. The level needs to be positioned fore and aft and cross-wise to assure leveling in both directions.
4. A third way to level the boom is by using the hoist line as a plumb-bob. This is a very accurate leveling procedure. The above diagram illustrates it. The boom is raised and the hoist wire is lowered almost to ground level. A person on the ground directs the operator to raise or lower the outriggers until the hoist line is plumb with the boom.

CRANE TO GROUND PRESSURE POINTS



Lifting a load over a corner produces maximum ground bearing pressure.

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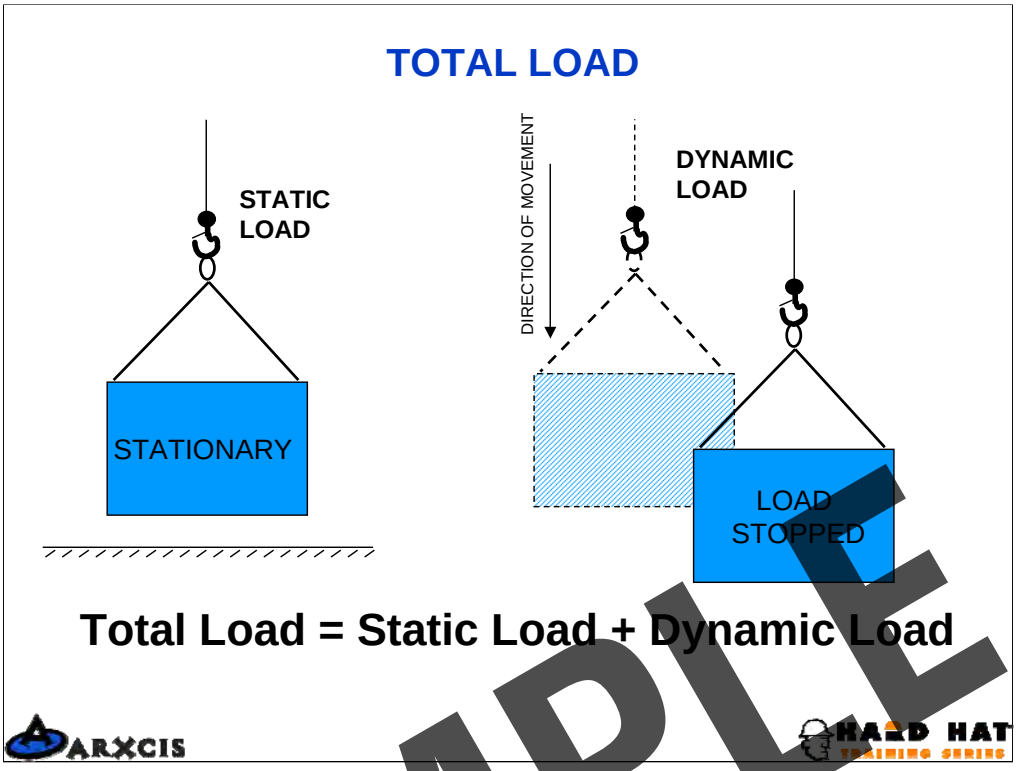
HARD HAT TRAINING SERIES

Objective: To show how the load on stabilizers changes as the boom is rotated.

As the boom swings around, the pressure on each outrigger pad changes. Note that the greatest ground bearing pressure is produced when the boom is located over an outrigger pad.

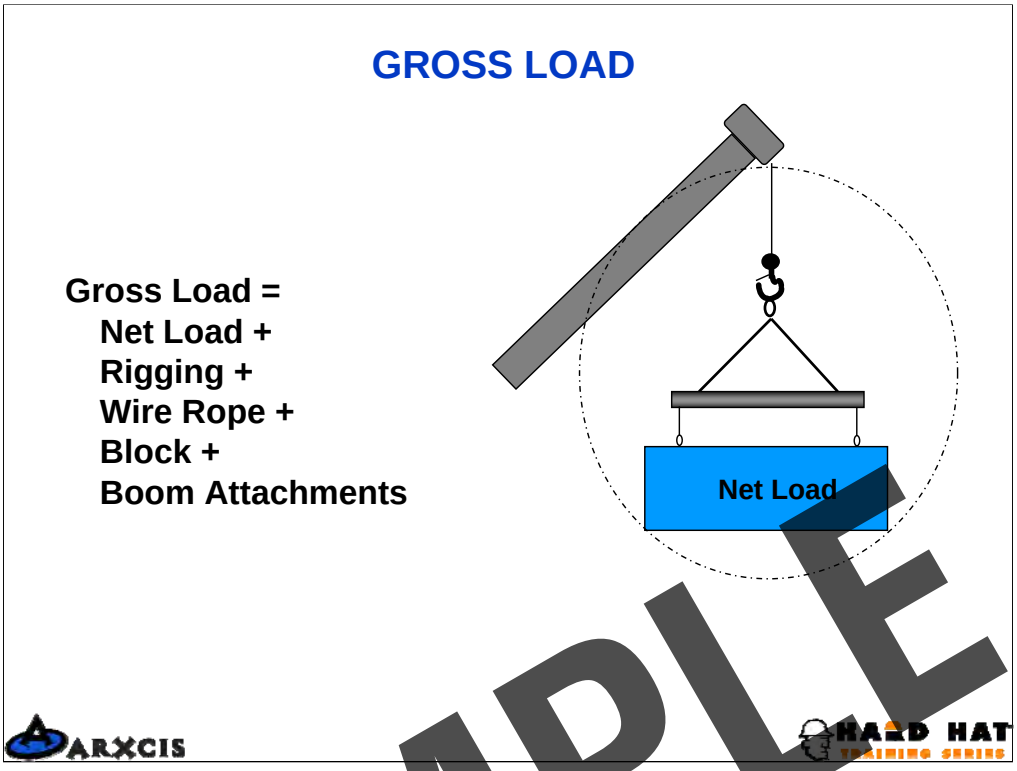


Objectives: To help students understand how additional stresses can be imposed on crane when a load is moved.

1. When a load is moved, additional stresses are imposed on the crane's structure.

2. Newton's first and second laws of motion state basically that a body at rest wants to remain at rest, and body in motion wants to remain in motion until acted upon by an outside force.

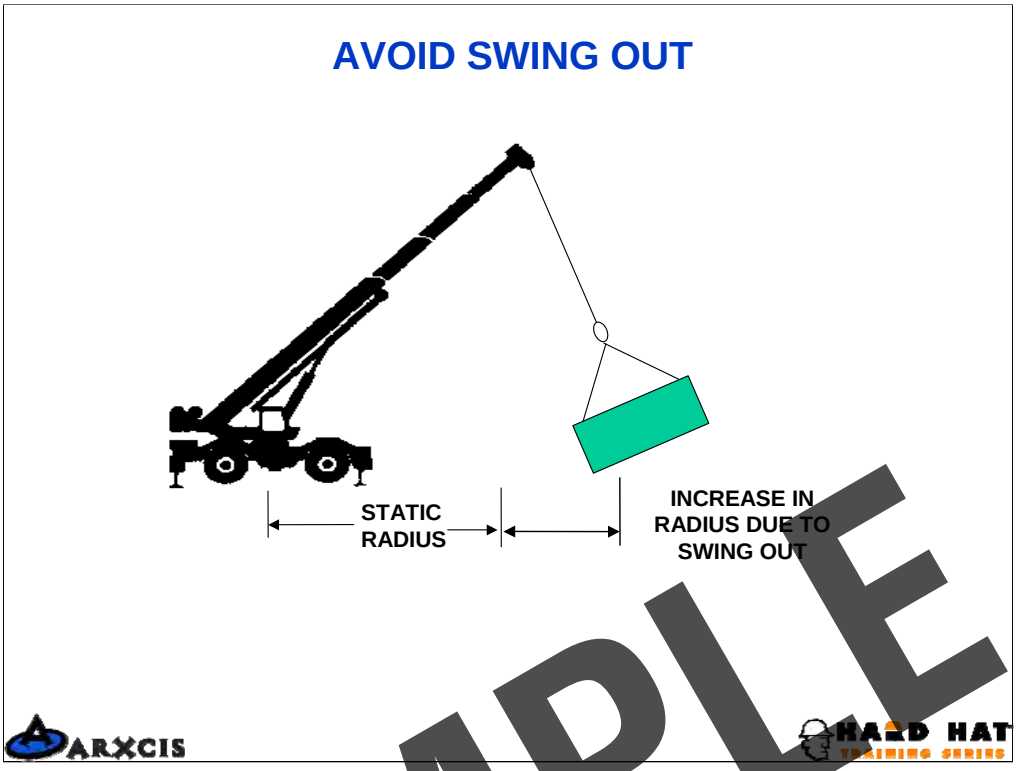
3. To start a load moving either by hoisting, booming or swinging, a crane has to exert an additional force. How much additional force imposed depends on the weight of the load and how fast it is moved. Loads started and stopped slowly do will not exert as much stress on the crane as those which are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



Objective: To determine what constitutes gross load.

1. All crane load charts are based on the load comprising everything that is hanging from the tip of the boom.

2. All of the above items listed on the slide need to be included in the load calculation.



Objective: To discuss how swing-out affects the stability of a crane.

When a load is swung rapidly, it swings away from the crane. When this happens, the distance from the load to the tipping moment of the outrigger increases thus increasing the leverage of the load. If a crane is at its maximum capacity for a given load radius, the crane has a potential of tipping over. Loads should be swung slowly, to prevent swing-out and to maintain control of the load.

EXCEEDING THE CAPACITY OF A GIVEN SETUP

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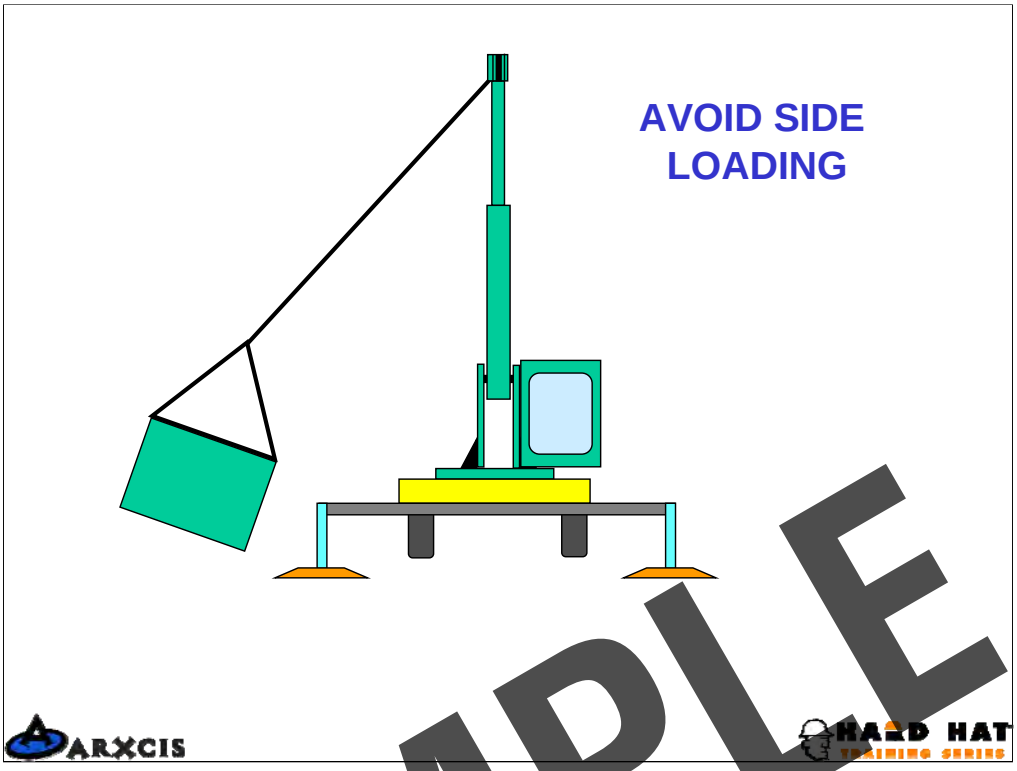
HARD HAT TRAINING SERIES

Objective: To illustrate how swinging a heavy load too fast can tip a crane over.

When a load is swung rapidly and then the swing is suddenly stopped, the load continues to travel until it is stopped by the crane. The added dynamic load may cause the crane to become unstable and tip over.



Objective: To show how side loading can have a negative affect on a crane.

A crane's boom is designed to lift loads vertically. Any side loading has a negative impact on the boom and whole crane. Side loading can be a result of wind or attempting to drag a load by swinging the crane. Although not very apparent, wind can cause excessive stresses on the crane. Wind on the boom itself, especially if it's extended fully, can contribute to a tipover. The operator must stop operations if wind becomes a significant factor. When to stop operations is left to the judgment of the operator. The wind pressure on the load can also add side loading to the boom as well as loosing control of the load. Tag lines may be necessary to help control the load but should never be used to pull the load around.

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 load line must remain vertical at all times.

Objective: To review considerations an operator should make before attempting a lift.

The Big Picture. An 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 set-up.

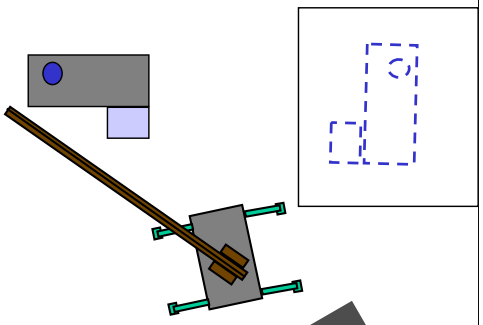
When assessing an load, the operator must know the weight. Along with weight, the load's center of gravity must be known in order to rig properly. Also, the load's structural strength must be assessed to ensure the load will not be damaged during the lift.

The type of rigging required needs to be determined. An operator needs to ensure the rigging is equal to the job.

Where the load will be picked from and where it will be placed must also be determined, so the crane can be placed such that both picking and placing of the load will remain within the load chart.

LOCATING THE CRANE

- **Ground Stability**
- **Obstructions**
- **Power Lines**
- **Load Travel Path**



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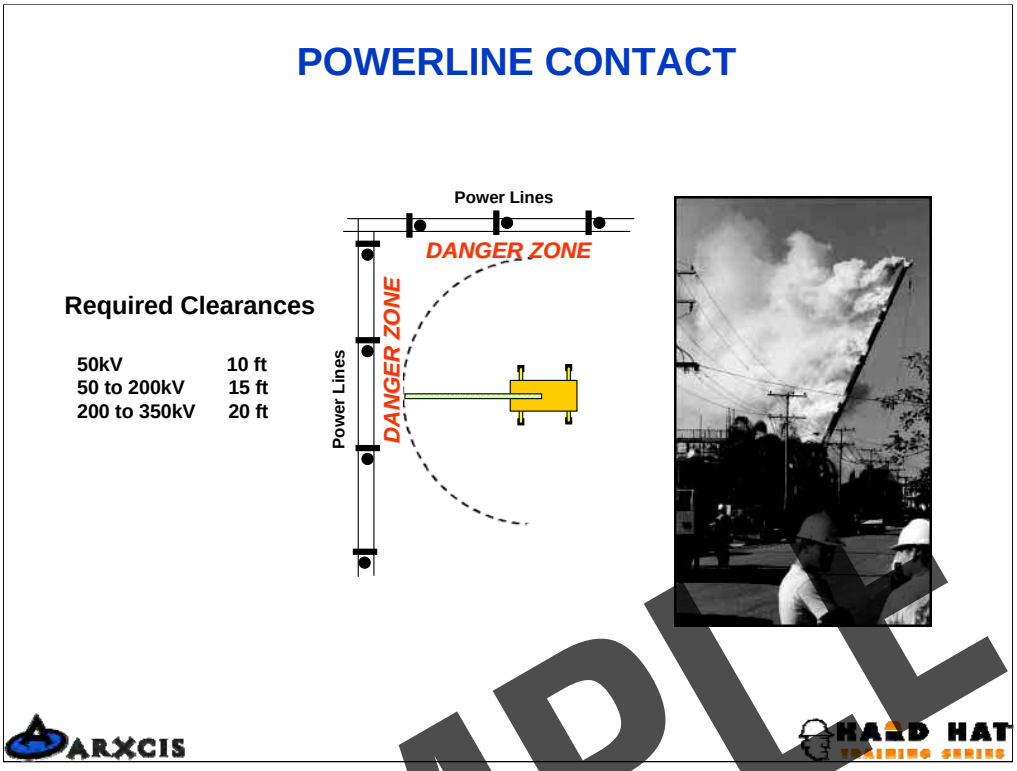
HARD HAT TRAINING SERIES

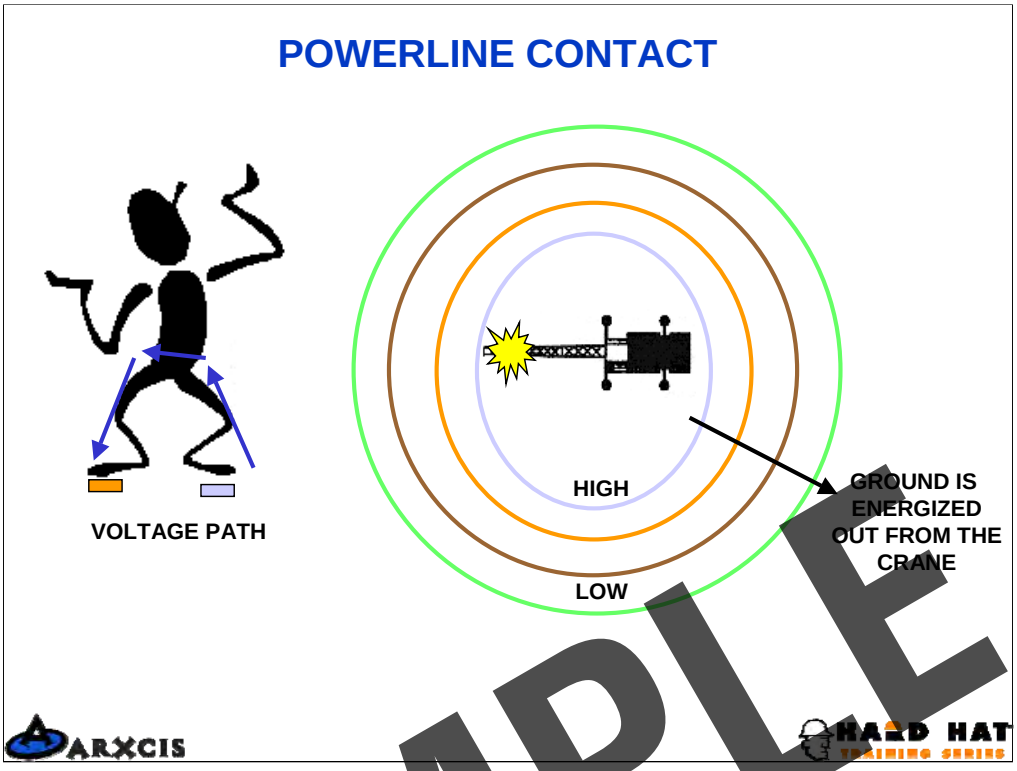
Objective: This slide is to review requirements for locating a crane.

Note all of the items listed above in determining exact placement. When a load exceeds 75% of the rated load capacity, the lift is considered a critical lift. Before the lift is attempted, make a dry run to verify the crane is adequately located and the lift remains within the parameters of the load chart.



Objective: To review requirements for operating around power lines.

Minimum clearance requirements need to be observed. It may be necessary to a have an assigned spotter watch the crane boom to ensure that it does not enter the danger zone, as electrocution is the number one cause of death involving cranes.



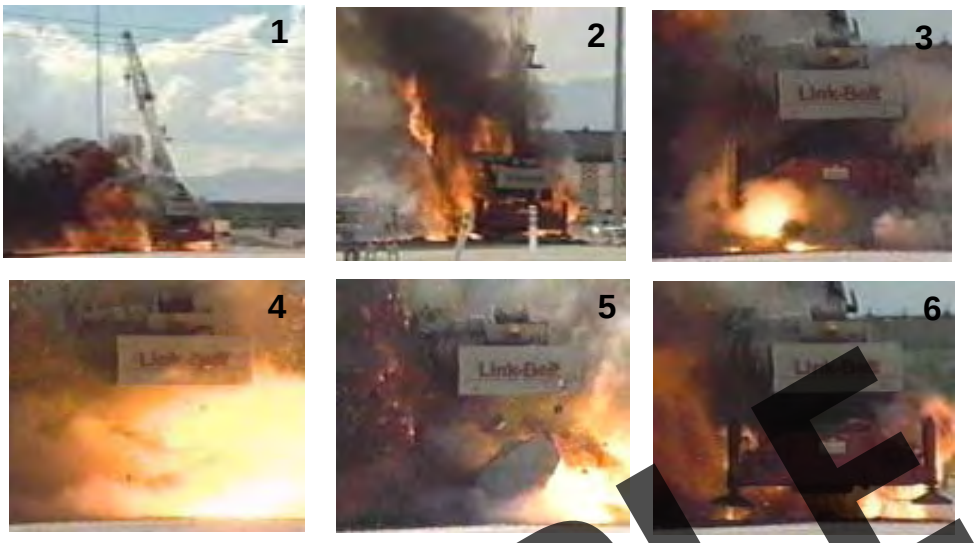
Objective: To discuss what should be done in case of power line contact.

The operator should remain with the crane if at all possible until the power company indicates it is safe to leave the crane. This is because the crane components could be at different voltage potentials, and touching parts of the crane could result in electrocution.

No one should be allowed to touch or even approach the crane. If the operator is unconscious, no attempt should be made to rescue him until the power company indicates it is safe to do so.

If the operator must leave the crane due to fire, he should shuffle to the edge of the platform he is standing on and carefully jump to the ground. It is important that he lands standing. Once on the ground, shuffle away from the crane.

POWER LINE CONTACT



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HARD HAT TRAINING SERIES

Objective: To illustrate how disastrous contact with power lines can be.

Pictures one through six show the progression of a fire resulting from a crane coming in contact with power lines.

MAKING A LIFT

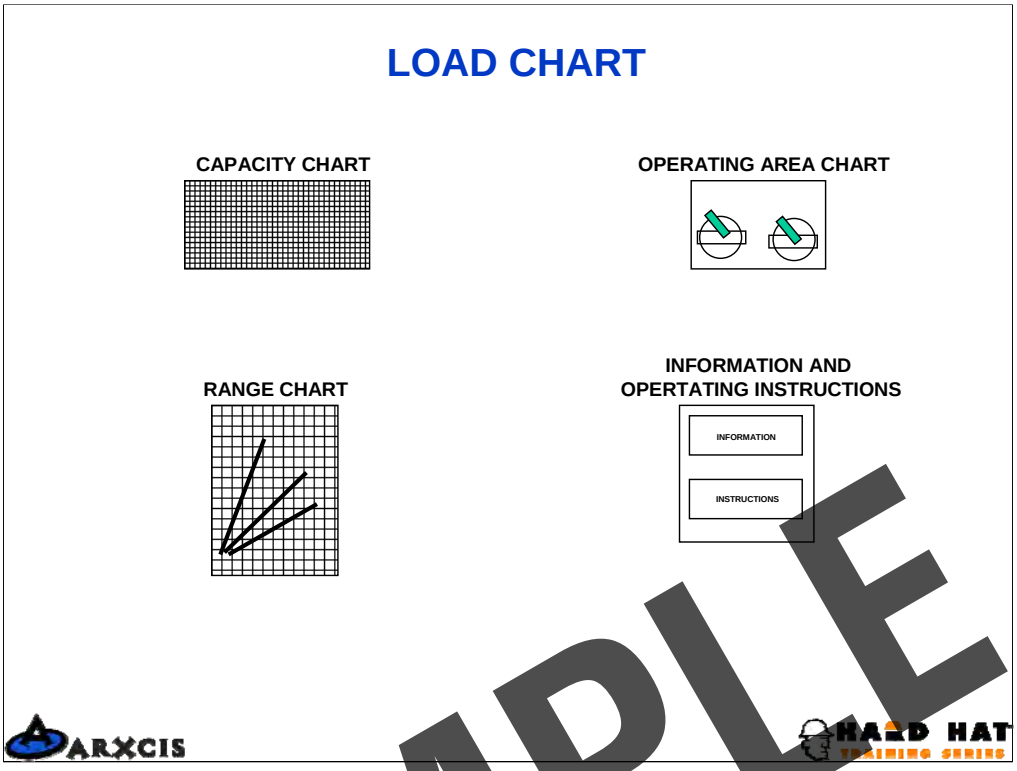
BEFORE ATTEMPTING A LIFT, GATHER ALL NECESSARY INFORMATION ABOUT THE LOAD AND REFER TO THE LOAD CHART TO DETERMINE LIFT CAPACTIY.

DETERMINING LIFTING CAPACITY

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

Objective: To review primary items necessary before making a lift.

Gross weight, maximum radius and maximum height of the lift are required in order to determine if the crane is capable of making a lift. When these three pieces of information are known, the crane's load chart is then consulted to determine if the lift can be made.

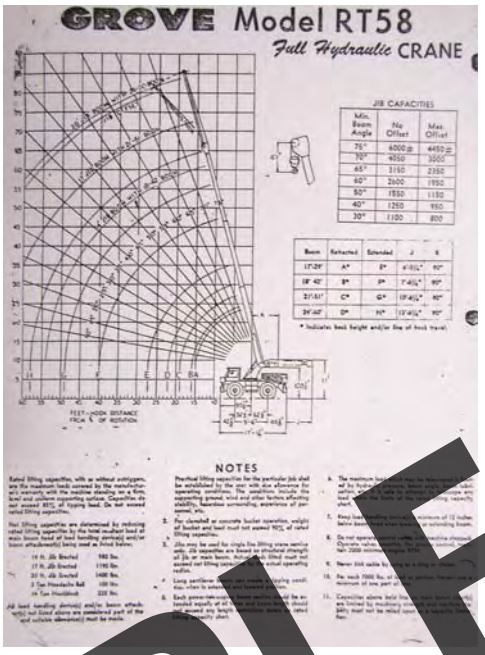


Objective: This slide introduces the discussion on load charts.

Most load charts will have at least 4 basic areas of information. The capacity chart provides the lifting capacity for a given boom angle and boom length. The range chart is useful for determining whether the crane will be capable of placing a given load at a specific height. The operating area chart indicates any lifting restrictions based on the position of the crane with respect to the carrier. The notes section of the load chart provides important information regarding the crane's operation.

The operator is responsible for being familiar with and capable of using the load chart.

TYPICAL LOAD CHART

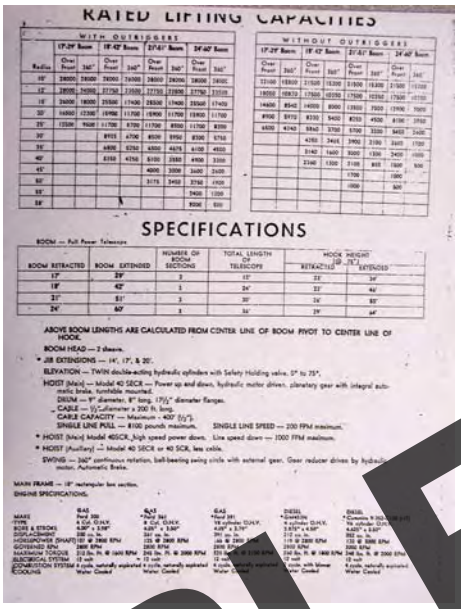


Objective: To show a typical example of a load chart.

This slide and the one that follows are examples of a load chart for a rough terrain crane. Load charts for other cranes may be substituted here.

Show the different areas of the load chart to the class.

TYPICAL LOAD CHART



RATED LIFTING CAPACITIES

SPECIFICATIONS

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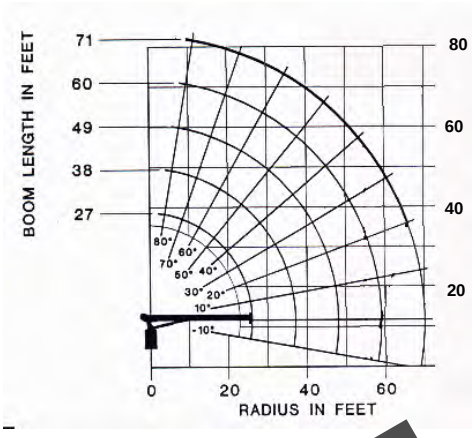
HARD HAT TRAINING SERIES

Objective: To show a typical example of a load chart.

RANGE DIAGRAM

USED TO DETERMINE APPROXIMATE DISTANCES FOR PLANNING PURPOSES



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HARD HAT TRAINING SERIES

Objective: To discuss use of the range diagram.

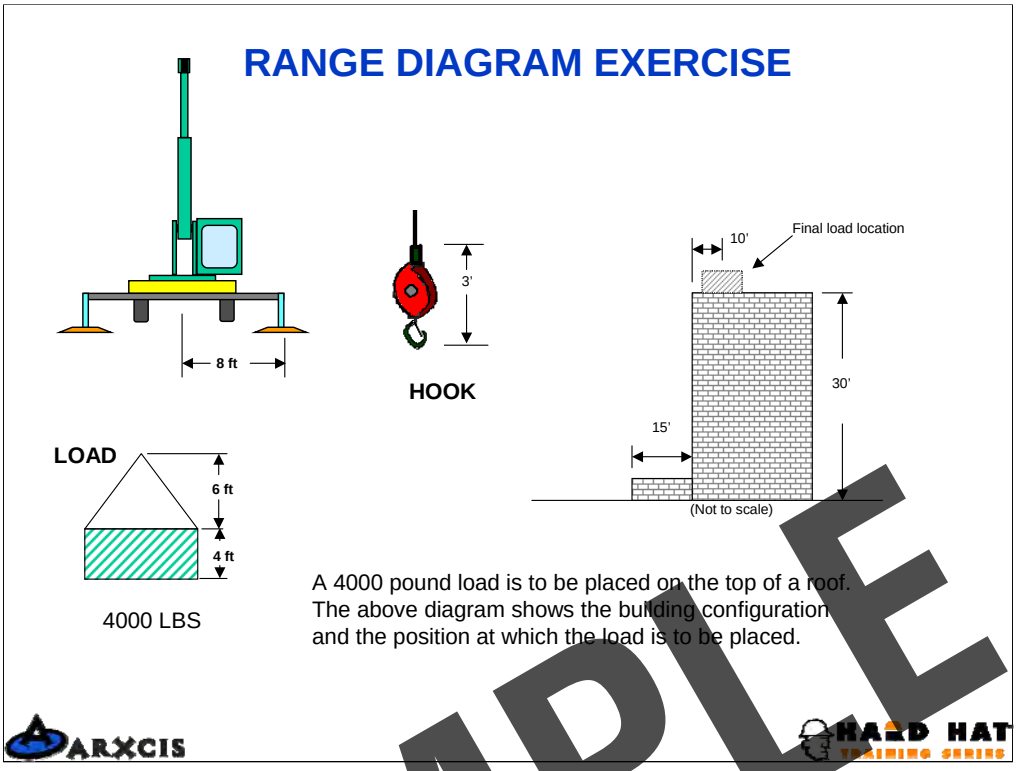
1. The range diagram shows various boom tip heights based on boom length and radius.
2. This diagram is useful in determining if an individual crane will have the lifting and range capacity to make a particular lift to or from the top of a structure.
3. Using the diagram in pre-planning can prevent a crane from being sent to a job site and inadequate for the job.
4. Note that there is an arc for each boom length section.

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***	

Objective: To review the load capacity chart.

1. A typical load capacity chart shows the radius in the left hand column.
2. Corresponding to each radius, subsequent columns to the right show corresponding boom angle and boom length.
3. If a desired radius falls between two radii shown on the load chart, the next longer radius must be selected and the associated capacities used. For example: If the boom length is set at 38 feet and the measured radius was 27 feet, the maximum lifting capacity will be 6,300 lbs. which is associated with a 30-foot radius. It is not permissible to estimate a capacity for a radius of 27 feet.
4. The boom angles shown on the chart are for loaded booms. When setting up for a lift where the boom angle is to be used as the means of establishing the radius, 2 degrees should be added to the load chart number. As the boom is loaded, it will tend to droop somewhat, and the added 2 degrees will compensate for that droop.



Objective: To demonstrate how to use the range diagram and load chart for planning a lift.

1. Explain the problem to the students and walk them through each part.
2. A range diagram for each student will be helpful for them to sketch the problem.
3. The overall load height is 10 feet. This height is of the load and the rigging combined.
4. The distance from the center of rotation to the stabilizer pad is 8 feet. The actual distance for a specific crane can be found in the operator's manual.
5. For this problem it is assumed that the stabilizer pad can be placed against the base of the 15-foot porch.

RANGE DIAGRAM EXERCISE

Step One: Calculate total gross load including deductions

Load	= 4000 lbs	
Load Deductions	= 700 lbs	(1 sheave block, 200 lbs; stowed jib, 500 lbs; rigging and hoist wire rope is consider 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

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HARD HAT TRAINING SERIES

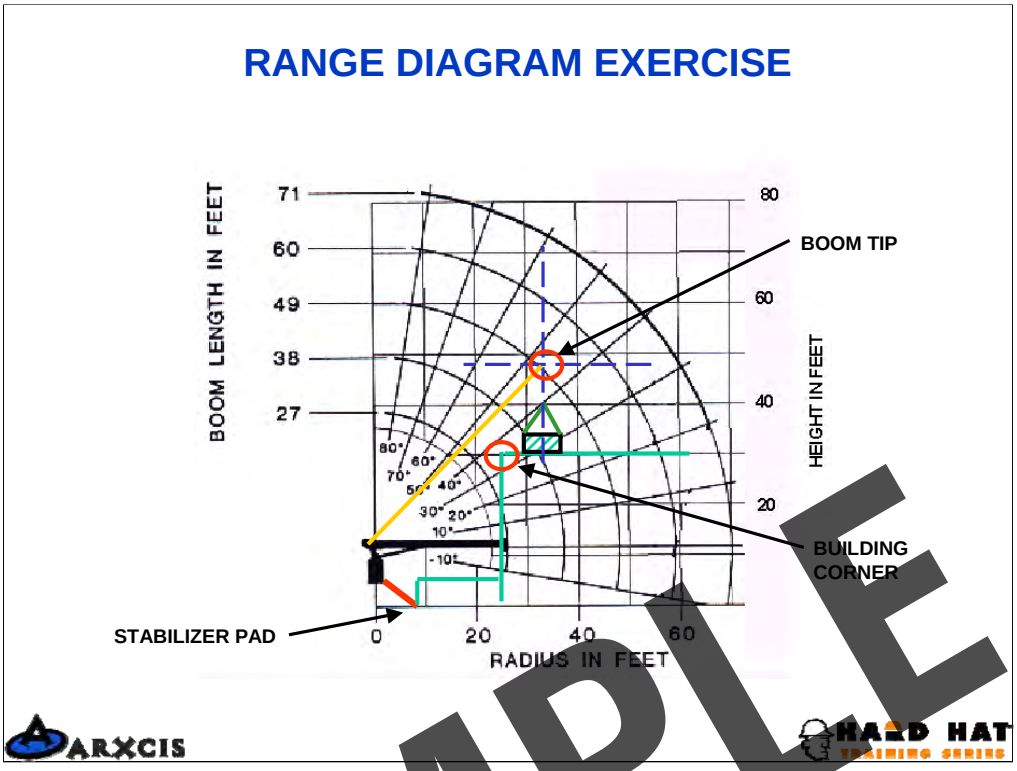
Objective: To show how the calculations are done.

1. First, calculate the total load to be imposed on the crane. Remember to include any load deductions along with the net load.

2. The next step is to determine the minimum boom height required to make lift safely. In this example, the building is 30 feet tall. The load with rigging requires another 10 feet. The hook and associated hardware is 3 feet, and we have determined that we want at least 5 feet for free operating room. If the crane has an anti-two-block device installed, an additional height will be required.

3. The third step is to determine the minimum radius at which the crane can make the lift. The closest the crane can get to the building is 8 feet, the distance from the center of rotation to the stabilizer pad. Next is the 15-foot wide porch, and added to that is the 10 feet from the edge of the building to the center of the load.

RANGE DIAGRAM EXERCISE



Objective: To show how to place data on the range diagram and determine if a lift can be made.

1. First, draw a horizontal line at 30 feet high, the height of the building.

2. Next, draw a vertical line at 23 feet of radius, which represents the side of the building. The intersection of these two lines is the corner of the building.

3. At 33 feet of radius, draw a vertical line from the top of the building upward. This line represents the center of the load and where the hoist line needs to be in for placing the load on top of the building.

4. At 48 feet high from the ground, draw a horizontal line (the minimum boom tip height) that intersects the vertical line representing the hoist line. The intersection of these two lines is the lowest point the boom tip can be placed and still make the lift.

5. A line drawn from boom hinge to boom tip point shows the minimum boom angle and also show how much clearance the boom has from the edge of the building.

6. The next thing to determine is the length of boom required. This is figured from the boom length arcs. In this case the 49-foot boom length will barely meet requirements. Checking the load chart on the next slide for 49-foot boom and 35-foot radius shows a lifting capacity of 4,900 lbs. The total gross load is 4,700 lbs. Therefore the lift can be made, but will be considered a critical lift which requires that all of the lift conditions be checked and verified by an additional person.

RANGE DIAGRAM EXERCISE

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

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

Step 6: Knowing boom length and 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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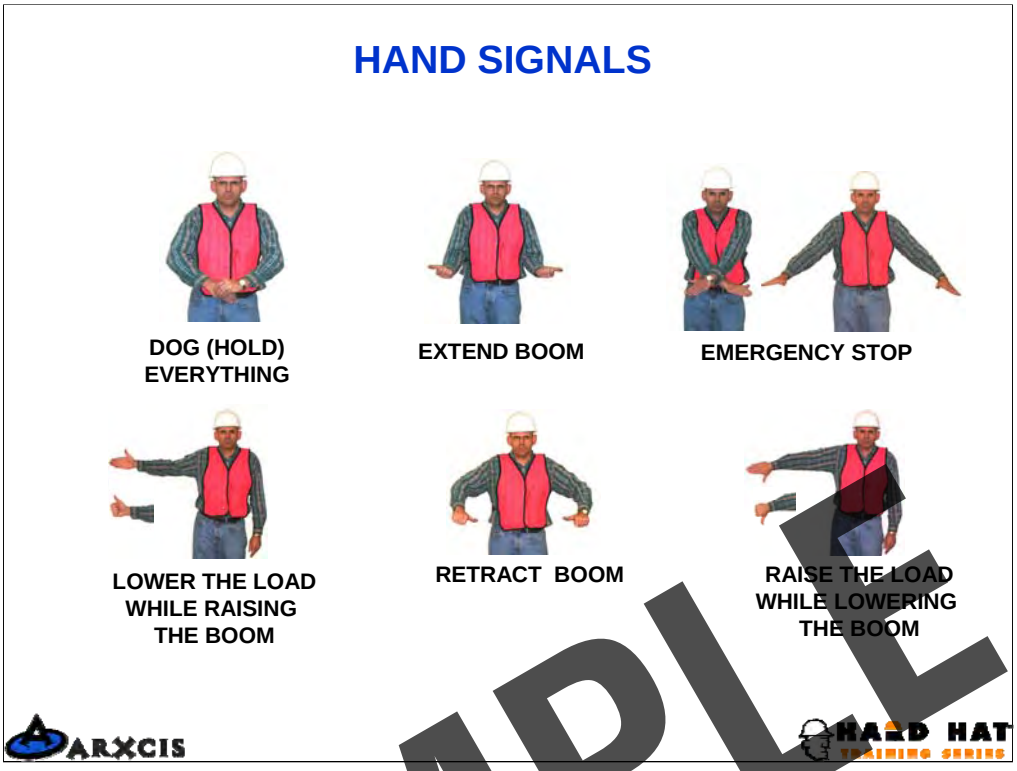
60									33	*2,100*	
65									23.5	*1,750*	
70									4	*1,100*	
	0	*6,000*	0	*3,800*	0	*2,400*	0	*1,550*	0	*950*	

ARXCIS

HARD HAT TRAINING SERIES

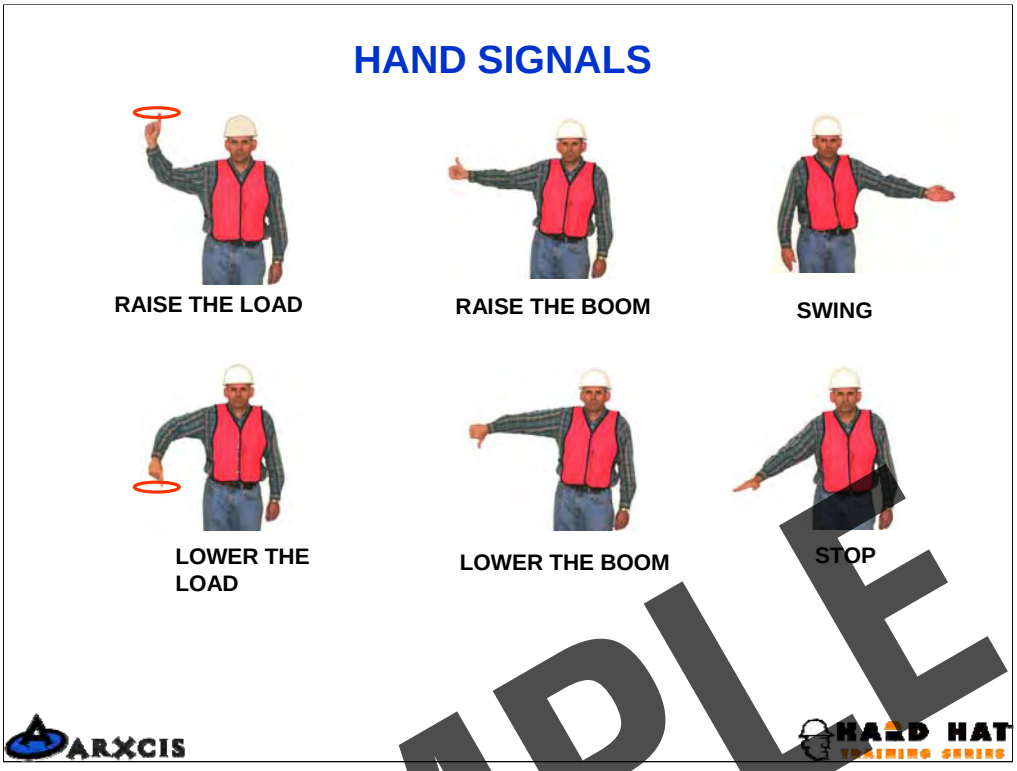
Objective: Continuation of the previous slide.



Objective: To review standard hand signals used in crane operations.

1. Emphasize the importance of using the standard hand signals to avoid misunderstandings which may lead to an accident.

2. When working at night, a reflective orange glove is useful for making hand signals visible.



Continuation of previous slide.

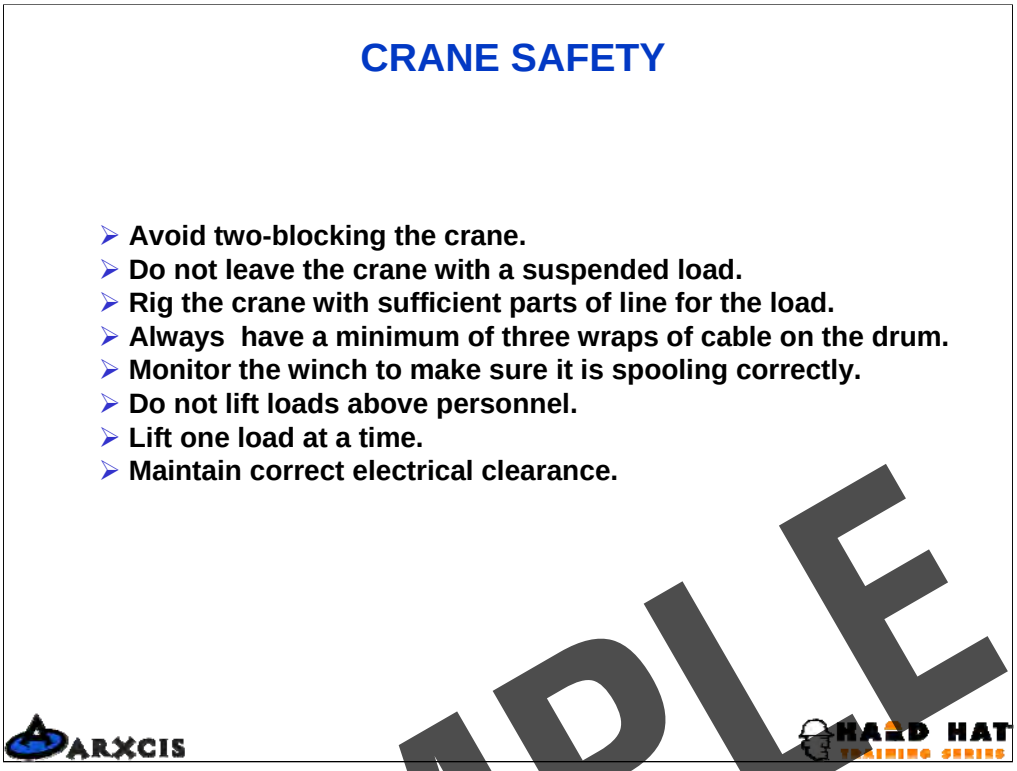
MAKING THE LIFT

- 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 IF uncertain
- Lower load ***slowly***

ARXCIS

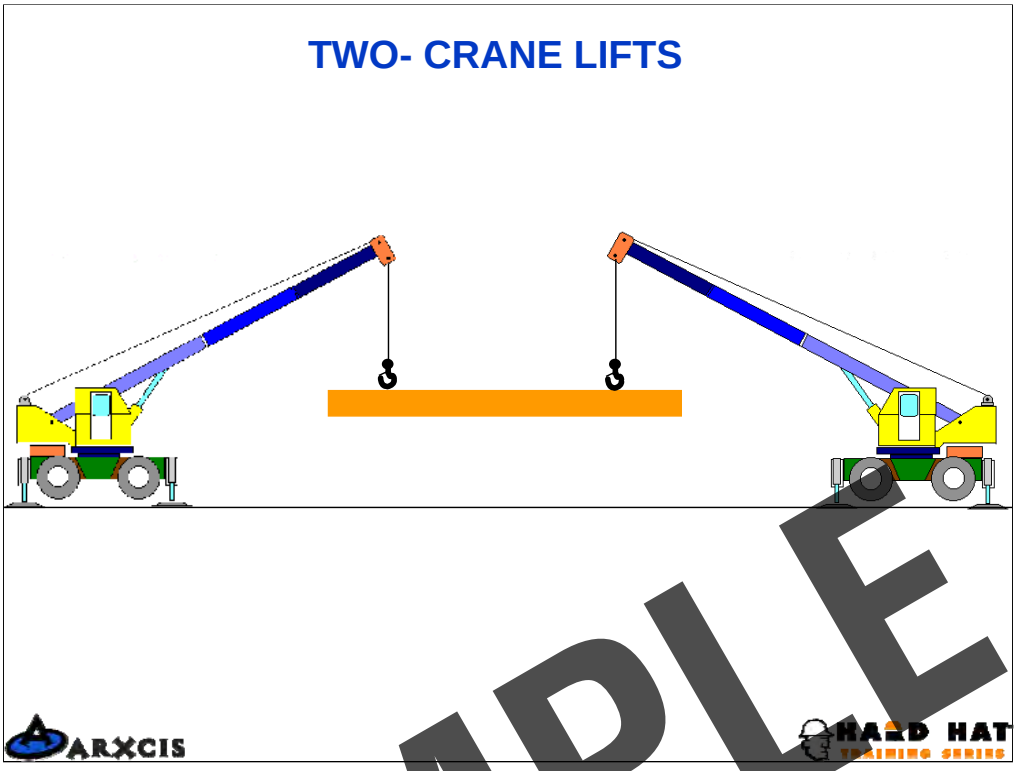
HARD HAT TRAINING SERIES

Objective: To review points for a safe lift.



Objective: To review the points for a safe lift.

1. Review each item and have the class comment on each.
2. Ask participants for any additional items that could be added to the list.

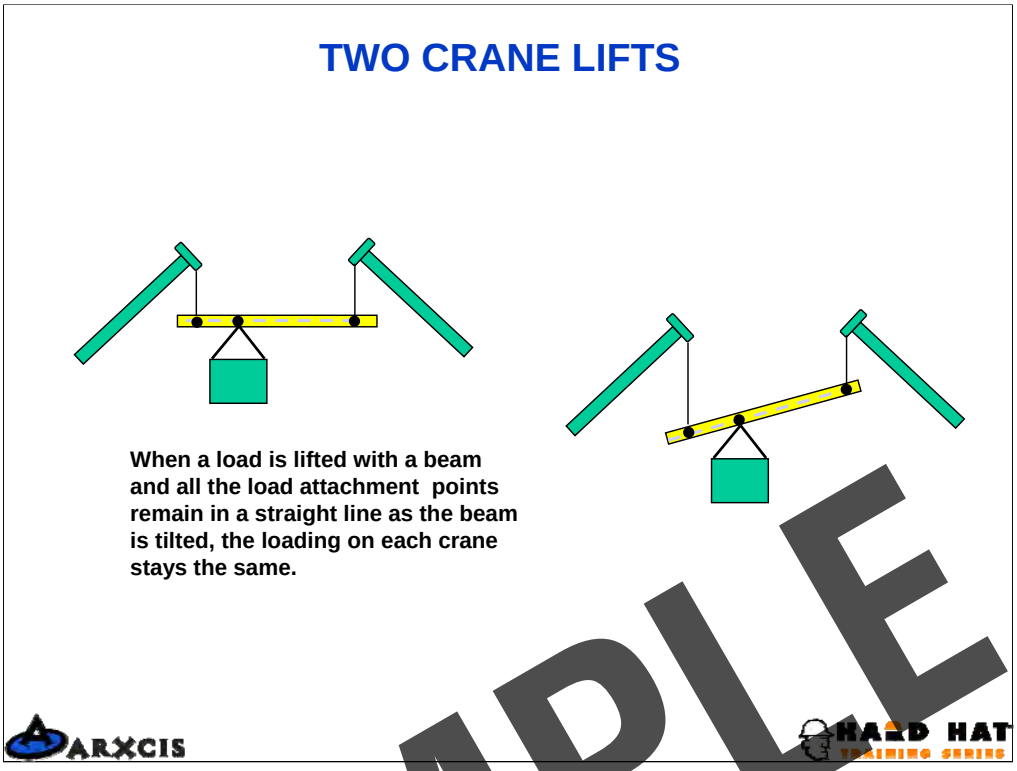


Objective: To introduce basic principles of lifting a load with two cranes.

There are occasions when it may be necessary to lift a load with two cranes. These lifts should be done with experienced crane operators and under the supervision of an experienced signal person to coordinate the lift. Each crane must be set up properly, and the load weight imposed on each crane must be accurately determined.

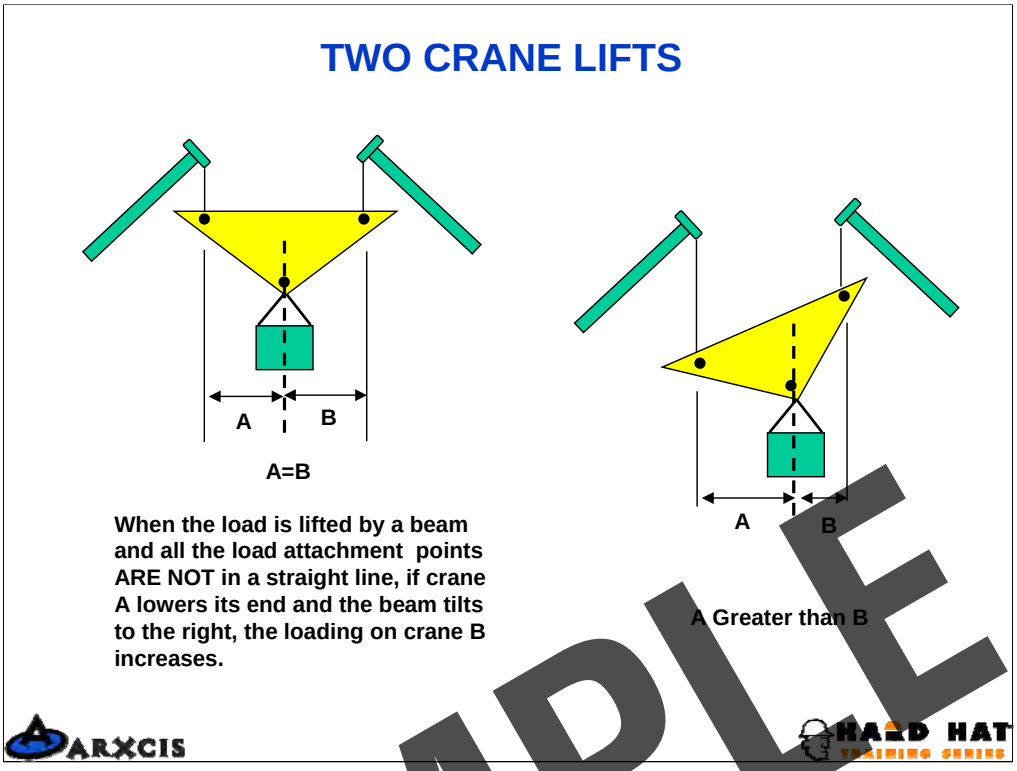
When the center of gravity of the load is at its physical center and each crane is lifting at the same distance from the center of gravity, each crane will be supporting the same weight. If one crane is closer to the center of gravity than the other, that crane will be holding a greater portion of the load.

Based on the location of the center of gravity and where the cranes are attached to the load, when the load is tilted, one of the cranes could easily be over loaded.



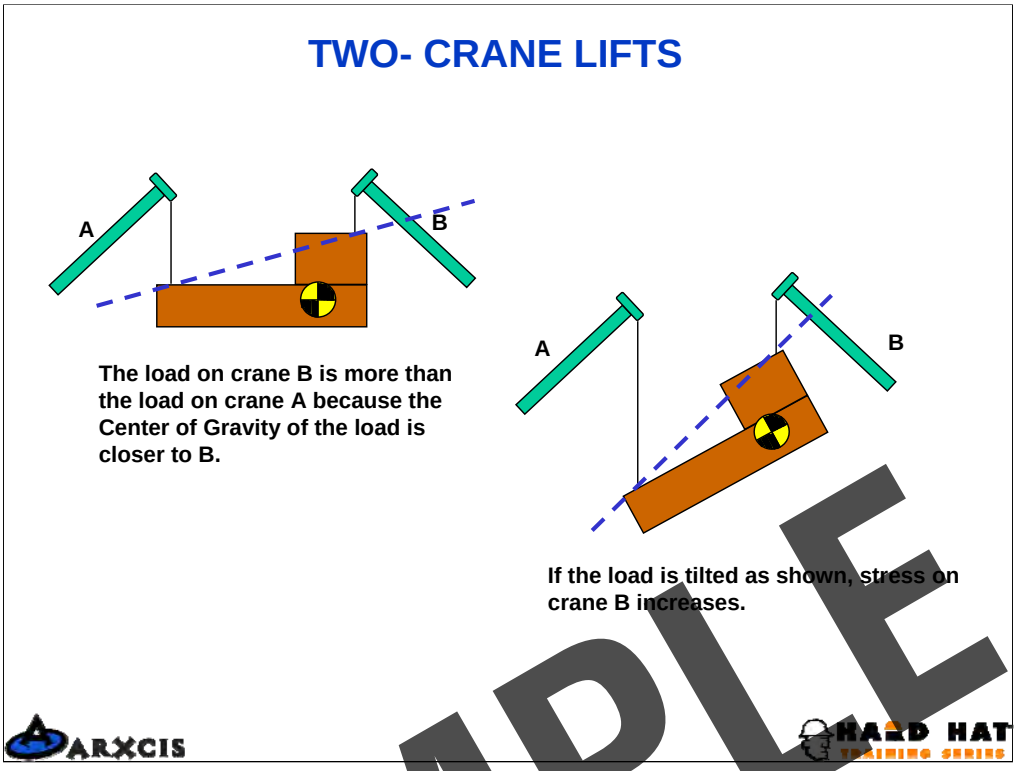
Objective: To introduce the basic principle of lifting a load with two cranes.

When a load is lifted with a beam or when the center of gravity of the load is in line with the attachment points for the two cranes, as the load is tilted, the weight on each crane remains the same.



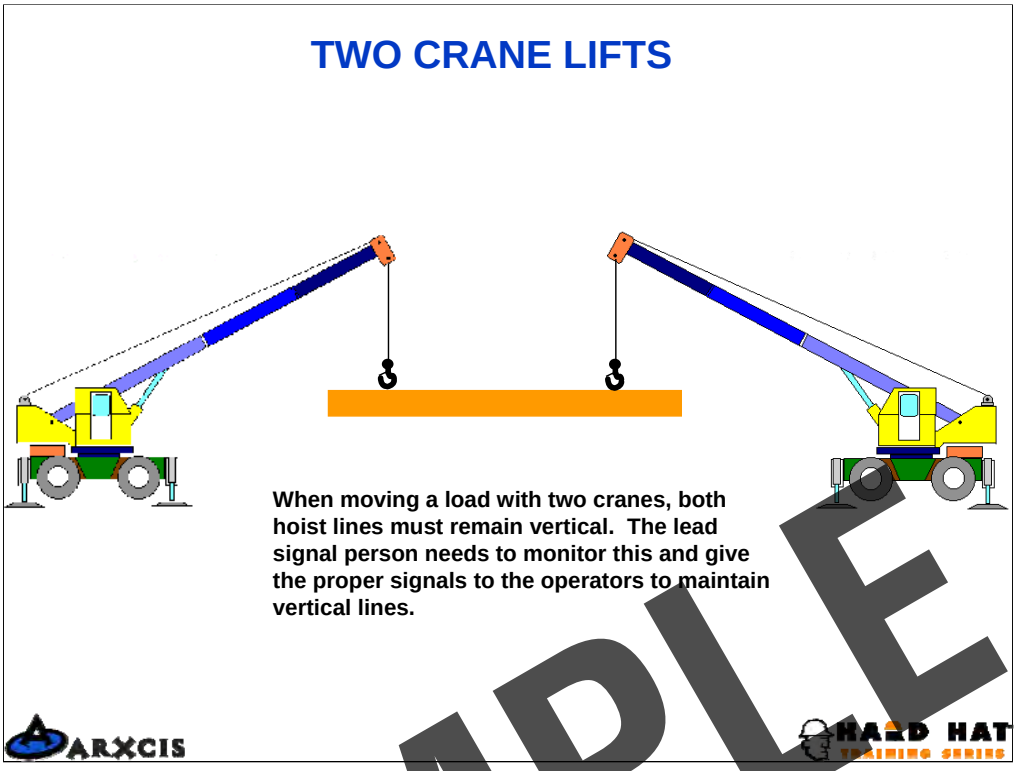
Objective: To introduce the basic principles of lifting a load with two cranes.

When a load is lifted by a beam similar to that shown in the above diagram, the load and crane attachment points do not lie on a straight. When the beam is tilted, the load rotates closer to one crane than the other. This tilt increases the load on the crane closest to the load.



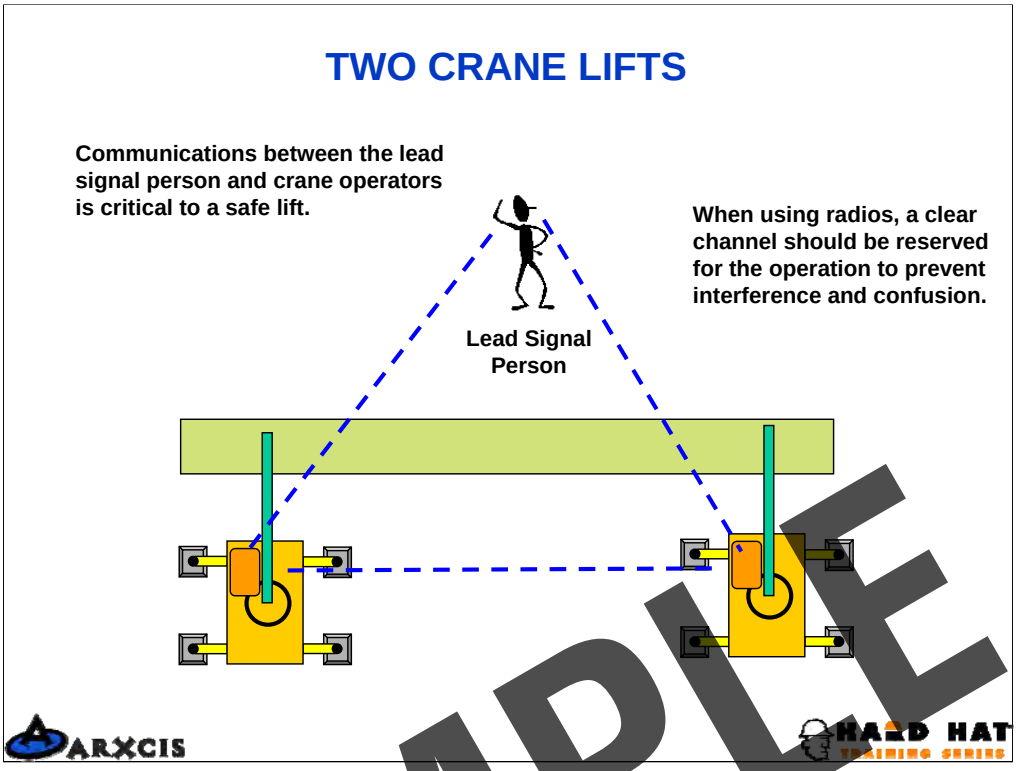
Objective: To introduce basic principles of lifting a load with two cranes.

When lifting an object which has its center of gravity not in line with the two attachment points, the weight supported by each crane will change as the load is tilted. Care must be exercised to prevent either of the cranes from being over loaded.



Objective: To review basic principles of lifting a load with two cranes.

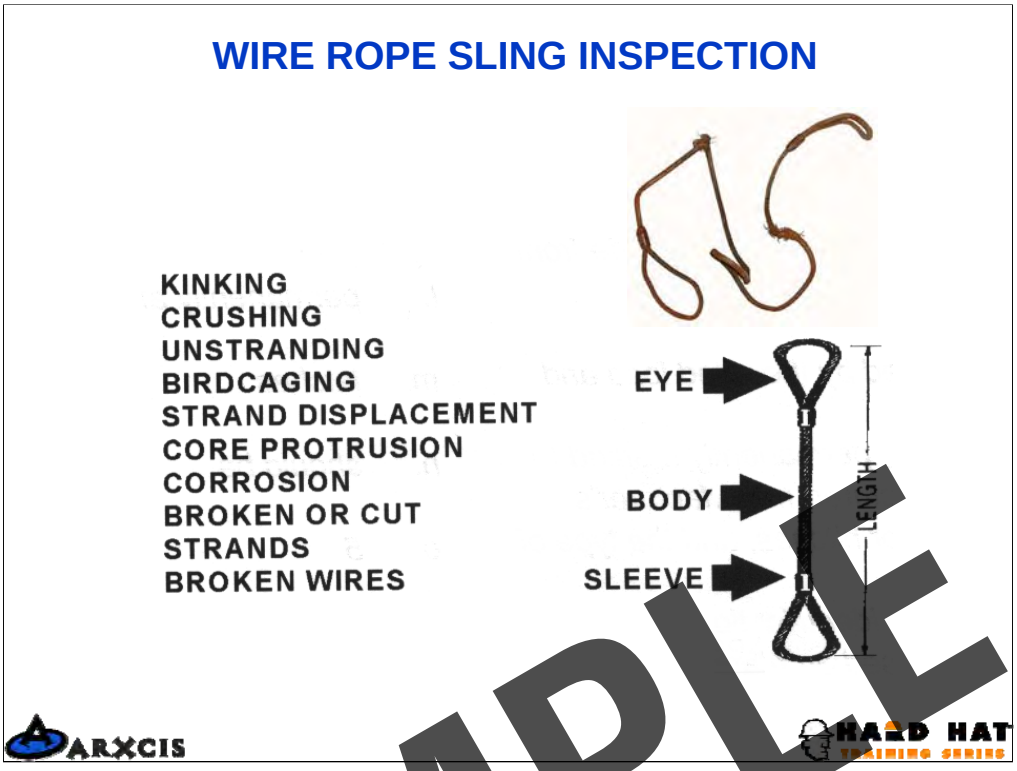
When lifting a load with two cranes, it is very important that both hoist lines remain vertical at all times to prevent one crane from pulling on the other. When maneuvering a load, it is easy for one crane to pull on the other without the operator's awareness. To prevent pulling from occurring, a monitor for each crane may be required to keep the hoist lines vertical.



Objective: To review basic principles of lifting a load with two cranes.

Coordinating a two-crane lift is critical to completing the job safely. One person needs to be designated as lift coordinator. This person is responsible for conducting a pre-lift meeting with all operators, signalers, and any others involved with the lift. The coordinator may function as the lead signaler also. He needs to stay where he can observe the load during the lift as well as be in direct contact with each crane operator. Any additional load monitors need to be in direct contact with the lead signal person as well. When radios are used for communicating with all participants, a channel needs to be reserved to prevent outside interference and possible confusion.

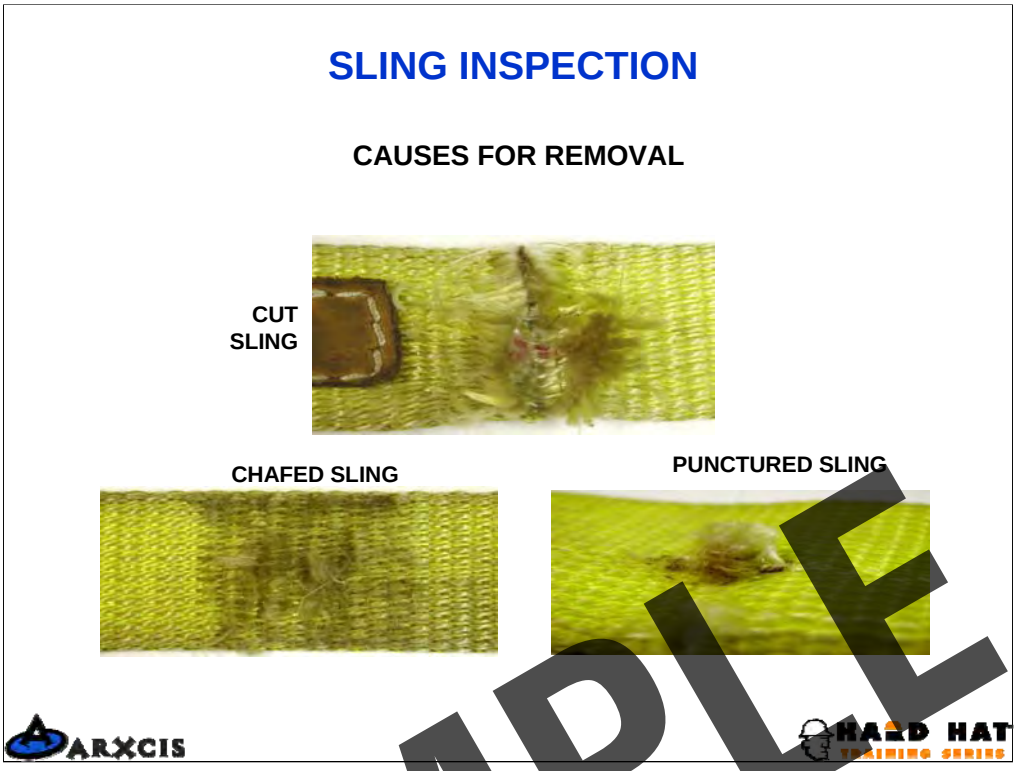
WIRE ROPE SLING INSPECTION



Objective: To review requirements for inspecting wire rope slings.

1. Wire rope slings are to be inspected on a regular basis and a record kept of these inspections. Refer to the inspection card for inspection criteria.

2. As of July 2000 wire rope slings are to have a tag which indicates the lifting capacities of the sling for vertical, choker, and basket hitches.



Objective: To review requirements for inspecting synthetic slings.

1. This slide and the next two show the different types of sling damage that can occur. Refer to the inspection record for additional inspection criteria.

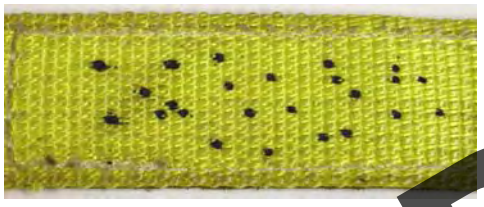
2. Synthetic slings are required to be inspected on a regular basis and a record kept of such inspections.

SLING INSPECTION

CAUSES FOR REMOVAL

KNOTS IN SLING

WELD SPLATTER DAMAGE



HEAT DAMAGE

ARXCIS

HARD HAT TRAINING SERIES

SLING INSPECTION

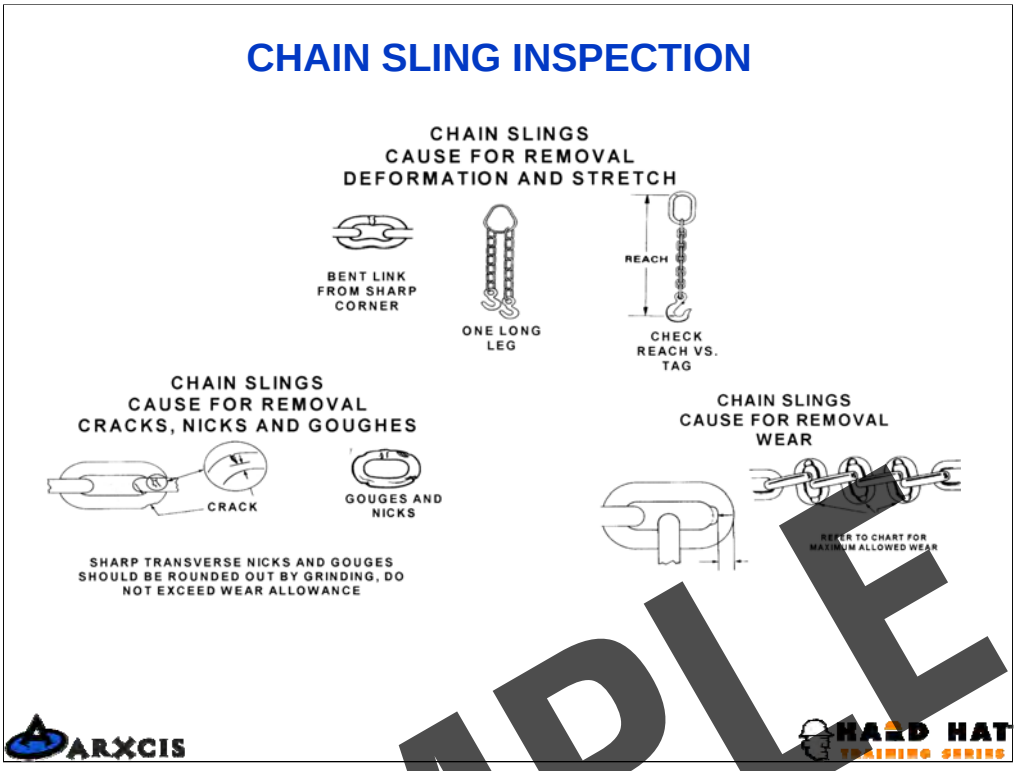
CAUSES FOR REMOVAL

ILLEGIBLE DATA TAG

BROKEN STITCHES

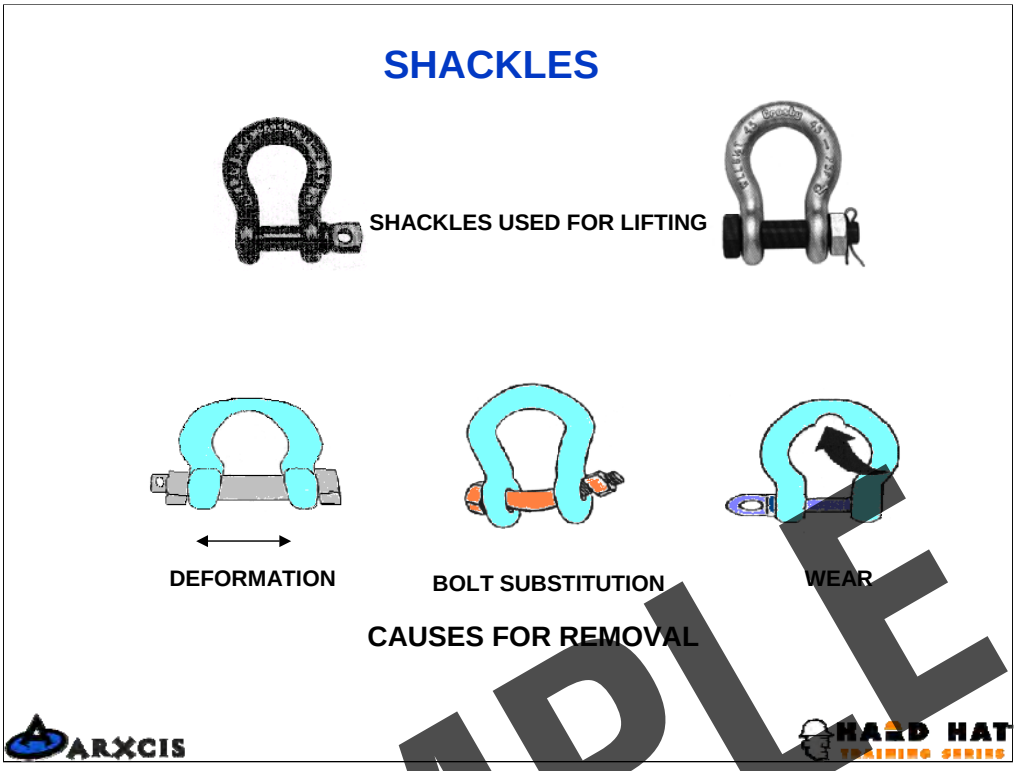
EXPOSED RED YARNS

CHAIN SLING INSPECTION



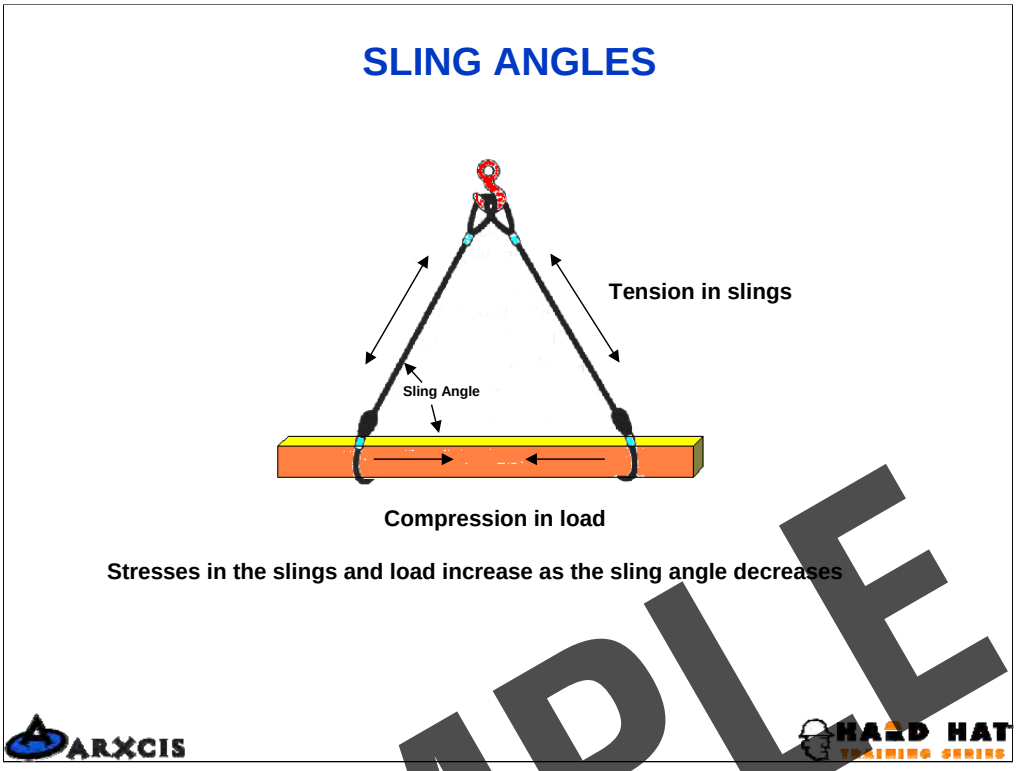
Objective: To discuss how to inspect chain slings.

1. Chain length should be recorded when the chain is new and then subsequent measurements will disclose stretch due to overloading.
2. Review the various causes for chains being removed from service.



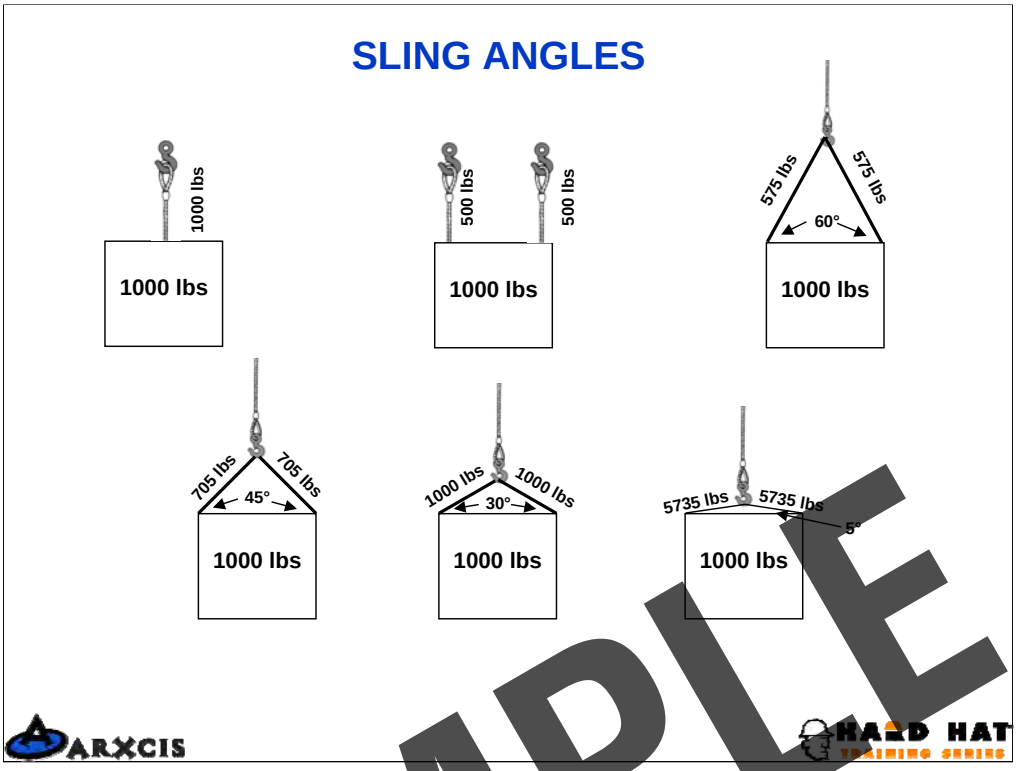
Objective: Discuss basic design and inspection of shackles.

1. Use only load rated shackles.
2. Review the examples on the slide for inspecting shackles.



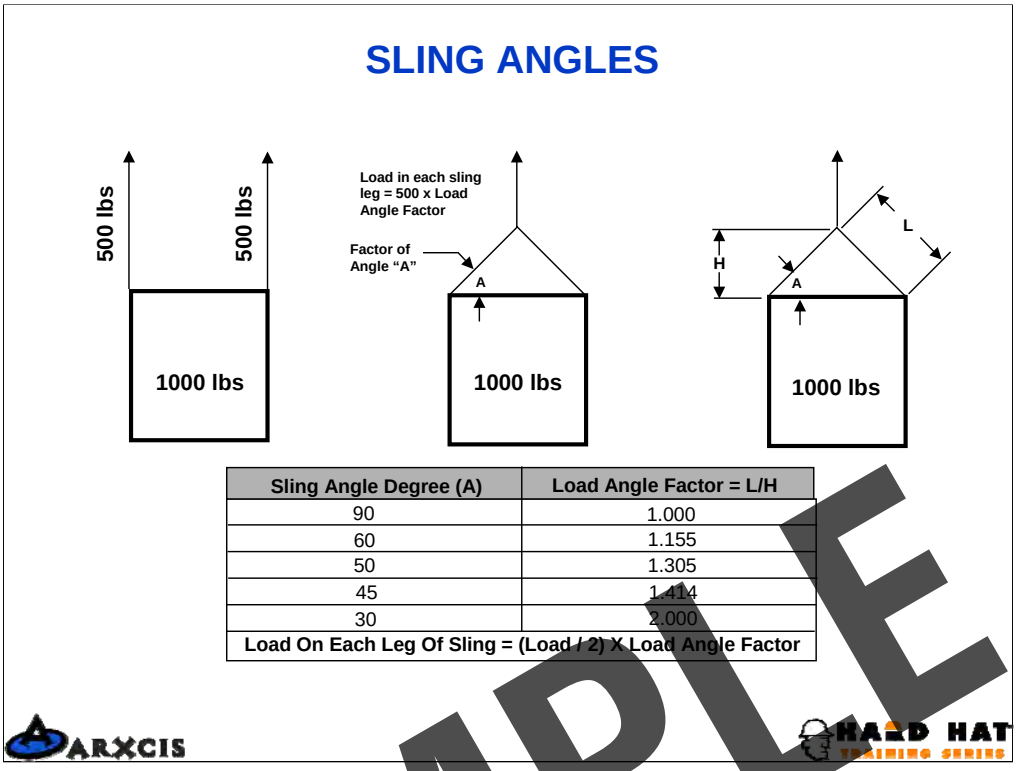
Objective: To show how stresses in the load and slings increase as the sling angle decreases.

As the angle of the sling decreases, the stress in the sling and the compression load imposed on the load increases.



Objective: To demonstrate how load in the slings increases as the sling angle decreases.

This slide shows how stress in a sling increases as the sling angle decreases. The ideal sling angle is 60 degrees which minimizes stress on the slings and the load itself.



Objective: To show how the sling angle affects stress on a sling.

This method of determining the stress in a sling is very simple and effective. Sling stress can be calculated by knowing the weight of the load that each sling is to support. First measure the length of the sling and then the vertical distance from the hook to the load. Divide the L by H and multiply this result by the sling's share of the load. This will give the stress in the sling.