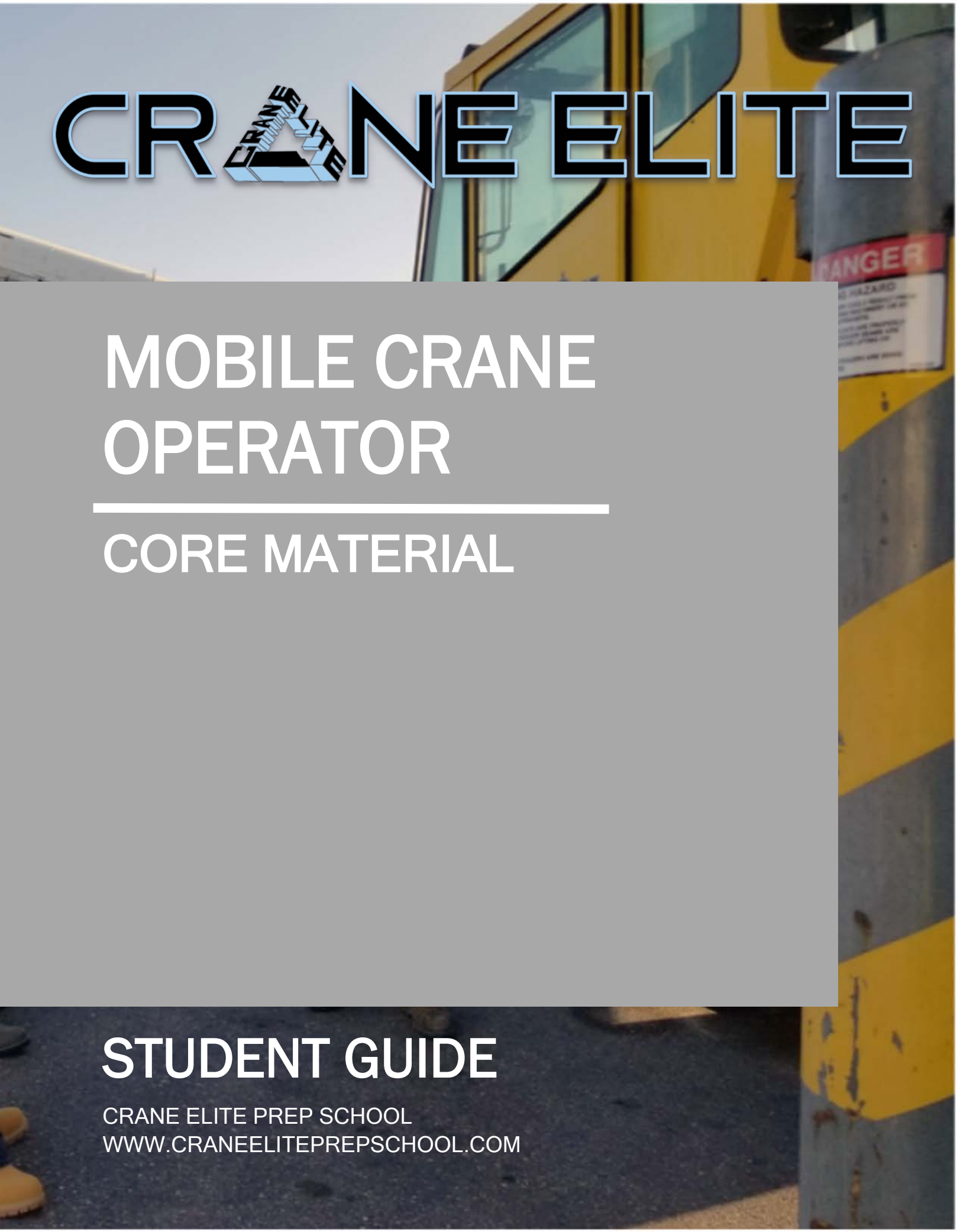

CRANE ELITE

MOBILE CRANE OPERATOR

CORE MATERIAL

STUDENT GUIDE

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EQUIPMENT
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American Society of Mechanical Engineers (ASME)

B30.5 – 2007 - Mobile & Locomotive Cranes
B30.23 – 2011 - Personnel Platforms

DEFINITIONS:

A/D director (Assembly/Disassembly director) means an individual who meets this subpart's requirements for an A/D director, irrespective of the person's formal job title or whether the person is non-management or management personnel.

Articulating crane means a crane whose boom consists of a series of folding, pin connected structural members, typically manipulated to extend or retract by power from hydraulic cylinders.

Assembly/Disassembly means the assembly and/or disassembly of equipment covered under this standard. With regard to tower cranes, "erecting and climbing" replaces the term "assembly," and "dismantling" replaces the term "disassembly." Regardless of whether the crane is initially erected to its full height or is climbed in stages, the process of increasing the height of the crane is an erection process.

Assist crane means a crane used to assist in assembling or disassembling a crane.

Attachments means any device that expands the range of tasks that can be done by the equipment. Examples include, but are not limited to: An auger, drill, magnet, pile-driver, and boom-attached personnel platform.

Audible signal means a signal made by a distinct sound or series of sounds. Examples include, but are not limited to, sounds made by a bell, horn, or whistle.

Blocking (also referred to as "cribbing") is wood or other material used to support equipment or a component and distribute loads to the ground. It is typically used to support lattice boom sections during assembly/disassembly and under outrigger and stabilizer floats.

Boatswain's chair means a single-point adjustable suspension scaffold consisting of a seat or sling (which may be incorporated into a full body harness) designed to support one employee in a sitting position.

Boom angle indicator means a device which measures the angle of the boom relative to horizontal.

Boom hoist limiting device includes boom hoist disengaging device, boom hoist shut-off, boom hoist disconnect, boom hoist hydraulic relief, boom hoist kick-outs, automatic boom stop device, or derricking limiter. This type of device disengages boom hoist power when the boom reaches a predetermined operating angle. It also sets brakes or closes valves to prevent the boom from lowering after power is disengaged.

Boom length indicator indicates the length of the permanent part of the boom (such as ruled markings on the boom) or, as in some computerized systems, the length of the boom with extensions/attachments.

Boom stop includes boom stops, (belly straps with struts/standoff), telescoping boom stops, attachment boom stops, and backstops. These devices restrict the boom from moving above a certain maximum angle and toppling over backward.

Boom suspension system means a system of pendants, running ropes, sheaves, and other hardware which supports the boom tip and controls the boom angle.

Builder means the builder/constructor of equipment.

Center of gravity means the center of gravity of any object is the point in the object around which its weight is evenly distributed. If you could put a support under that point, you could balance the object on the support.

Certified welder means a welder who meets nationally recognized certification requirements applicable to the task being performed.

Come-a-long means a mechanical device typically consisting of a chain or cable attached at each end that is used to facilitate movement of materials through leverage.

Competent person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Controlled load lowering means lowering a load by means of a mechanical hoist drum device that allows a hoisted load to be lowered with maximum control using the gear train or hydraulic components of the hoist mechanism. Controlled load lowering requires the use of the hoist drive motor, rather than the load hoist brake, to lower the load.

Controlling entity means an employer that is a prime contractor, general contractor, construction manager or any other legal entity which has the overall responsibility for the construction of the project, its planning, quality and completion.

Counterweight means a weight used to supplement the weight of equipment in providing stability for lifting loads by counterbalancing those loads.

Crane/derrick includes all equipment covered by this subpart.

Crawler crane means equipment that has a type of base mounting which incorporates a continuous belt of sprocket driven track.

Crossover points means locations on a wire rope which is spooled on a drum where one layer of rope climbs up on and crosses over the previous layer. This takes place at each flange of the drum as the rope is spooled onto the drum, reaches the flange, and begins to wrap back in the opposite direction.

Dedicated channel means a line of communication assigned by the employer who controls the communication system to only one signal person and crane/derrick or to a coordinated group of cranes/derricks/signal person(s).

Dedicated pile-driver is a machine that is designed to function exclusively as a pile-driver. These machines typically have the ability to both hoist the material that will be pile-driven and to pile-drive that material.

Dedicated spotter (power lines): To be considered a dedicated spotter, the requirements of § 1926.1428 (Signal person qualifications) must be met and his/her sole responsibility is to watch the separation between the power line and the equipment, load line and load (including rigging and lifting accessories), and ensure through communication with the operator that the applicable minimum approach distance is not breached.

Directly under the load means a part or all of an employee is directly beneath the load.

Dismantling includes partial dismantling (such as dismantling to shorten a boom or substitute a different component).

Drum rotation indicator means a device on a crane or hoist which indicates in which direction and at what relative speed a particular hoist drum is turning.

Electrical contact occurs when a person, object, or equipment makes contact or comes in close proximity with an energized conductor or equipment that allows the passage of current.

Employer-made equipment means floating cranes/derricks designed and built by an employer for the employer's own use.

Encroachment is where any part of the crane, load line or load (including rigging and lifting accessories) breaches a minimum clearance distance that this subpart requires to be maintained from a power line.

Equipment means equipment covered by this subpart.

Equipment criteria means instructions, recommendations, limitations and specifications.

Fall protection equipment means guardrail systems, safety net systems, personal fall arrest systems, positioning device systems or fall restraint systems.

Fall restraint system means a fall protection system that prevents the user from falling any distance. The system is comprised of either a body belt or body harness, along with an anchorage, connectors and other necessary equipment. The other components typically include a lanyard, and may also include a lifeline and other devices.

Fall zone means the area (including but not limited to the area directly beneath the load) in which it is reasonably foreseeable that partially or completely suspended materials could fall in the event of an accident.

Flange points are points of contact between rope and drum flange where the rope changes layers.

Floating cranes/derricks means equipment designed by the manufacturer (or employer) for marine use by permanent attachment to a barge, pontoons, vessel or other means of flotation.

For example means "one example, although there are others."

Free fall (of the load line) means that only the brake is used to regulate the descent of the load line (the drive mechanism is not used to drive the load down faster or retard its lowering).

Free surface effect is the uncontrolled transverse movement of liquids in compartments which reduce a vessel's transverse stability.

Hoist means a mechanical device for lifting and lowering loads by winding a line onto or off a drum.

Hoisting is the act of raising, lowering or otherwise moving a load in the air with equipment covered by this standard. As used in this standard, "hoisting" can be done by means other than wire rope/hoist drum equipment.

Include/including means "including, but not limited to."

Insulating link/device means an insulating device listed, labeled, or accepted by a Nationally Recognized Testing Laboratory in accordance with 29 CFR 1910.7.

Jib stop (also referred to as a jib backstop), is the same type of device as a boom stop but is for a fixed or luffing jib.

Land crane/derrick is equipment not originally designed by the manufacturer for marine use by permanent attachment to barges, pontoons, vessels, or other means of flotation.

List means the angle of inclination about the longitudinal axis of a barge, pontoons, vessel or other means of flotation.

Load refers to the object(s) being hoisted and/or the weight of the object(s); both uses refer to the object(s) and the load-attaching equipment, such as, the load block, ropes, slings, shackles, and any other ancillary attachment.

Load moment (or rated capacity) indicator means a system which aids the equipment operator by sensing (directly or indirectly) the overturning moment on the equipment, i.e., load multiplied by radius. It compares this lifting condition to the equipment's rated capacity, and indicates to the operator the percentage of capacity at which the equipment is working. Lights, bells, or buzzers may be incorporated as a warning of an approaching overload condition.

Load moment (or rated capacity) limiter means a system which aids the equipment operator by sensing (directly or indirectly) the overturning moment on the equipment, i.e., load multiplied by radius. It compares this lifting condition to the equipment's rated capacity, and when the

rated capacity is reached, it shuts off power to those equipment functions which can increase the severity of loading on the equipment, e.g., hoisting, telescoping out, or luffing out. Typically, those functions which decrease the severity of loading on the equipment remain operational, e.g., lowering, telescoping in, or luffing in.

Luffing jib limiting device is similar to a boom hoist limiting device, except that it limits the movement of the luffing jib.

Mobile crane means a lifting device incorporating a cable suspended latticed boom or hydraulic telescopic boom designed to be moved between operating locations by transport over the road.

Moving point-to-point means the times during which an employee is in the process of going to or from a work station.

Multi-purpose machine means a machine that is designed to be configured in various ways, at least one of which allows it to hoist (by means of a winch or hook) and horizontally move a suspended load. For example, a machine that can rotate and can be configured with removable forks/tongs (for use as a forklift) or with a winch pack, jib (with a hook at the end) or jib used in conjunction with a winch. When configured with the forks/tongs, it is not covered by this subpart. When configured with a winch pack, jib (with a hook at the end) or jib used in conjunction with a winch, it is covered by this subpart.

Nationally recognized accrediting agency is an organization that, due to its independence and expertise, is widely recognized as competent to accredit testing organizations. Examples of such accrediting agencies include, but are not limited to, the National Commission for Certifying Agencies and the American National Standards Institute.

Nonconductive means that, because of the nature and condition of the materials used, and the conditions of use (including environmental conditions and condition of the material), the object in question has the property of not becoming energized (that is, it has high dielectric properties offering a high resistance to the passage of current under the conditions of use).

Operational aids are devices that assist the operator in the safe operation of the crane by providing information or automatically taking control of a crane function. These include, but are not limited to, the devices listed in § 1926.1416 ("listed operational aids").

Operational controls means levers, switches, pedals and other devices for controlling equipment operation.

Operator means a person who is operating the equipment.

Paragraph refers to a paragraph in the same section of this subpart that the word "paragraph" is used, unless otherwise specified.

Pendants includes both wire and bar types. Wire type: A fixed length of wire rope with mechanical fittings at both ends for pinning segments of wire rope together. Bar type: Instead of wire rope, a bar is used. Pendants are typically used in a latticed boom crane system to easily

change the length of the boom suspension system without completely changing the rope on the drum when the boom length is increased or decreased.

Personal fall arrest system means a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, a body harness and may include a lanyard, deceleration device, lifeline, or suitable combination of these.

Power lines means electric transmission and distribution lines.

Procedures include, but are not limited to: Instructions, diagrams, recommendations, warnings, specifications, protocols and limitations.

Proximity alarm is a device that provides a warning of proximity to a power line and that has been listed, labeled, or accepted by a Nationally Recognized Testing Laboratory in accordance with 29 CFR 1910.7.

Qualified evaluator (not a third party) means a person employed by the signal person's employer who has demonstrated that he/she is competent in accurately assessing whether individuals meet the Qualification Requirements in this subpart for a signal person.

Qualified evaluator (third party) means an entity that, due to its independence and expertise, has demonstrated that it is competent in accurately assessing whether individuals meet the Qualification Requirements in this subpart for a signal person.

Qualified person means a person who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, successfully demonstrated the ability to solve/resolve problems relating to the subject matter, the work, or the project.

Qualified rigger is a rigger who meets the criteria for a qualified person.

Range control limit device is a device that can be set by an equipment operator to limit movement of the boom or jib tip to a plane or multiple planes.

Range control warning device is a device that can be set by an equipment operator to warn that the boom or jib tip is at a plane or multiple planes.

Rated capacity means the maximum working load permitted by the manufacturer under specified working conditions. Such working conditions typically include a specific combination of factors such as equipment configuration, radii, boom length, and other parameters of use.

Rated capacity indicator: See load moment indicator.

Rated capacity limiter: See load moment limiter.

Repetitive pickup points refer to, when operating on a short cycle operation, the rope being used on a single layer and being spooled repetitively over a short portion of the drum.

Running wire rope means a wire rope that moves over sheaves or drums.

Runway means a firm, level surface designed, prepared and designated as a path of travel for the weight and configuration of the crane being used to lift and travel with the crane suspended platform. An existing surface may be used as long as it meets these criteria.

Section means a section of this subpart, unless otherwise specified.

Special hazard warnings means warnings of site-specific hazards (for example, proximity of power lines).

Stability (flotation device) means the tendency of a barge, pontoons, vessel or other means of flotation to return to an upright position after having been inclined by an external force.

Standard Method means the protocol in Appendix A of this subpart for hand signals.

Such as means "such as, but not limited to."

Superstructure: See Upperworks.

Tagline means a rope (usually fiber) attached to a lifted load for purposes of controlling load spinning and pendulum motions or used to stabilize a bucket or magnet during material handling operations.

Tilt up or tilt down operation means raising/lowering a load from the horizontal to vertical or vertical to horizontal.

Trim means angle of inclination about the transverse axis of a barge, pontoons, vessel or other means of flotation.

Two blocking means a condition in which a component that is uppermost on the hoist line, such as the load block, hook block, overhaul ball, or similar component, comes in contact with the boom tip, fixed upper block or similar component. This binds the system and continued application of power can cause failure of the hoist rope or other component.

Upperworks means the revolving frame of equipment on which the operating machinery (and many cases the engine) are mounted along with the operator's cab. The counterweight is typically supported on the rear of the upperstructure and the boom or other front end attachment is mounted on the front.

Up to means "up to and including."

Wire rope means a flexible rope constructed by laying steel wires into various patterns of multi-wired strands around a core system to produce a helically wound rope.

EXAM DEFINITIONS:

1. ***Gross Capacity*** = Maximum Weight a crane can lift (including all capacity deductions) given by the Manufacturer for each configuration (Chart or Line Pull)

2. ***Capacity Deductions*** = Weight of each component the manufacturer requires to be deducted from its Rated/Gross Capacity (block, ball, weight of rigging, etc.)

3. ***Net Capacity*** = Rated/Gross Capacity minus Capacity Deductions

4. ***Net Load*** = Gross Load minus Capacity deductions (Actual weight of the load to be lifted)

5. ***Gross Load*** = Combined actual weight of the load to be lifted and the weight of all capacity deductions.

6. ***Radius:*** Horizontal distance from center or axis of rotation to the center of gravity of the **SUSPENDED** load. (B30.5-1.1.1(b)(2))

7. ***Boom Length Lattice Measurement:*** Center of the boom foot pin to the center of head sheave pin.

8. ***Effective Weight:*** The weight the manufacturer determines must be used as a capacity deduction. (ABPS, Jib, Extension, etc.). May be less or more than actual weight. The effective weight of the deduction may be **heavier or lighter** than the actual weight.

9. ***Anti two-block damage prevention feature:*** A system that will stall when two-blocking occurs without causing damage to the hoist rope or crane machinery components. (ASME B30.5-0.2)

10. ***Anti two-block warning feature:*** A warning device to alert the operator of an impending two-blocking condition. (ASME B30.5-0.2)

11. **Anti–two-block device:** a device that, when activated, disengages all crane functions whose movement can cause two-blocking.

12. ***IWRC:*** Independent Wire Rope Core

13. ***Line Pull***: The amount of weight a drum will hoist for a given layer. (Decreases as layer increase.

14. **Load block position:** positioned directly above the load's center of gravity.

15. **ASME B30.5 Physical Examination Requirements:** Every 3 years

Characteristics and Limitations

Limitations and Crane Operating Characteristics

Drift –

"Drift" is a condition that occurs when the load continues to move after the crane or crane boom has stopped. Drift can be either an in and out motion, a side to side motion, or both, the infamous circle. This motion is caused when booming or swinging functions are started or stopped too rapidly. The motion will cause increased radius and/or side loading of the boom. Extreme caution must be used when signaling crane near electric power lines. Uncontrolled drift may cause the load or wire rope to contact the power lines.

Compensation for "Boom Drift" is accomplished by booming up to move the boom tip over top of the ball as the ball motion reaches its inward apex or boom down to move the boom tip over the top of the ball as the ball motion reaches its outward apex. Either of these methods is acceptable.

Compensation for "Swing Drift" is accomplished by swinging the boom tip over the top of the ball or block when it reaches its right or left apex.

To minimize the chance of excessive drifting, it is important to begin the booming or swinging function slowly and allow plenty of time to slow the function down before stopping.

Radius –

"Radius" is the horizontal distance between the center of rotation of the crane and the center of gravity of the suspended load. It is important that a signal person understand that increasing radius will generally decrease the lifting capacity of a crane and increase ground pressure applied by the crane.

Crane functions or action that will cause increased radius are:

1. Extending the boom.
2. Booming down.
3. Rapid swinging will cause the load, block, or ball to move out past the tip of the crane boom, increasing radius even more.
4. Booming down rapidly and stopping will cause the load, block, or ball to move past the tip of the crane, increasing radius even more.
5. Boom deflection, if not compensated for, will allow the load when it leaves the ground to move out past the tip of the crane boom, increasing radius.

When in between values the longer radii should be used. Unless specified by the manufacturer.

Boom Angle –

"Boom Angle" is the angle of the loaded boom to the ground or horizontal.

Lowering the boom angle will increase radius, decrease lifting capacity, and increase ground pressure. The longer the boom and the lower the boom angle the more flex the boom will have and will appear to bow in the middle.

Boom Length -

The distance from the center of the foot pin and the center of the tip sheave shaft.

When boom length is in between values use the next longer or shorter value whichever has the lower capacity, unless otherwise specified by the manufacturer.

Jib Offset -

The angle of the jib to the centerline of the main boom. As jib offset increases capacity usually decrease and jib radius increase.

Two-Blocking –

"Two-Blocking" is a condition that occurs when the ball or load block comes into contact with the sheaves in the tip of the boom. This may cause the wire rope to part and drop the ball, block, and load to the ground.

A dynamic unloading effect is caused if the crane is holding a load at the time of two-blocking. This will have a dramatic effect on the crane, causing a loss of backward stability and/or a loss of structural integrity that may cause the boom to collapse.

If the crane is equipped with an "Anti Two-Block" device, this device should never be used as a limiting device when hoisting, booming, or extending. Malfunctions may occur causing disastrous results. These devices are operational aids ONLY!!!

The crane functions that could cause two-blocking are:

1. Extending the boom.
2. Booming down.
3. Hoisting.

Boom Deflection –

"Boom Deflection" is created when a load is applied to the crane, taking the slack out of pendants, hoist lines, or telescopic boom sections and compressing the boom, slightly bending it. This MUST be compensated for prior to lifting the load off the ground or the load will move out away from the crane, increasing radius, and putting the ground crew at risk.

It is extremely important that the hoist line or lines are vertical when the load leaves the ground. The signal person must observe the hoisting to verify that the hoist line is vertical; if it is not he or she must stop the operation and compensate for the deflection. This can be accomplished by taking a step back and visually determine that the boom tip is centered over the load and the hoist line is vertical in all directions.

Another serious concern dealing with deflection is releasing the stress. This must be compensated for also, especially when the crane being used has boom stops. If deflection is not compensated for when a crane is boomed up high and the load placed on the ground, the boom will rise up and may bend the boom stops.

Dynamic Loading –

"Dynamic Loading" is a condition that occurs when the dynamic motion of the load dramatically increases the amount of stress applied to the crane. This can dramatically affect the stability and/or structural integrity of a crane.

Dynamic loading can be caused by rapidly accelerating while lifting a load or rapidly stopping while lowering a load.

The dynamic load applied to the crane may be many times the weight of the original load. This may cause crane instability or structural damage and boom collapse.

Care must be taken to slow the descent of the load prior to stopping it.

Attention must be paid to this at all times!!!

Before a full throttle hoist signal is taken, make sure the crane is not near its rated capacity and has the stability or the structural competence to perform such an action.

A steady increase in speed increases stress on the crane much less than a sudden increase.

Dynamic Unloading –

"Dynamic Unloading" is a condition that occurs when the load applied to the crane during lifting operations is suddenly released. This can have dramatic effects on the crane. The sudden and uncontrolled release of the applied load can cause loss of backward stability, or in the case of a lattice boom crane, may cause a loss of backward stability of the crane boom, causing structural damage and collapse.

A common cause of this is improper rigging techniques, rigging failure, or the uncontrolled release of the load when the crane experiences a loss of stability (TIP OVER).

Side Loading –

"Side Loading" can be caused by lifting a load without the boom tip completely centered over top of the load or rapid swinging or stopping of the swing. Side loading can cause structural damage especially when lifting from a jib.

Concrete bucket pouring, steel erection, and excavation or magnet work are some operations that manufacturers consider to be "Duty Cycle" operations. These operations may cause side loading, and normally manufacturers will require a reduction in the rated capacity for these operations.

Rated Capacity –

"Rated Capacity" is the maximum allowable load that can be applied to a crane at a given radius. As the radius increases, the rated capacity generally decreases.

Rated capacity can also be affected by the quadrant of operation. Some capacity charts are based on 360° rotation of the crane and others are based on the quadrant of operation and have different rated capacities for over the side or over the rear, etc.

Another factor that affects rated capacity is the number of wire rope parts a crane and block are reeved with. In order for the crane to lift the rated capacity as shown in the crane manufacturer's load

chart, the crane must be reeved with sufficient number parts as specified by the crane manufacturer.

Remember the "Maximum Rated Capacity" can usually only be lifted at

"Maximum Boom Angle" with "Minimum Boom Length."

Quadrants of Operation –

"Quadrants of Operation" dramatically affect the stability of a crane. Normally a crane's work area is broken into four distinct quadrants: an over the rear quadrant, an over the front quadrant, and two over the side quadrants.

The most stable quadrant is generally over the rear on truck mounted cranes and over the front on crawler mounted and rough terrain cranes. The least stable quadrant is generally over the side.

Care must be taken when swinging the crane from a quadrant with greater stability to a quadrant with less stability!

Reducing the radius is usually a good idea in these situations.

Swinging from the rear or front quadrant to a the side actually reduces the distance from the crane's center of gravity and the tipping axis. This reduces the stability of the crane.

Wind –

The effect of high or gusting winds on a crane can be dramatic and dangerous. Uncontrolled swinging of the crane and load may occur. Loads with a large wind surface create a sail effect that greatly compounds the problem, and in addition an uncontrollable rotation of the load occurs.

This condition is extremely dangerous to ground personnel and to the crane itself. Personnel attempting to assist in stopping either the swinging or rotation of the load may be injured in the process.

The side load stress applied to the crane is dynamically increased and may cause structural damage to the boom or jib; additionally, if the load contacts the boom, complete collapse may occur.

Many times the effects of wind on the load are underestimated and often attempts are made with the mistaken idea that all loads can be controlled with taglines even in extreme wind conditions, with disastrous results.

Manufacturer's shut down recommendations should be followed when positioning a crane overnight.

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Site Conditions, Assembly & Disassembly, Crane Set-up

SITE CONDITIONS

GROUND or BARGE

Don't forget the importance of site access.

Ground conditions must be firm, drained and graded. *(OSHA 1926.1402(b))*

Controlling entity must: *(OSHA 1926.1402(c)(1-2))*

Ensure the ground conditions in conjunction with support materials such as blocking, mats, cribbing, etc., if necessary, provide sufficient support for the assembly and operation of the crane.

Inform user and operator of the location of any underground hazards such as voids, tanks, vaults, and utilities.

List and Trim *(OSHA 1926.1437(n)(3-4))*

The maximum allowable list and the maximum allowable trim for the barge, pontoon, vessel or other means of flotation must not exceed the amount necessary to ensure that all deck surfaces are above water and that the entire bottom area of the barge is submerged.

In addition, that the maximum allowable list and the maximum allowable trim does not exceed the least of the following: **5 degrees**, the amount specified by the crane/derrick manufacturer, or, when an amount is not so specified, the amount specified by a qualified person.

The maximum allowable list and the maximum allowable trim for the land crane/derrick does not exceed the amount specified by the crane/derrick manufacturer, or, when an amount is not so specified, the amount specified by the qualified person.

ASSEMBLY AND DISASSEMBLY

Manufacturer or employer assembly procedures may be used. *(OSHA 1926.1403(a))*

A /D Director must:

Meet the criteria for both a "Competent Person" and a "Qualified Person". *(OSHA 1926.1404(a)(1))*

Understand the assembly/disassembly procedures. *(OSHA 1926.1404(b))*

Ensure that the crew understands their tasks, the associated hazards and how to avoid the hazardous conditions and locations.
(OSHA 1926.1404(d)(1)(i-iii)

Address specific hazards such as but not limited to: *(OSHA 1926.1404(h))*

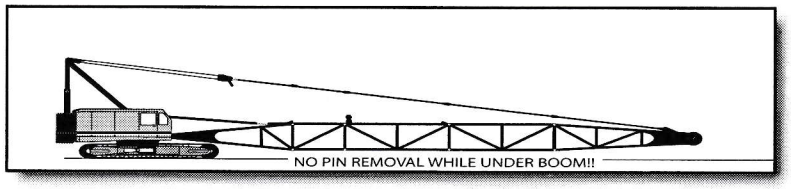
Site and ground bearing conditions.
Blocking material and position of blocking.
Boom and jib pick points.
Assist crane loads.
Pin removal hazards.
Counterweight removal.

If employer procedures are used the procedures must: *(OSHA 1926.1406(a)(1-3) and (b))*

1. Prevent dangerous movement or collapse of equipment.
2. Provide support and stability for equipment.
3. Position employees to minimize exposure to unintended movement and collapse of equipment.
4. Be developed by qualified person.

Working under the boom, jib or other components:

When removing pins, employees must not be under the boom, jib, or other components. *(OSHA 1926.1404(f)(1-2))*

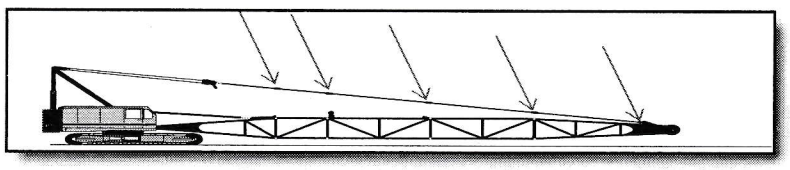


Exception:
Where the employer demonstrates that site constraints require one or more employees to be under the boom, jib, or other components when pins (or similar devices) are being removed, the A/D director must implement procedures that minimize the risk of unintended dangerous movement and minimize the duration and extent of exposure under the boom.

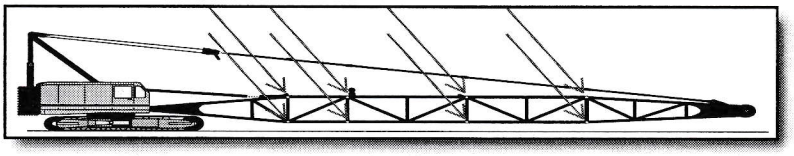
Maximum boom length that can be cantilevered for assembly or disassembly as stated in ***manufacturer's specifications*** must not be exceeded**.** If none are available a registered professional engineer must determine these limitations (In writing). *(OSHA 1926.1404(j))*

Pin Removal:

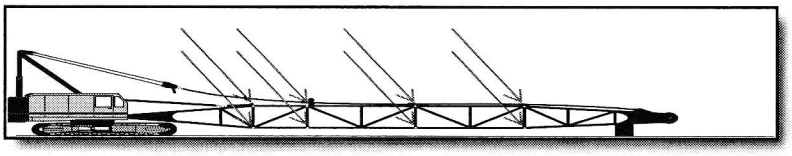
None of the pins in the pendants are to be removed (partly or completely) when the pendants are in tension. *(OSHA 1926.1405(a))*



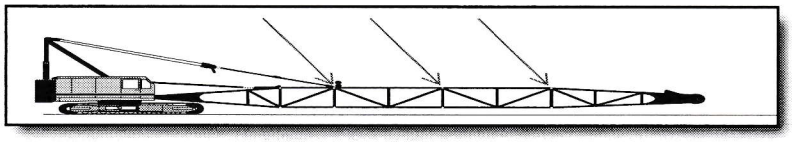
None of the pins (top or bottom) on boom sections located between the pendant attachment points and the crane/derrick body are to be removed (partly or completely) when the pendants are in tension. *(OSHA 1926.1405(b))*



None of the pins (top or bottom) on boom sections located between the uppermost boom section and the crane/derrick body are to be removed (partly or completely) when the boom is being supported by the uppermost boom section resting on the ground (or other support). *(OSHA 1926.1405(c))*



None of the top pins on boom sections located on the cantilevered portion of the boom being removed (the portion being removed ahead of the pendant attachment points) are to be removed (partly or completely) until the cantilevered section to be removed is fully supported. *(OSHA 1926.1405(d))*



Assembly restrictions near power lines:

Assembly/disassembly below power lines is prohibited. *(OSHA 1926.1407(c))*

Exception: The employer has confirmed that the utility owner/operator has de-energized and (at the worksite) visibly grounded the power line.

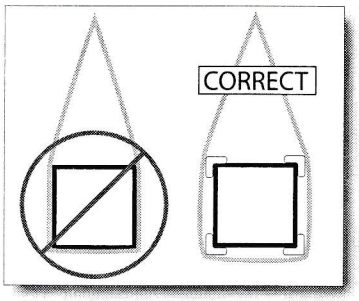
Assembly/disassembly inside Table "A" clearance is prohibited. *(OSHA 1926.1407(d))*

Exception: The employer has confirmed that the utility owner/operator has de-energized and (at the worksite) visibly grounded the power line.

Assembly or Disassembly Precautions:

During assembly or disassembly, the outriggers or stabilizers must be either fully extended or, if manufacturer procedures permit, deployed as specified in the load chart. *(OSHA 1926.1404(q)(1)).*

During assembly or disassembly employer must ensure:



The rigging work is done by a qualified rigger. *(OSHA 1926.1404(r)(1))*

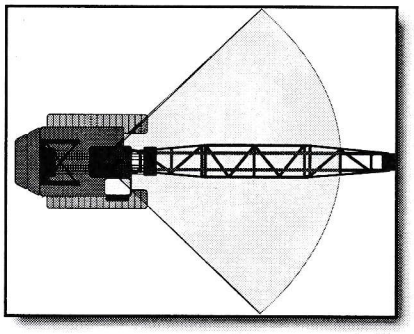
Synthetic slings are protected from: Abrasive, sharp or acute edges, etc. *(OSHA 1926.1404(r)(2))*

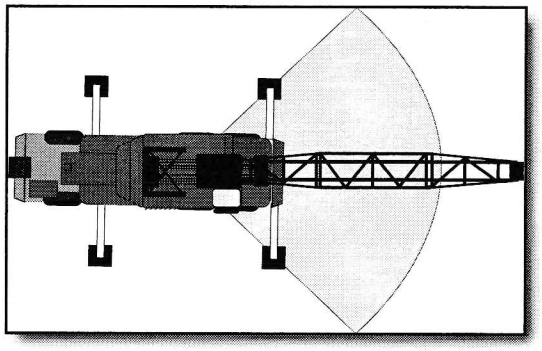
When synthetic slings are used, the synthetic sling manufacturer's instructions, limitations, specifications and recommendations must be followed. *(OSHA 1926.1404(r)(3))*

The order of boom sections should be ***SHORT TO LONG*** unless manufacturer specifies otherwise.

Only manufacturer's approved attachments may be used.

For crawler or truck crane, assemble or disassemble ***over the quadrant of maximum stability.***





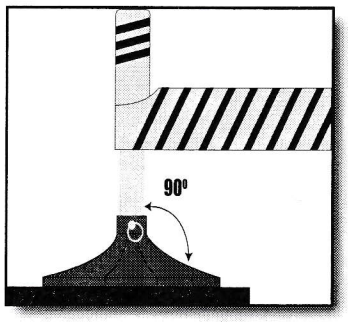
If you are going to rely on the boom hoist brake to prevent boom movement, prior to assembly or disassembly test it to ensure it is capable of preventing boom movement. If it is not, use boom pawl (dog) or other method such as blocking. *(OSHA 1926.1404(h)(10))*

CRANE SETUP

Outriggers must be fully extended or if permitted by the manufacturer partially extended to match a corresponding load chart. *(OSHA 1926.1404(q)(1))*

Outrigger must be set ***to remove machine weight from the wheels.*** *(OSHA 1926.1404(q)(2))*

Floats shall be ***secured to outriggers.*** *(OSHA 1910.180(h)(3)(ix); 1926.1404(q)(3))*



Pads must be **90° angle** to cylinder.

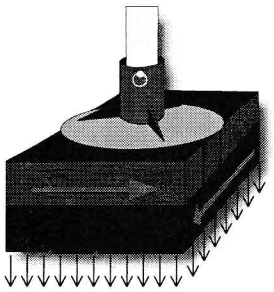
Never block under the outrigger beams.

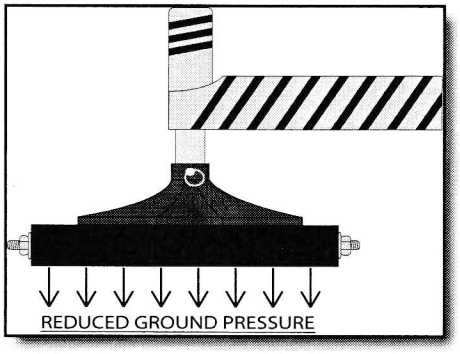
Outrigger pads and dunnage should be able to ***support total weight of crane & load.***

On truck-mounted cranes, no loads shall be lifted over the front area except as approved by the crane manufacturer. *(OSHA 1910.180(h)(3)(vii))*

Outriggers or stabilizers must be visible to the operator during extension and setting or a signal person must be used. *(OSHA 1926.1404(q)(4))*

The blocking material must be of the size, amount, condition and method of stacking the blocking must be sufficient to sustain the loads and maintain stability. *(OSHA 1926.1404(h)(2))*



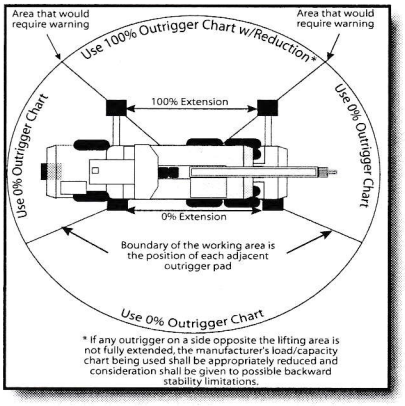


Mats & blocking are used to **distribute ground pressure** over a larger area, reducing the amount applied to the ground.

Best mats are those that are **bolted** together.

Outrigger Use *(ASME B30.5-3.2.1.5(h))*

1. Extended and set as per manufacturer's specifications.
2. Remove machine weight from wheels.
3. Partial extension permitted only with corresponding load chart (0%, 50%) and extended to equal positions.
4. When equal corresponding load chart positions NOT possible: (i.e. 2 at 100% and 2 at 50%)
   a. Manufacturer or Qualified person must be consulted.
   b. Crane operator must approve setup.
   c. If supervisor involved in setup, operator and supervisor must approve.
   d. Means must be provided to **stop or warn an operator of proximity to a quadrant with lower capacity.**
5. If outrigger position does not correspond to a load chart position **consult manufacturer or a qualified person** prior to commencing lift operation.



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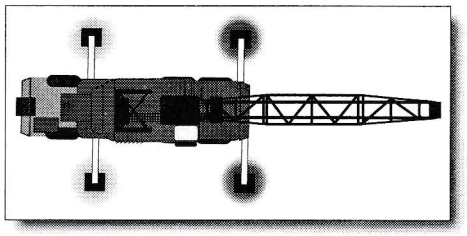
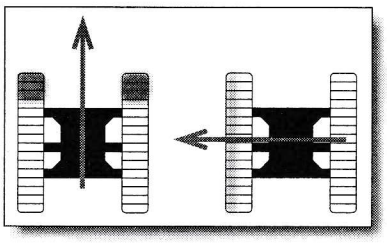
Ground Pressure:

The amount of ground pressure generated by lifting operations changes from outrigger to outrigger or crawler to crawler as the superstructure rotates, booms up or down, or extends and retracts. This must be taken into consideration when determining proper setup location.





On crawlers, the least ground pressure applied is ***over the side***.

On outriggers, the most ground pressure is usually generated **over a corner.**

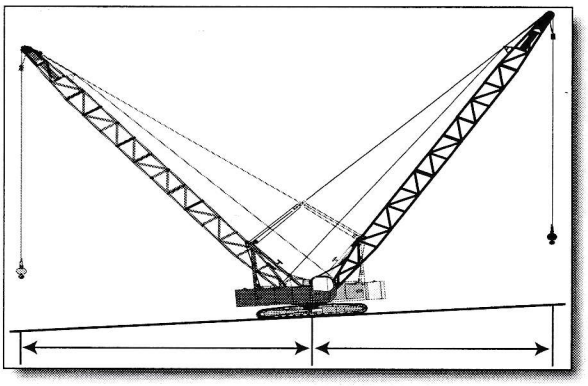
Leveling:

The **upper works** provides an accurate measure of level.

Cranes should be leveled to within **one percent of grade**.

Crane 3^0 off level may decrease capacity by as much as ***50%***.

Boom Length and Radius	Capacity Lost When Out of Level		
	1^0	2^0	3^0
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%



Swinging an un-level crane causes ***increased radius.***

Extended crawlers - ***increases over the side capacities.***

For land cranes used on barges:

One of the following options must be used to secure the crane to the barge: *(OSHA 1926.1437(n)(5)(i-iv))*

Option (1) **Physical attachment.** The crane/derrick is physically attached to the barge, pontoons, vessel or other means of flotation. Methods of physical attachment include crossed-cable systems attached to the crane/derrick and vessel/flotation device, bolting or welding the crane/derrick to the vessel/flotation device, strapping the crane/derrick to the vessel/flotation device with chains, or other methods of physical attachment.

Option (2) **Corralling.** The crane/derrick is prevented from shifting by installing barricade restraints (i.e., a corralling system). Employers must ensure that corralling systems do not allow the equipment to shift by any amount of shifting in any direction.

Option (3) **Rails.** The crane/derrick must be prevented from shifting by being mounted on a rail system. Employers must ensure that rail clamps and rail stops are used unless the system is designed to prevent movement during operation by other means.

Option (4) **Centerline cable system.** The crane/derrick is prevented from shifting by being mounted to a wire rope system.

Exception: *(OSHA 1926.1437(n)(6))*
A marine engineer or registered professional engineer familiar with floating crane/derrick design develops and signs a written plan for the use of the mobile auxiliary crane.

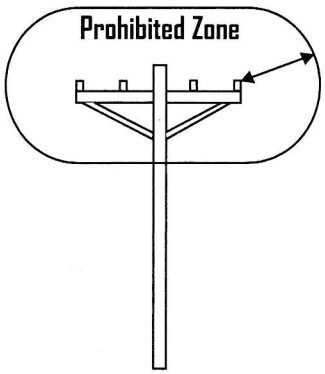
EQUIPMENT
TRAINING
SOLUTIONS

MOBILE CRANE OPERATOR CORE MATERIAL

Power Line Safety

OSHA POWER LINE SAFETY *(OSHA 1926.1407 – 1926.1411)*

If at any time during the assembly, disassembly or operation of a crane, any part of the crane can get closer than 20 feet to a power line, then one of the following three options must be selected: *(OSHA 1926.1407(a)(1-3))*



Option (1): De-energize and ground. Confirm from the utility owner/ operator that the power line has been de-energized and visibly grounded at the worksite.

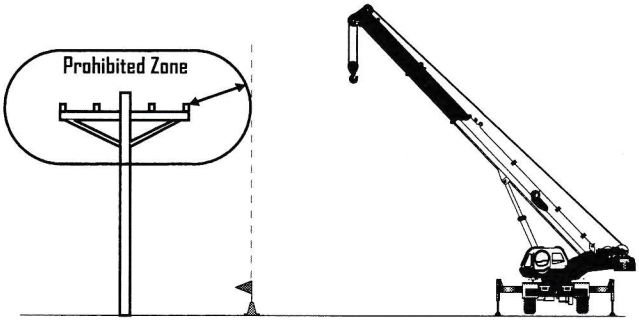
Option (2): **20-foot clearance.** Ensure that no part of the equipment, load line or load (including rigging and lifting accessories), gets closer than **20 feet** to the power line by implementing the measures specified in **paragraph (b)** of this section. (For power lines 350kV and under)

Option (2): **50-foot clearance.** Ensure that no part of the equipment, load line or load (including rigging and lifting accessories), gets closer than **50 feet** to the power line by implementing the measures specified in **paragraph (b)** of this section. (For power lines over 350kV)

Option (3): Table **"A"** clearances plus the requirements of **paragraph (b).**

Table A - Minimum Clearance Distances	
Voltage (nominal, kV, alternating current)	Minimum clearance sistance (feet)
up to 50	10
over 50 to 200	15
over 200 to 350	20
over 350 to 500	25
over 500 to 750	35
over 750 to 1,000	45
over 1,000	(as established by the utility owner/ operator or registered professional engineer who is a qualified person with respect to electrical power transmission and

Paragraph (b) (Preventing Encroachment/Electrocution): *(OSHA 1926.1407(b))*



1. Conduct a planning meeting with the crane operator and other workers in the area.
2. If taglines are used, they must be non-conductive taglines.
3. Use elevated warning lines, barricades or line of signs.

If operator is unable to see warning lines, then a **dedicated spotter** must be used, in addition **one of the four remain measures** listed below. *(OSHA 1926.1408(b)(3))*

4. In addition to the 3 measures above, implement at least one of these measures:

    1. Use a proximity alarm.
    2. Use dedicated spotter: *(Continuous contact required)*

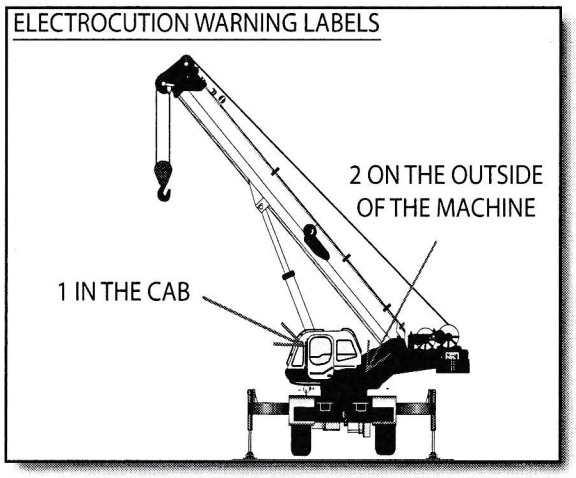
        a. Equipped with visual aid to identify minimum clearance distance.
        b. Be positioned to effectively gauge clearance distance.
        c. When needed, use equipment that enables spotter to directly communicate with the operator.
        d. Give timely information to the operator

    3. Use a device that automatically warns the operator to stop (range control warning device).
    4. Use device that limits range of movement.
    5. Use an insulating link/device installed between the end of the load line and the load.

When Option (3) is used the utility owner/operator must provide the voltage information within **two working days** of the employer's request.
(OSHA 1926.1407(e))

All power lines must be **presumed energized** unless the utility owner/operator confirms that the power line has been and continues to be de-energized and visibly grounded at the worksite. *(OSHA 1926.1407(f))*

There must be at least **one electrocution hazard warning** conspicuously posted **in the cab** so that it is in view of the operator and (except for overhead gantry and tower cranes) at least **two on the outside of the equipment**.
(OSHA 1926.1407(g))



Identify the work zone:

1. Demarcating boundaries; Flags or device.
2. Define work zone as the area 360^0 around crane up to the crane's maximum working radius.

Operating below power lines:

No part of the equipment, load line, or load (including rigging and lifting accessories) is allowed below a power line. *(OSHA 1926.1408(d)(1))*

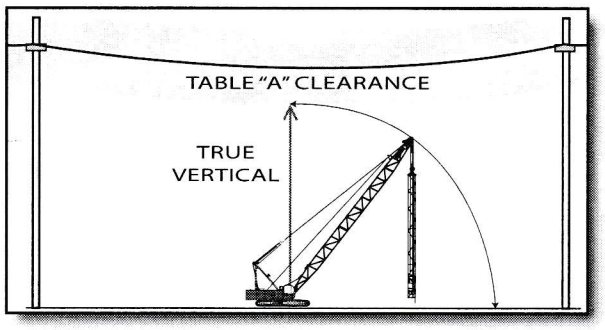
Exceptions: *(OSHA 1926.1408(d)(2))*

Work is covered by subpart V.

Utility owner/operator has de-energized and visibly grounded the power line (at the worksite).

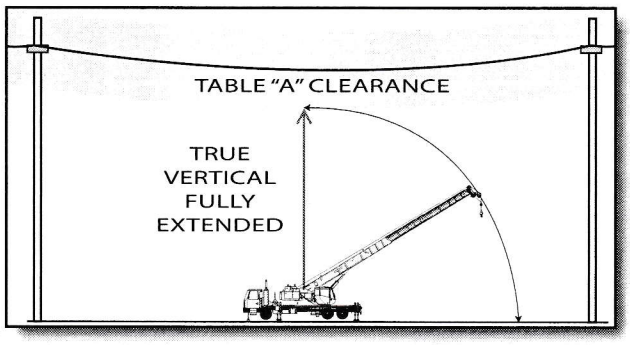
For non-extendable boom (Lattice):

With boom at true vertical the boom tip is more than 20 feet or table "A" clearance from power lines. *(350 kV and under) ((OSHA 1926.1408(d)(2)(ii))*



With boom at true vertical boom tip is more than 50 feet or table "A" clearance from power lines. *(Over 350 kV up to 1,000 kV) (OSHA 1926.1409(a))*

For articulating or extendable boom:



The boom at true vertical the uppermost part of the boom is 20 feet or table "A" clearance from power lines. *(350 kV and under)((OSHA 1926.1408(d)(2)(iii))*

The boom at true vertical the uppermost part of the boom is 50 feet or table "A" clearance from power lines. *(Over 350 kV up to 1,000 kV) (OSHA 1926.1409(a))*

Working closer than Table "A" clearances. *(OSHA 1926.1410)*

Only permitted if: *(OSHA 1926.1410(a-b))*

1. Infeasible to do the work without breaching the Table "A" clearance.

2. Infeasible to de-energize and ground the power lines.

Minimum clearance must be established by the power line owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution. *(OSHA 1926.1410(c))*
Procedures must be developed that at a minimum include: (*OSHA 1926.1410(d))*

1. Automatic circuit reclosing feature must be disabled.
2. Dedicated spotter must be used.
3. An elevated warning line of signs.
4. Insulating link must be used.
5. Non-conductive rigging must be used. (If within Table "A" clearance)
6. If used, a tagline must be non-conductive.
7. Crane must be properly grounded.

8. Barricades forming at least a ten foot barrier around the crane must be utilized.
9. Workers are prohibited from touching the load line above the insulating link.
10. Operators remotely operating the equipment from the ground must use either wireless controls that isolate the operator from the equipment or insulating mats that insulate the operator from the ground.
11. Only essential personnel permitted in the area of the crane and load.
12. Insulating covers must be installed by the utility owner/operator.

One person must be authorized to implement the procedures and to stop work at any time to ensure safety.

When traveling under or near power lines with no load: *(OSHA 1926.1411)*

1. Boom/mast must be lowered sufficiently.
2. Clearances specified in Table "T" must be maintained.
3. Effect of speed and terrain must be considered so the distances in Table "T" are not breached.
4. **Dedicated spotter is required if any part of the equipment will get closer than 20 feet of the power line.** The spotter shall be in continuous contact with the operator. Spotter must:
    a. be positioned to effectively gauge the clearance distance.
    b. when necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.
    c. give timely information to the operator so the required clearance distance can be maintained.

Table T –

Table T - Required Distance While Traveling Under Power Lines	
Voltage (nominal, kV, alternating current)	While Traveling - Minimum clearance distance (feet)
up to .75	4
over .75 to 50	6
over 50 to 345	10
over 345 to 750	16
over 750 to 1,000	20
over 1,000	(as established by the utility owner/ operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution)

Inspections: Crane Wire Rope

INSPECTIONS: *(OSHA 1926.1412; 1910.180(d))*

Each shift: *(OSHA 1926.1412(d)(1))*

1. Must begin prior to shift, must be completed **before or during** that shift.
2. Visual inspection, performed by a **"Competent Person".**
3. **No records** required.

Inspection must include the following:

1. **Control mechanisms** for maladjustment interfering with **proper operation**.
2. Control and drive mechanisms for apparent excessive **wear**.
3. Air, hydraulic, and other pressurized **lines** for deterioration or leakage.
4. Hydraulic system for proper **fluid level.**
5. **Hooks and latches** for deformation, cracks, excessive wear, or damage.
6. **Wire rope** reeving for compliance with the manufacturer's specifications.
7. **Electrical apparatus** for malfunctioning, signs of apparent excessive deterioration, dirt or moisture accumulation.
8. **Tires** (when in use) for proper inflation and condition.
9. **Ground conditions** around the equipment for proper support.
10. The equipment for **level** position.
11. Operator **cab windows**.
12. **Safety devices and operational aids** for proper operation.

Monthly: *(OSHA 1926.1412(e))*

Shift inspection criteria must be followed with **records maintained by the employer for a minimum of three months.**

Records must include the **items checked** and name and signature of the **person performing the inspection.**

Annual/Comprehensive: *(OSHA 1926.1412(f))*

At least every **12 months**;
Performed by a **"qualified person".**

Equipment not in regular use. *(OSHA 1926.1412(h))*

Equipment that has been idle for **3 months or more** must be inspected by a qualified person in accordance with the requirements of a **"Monthly inspection"** before initial use.

Inspection Criteria for Annual/Comprehensive Inspection: *(OSHA 1926.1412(f)(i-xxi))*

1. Shift inspection criteria must be followed with records **maintained by the employer for a minimum of 12 months.**

2. Disassembly **is required**, as necessary, to complete the inspection.

3. In addition, the equipment must be inspected for all of the following:

   a. Equipment structure (including the boom and, if equipped, the jib).

   b. Structural members: Deformed, cracked, or significantly corroded.

      i. Bolts, rivets and other fasteners: loose, failed or significantly corroded.
      ii. Welds for cracks.
      iii. Sheaves and drums for cracks or significant wear.
      iv. Parts such as pins, bearings, shafts, gears, rollers and locking devices for distortion, cracks or significant wear.
      v. Brake and clutch system parts, linings, pawls and ratchets for excessive wear.
      vi. Safety devices and operational aids for proper operation (including significant inaccuracies).
      vii. Gasoline, diesel, electric, or other power plants for safety-related problems (such as leaking exhaust and emergency shut-down feature) and conditions, and proper operation.
      viii. Chains and chain drive sprockets for excessive wear of sprockets and excessive chain stretch.
      ix. Travel steering, brakes, and locking devices, for proper operation.
      x. Tires for damage or excessive wear.

   c. Hydraulic, pneumatic and other pressurized hoses, fittings and tubing, as follows:

      i. Flexible hose or its junction with the fittings for indications of leaks.
      ii. Threaded or clamped joints for leaks.
      iii. Outer covering of the hose for blistering, abnormal deformation or other signs of failure/ impending failure.
      iv. Outer surface of a hose, rigid tube, or fitting for indications of excessive abrasion or scrubbing.

   d. Hydraulic and pneumatic pumps and motors, as follows:

      i. Performance indicators: Unusual noises or vibration, low operating speed, excessive heating of the fluid, low pressure.
      ii. Loose bolts or fasteners.
      iii. Shaft seals and joints between pump sections for leaks.

   e. Hydraulic and pneumatic valves, as follows:

      i. Spools: Sticking, improper return to neutral, and leaks.
      ii. Leaks.
      iii. Valve housing cracks.

f. Relief valves: Failure to reach correct pressure (if there is a manufacturer procedure for checking pressure, it must be followed).

g. Hydraulic and pneumatic cylinders, as follows:

   i. Drifting caused by fluid leaking across the piston.
   ii. Rod seals and welded joints for leaks.
   iii. Cylinder rods for scores, nicks, or dents.
   iv. Case (barrel) for significant dents.

h. Rod eyes and connecting joints: Loose or deformed.

i. Outrigger or stabilizer pads/floats for excessive wear or cracks.

j. Slider pads for excessive wear or cracks.

k. Electrical components and wiring for cracked or split insulation and loose or corroded terminations.

l. Warning labels and decals originally supplied with the equipment by the manufacturer or otherwise required under this standard: Missing or unreadable.

m. Originally equipped operator seat (or equivalent): Missing.

n. Operator seat: Unserviceable.

o. Originally equipped steps, ladders, handrails, guards: Missing.

p. Steps, ladders, handrails, guards: In unusable/unsafe condition.

4. This inspection must include functional testing to determine that the equipment as configured in the inspection is functioning properly.

5. If any deficiency is identified, an immediate determination must be made by the qualified person as to whether the deficiency constitutes a safety hazard or, though not yet a safety hazard, needs to be monitored in the monthly inspections.

6. If the qualified person determines that a deficiency is a safety hazard, the equipment must be taken out of service until it has been corrected, except when OSHA accepted temporary measures are utilized.

7. If the qualified person determines that, though not presently a safety hazard, the deficiency needs to be monitored, the employer must ensure that the deficiency is checked in the monthly inspections.

8. Documentation of annual/comprehensive inspection. The following information must be documented, maintained, and retained for a minimum of 12 months, by the employer that conducts the inspection:
    a. The items checked and the results of the inspection.
    b. The name and signature of the person who conducted the inspection and the date.

Modifications: *(OSHA 1926.1434)*

a) Modifications or additions which affect the capacity or safe operation of the equipment are prohibited except where the requirements of paragraphs (a)(1), (a)(2), (a)(3), (a)(4), or (a)(5) of this section are met.

1. Manufacturer review and approval.

    i. The manufacturer approves the modifications/additions in writing.

    ii. The load charts, procedures, instruction manuals and instruction plates/tags/decals are modified as necessary to accord with the modification/addition.

    iii. The original safety factor of the equipment is not reduced.

2. Manufacturer refusal to review request. The manufacturer is provided a detailed description of the proposed modification/addition, is asked to approve the modification/addition, but it declines to review the technical merits of the proposal or fails, within 30 days, to acknowledge the request or initiate the review, and all of the following are met:

    i. A registered professional engineer who is a qualified person with respect to the equipment involved:

        A. Approves the modification/addition and specifies the equipment configurations to which that approval applies, and

        B. Modifies load charts, procedures, instruction manuals and instruction plates/tags/decals as necessary to accord with the modification/addition.

    ii. The original safety factor of the equipment is not reduced.

3. Unavailable manufacturer. The manufacturer is unavailable and the requirements of paragraphs (a)(2)(i) and (ii) of this section are met.

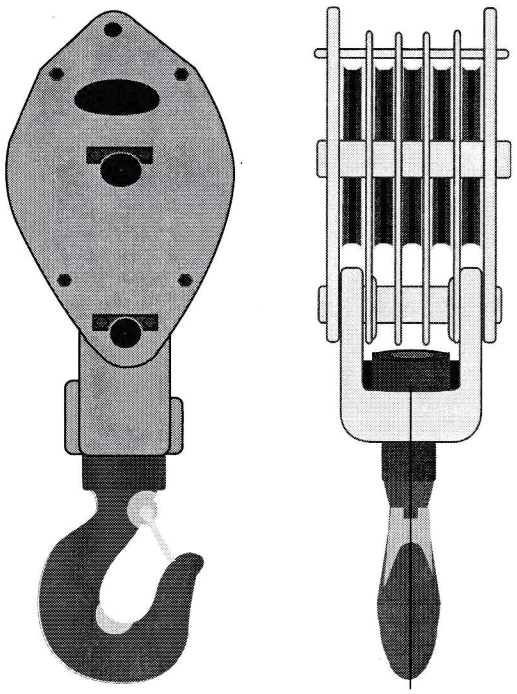
4. Manufacturer does not complete the review within 120 days of the request. The manufacturer is provided a detailed description of the proposed modification/addition, is asked to approve the modification/addition, agrees to review the technical merits of the proposal, but fails to complete the review of the proposal within 120 days of the date it was provided the detailed description of the proposed modification/addition, and the requirements of paragraphs (a)(2)(i) and (ii) of this section are met.

5. Multiple manufacturers of equipment designed for use on marine work sites. The equipment is designed for marine work sites, contains major structural components from more than one manufacturer, and the requirements of paragraphs (a)(2)(i) and (ii) of this section are met.

b) Modifications or additions which affect the capacity or safe operation of the equipment are prohibited where the manufacturer, after a review of the technical safety merits of the proposed

modification/addition, rejects the proposal and explains the reasons forthe rejection in a written response. If the manufacturer rejects the proposal but does not explain the reasons for the rejection in writing, the employer may treat this as a manufacturer refusal to review the request under paragraph 2 of this section.

HOOK INSPECTION: *(ASME B30.10)*



1. Removal Criteria:

   a. Distortion.
   b. Wear.
   c. Cracks, nicks, or gouges.
   d. Latch engagement.
   e. Hook attachment.
   f. Deformation. (No Twist allowed) (ASME)
   g. Throat opening – 5% not to exceed ¼ inch.
   h. Wear – Not to exceed 10%.
   i. Inability to Lock.
   j. Inoperative Latch.

WIRE ROPE INSPECTION: *(OSHA 1926.1413)*

1. **Shift inspection.**

   A competent person must begin a **visual inspection prior to each shift** the equipment is used, which must be completed before or during that shift. The inspection must consist of observation of wire ropes (running and standing) that are likely to be in use during the shift for apparent deficiencies. **Untwisting (opening) of wire rope or booming down is not required as part of this inspection.**

   Deficiencies:

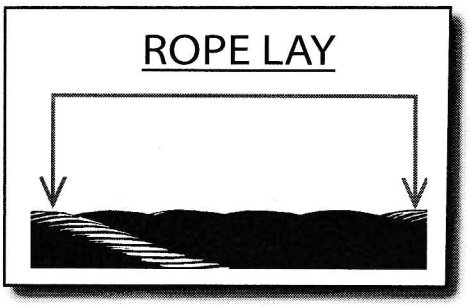
   a. **Category I** deficiencies.

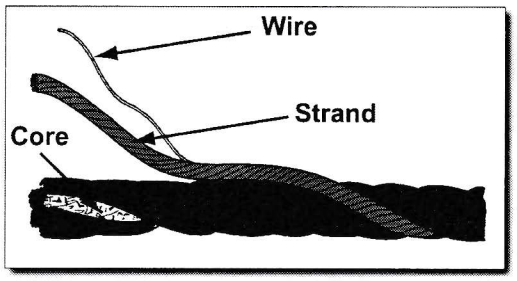
      i. **Significant distortion** of the wire rope structure such as kinking, crushing, unstranding, birdcaging, signs of core failure or steel core protrusion between the outer strands.
      ii. Significant **corrosion.**
      iii. **Electric arc damage** (from a source other than power lines) or heat damage.
      iv. **improperly applied end connections**.
      v. Significantly **corroded, cracked, bent, or worn end connections.**

   b. **Category II** deficiencies.

      i. **Visible broken wires**, as follows:
         1. In running wire ropes: **Six randomly distributed broken wires in one rope lay**

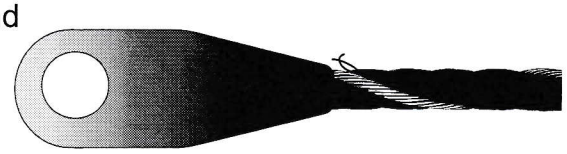
or **three broken wires in one strand in one rope lay,** where a rope lay is the length along the rope in which one strand makes a complete revolution around the rope.



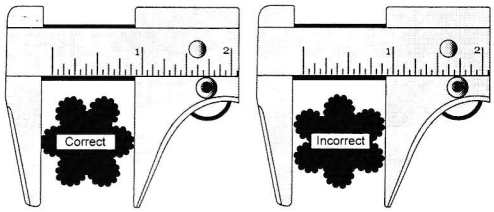


2. In *rotation resistant ropes*: **Two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.**

3. In pendants or standing wire ropes: **More than two broken wires in one rope lay** located in rope beyond end connections and/or **more than one broken wire in a rope lay located at an end connection.**



4. A **diameter reduction** of more than **5% from nominal diameter.**



c. **Category III** deficiencies.

i. In *rotation resistant* wire rope, **core protrusion or other distortion** indicating core failure.
ii. **Prior electrical contact** with a power line.
iii. **A broken strand.**
iv. **Critical review items.** The competent person must give particular attention to all of the following:

1. **Rotation resistant** wire rope in use.
2. Wire rope being used for **boom hoists and luffing hoists**, particularly at reverse bends.
3. Wire rope at **flange points, crossover points** and repetitive pickup points on drums.
4. Wire rope at or **near terminal ends.**
5. Wire rope in contact with **saddles, equalizer sheaves or other sheaves** where rope travel is limited.

d. **Removal from service.**

i. If a deficiency in **Category I** is identified, an **immediate determination must be made** by the competent person as to whether the deficiency constitutes a safety hazard. If the deficiency is determined to constitute a safety hazard, operations involving use of the wire rope in question must be prohibited until:

1. The wire rope is **replaced,** or
2. If the deficiency is localized, the **problem is corrected by severing the wire rope** in two; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will **still have two wraps of wire** when the load and/or boom are in their lowest position.

ii. If a deficiency in **Category II** is identified, operations involving use of the wire rope in question must be prohibited until:

1. The employer complies with the **wire rope manufacturer's established criterion** for removal from service or a different criterion that the wire rope manufacturer has approved in writing for that specific wire rope.
2. The wire rope is **replaced**, or
3. If the deficiency is localized, the **problem is corrected by severing the wire rope** in two; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have **two wraps** of wire when the load and/or boom are in their lowest position.

iii. If a deficiency in **Category III** is identified, operations involving use of the wire rope in question must be prohibited until:

1. The wire rope is **replaced**, or
2. If the deficiency (other than power line contact) is localized, **the problem is corrected by severing the wire rope in two**; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. Repair of wire rope that contacted an energized power line is also prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have **two wraps of wire** when the load and/or boom are in their lowest position.
3. Where a wire rope is required to be removed from service under this section, either the equipment (as a whole) or the hoist with that wire rope must be tagged-out, until the wire rope is repaired or replaced.

"Where the employer has taken the **equipment out of service**, a tag must be placed in the **cab** stating that the equipment is out of service and is not to be used. Where the employer has taken a **function(s) out of service**, a tag must be placed in a **conspicuous position** stating that the function is out of service and is not to be used."

2. Monthly inspection.

a. **Each month** an inspection must be conducted in accordance with paragraph (a) (**shift inspection**) of this section.

b. The inspection must include any deficiencies that the qualified person who conducts the annual inspection determines under paragraph (c)(3)(ii) of this section must be monitored.

c. Wire ropes on equipment must not be used until an inspection under this paragraph demonstrates that no corrective action under paragraph (a)(4) of this section is required.

d. The **inspection must be documented** as per the monthly inspection documentation requirements.

i. Maintained, and **retained for a minimum of 3 months**, by the employer that conducts the inspection:

1. The **items** checked and the **results** of the inspection.
2. The **name and signature of the person** who conducted the inspection and the date.

3. Annual/comprehensive.

a. **At least every 12 months**, wire ropes in use on equipment must be inspected by a qualified person in accordance with paragraph (1) of this section (shift inspection).
b. In addition, at least every 12 months, the wire ropes in use on equipment must be inspected by a qualified person, as follows:

i. The inspection must be for deficiencies of the types listed in paragraph (1)(a-c) of this section.
ii. The inspection must be complete and thorough, covering the surface of the entire length of the wire ropes, with particular attention given to all of the following:

1. Critical review items listed in paragraph (1)(c)(iv) of this section.
2. Those sections that are normally hidden during shift and monthly inspections.
3. Wire rope subject to reverse bends.
4. Wire rope passing over sheaves.

Exception: In the event an inspection under paragraph (3) of this section is not feasible due to existing setup and configuration of the equipment (such as where an assist crane is needed) or due to site conditions (such as a dense urban setting), such inspections must be conducted as soon as it becomes feasible, but no longer than an **additional 6 months** for running ropes and, for standing ropes, at the time of disassembly.

c. If a deficiency is identified, an immediate determination must be made by the qualified person as to whether the deficiency constitutes a safety hazard.

d. If the deficiency is determined to constitute a safety hazard, operations involving use of the wire rope in question must be prohibited until:
   i. The wire rope is replaced, or
   ii. If the deficiency is localized, the problem is corrected by severing the wire rope in two; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have two wraps of wire when the load and/or boom is in its lowest position.
   iii. If the qualified person determines that, though not presently a safety hazard, the deficiency needs to be monitored, the employer must ensure that the deficiency is checked in the monthly inspections.

e. The inspection must be documented as per the annual/comprehensive inspection documentation requirements.

   i. **Maintained, and retained for a minimum of 12 months**, by the employer that conducts the inspection:

      1. The items checked and the results of the inspection.
      2. The name and signature of the person who conducted the inspection and the date.

f. Rope lubricants must **NOT** hinder visual inspections.

g. **All documents produced under this section must be available**, during the applicable document retention period, to all persons who conduct inspections under this section.

Wire rope design factors:

Other than rotation resistant: *(Regular lay) (ASME B30.5-1.7.1- 2004; OSHA 1926.1414(b)(1))*

1. The design factor for **live or running ropes** that wind on drums or travel over sheaves shall **not be less than 3.5.**

2. The design factor for boom **pendants or standing ropes** shall **not be less than 3.0.**

Rotation resistant ropes. *(OSHA 1926.1414(e))*

Rotation resistant ropes (including Types I, II and III) must have an operating design factor of **no less than 3.5.**

Definitions. *(OSHA 1926.1414(e)(1))*

1. **Type I** rotation resistant rope is stranded rope constructed to have little or no tendency to rotate or, if guided, transmits little or no torque. It has **at least 15 outer strands** and comprises an assembly of **at least three layers of strands** laid helically over a center

in two operations. The direction of lay of **the outer strands is opposite to that of the underlying layer**.

2. **Type II** rotation resistant rope is stranded rope constructed to have significant resistance to rotation. It has **at least 10 outer strands** and comprises an assembly of **two or more layers of strands** laid helically over a center in two or three operations. The direction of lay of the **outer strands is opposite to that of the underlying layer.**

3. **Type III** rotation resistant rope is stranded rope constructed to have limited resistance to rotation. It has **no more than nine outer strands**, and comprises an assembly of **two layers of strands** laid helically over a center in two operations. The direction of lay of the **outer strands is opposite to that of the underlying layer.**

Requirements. *(OSHA 1926.1414(e)(2))*

1. **Type I** must have an operating design factor of **no less than 5**, except where the wire rope manufacturer and the equipment manufacturer approves the design factor, in writing.

2. **Types II and III** with an operating design factor of less than 5 must **NOT** be used for **duty cycle or repetitive lifts.**

    a. Exception:

        i. A qualified person must inspect the rope in accordance with § 1926.1413(a) ***(shift inspection)***. The rope must be used only if the qualified person determines that there are no deficiencies constituting a hazard. In making this determination, more than one broken wire in any one rope lay must be considered a hazard.
        ii. Operations must be conducted in such a manner and at such speeds as to minimize dynamic effects.
        iii. Each lift made under § 1926.1414(e)(3)*(Duty cycle or repetitive lifts)* must be recorded in the monthly and annual inspection documents. Such prior uses must be considered by the qualified person in determining whether to use the rope again.

Minimum Drum Pitch Diameter:

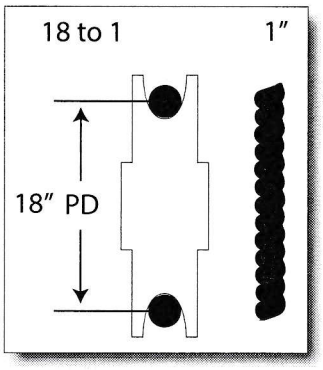
Boom Hoist:

The drum must provide a first layer rope pitch diameter of not less than 15 times the nominal diameter of the rope used. (ASME B30.5-1.3.1(b)(2))

Load Hoist:

The drum must provide a first layer rope pitch diameter of not less than 18 times the nominal diameter of the rope used. (ASME B30.5-1.3.2(a)(3))

The hoist drum flange shall extend a minimum of **1/2 inch** over the top layer of wire rope at all times while crane is in operation.



The more layers on drum - ***line pull decreases.***

Minimum Sheave Pitch Diameter: (ASME B30.5-1.7.5)

(a) Boom-hoisting sheaves shall have pitch diameters of not less than 15 times the nominal diameter of the rope used.

(b) Load-hoisting sheaves shall have pitch diameters not less than 18 times the nominal diameter of the rope used.

(c) Load block (lower) sheaves shall have pitch diameters not less than 16 times the nominal diameter of the rope used.

Rotation Resistant Rope

The requirements in ASME B30.5-2004 sections 5-1.3.2(a), (a)(2) through (a)(4), (b) and (d) (incorporated by reference, see § 1926.6) except that the minimum pitch diameter for sheaves used in multiple rope reeving is 18 times the nominal diameter of the rope used (instead of the value of 16 specified in section 5-1.3.2(d)).

Seat belts must be installed only on cranes with a single control station (i.e. **Rough Terrain, Carry Decks, and All Terrain** Cranes, etc.) *(ASME B30.5-1.8(e)).*

The most common wire rope used on cranes is right regular lay.

Maintenance programs should follow the recommendations of the crane manufacturer.

EQUIPMENT
TRAINING
SOLUTIONS

MOBILE CRANE OPERATOR CORE MATERIAL

Safety Devices, Operation Aids, Operations

SAFETY DEVICES: *(OSHA 1926.1415(a))*

1. Required on all equipment covered in this part.
2. Crane Level Indicator..
3. The equipment must have a crane level indicator that is either built into the equipment or is available on the equipment.
4. Boom Stops, except for derricks.
5. Jib Stops, except for derricks.
6. Pedal locks, when crane is equipped with pedals.
7. Integral holding device/check valve on hydraulic outrigger/stabilizer jacks.
8. Horns either built in or on the equipment immediately available to the operator.
9. All safety devices must be in proper working order or operations must stop.
10. **Alternative measures are NOT permitted.**

OPERATION AIDS: *(OSHA 1926.1416)*

Category 1 device w/temporary alternative measure:

Repair period: **7 days**.

1. Boom hoist limiting device. (Stops boom hoisting operation when max. angle is reached)
    a. *Alternative measure:* One of the following:
        i. Use a boom angle indicator.
        ii. Clearly mark the boom hoist cable *(so that it can easily be seen by the operator)* at a point that will give the operator sufficient time to stop the hoist to keep the boom within the minimum allowable radius. In addition, install mirrors or remote video cameras and displays if necessary for the operator to see the mark.
2. Luffing jib limiting device.
    a. *Alternative measure:* Same as boom hoist limiting device.
3. Anti two-block **device**, telescopic boom cranes manufactured after February 28, 1992.
    a. *Alternative measure:* **Clearly mark the cable** *(so that it can easily be seen by the operator)* at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, and use a spotter when extending the boom.
4. Anti two-block **device or warning system**, Lattice boom cranes manufactured after Feb. 28, 1992.
    a. *Alternative measure:* **Clearly mark the cable** *(so that it can easily be seen by the operator)* at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, or use a spotter.

5. Anti two-block **device**, Lattice boom cranes manufactured after November 8, 2011.

    a. *Alternative measure:* **Clearly mark the cable** *(so that it can easily be seen by the operator)* at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, or use a spotter.

Category 2 device w/temporary alternative measure:

Repair period: **30 days, Parts must be ordered within 7 days.**

1. Boom angle or radius indicator.

    a. *Alternative measure:* Radii or boom angle must be determined by measuring the radii or boom angle with a measuring device.

2. Jib angle indicator.

    a. *Alternative measure:* Radii or jib angle must be determined by ascertaining the main boom angle and then measuring the radii or jib angle with a measuring device.

3. Boom length indicator.

    a. *Alternative measure:* One of the following:

        i. Mark the boom with measured marks to calculate boom length.
        ii. Calculate boom length from boom angle and radius measurements.
        iii. Measure the boom with a measuring device.

Equipment manufactured after November 8, 2011

1. Outrigger/stabilizer position monitor.
2. Hoist drum rotation indicator.

OPERATION: *(OSHA 1926.1417)*

1. Rated Capacity:

   a. Crane must **NOT** lift a load that is in excess of rated capacity.
   b. Employer cannot require operator to lift a load that is in excess of the rated capacity.

2. Load Weight:

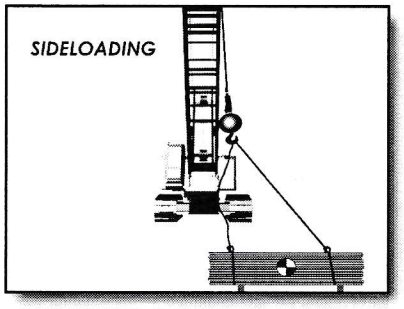
   a. The operator must **verify that the load weight is within the rated capacity** in one of the following methods:

      i. Recognized source in the industry. *(Load manufacturer)*
      ii. Calculation method recognized by the industry, or
      iii. By equally reliable means.

   b. When requested by the operator, **this information must be provided to the operator** prior to the lift; or

   c. The operator must begin hoisting the load to determine, using a load weighing device, load moment indicator, rated capacity indicator, or rated capacity limiter, **if it exceeds 75 percent** of the maximum rated capacity at the longest radius that will be used during the lift operation. If it does, the operator must **NOT** proceed with the lift **until** he/she **verifies the weight of the load.**

   d. Care must be taken **when lifting load from beneath the water** as the load applied to the crane **will increase** as load leaves the water.



3. The boom or other parts of the equipment **must NOT contact any obstruction.**

4. The equipment must **NOT** be used to **drag or pull loads sideways**.

5. On wheel-mounted equipment, **NO** loads must be lifted **over the front area,** except as permitted by the manufacturer.

6. The operator must test the brakes each time a load that is **90% or more of the maximum line pull** is handled by lifting the load a few inches and applying the brakes. In duty cycle and repetitive lifts where each lift is 90% or more of the maximum line pull, this requirement applies to the first lift but not to successive lifts.

7. Neither the load nor the boom must be lowered below the point where **less than two full wraps** of rope remain on their respective drums.

8. Traveling with a load:

    a. A **competent person supervises** the operation, determines if it is necessary to reduce rated capacity, and makes determinations regarding load position, boom location, ground support, travel route, overhead obstructions, and speed of movement necessary to ensure safety.
        i. For equipment with tires, **tire pressure** specified by the manufacturer **is maintained.**
        ii. Rotational speed of the equipment must be such that the load does **NOT** swing out beyond the radius at which it can be controlled.
        iii. **A tag or restraint line must be used if necessary** to prevent rotation of the load that would be hazardous.
        iv. The **brakes must be adjusted** in accordance with manufacturer procedures to prevent unintended movement.
        v. The operator **must obey a stop (or emergency stop) signal**, irrespective of who gives it.

9. A **tag or restraint line** must be used if necessary to prevent rotation of the load that would be hazardous.

10. Whenever there is a concern as to safety, the operator must have the authority to stop and refuse to handle loads until a qualified person has determined that safety has been assured. *(OSHA 1926.1418)*

11. Load Charts:

    a. The procedures applicable to the operation of the equipment, including rated capacities (load charts), recommended operating speeds, special hazard warnings, instructions, and operator's manual, **must be readily available in the cab at all times for use by the operator**. *(OSHA 1926.1417(c)(1))*

    b. Cranes used on barges: *(OSHA 1926.1437(n))*

        i. The rated capacity of the equipment (including but not limited to modification of load charts) applicable for use on land is reduced to account for increased loading from list, trim, wave action, and wind.
        ii. The rated capacity must be applicable to a specified location(s) on the specific barge, pontoons, vessel or other means of flotation that will be used, under the environmental conditions expected and encountered.
        iii. The rated capacity modification must be performed by the equipment manufacturer, or a qualified person who has expertise with respect to both land crane/derrick capacity and the stability of vessels/flotation devices.

12. Swing Radius Hazards: *(OSHA 1926.1424(a))*

    a. To prevent employees from entering these hazard areas, the employer must:

        i. Train each employee assigned to work on or near the equipment ("authorized

personnel") in how to recognize struck-by and pinch/crush hazard areas posed by the rotating superstructure.

ii. Erect and maintain control lines, warning lines, railings or similar barriers to mark the boundaries of the hazard areas.

Exception: When the employer can demonstrate that it is neither feasible to erect such barriers on the ground nor on the equipment, the hazard areas must be clearly marked by a combination of warning signs (such as "Danger--Swing/Crush Zone") and high visibility markings on the equipment that identify the hazard areas. In addition, the employer must train each employee to understand what these markings signify.

b. Protecting employees in the hazard area.

i. Before an employee goes to a location in the hazard area that is out of view of the operator, the employee (or someone instructed by the employee) must ensure that the operator is informed that he/she is going to that location.
ii. Where the operator knows that an employee went to a location out of his/her view, the operator must not rotate the superstructure until the operator is informed in accordance with a pre-arranged system of communication that the employee is in a safe position.

13. Keeping clear of the load: *(OSHA 1926.1425)*

a. While **MOVING** the load:

i. Where available, hoisting routes that **minimize the exposure of employees** to hoisted loads must be used, to the extent consistent with public safety.

b. While the operator is **NOT** moving a suspended load, no employee must be within the fall zone, except for employees:

i. Engaged in hooking, unhooking or guiding a load;
ii. Engaged in the initial attachment of the load to a component or structure; or
iii. Operating a concrete hopper or concrete bucket.

14. Load line free fall: *(OSHA 1926.1425(d))*

a. In each of the following circumstances, controlled load lowering is required and **free fall of the load line hoist is prohibited:**

i. An **employee** is directly **under the load**.
ii. The load is directly over a power line, or over any part of the area extending the Table "A" clearance distance to each side of the power line; or any part of the area extending the Table "A" clearance distance to each side of the power line is within the radius of vertical travel of the load.

iii. The load is **over a shaft**.
iv. The load is **over a cofferdam**, except where there are no employees in the fall zone of the load.

15. Pre-Qualification/Certification training period: *(OSHA 1926.1427(f))*

a. The operator's trainer is either a certified operator under this section, or has passed the written portion of a certification test under one of the options in paragraphs (b) through (e) of this section, and is familiar with the proper use of the equipment's controls.

b. While monitoring the operator-in-training, the operator's trainer performs no tasks that detract from the trainer's ability to monitor the operator-in-training.

c. For equipment other than tower cranes: The operator's trainer and the operator-in-training must be in direct line of sight of each other. In addition, they must communicate verbally or by hand signals.

d. Continuous monitoring. The operator-in-training must be monitored by the operator's trainer at all times, except for short breaks where all of the following are met:

i. The break lasts no longer than 15 minutes and there is no more than one break per hour.
ii. Immediately prior to the break the operator's trainer informs the operator-in-training of the specific tasks that the operator-in-training is to perform and limitations to which he/she must adhere during the operator trainer's break.
iii. The specific tasks that the operator-in-training will perform during the operator trainer's break are within the operator-in-training's abilities.

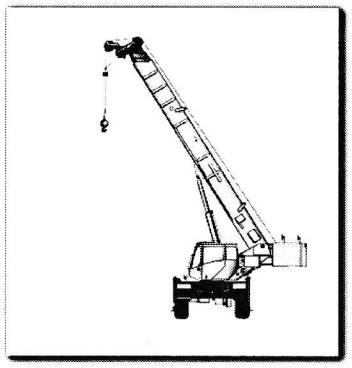
e. The operator-in-training must not operate the equipment in any of the following circumstances unless the exception stated in paragraph (f)(5)(v) of this section is applicable:

i. If any part of the equipment, load line or load (including rigging and lifting accessories), if operated up to the equipment's maximum working radius in the work zone (see § 1926.1408(a)(1)), could get within 20 feet of a power line that is up to 350 kV, or within 50 feet of a power line that is over 350 kV.
ii. If the equipment is used to hoist personnel.
iii. In multiple-equipment lifts.
iv. If the equipment is used over a shaft, cofferdam, or in a tank farm.
v. In multiple-lift rigging operations, except where the operator's trainer determines that the operator-in-training's skills are sufficient for this high-skill work.

16. Load Control

a. Center of gravity ***below*** lowest point of attachment equals stable load.

17. Crane Stability: *(ASME B30.5-1.1.1 Table 1)*



a.	Crawler Cranes	75%
b.	Truck Cranes on Outriggers:	85%
c.	Truck Cranes on Rubber:	75%
d.	R/T on Outriggers	85%
e.	R/T on Rubber	75%

18. Backward Stability:

a. Shortest Boom.
b. Maximum Boom Angle.
c. No Load.
d. Over Side.

(MINIMUM Boom Length at MAXIMUM (Highest) Boom Angle)

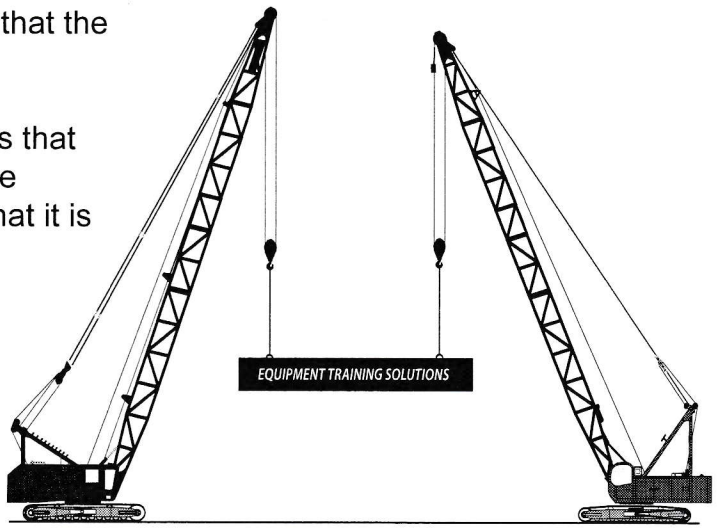
MULTIPLE CRANE LIFTS *(OSHA 1926.1432)*

1. **Plan development**. Before beginning a crane/derrick operation in which more than one crane/derrick will be supporting the load, the operation must be planned. The planning must meet the following requirements:

   a. The plan must be developed by a **qualified person**.

   b. The plan must be designed to ensure that the requirements of this subpart are met.

   c. Where the qualified person determines that engineering expertise is needed for the planning, the employer must ensure that it is provided.

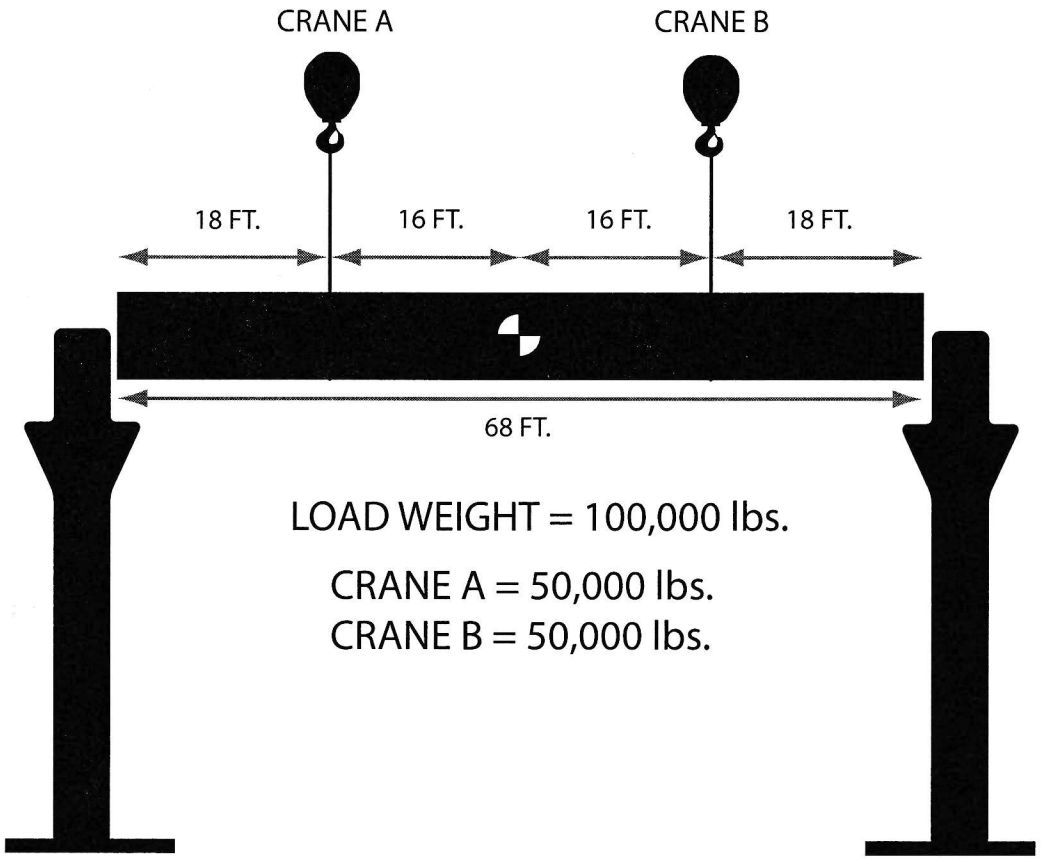


2. Plan implementation.

   a. The multiple-crane/derrick **lift** must be **directed by a person who meets the criteria for both a competent person and a qualified person**, or by a competent person who is assisted by one or more qualified persons (lift director).

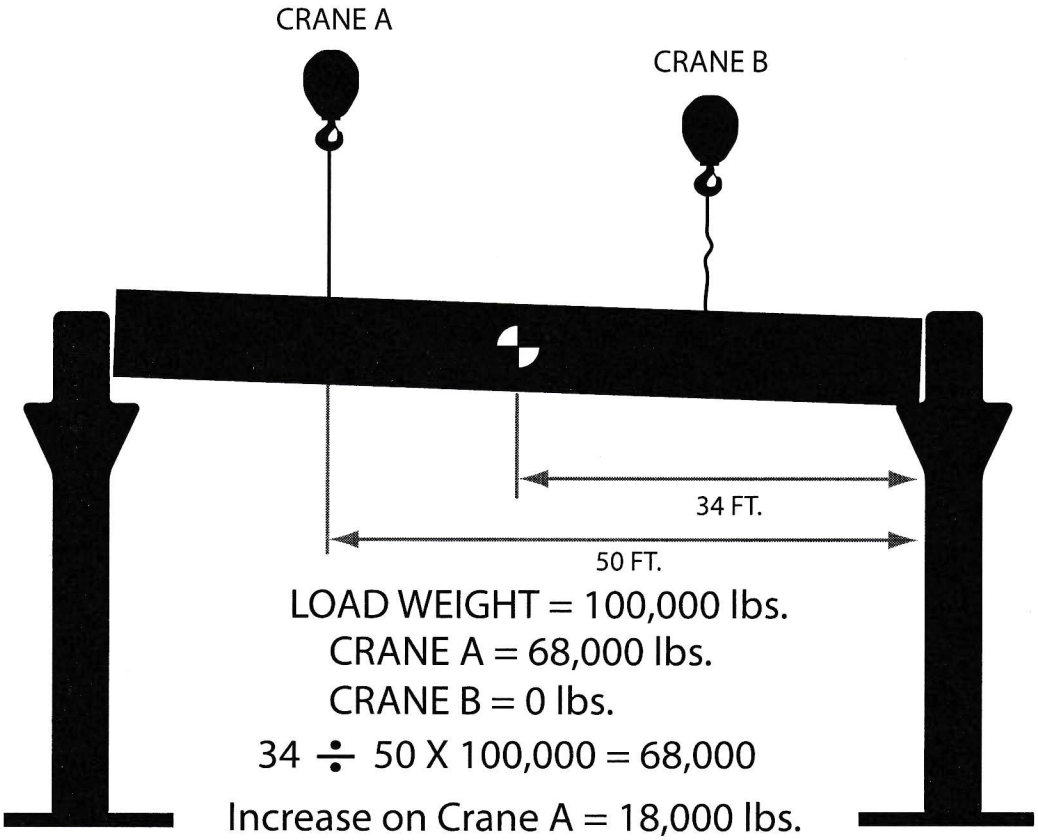
   b. The **lift director must review the plan** in a **meeting with all workers who will be involved with the operation.**

Tandem Lift Weight Change:



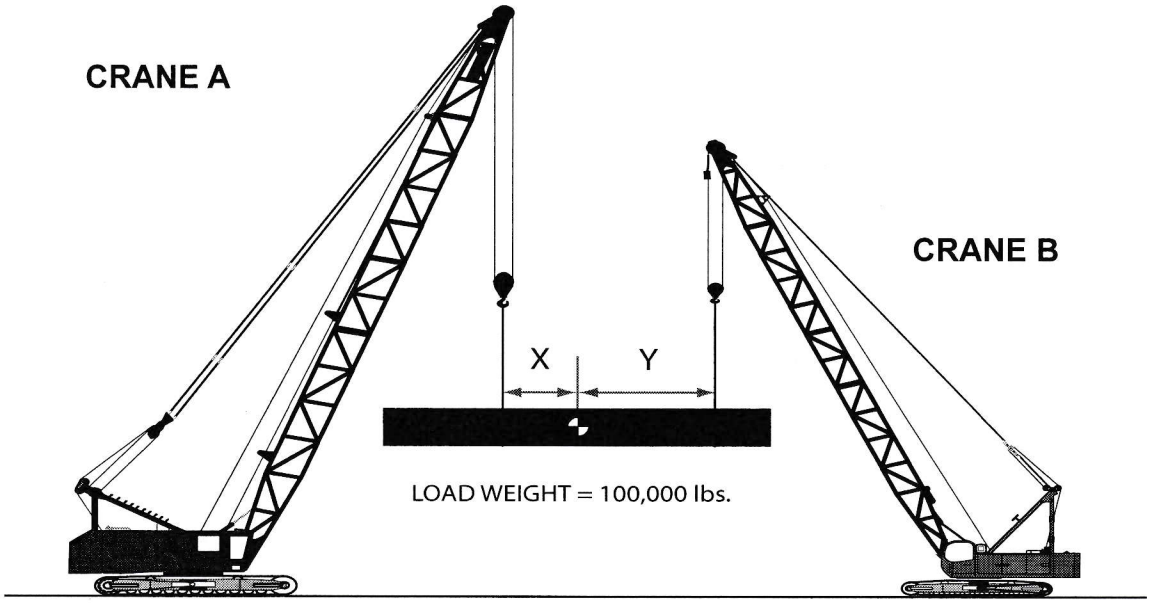
LOAD WEIGHT = 100,000 lbs.

CRANE A = 50,000 lbs.
CRANE B = 50,000 lbs.



LOAD WEIGHT = 100,000 lbs.
CRANE A = 68,000 lbs.
CRANE B = 0 lbs.
34 ÷ 50 X 100,000 = 68,000
Increase on Crane A = 18,000 lbs.

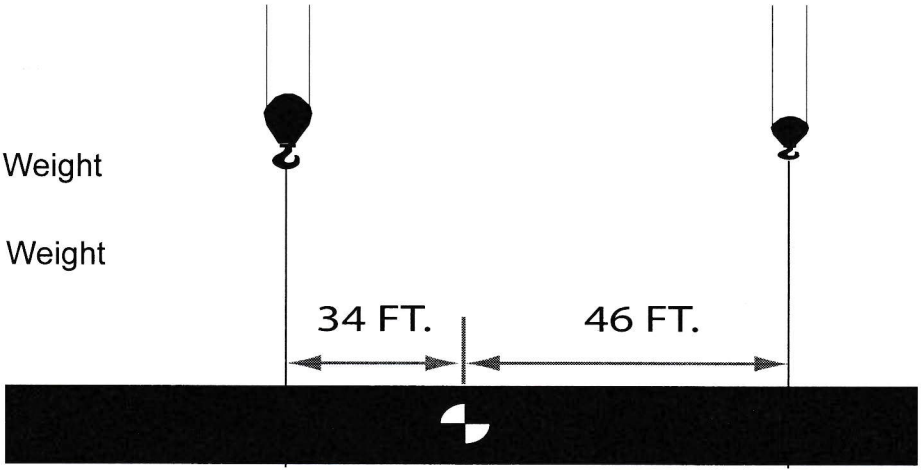
Determining Load On Each Crane:



Formula:

$$\text{Crane A} = \left(\frac{Y}{X+Y}\right) \times \text{Load Weight}$$

$$\text{Crane B} = \left(\frac{X}{X+Y}\right) \times \text{Load Weight}$$



Crane Loads:

$$\text{Crane A} = \left(\frac{46}{34+46\ (80)}\right) \times 100{,}000$$

Crane A = (0.575) x 100,000 = 57,500 lbs.

$$\text{Crane B} = \left(\frac{34}{34+46\ (80)}\right) \times 100{,}000$$

Crane B = (0.425) x 100,000 = 42,500 lbs.

Hoist lines should be kept **vertical** and maximum loads on each crane should not exceed **75% of rated capacity.**

Miscellaneous:

Static load: This is a stationary load, "no movement"

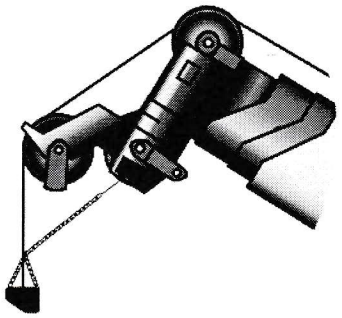
Dynamic load: This is caused by sudden lifting, stopping or swinging with a suspended load.

Dynamic swinging ***may increase radius.***

Dynamic stopping increases the load applied to the crane and may cause ***structural failure.***

An Anti two-block device ***shuts the system down***. *(It is NOT just an alarm.)* (ASME B30.5-0.2)

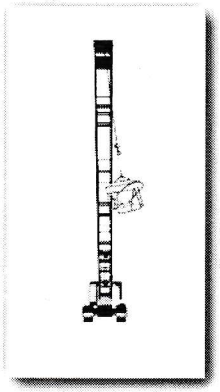
Rooster sheave/Auxiliary Boom Point Sheaves separate the whip-line and the main load line.



Jib/fly/extensions are primarily used for **increased height.**

Always maintain **vertical hoist lines**.

If power fails - ***set all brakes and locking devices***.



Side loading will cause loss of capacity and may cause structural failure. A **long boom at a mininum radius** is most suseptable to side loading.

Duty cycle operations such as concrete, clamshell, dragline, ***create side-loading forces***.

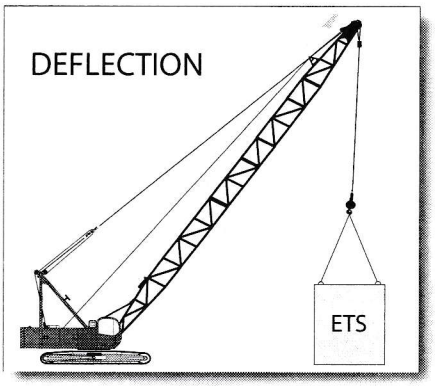
A mobile crane's least stable position is the ***over side***.

Signs of tipping should ***NEVER*** be used to determine capacity.

Pick and carry with RT or carry deck ***over front and keep boom and load as low as possible.***

Parts of line - ***individual lines supporting load block***.

Deflection must be compensed for prior to the load leaving the ground.



A crane will lose stability when its leverage is less than the loads leverage.

Eccentric or improper reeving may cause twisting of the main boom.

Boom tip elevation can be found using the **range diagram**.

Boom length and boom angle can be used to determine radius on a range diagram.

LMI values are best verified through actual measurements.

When traveling with a load on an incline, the load should be in the **uphill position.**

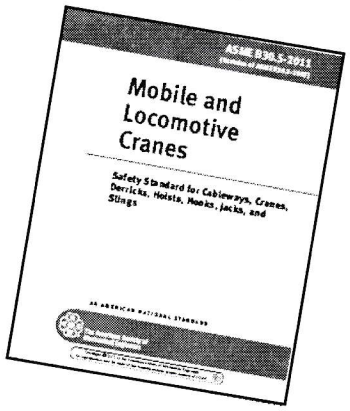
Load chart should match cranes **serial number.**

Jib/fly/extensions may be removed from mobile cranes, when not in use.

Boom retraction causes load block lowering.

Responsibilities

RESPONSIBILITIES - *(ASME B30.5-3.1.3)*



Roles:

1. Crane Operator;
2. Crane Owner;
3. Crane User;
4. Lift Director;
5. Site Supervisor.

Responsibilities of Owner:

1. Supply crane and all necessary components that meet ASME B30.5 requirements.
2. Establish inspection, testing, and maintenance program.
3. Use a designated person for maintenance, repair, transport, assembly, disassembly, and inspection.

Responsibilities of User:

1. Verify crane is in proper operating condition and has sufficient lifting capacity prior to initial use.
2. Use only personnel that meet the requirements of "Designated or Qualified Person" when required.
3. Use only Operators that meet the requirements of B30.5.

Responsibilities of Site Supervisor:

1. Ensure "Lift Director" and rigging supervisor meet the requirements of a "Qualified Person".
2. Coordinate crane operations with other jobsite activities and ensure the area for the crane is adequately prepared. (Access roads, level, ground conditions, power lines, traffic control, etc.)
3. Ensure any adverse conditions are addressed prior to lift operations. (poor ground conditions, wind, rain, fog, night work)
4. Ensure all personnel meet the qualifications as stipulated in B30.5.

Responsibilities of Lift Director:

1. Be on jobsite during lift operations.

2. Stop crane operation if unsafe or hazard condition exists.

3. Ensure all personnel understand their duties and associated hazards.

4. Appoint signal person.

5. Ensure precautions associated with multi-crane lifts, personnel platforms, pick and carry operations, and barge work are in place prior to lift operations.

6. Supply operator with:

    a. Weight of load;
    b. Lifting, moving, and placement locations.

7. Obtain operator's verification that load is within crane's rated capacity.

8. Ensure loads are rigged properly and rigging is performed by a "Designated Person".

Responsibilities of Operator:

1. Review the requirements for the crane with the lift director prior to commencing lift operations.

2. Know what types of site conditions could adversely affect the operation of the crane and consult with the lift director concerning the possibility of those conditions being onsite.

3. Understand the information contained in the crane manufacturer's operating manual and apply when necessary

4. Understand the particular crane's functions, operating characteristics and limitations.

5. Use the crane's load/capacity chart(s) and diagrams as well as all notes and warnings related to the charts to confirm the correct crane configuration to suit the load, site, and lift conditions.

6. Refuse to operate the crane when any portion of the load or crane would enter the prohibited zone of energized power lines except as defined in para. 5-3.4.5.4.

7. Perform a daily inspection as specified in ASME B30.5-2.1.2(a), (c), (d), (h), and 5-2.4.2(a)(1).

   Control mechanisms;
   Operational aids;
   Hydraulic Hoses;
   Hydraulic Systems fluid level;
   Running wire rope.

8. Promptly report the required adjustments or repairs to a designated person.
9. Follow applicable lock out/tag out procedures.

10. Do NOT operate the crane when physically or mentally unfit.

11. Ensure that all controls are in the off or neutral position and that all personnel are in the clear before energizing the crane or starting the engine.

12. Do NOT engage in any practice that will divert attention while actually operating the crane controls.

13. Test the crane function controls that will be used and Do NOT operate the crane if those function controls do not respond properly.

14. Operate the crane's functions, under normal operating conditions, in a smooth and controlled manner.

15. Know and follow the procedures specified by the manufacturer or approved by a qualified person, for assembly, disassembly, setting up, and reeving the crane.

16. Know how to travel the crane.

17. Observe each outrigger during extension, setting, and retraction or use a signal person to observe each outrigger during extension, setting, or retraction.

18. Ensure the load and rigging weight(s) have been provided by the "Lift Director".

19. Calculate the net capacity for all configurations that will be used and verify, using the load/capacity chart(s), that the crane has sufficient net capacity for the proposed lift.

20. Consider all factors known that might affect the crane capacity and inform the lift director of the need to make appropriate adjustments.

21. Know the standard and special signals and respond to such signals from the person who is directing the lift or an appointed signal person. (However, obey a stop signal at all times, no matter who gives it.)

22. Understand basic load rigging procedures. *For responsibility of rigging the load and ensuring that the load is rigged properly see lift director (8).*

23. If power fails during operations the operator must:

    a. set all brakes and locking devices;
    b. ensure all controls and clutches are in the off or neutral position and if practical land any load suspended below the hook under brake control.

24. Before leaving the crane unattended the operator must:

    a. land any load suspended below the hook, unless the requirements of para. 5-3.2.1.4(d) are met;
    b. if applicable, disengage the master clutch;
    c. set locking devices, such as travel, swing, boom brakes, etc.;
    d. ensure all controls are in the off or neutral position;
    e. stop the engine. Unless the crane operation is frequently interrupted during a shift and the operator must leave the crane. Under these circumstances, the engine may remain running and paras. 5-3.1.3.3.1(x)(1) through (4) shall apply. The operator shall be situated where any entry to the crane can be observed;
    f. When a local weather storm warning exists, the operator should consider the recommendations of the manufacturer for securing the crane,

EQUIPMENT
TRAINING
SOLUTIONS

MOBILE CRANE OPERATOR CORE MATERIAL

Signals, Personnel Platforms, Basic Rigging and Math

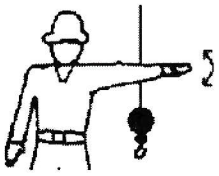
SIGNALS: *(OSHA 1926 1419-1422 & 1428)*

1. A signal person must be provided in each of the following situations: (OSHA 1926.1419(a))
   a. The point of operation, meaning the load travel or the area near or at load placement, is **NOT in full view of the operator**.
   b. When the equipment is traveling, the view in the direction of travel is obstructed.
   c. Due to site specific safety concerns, either the operator or the person handling the load determines that it is necessary.
2. **Standard method hand signals** found in Subpart CC Appendix A (OSHA 1926.1419(c)(1))
3. **Non-standard** hand signals **must be agreed upon** by the lift director, operator, and signal person. (OSHA 1926.1419(c)(2))
4. ***Suitability.*** The signals used (hand, voice, audible, or new) must be **appropriate** for the **site conditions.**
5. During operations requiring signals, the ability to transmit signals between the operator and signal person must be maintained. If that ability is interrupted at any time, the operator must safely stop operations requiring signals until it is reestablished and a proper signal is given and understood. (OSHA 1926.1419(f)) ***(Continuously)***
6. Only **one qualified signal person may give signals** to a crane/derrick at a time, except for stop signal. (OSHA 1926.1419(h))
7. Voice signals **must be agreed upon by the operator, signal person, and lift director.** (OSHA 1926.1421(a))
8. Prior to commencing voice signals signalperson and operator **must contact and identify** each other. (OSHA 1926.1421(a))
9. Voice Signals **must contain** the following elements: (OSHA 1926.1421(b))
   a. Function and Direction;
   b. Distance and/or Speed;
   c. Function Stop.
10. Voice signals must use a dedicated channel. (OSHA 1926.1420(b)
11. Hand signal charts must be either posted **on the equipment** or conspicuously posted in the **vicinity of the hoisting operations.** (OSHA 1926.1422)
12. **Audible Travel Signals** are as follows:

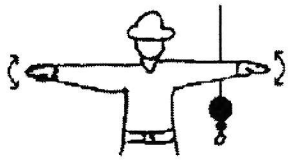
(a) 1 short beep = Stop; (b) 2 short beeps = Forward; (c) 3 short beeps = Backwards.

OSHA Subpart CC – Appendix A

Appendix A to Subpart CC of Part 1926–Standard Hand Signals.

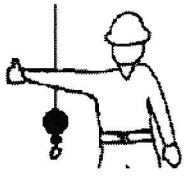


STOP – With arm extended horizontally to the side, palm down, arm is swung back and forth.

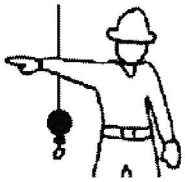


EMERGENCY STOP – With both arms extended horizontally to the side, palms down, arms are swung back and forth.

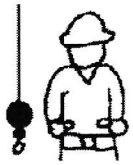
HOIST – With upper arm extended to the side, forearm and index finger pointing straight up, hand and finger make small circles.



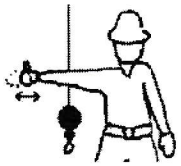
RAISE BOOM – With arm extended horizontally to the side, thumb points up with other fingers closed.



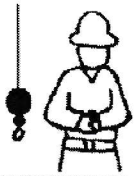
SWING – With arm extended horizontally, index finger points in direction that boom is to swing.



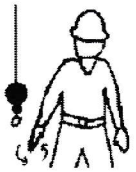
RETRACT TELESCOPING BOOM – With hands to the front at waist level, thumbs point at each other with other fingers closed.



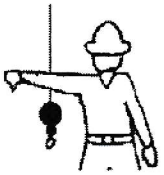
RAISE THE BOOM AND LOWER THE LOAD – With arm extended horizontally to the side and thumb pointing up, fingers open and close while load movement is desired.



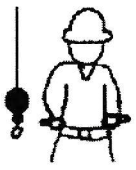
DOG EVERYTHING – Hands held together at waist level.



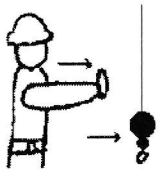
LOWER – With arm and index finger pointing down, hand and finger make small circles.



LOWER BOOM – With arm extended horizontally to the side, thumb points down with other fingers closed.

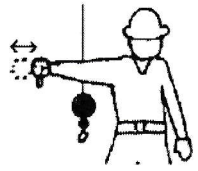


EXTEND TELESCOPING BOOM – With hands to the front at waist level, thumbs point outward with other fingers closed.

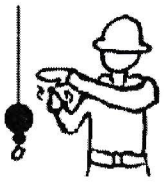


TRAVEL/TOWER TRAVEL – With all fingers pointing up, arm is extended horizontally out and back to make a pushing motion in the direction of travel.

OSHA Subpart CC – Appendix A (con't)

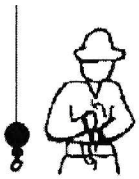


LOWER THE BOOM AND RAISE THE LOAD – With arm extended horizontally to the side and thumb pointing down, fingers open and close while load movement is desired.

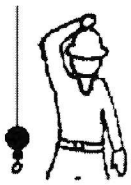


MOVE SLOWLY – A hand is placed in front of the hand that is giving the action signal.

USE AUXILIARY HOIST (whipline) – With arm bent at elbow and forearm vertical, elbow is tapped with other hand. Then regular signal is used to indicate desired action.

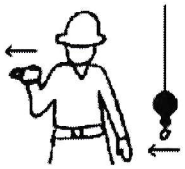


CRAWLER CRANE TRAVEL, BOTH TRACKS – Rotate fists around each other in front of body; direction of rotation away from body indicates travel forward; rotation towards body indicates travel backward.



USE MAIN HOIST – A hand taps on top of the head. Then regular signal is given to indicate desired action.

CRAWLER CRANE TRAVEL, ONE TRACK – Indicate track to be locked by raising fist on that side. Rotate other fist in front of body in direction that other track is to travel.



TROLLEY TRAVEL – With palm up, fingers closed and thumb pointing in direction of motion, hand is jerked horizontally in direction trolley is to travel.

EXCERPTS FROM 1926.1431 HOISTING PERSONNEL.

(a) The use of equipment to hoist employees is prohibited except where the employer demonstrates that the erection, use, and dismantling of conventional means of reaching the worksite, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform, or scaffold, would be more hazardous, or is not possible because of the project's structural design or worksite conditions. This paragraph does not apply to work covered by subpart R (Steel Erection) of this part.

(c) Equipment setup.

(1) **The equipment must be uniformly level**, within **one percent of level** grade, and located on footing that a qualified person has determined to be sufficiently firm and stable.

(2) **Equipment with outriggers or stabilizers must have them all extended and locked**. The amount of extension must be the same for all outriggers and stabilizers and in accordance with manufacturer procedures and load charts.

(d) Equipment criteria.

(1) Capacity: use of suspended personnel platforms. The total load (with the platform loaded, including the hook, load line and rigging) **must not exceed 50 percent of the rated capacity** for the radius and configuration of the equipment, except during proof testing.

(2) Capacity: use of boom-attached personnel platforms. The total weight of the loaded personnel platform must not exceed 50 percent of the rated capacity for the radius and configuration of the equipment (except during proof testing).

(3) Capacity: hoisting personnel without a personnel platform. When hoisting personnel without a personnel platform pursuant to paragraph (b)(2) of this section, the total load (including the hook, load line, rigging and any other equipment that imposes a load) must not exceed 50 percent of the rated capacity for the radius and configuration of the equipment, except during proof testing.

(4) When the occupied personnel platform is in a stationary working position, the load and boom hoist brakes, swing brakes, and operator actuated secondary braking and locking features (such as pawls or dogs) or automatic secondary brakes must be engaged.

(5) Devices.

(i) Equipment (except for derricks and articulating cranes) with a variable angle boom must be equipped with all of the following:

(A) A boom **angle indicator**, readily visible to the operator, and

(B) A boom **hoist limiting device**.

(ii) Articulating cranes must be equipped with a properly functioning automatic overload protection device.

(iii) Equipment with a luffing jib must be equipped with:

(A) A **jib angle indicator**, readily visible to the operator, and

(B) A **jib hoist limiting device**.

(iv) Equipment with telescoping booms must be equipped with **a device** to indicate the boom's extended length clearly to the operator, or must have **measuring marks on the boom**.

(v) **Anti two-block**. A device which **automatically prevents damage** and load failure from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component) must be used. The device(s) must prevent such damage/failure at all points where two-blocking could occur. Exception: This device is not required when hoisting personnel in pile driving operations. Instead, paragraph (p)(2) of this section specifies how to prevent two-blocking during such operations.

(vi) **Controlled load lowering.** The load line hoist drum must have a system, other than the load line hoist brake, which regulates the lowering rate of speed of the hoist mechanism. This system or device must be used when hoisting personnel.

(NOTE: **Free fall of the load line hoist is prohibited** (see § 1926.1426(d); the use of equipment in which the boom hoist mechanism can free fall is also prohibited (see § 1926.1426(a)(1)).

(vii) Proper operation required. Personnel hoisting operations must not begin unless the devices listed in this section are in proper working order. If a device stops working properly during such operations, the operator must safely stop operations. Personnel hoisting operations must not resume until the device is again working properly. Alternative measures are not permitted.

(6) Direct attachment of a personnel platform to a luffing jib is prohibited.

(e) Personnel platform criteria.

(1) A qualified person familiar with structural design must design the personnel platform and attachment/suspension system used for hoisting personnel.

(2) The system used to connect the personnel platform to the equipment must allow the platform to remain within **10 degrees of level**, regardless of boom angle.

(3) The suspension system must be designed to minimize tipping of the platform due to movement of employees occupying the platform.

(4) The personnel platform itself (excluding the guardrail system and personal fall arrest system anchorages), must be capable of supporting, without failure, its own weight and at least five times the maximum intended load.

(5) All welding of the personnel platform and its components must be performed by a certified welder familiar with the weld grades, types and material specified in the platform design.

(6) The personnel platform must be equipped with a guardrail system which meets the requirements of subpart M of this part, and must be enclosed at least from the toeboard to mid-rail with either solid construction material or expanded metal having openings no greater than ½ - inch (1.27cm). Points to which personal fall arrest systems are attached must meet the anchorage requirements in subpart M of this part.

(7) A **grab rail** must be installed inside the **entire perimeter** of the personnel platform except for access gates/doors.

(8) ***Access gates/doors***. If installed, access gates/doors of all types (including swinging, sliding, folding, or other types) must:

(i) **Not swing outward.** If due to the size of the personnel platform, such as a 1-person platform, it is infeasible for the door to swing inward and allow safe entry for the platform occupant, then the access gate/door may swing outward.

(ii) Be equipped with a device that prevents accidental opening.

(9) Headroom must be sufficient to allow employees to stand upright in the platform.

(10) In addition to the use of hard hats, employees must be protected by overhead protection on the personnel platform when employees are exposed to falling objects. The platform overhead protection must not obscure the view of the operator or platform occupants (such as wire mesh that has up to ½ - inch openings), unless full protection is necessary.

(11) All edges exposed to employee contact must be smooth enough to prevent injury.

(12) The **weight of the platform and its rated capacity** must be conspicuously **posted on the platform** with a plate or other permanent marking.

(f) Personnel platform loading.

(1) The personnel platform must not be loaded in excess of its rated capacity.

(2) Use.

(i) Personnel platforms must be used only for employees, their tools, and the materials necessary to do their work. Platforms must not be used to hoist materials or tools when not hoisting personnel.

(ii) *Exception*: Materials and tools to be used during the lift, if secured and distributed in accordance with paragraph (f)(3) of this section, may be in the platform for trial lifts.

(3) Materials and tools must be:

(i) Secured to prevent displacement.

(ii) Evenly distributed within the confines of the platform while it is suspended.

(4) The number of employees occupying the personnel platform must not exceed the maximum number the platform was designed to hold or the number required to perform the work, whichever is less.

(g) Attachment and rigging.

(1) Hooks and other detachable devices.

(i) Hooks used in the connection between the hoist line and the personnel platform (including hooks on overhaul ball assemblies, lower load blocks, bridle legs, or other attachment assemblies or components) must be:

(A) **Of a type that can be closed and locked**, eliminating the throat opening.

(B) Closed and locked when attached.

(ii) Shackles used in place of hooks must be of the alloy anchor type, with either:

(A) A bolt, nut and retaining pin, in place; or

(B) Of the screw type, with the **screw pin secured from accidental removal.**

(iii) Where other detachable devices are used, they must be of the type that can be closed and locked to the same extent as the devices addressed in paragraphs (g)(1)(i) and (ii) of this section. Such devices must be closed and locked when attached.

(2) Rope bridle. When a rope bridle is used to suspend the personnel platform, each bridle leg **must be connected to a master link or shackle** (see paragraph (g)(1) of this section) in a manner that ensures that the load is evenly divided among the bridle legs.

(3) **Rigging hardware** (including wire rope, shackles, rings, master links, and other rigging hardware) and hooks **must be capable of supporting, without failure, at least five times the maximum intended load** applied or transmitted to that component. Where rotation resistant rope is used, the slings must be capable of supporting without failure at least ten times the maximum intended load.

(4) Eyes in wire rope slings **must be fabricated with thimbles**.

(5) Bridles and associated rigging for suspending the personnel platform must be used only for the platform and the necessary employees, their tools and materials necessary to do their work. **The bridles and associated rigging must not have been used for any purpose other than hoisting personnel.**

(h) Trial lift and inspection.

(1) **A trial lift** with the **unoccupied personnel platform loaded at least to the anticipated lift weight** must be made **from ground level**, or any other location where employees will enter the platform, **to each location** at which the platform is to be hoisted and positioned. Where there is more than one location to be reached from a single setup position, either individual trial lifts for each location, or a single trial lift, in which the platform is moved sequentially to each location, must be performed; the method selected must be the same as the method that will be used to hoist the personnel.

(2) **The trial lift must be performed immediately prior to each shift** in which personnel will be hoisted. In addition, the trial lift **must be repeated** prior to hoisting employees in each of the following circumstances:

(i) The **equipment is moved** and set up in a new location or returned to a previously used location.

(ii) The **lift route is changed**, unless the competent person determines that the new route presents no new factors affecting safety.

(3) The competent person must determine that:

(i) Safety devices and operational aids required by this section are activated and functioning properly. Other safety devices and operational aids must meet the requirements of § 1926.1415 and § 1926.1416.

(ii) Nothing interferes with the equipment or the personnel platform in the course of the trial lift.

(iii) The lift will not exceed 50 percent of the equipment's rated capacity at any time during the lift.

(iv) The load radius to be used during the lift has been accurately determined.

(4) Immediately after the trial lift, the competent person must:

(i) **Conduct a visual inspection of the equipment,** base support or ground, and personnel platform, to determine whether the trial lift has exposed any defect or problem or produced any adverse effect.

(ii) Confirm that, upon the completion of the trial lift process, the test weight has been removed.

(5) Immediately prior to each lift:

(i) The platform must be hoisted a few inches with the personnel and materials/tools on board and inspected by a competent person to ensure that it is secure and properly balanced.

(ii) The following conditions must be determined by a competent person to exist before the lift of personnel proceeds:

(A) Hoist ropes must be free of deficiencies in accordance with § 1926.1413(a).

(B) Multiple part lines must not be twisted around each other.

(C) The primary attachment must be centered over the platform.

(D) If the load rope is slack, the hoisting system must be inspected to ensure that all ropes are properly seated on drums and in sheaves.

(6) Any condition found during the trial lift and subsequent inspection(s) that fails to meet a requirement of this standard or otherwise creates a safety hazard must be corrected before hoisting personnel. (See § 1926.1417 for tag-out and related requirements.)

(j) Proof testing.

(1) **At each jobsite**, prior to hoisting employees on the personnel platform, and after any repair or modification, the platform and rigging must be proof tested to **125 percent of the platform's rated capacity**. The proof test may be done concurrently with the trial lift.

(2) The platform **must be lowered by controlled load lowering, braked, and held in a suspended position for a minimum of five minutes** with the test load evenly distributed on the platform.

(3) **After proof testing, a competent person must inspect the platform and rigging** to determine if the test has been passed. If any deficiencies are found that pose a safety hazard, the platform and rigging must not be used to hoist personnel unless the

deficiencies are corrected, the test is repeated, and a competent person determines that the test has been passed. (See § 1926.1417 for tag-out and related requirements.)

(4) Personnel hoisting must not be conducted until the competent person determines that the platform and rigging have successfully passed the proof test.

(k) Work practices.

(1) Hoisting of the personnel platform must be performed in a **slow, controlled, cautious manner**, with no sudden movements of the equipment or the platform.

(2) Platform occupants must:

(i) **Keep all parts of the body inside the platform** during raising, lowering and horizontal movement. This provision **does not apply** to an **occupant** of the platform when necessary to **position the platform** or while performing the duties of a **signal person**.

(ii) Not stand, sit on, or work from the top or intermediate rail or toeboard, or use any other means/device to raise their working height.

(iii) Not pull the platform out of plumb in relation to the hoisting equipment.

(3) Before employees exit or enter a hoisted personnel platform that is not landed, the platform must be secured to the structure where the work is to be performed, unless the employer can demonstrate that securing to the structure would create a greater hazard.

(4) If the platform is tied to the structure, the operator must not move the platform until the operator receives confirmation that it is freely suspended.

(5) **Tag lines** must be used when **necessary to control the platform**.

(6) Platforms without controls. Where the platform is not equipped with controls, the **equipment operator must remain at the equipment controls**, on site, and in view of the equipment, at all times while the platform is occupied.

(7) Platforms with controls. Where the platform is equipped with controls, all of the following must be met at all times while the platform is occupied:

(i) The occupant using the controls in the platform must be a qualified person with respect to their use, including the safe limitations of the equipment and hazards associated with its operation.

(ii) The equipment operator must be at a set of equipment controls that include boom and swing functions of the equipment, and must be on site and in view of the equipment.

(iii) The platform operating manual must be in the platform or on the equipment.

(8) *Environmental conditions.*

(i) Wind. When wind speed (sustained or gusts) **exceeds 20 mph** at the personnel platform, a **qualified person** must determine if, in light of the wind conditions, it is not safe to lift personnel. If it is not, the lifting operation must not begin (or, if already in progress, must be terminated).

(ii) Other weather and environmental conditions. A qualified person must determine if, in light of indications of **dangerous weather conditions**, or other impending or existing danger, it is not safe to lift personnel. If it is not, the lifting operation must not begin (or, if already in progress, must be terminated).

(9) Employees being hoisted **must remain in direct communication with the signal person (where used), or the operator.**

(10) *Fall protection.*

(i) **Except over water**, employees occupying the personnel platform must be provided and use a personal fall arrest system. **The system must be attached to a structural member within the personnel platform**. When working over or near water, the requirements of § 1926.106 apply.

a) Employees working over or near water, where the danger of drowning exists, shall be provided with U.S. Coast Guard-approved life jacket or buoyant work vests.

b) Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used.

c) Ring buoys with at least 90 feet of line shall be provided and readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.

d) At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.

(ii) The fall arrest system, including the attachment point (anchorage) used to comply with paragraph (i) of this section, must meet the requirements in § 1926.502.

(11) *Other load lines.*

(i) **No lifts** must be made on any **other of the equipment's load lines** while personnel are being hoisted, except in pile driving operations.

(ii) *Factory-produced boom-mounted personnel platforms that incorporate a winch as original equipment.* Loads are permitted to be hoisted by such a winch while employees occupy the personnel platform only where the load on the winch line does not exceed 500 pounds and does not exceed the rated capacity of the winch and platform.

(12) *Traveling – equipment other than derricks.*

(i) Hoisting of employees while the equipment is traveling is prohibited, except for:

(A) Equipment that travels on fixed rails; or

(B) Where the employer demonstrates that there is no less hazardous way to perform the work.

(C) This exception does **NOT** apply to rubber-tired equipment.

(ii) Where employees are hoisted while the equipment is traveling, all of the following criteria must be met:

(A) **Equipment travel must be restricted to a fixed track or runway**.

(B) Where a runway is used, it must be a firm, level surface designed, prepared and designated as a path of travel for the weight and configuration of the equipment being used to lift and travel with the personnel platform. An existing surface may be used as long as it meets these criteria.

(C) Equipment travel must be limited to boom length.

(D) The **boom** must be **parallel to the direction of travel**, except where it is safer to do otherwise.

(E) A complete trial run must be performed to test the route of travel before employees are allowed to occupy the platform. This trial run can be performed at the same time as the trial lift required by paragraph (h) of this section which tests the lift route.

(13) *Traveling – derricks*. Derricks are prohibited from traveling while personnel are hoisted.

(m) Pre-lift meeting. A pre-lift meeting must be:

(1) Held to review the applicable requirements of this section and the procedures that will be followed.

(2) Attended by the **equipment operator, signal person** (if used for the lift), employees to be hoisted, and the person responsible for the task to be performed.

(3) **Held prior to the trial lift** at each new work location, and must be repeated for any employees newly assigned to the operation.

(n) ***Hoisting personnel near power lines***. Hoisting personnel within **20 feet of a power line that is up to 350 kV**, and hoisting personnel within **50 feet of a power line that is over 350 kV**, is prohibited, except for work covered by subpart V of this part (Power Transmission and Distribution).

(p)(2) (Anti two-block device and pile driving operations.)

For lattice boom cranes: Clearly **mark the cable** (so that it can easily be seen by the operator) at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, **or use a spotter** who is in direct communication with the operator to inform the operator when this point is reached.

For telescopic boom cranes: Clearly **mark the cable** (so that it can be easily seen by the operator) at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, **and use a spotter** who is in direct communication with the operator to inform the operator when this point is reached.

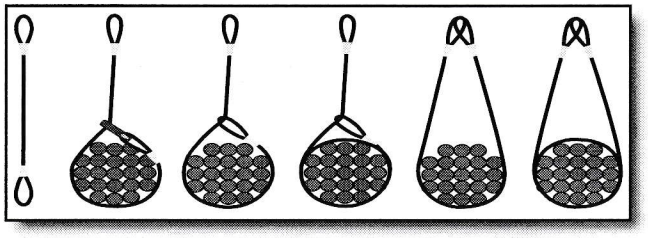
Synthetic webbing or natural or synthetic fiber rope slings shall **NOT** be used for suspension systems. *(ASME B30.23-1.1.1(b)(10)(e))*

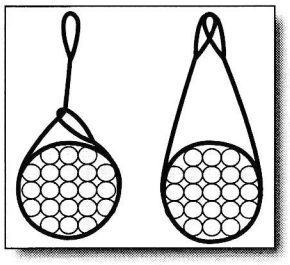
RIGGING and HARDWARE

Sling safety factor 5-1, 4-1 for chain slings. *(ASME B30.9)*

Strongest to weakest hitches. ***(Basket, vertical, choker)***

Type of hitches - Vertical, Choke w/shackle, Choke, Double wrap choke, Basket, Double wrap basket.





To achieve **360 degree contact** use double wrap basket hitch or double wrap choker hitch.

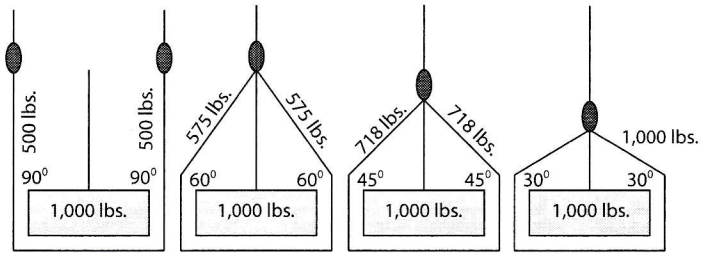
Quadruple sling bridle rating is the same as the triple rating.

Hoisting Chains must be **Grade 80 or Grade 100** chains.

Sling Strength: *(Strengths based on vertical hitch)*

1. Choker = 75% of vertical strength. (De-rated 25%)
2. Vertical = 100%.
3. Basket = 200% of vertical strength.

Lower sling angle - greater tension.

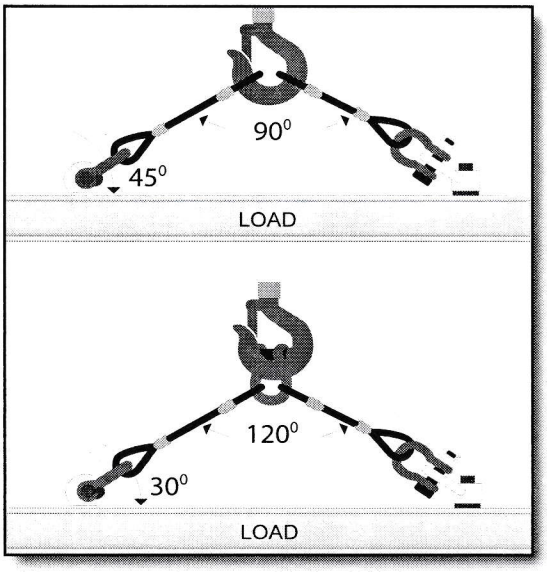


Horizontal Sling Angle	Load Angle Factor	Horizontal Sling Angle	Load Angle Factor
90°	1.000	40°	1.555
85°	1.004	35°	1.742
80°	1.015	30°	2.000
75°	1.035	25°	2.364
70°	1.064	20°	2.924
65°	1.104	15°	3.861
60°	1.155	10°	5.747
55°	1.221	5°	11.490
50°	1.305		
45°	1.414		

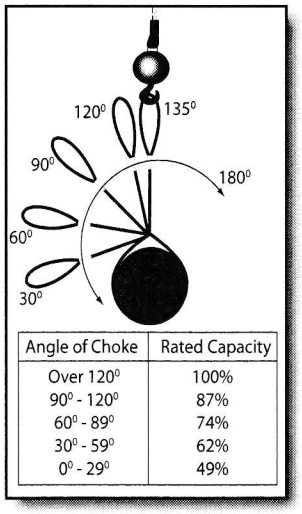
Tension in Each Leg:

(Weight of Load) divided by (Number of Legs) X (Load Angle Factor).

Included Angle:

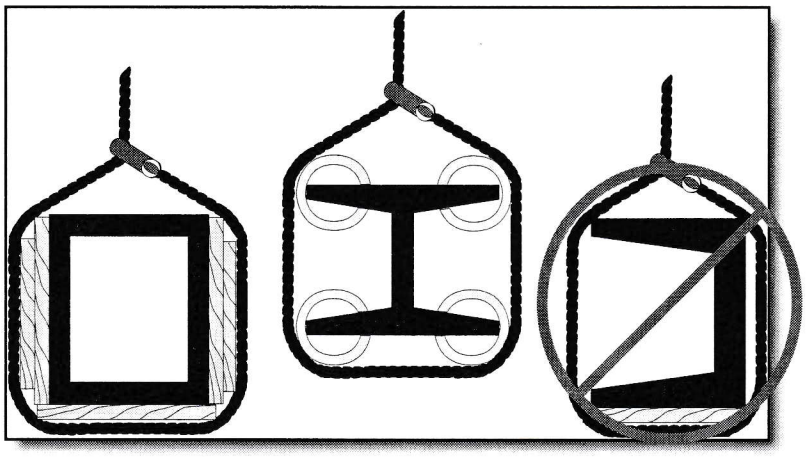


Angle of Choke:



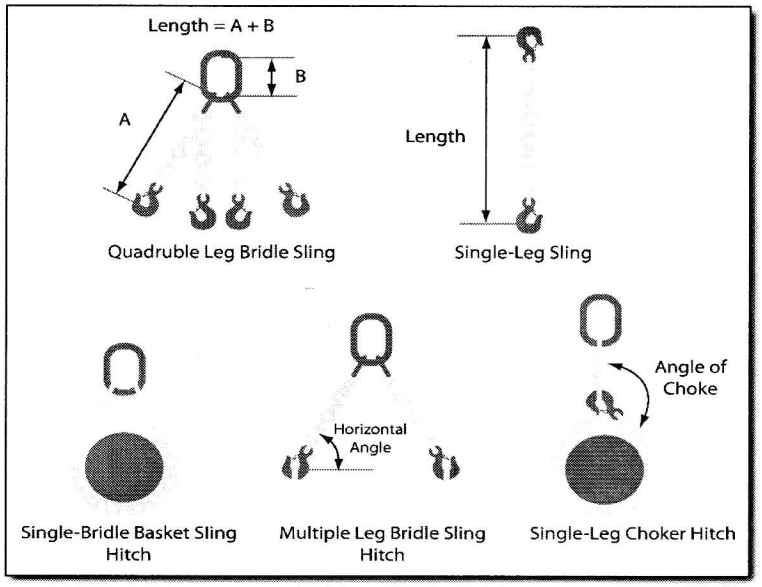
Angle of Choke	Rated Capacity
Over 120°	100%
90° - 120°	87%
60° - 89°	74%
30° - 59°	62%
0° - 29°	49%

Softeners:



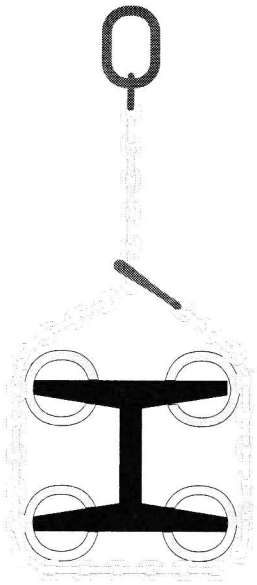
Type: Alloy Steel Chain

1. Rated load of sling shall not be exceeded.
2. Multiple leg slings used with nonsymmetrical loads should be analyzed by a qualified person to prevent the overloading of any leg.
3. When multiple slings are used in the basket hitch, load must be balanced to prevent slipping.

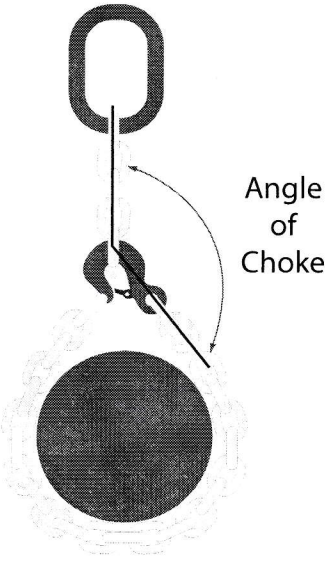


Alloy chain slings should NOT:

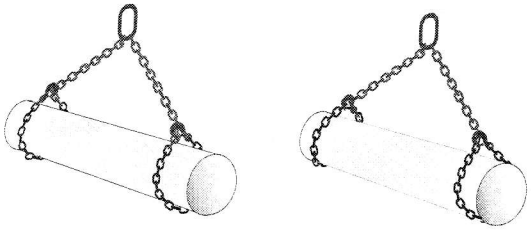
1. Be used with horizontal sling angles less than 30 degrees. (Except as recommended by the sling manufacturer or a qualified person)
2. Be shortened or adjusted except in the method determined by the manufacturer or a qualified person.
3. Be shock loaded.
4. Be knotted or twisted.



5. Come in contact with sharp edges.
6. Have the load landed on it.
7. Be pulled out from under the load while the load's weight is resting on it.
8. Rigged using any hitch that would allow the sling to slide along the load.
9. Use a choke angle that would be less than 120 degrees without reducing the rated load of the sling. Rated loads shall be determined by sling manufacturer or qualified person.

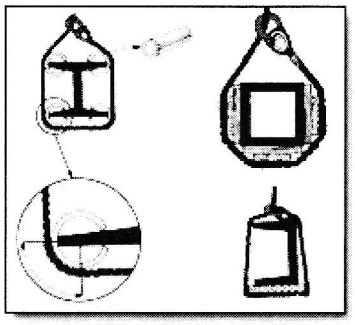


Choked in the OPPOSING plane.

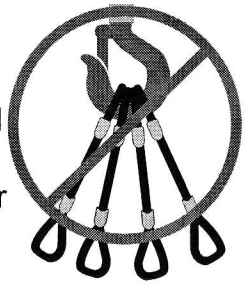


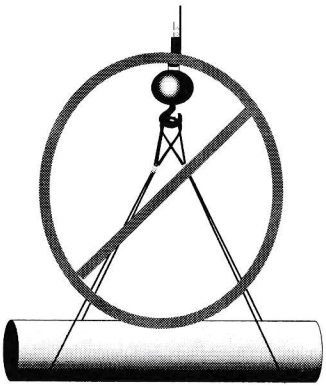
Choked in the SAME plane.

Type: Wire Rope



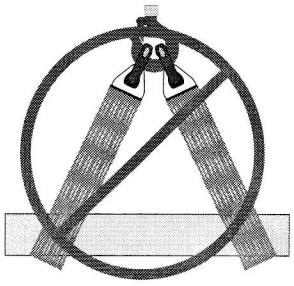
1. Slings shall be shortened or adjusted only by methods approved by the sling manufacturer or a qualified person.
2. Slings shall not be shortened or lengthened by knotting, twisting, or by wire rope clips.
3. The sling shall be hitched in a manner providing control of the load.
4. Slings in contact with edges, corners, or protrusions should be protected with a material of sufficient strength, thickness, and construction to prevent damage to the sling.
5. Shock loading should be avoided.
6. Loads should not be rested on the sling.
7. Slings should not be pulled from under a load when the load's weight is resting on the sling.
8. Twisting and kinking shall be avoided.
9. During lifting, with or without load, personnel shall be alert for possible snagging.
10. When using multiple basket or choker hitches, the load should be rigged to prevent the sling from slipping or sliding along the load.
11. When using a basket hitch, the legs of the sling should contain or support the load from the sides, above the center of gravity, so that the load remains balanced and under control.
12. Attachment points should be above load center of gravity.
13. Slings should not be dragged on the floor or over an abrasive surface.
14. In a choker hitch, an angle of choke less than 120 deg. should not be used without reducing the rated load.
15. Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.



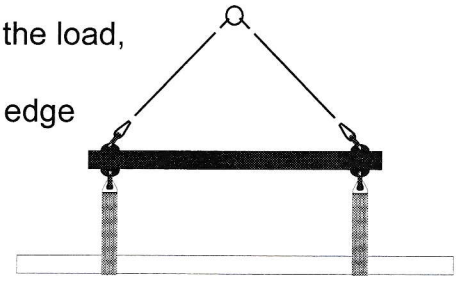


16. The load applied to the hook should be centered in the base (bowl) of the hook to prevent point loading on the hook, unless the hook is designed for point loading.
17. An object in the eye of a sling should not be wider than one half the length of the eye.
18. Sling and load shall not be allowed to rotate when hand tucked slings are used in a single leg vertical lift application. Care shall be taken to minimize sling rotation.
19. Slings made with wire rope clips shall not be used as a choker hitch.

Type: Metal Mesh

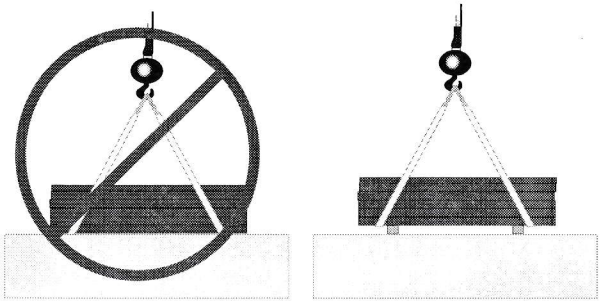


1. Slings shall be shortened or adjusted only by methods approved by the sling manufacturer or a qualified person.
2. The load should be evenly distributed across the width of the metal mesh.
3. The sling shall be hitched in a manner providing control of the load.
4. Slings in contact with edges, corners, or protrusions should be protected with a material of sufficient strength, thickness, and construction to prevent damage.
5. Shock loading should be avoided.
6. Loads should not be rested on the sling.
7. Slings should not be pulled from under a load when the load's weight is resting on the sling.
8. Twisting and kinking shall be avoided.
9. During lifting, with or without load, personnel shall be alert for possible snagging.
10. In a basket hitch, the load should be balanced to prevent slippage.
11. When using a basket hitch, the sling should contain or support the load from the sides, above the center of gravity, so that the load remains under control.
12. Slings should not be dragged on the floor or over an abrasive surface.
13. In a choker hitch, the choke point should only be on the sling body, not on a weld, braze, or end fitting.
14. Attachment points should be above load center of gravity.
15. Rated loads for angles of choke less than 120 degrees shall be determined by the sling manufacturer or a qualified person.
16. Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.
17. In a choker hitch, the load should be balanced to prevent edge overload.
18. Straightening a spiral or cross rod or forcing a spiral into position shall not be done.
19. Slings used in pairs should be attached to a spreader beam.
20. Sling handles and metal fabric must have the same rated capacity.

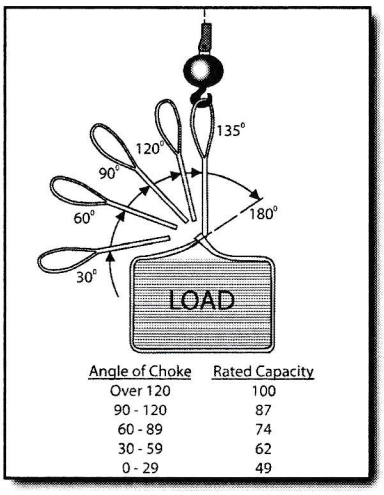


Type: Synthetic Web

1. The sling shall be hitched in a manner providing control of the load.
2. Slings in contact with edges, corners, protrusions, or abrasive surfaces shall be protected with a material of sufficient strength, thickness, and construction to prevent damage.
3. Shock loading should be avoided.
4. Loads should not be rested on the sling.
5. Slings should not be pulled from under a load when the load's weight is resting on the sling.
6. Twisting shall be avoided.
7. During lifting, with or without load, personnel shall be alert for possible snagging.

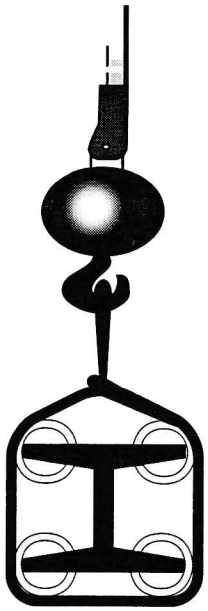


8. When using multiple basket or choker hitches, the load should be rigged to prevent the sling from slipping or sliding along the load.
9. When using a basket hitch, the legs of the sling should contain or support the load from the sides, above the center of gravity, so that the load remains balanced and under control.
10. Slings should not be dragged on the floor or over an abrasive surface.
11. In a choker hitch, the choke point should only be on the sling body, not on a splice or fitting.
12. In a choker hitch, an angle of choke less than 120 deg. should not be used without reducing the rated load.
13. Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.
14. The load applied to the hook should be centered in the base (bowl) of the hook to prevent point loading on the hook, unless the hook is designed for point loading.
15. An object in the eye of a sling should not be wider than one-third the length of the eye.
16. Shall not be used for suspension systems for personnel platforms. (ASME B30.23-1.1.1(b)(10)(e))

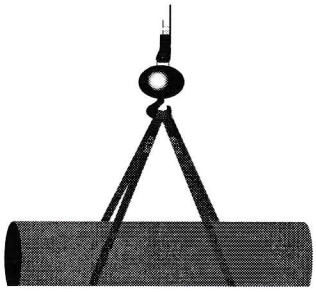


Angle of Choke	Rated Capacity
Over 120	100
90 - 120	87
60 - 89	74
30 - 59	62
0 - 29	49

Type: Synthetic Roundslings



1. The sling shall be hitched in a manner providing control of the load.
2. Slings in contact with edges, corners, protrusions, or abrasive surfaces shall be protected with a material of sufficient strength, thickness, and construction to prevent damage.
3. Shock loading should be avoided.
4. Loads should not be rested on the sling.
5. Slings should not be pulled from under a load when the load's weight is resting on the sling.
6. Twisting shall be avoided.
7. During lifting, with or without load, personnel shall be alert for possible snagging.
8. When using multiple basket or choker hitches, the load should be rigged to prevent the sling from slipping or sliding along the load.

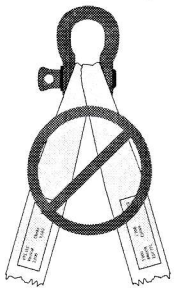


9. When using a basket hitch, the legs of the sling should contain or support the load from the sides, above the center of gravity, so that the load remains balanced and under control.
10. Attachment points should be above load center of gravity.
11. Slings should not be dragged on the floor or over an abrasive surface.
12. In a choker hitch, the choke point should only be on the sling body, not on a splice or fitting.
13. In a choker hitch, an angle of choke less than 120 deg. should not be used without reducing the rated load.
14. Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.

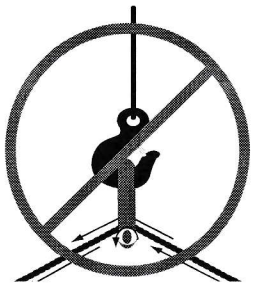
Rigging Hardware:

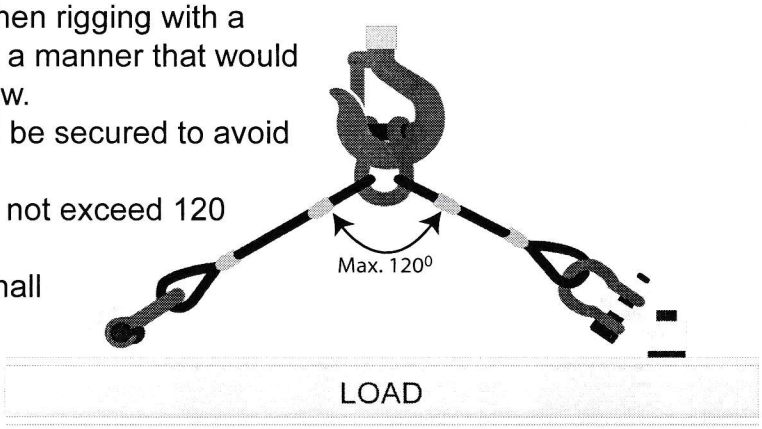
Shackles

1. Screw pin shall be fully engaged.
2. Cotter pins, if applicable, shall be used and maintained in good working condition.
3. Avoid contact with sharp edges.
4. Do not shock load.
5. Load applied should be center of bow, to avoid side loading.



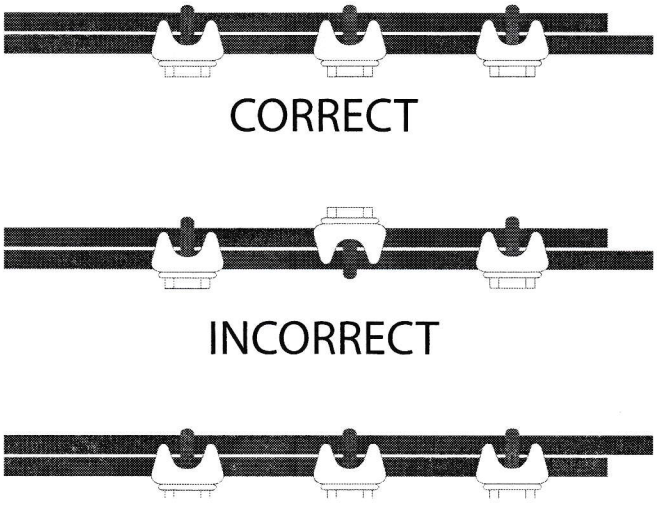
6. More than one sling leg should not be applied to the shackle pin.
7. If side loading, the recommendation of the manufacturer or a qualified person shall be followed.
8. Care must be taken when rigging with a shackle not to use it in a manner that would allow the pin to unscrew.
9. For long term use, screw pins shall be secured to avoid pin rotation.
10. Slings attached to shackles should not exceed 120 degree included angle
11. If choking with a shackle, the pin shall be attached to the choking eye of the sling.

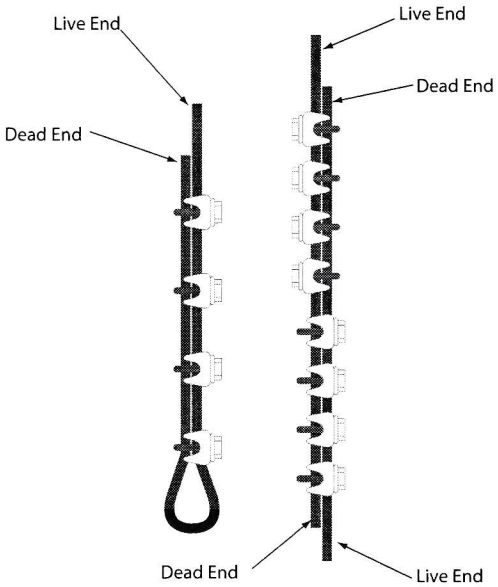




Wire Rope Clips:

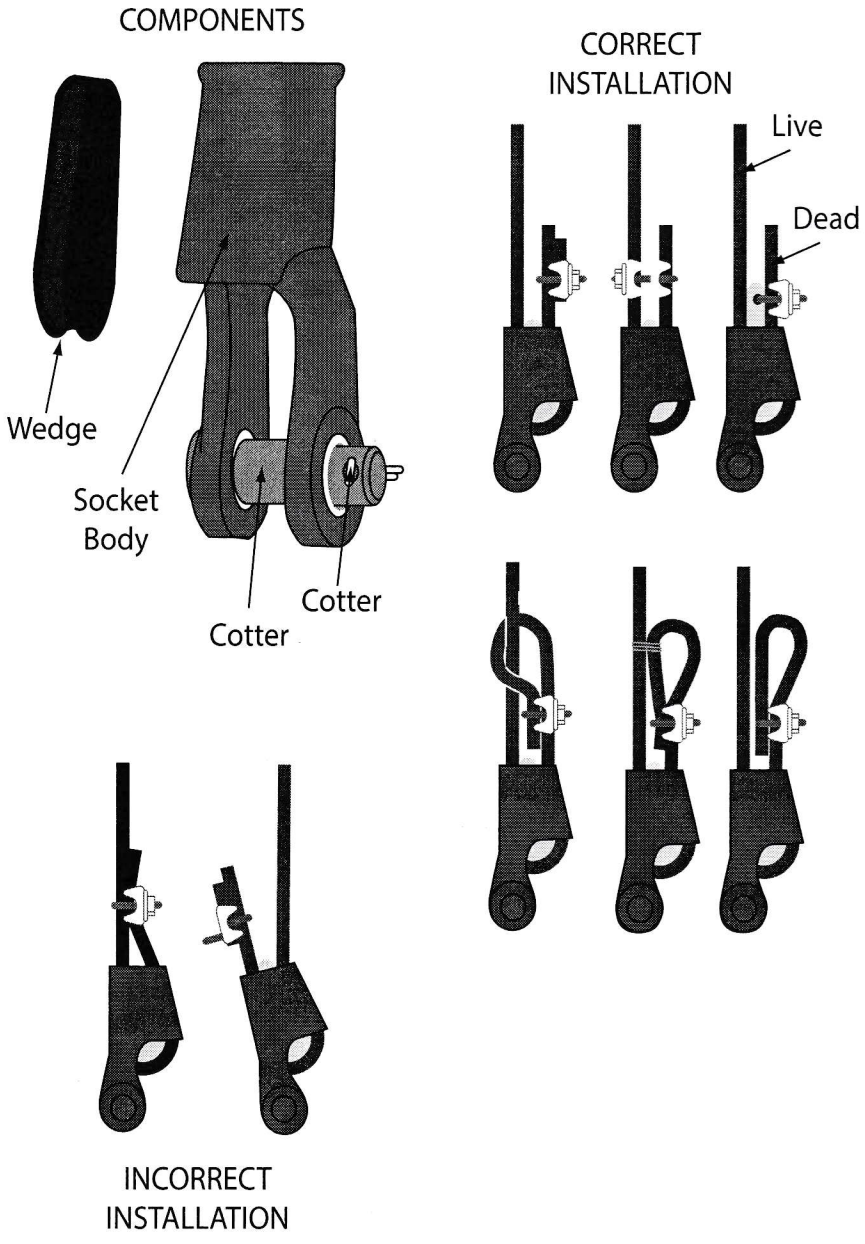
1. Clips should not be in contact with obstructions during lifting operations.
2. Do not shock load.
3. Do not use wire rope clips to fabricate slings.





Wedge Sockets

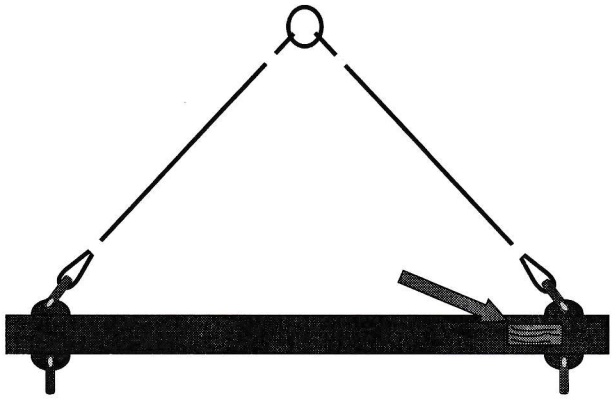
1. Do not side load.
2. Wedge sockets should not come into contact with sharp edges.
3. Do not shock load.
4. Avoid impacts on the wedge socket.
5. Do not drag across abrasive surfaces.
6. Must be installed as so the load line is pulling in a straight line with the pin.
7. Dead end tail length to be determine by the manufacturer.



Miscellaneous Rigging Hardware:

Liftting/Spreader beams must be marked with:

1. Manufacturer's name and address.
2. Serial Number.
3. Weight of the beam.
4. Beam's rated load.



J-Hooks are an acceptable way of attaching wooden trusses to the crane. (OSHA 1926.1425(c)(2))

```
 48,123
  3,600
      8
  2,712
+   640
      3
```

Add the numbers in the first column.

The sum of these numbers is "13".

Write in "3"

Don't forget to carry the 1.

```
    1
 48,123
  3,600
      8
  2,712
+   640
     83
```

Add the numbers in the second column.

The sum of these numbers is "8".

Write in "8"

```
    1
 48,123
  3,600
      8
  2,712
+   640
    083
```

Add the numbers in the third column.

The sum of these numbers is "20".

Write in "0"

Don't forget to carry the 2.

```
  2 1
 48,123
  3,600
      8
  2,712
+   640
  5,083
```

Add the numbers in the fourth column.

The sum of these numbers is "15".

Write in "5"

Don't forget to carry the 1.

```
 1 2 1
 48,123
  3,600
      8
  2,712
+   640
 55,083
```

Add the numbers in the last column.

The sum of these numbers is "5".

Write in "5"

ADDITION EXERCISES:

		2	5	8	9	3	
			2	7	8	6	
		1	1	0	1	0	
					7	8	
	+			4	6	5	
		5	6	3	2	0	
			5	5	9	8	
			3	2	4	5	
					9	0	
	+				6	5	
		1	5	8	4	3	
			8	7	0	1	
		2	1	3	4	6	
			4	9	6	2	
	+		5	5	6	6	

```
 48,123
- 5,487
--------
```

Subtract the numbers in the first column.

```
      13
 48,12⁄3
- 5,487
--------
      6
```

Since "7" cannot be subtracted from "3", we must borrow from the next column, then subtract.

```
    1
      13
 48,12⁄3
- 5,487
--------
      6
```

Subtract the numbers in the second column.

```
    11
     1 13
 48,1⁄2⁄3
  5,487
--------
     36
```

Since "8" cannot be subtracted from "1", we must borrow from the next column, then subtract.

```
   1011
   7 0⁄1 13
 48,1⁄2⁄3
  5,487
--------
    636
```

Subtract the numbers in the third column.

Since "4" cannot be subtracted from "0", we must borrow from the next column, then subtract.

```
   1011
   7 0⁄1 13
 48,1⁄2⁄3
  5,487
--------
  2,636
```

Subtract the numbers in the fourth column.

```
   1011
   7 0⁄1 13
 48,1⁄2⁄3
  5,487
--------
 42,636
```

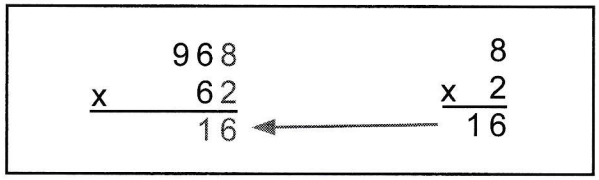
Subtract the numbers in the last column.

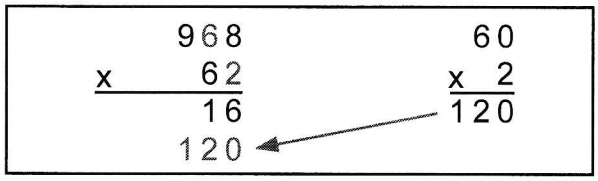
SUBTRACTION EXERCISES:

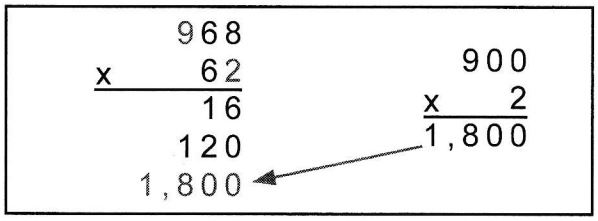
		2	5	8	9	3	
	-		2	7	8	6	
		5	6	3	2	0	
	-		5	5	9	8	
		1	6	4	2	0	
	-		1	6	2	1	
		3	9	0	2	2	
	-		3	5	9	7	

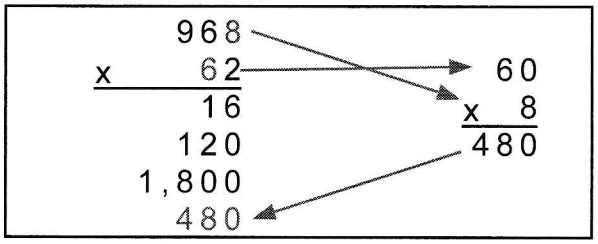
PROBLEM:

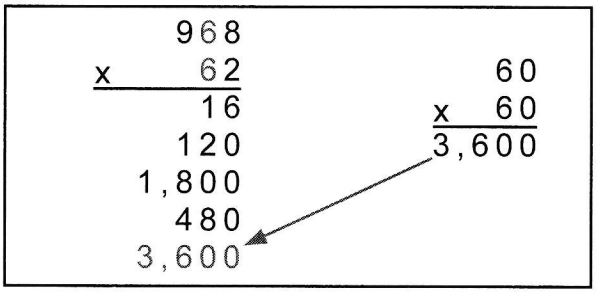
```
   968
x   62
```

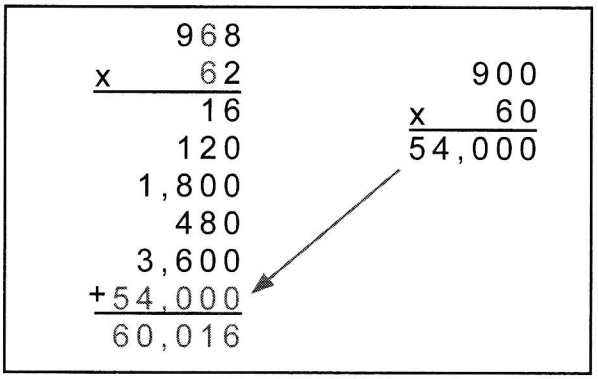




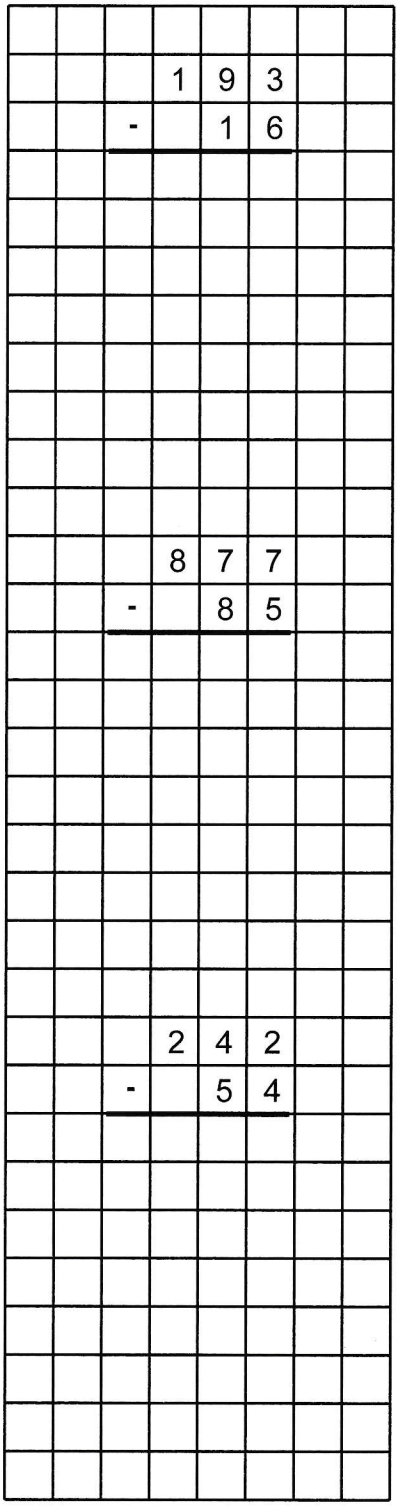








MULTIPLICATION EXERCISES:

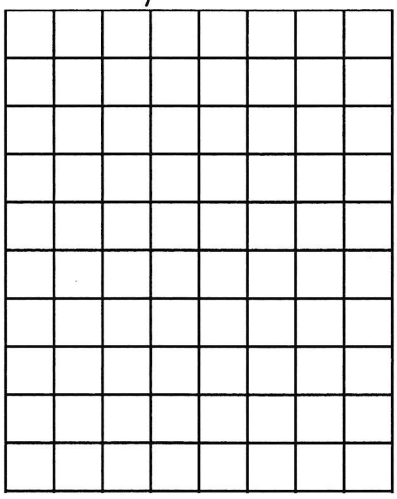


PROBLEM: $6\overline{)354}$

$6\overline{)354}$ 0	Since "3" cannot be divided by "6", insert a "0" .
$6\overline{)354}$ 0 3	Subtract “0” from “3”, which equals “3”.
$6\overline{)354}$ 0↓ 35	Bring down the “5”.
5 $6\overline{)354}$ 0 35	How many times does “6” go into “35”? The answer is “5”.
5 $6\overline{)354}$ 0 35 30	Multipy “6” x “5”, which equals “30”.
5 $6\overline{)354}$ 0 35 30 5	Subtract “30” from “35”, which equals “5”.
5 $6\overline{)354}$ 0 35 30↓ 54	Bring down the “4”.
59 $6\overline{)354}$ 0 35 30 54	How many times does “6” go into “54”? The answer is “9”.
59 $6\overline{)354}$ 0 35 30 54 54 0	Multipy “6” x “9”, which equals “54”. Final answer is 59.

DIVISION EXERCISES:

$8\overline{)448}$



$9\overline{)783}$