RIGGING

A. INTRODUCTION

The purpose of this program is to identify for **EAGLE INDUSTRIAL INSTRUMENTATION**personnel the requirements for working safely with cranes, hoists, slings and related equipment, and aid **EAGLE INDUSTRIAL INSTRUMENTATION**in complying with API 2D, 2C, and ANSI B30.5. The program applies to material handling and related equipment on customer and **EAGLE INDUSTRIAL INSTRUMENTATION**premises both on and offshore. It contains information to enable Eagle Industrial Instrumentation personnel to work safely while rigging and while in the vicinity of cranes and other lifting equipment.

B. DEFINITION

Anyone who attaches or unattaches lifting equipment to loads or lifting devices and who gives signals to crane operators. This person must have also successfully completed an approved training program prior to being used as a qualified rigger.

C. RESPONSIBILITIES

The management is responsible for ensuring that employees have completed the training required by this procedure, as well as:

- Ensuring that employees-including riggers, crane operators, and inspectors-have been properly trained.
- The implementation of this policy
- Taking corrective actions on all violations or suspected violations of this procedure.
- Documentation of completion for each employee.

The Safety Coordinator is responsible for aiding in the implementation of this procedure. The supervisor is responsible for providing assistance in the implementation of this policy by:

- Ensuring that proper inspections and maintenance records are completed and maintained.

EAGLE INDUSTRIAL INSTRUMENTATIONpersonnel are responsible for acquainting themselves with this procedure and applying it in their day to day operations.

D. GENERAL INFORMATION

Rigging consists of the ropes, cables, chains, slings, pulleys, winches and related

materials used to stabilize, lift, or move items. Safe rigging operations require observance of correct procedures and knowledge of the materials used. Remember the following:

- Your primary responsibility is to verify the weight of the load
- Always be certain that cables are in a safe condition and heavy enough to carry the load.
- Be sure that the rigging is safe and the loads are properly balanced.
- Keep the loads free of all loose objects such as tools.
- Be sure the load to be lifted is not greater than the capacity of the lifting device.
- Keep yourself and others clear of loads being lifted.
- Always utilize Tag Lines and never handle lifted loads by hand.

Serious injuries and extensive property damage can result from failure to observe the design limitations of hoisting equipment or from failure to recognize evidence of wear, weakening or damage. Hoisting equipment is made according to rigid standards, and it is tested and its limits verified by such national societies as American Society for Testing Materials (ASTM). Thus the user is assured that an individual item is suitable for use within certain load limits.

E. TRAINING REQUIREMENTS

The rigger training program as per API-RP-2D, 5th Edition will consist of the following, including both classroom and hands on training:

- Crane components
- Working safely around cranes
- Standard operating hand signals
- Complete familiarization with:
  - Rigging hardware
  - Slings and usage
  - Inspections and maintenance
  - Lift planning and procedures

Hands on training to include:

- Inspection of equipment
- Actual rigging of equipment
- Selection of slings
- Use of hand signals
- Both written and practical exams.

All training will be documented and kept in personnel and training files covering:

- Name of student

- Date of training
- Name of instructor

F. REFRESHER TRAINING

Riggers will be trained according to the following schedule:

- Before being assigned to do any rigging, or
- If their work shows lack of proficiency.

G. SLING CONSTRUCTION

1. Single-Part Sling: A single-part sling is comprised of a single wire rope commonly used for lifting easy to handle, light to medium weight loads.
2. Multi-Part Sling: These are continuous plaiting or braiding of several single ropes together that form a single braided sling.
3. Multi-Leg Sling: These types of slings consist of two, three, or four legs (single slings) secured in a master link. These generally provide better load stabilization when the load is distributed equally among the legs. They also provide increased capacity over the single leg sling.
4. Synthetic Web Slings: Used primarily for painted surfaces or fine instrumentation that wire rope could damage.

The following guidelines are intended to help a rigger make the proper sling selections for a particular job.

H. SELECTION PROCEDURE

1. Determine Weight-Make sure that the weight of the load to be lifted is known. If not, take proper steps to ensure the sling has more than adequate capacity.
2. Decide on Hitch or End Attachment-Make sure that the hitch accommodates the load's shape and size as well as its weight. Selection must take into consideration any possible physical damage to the load as well as providing a positive attachment. The hitch or end attachment chosen may affect the choice of sling construction.
3. Check Lifting Device-Make sure that the lifting device has sufficient capacity, is in proper working condition, and provides the maneuverability required once the load is lifted.
4. Consider Room to Lift-Make sure that the lifting device has sufficient room to pick up the load and handle it when the length of

the sling is added to the hook.

5. Determine Sling Length-Make sure to use the longest sling possible for completing the lift, since the longest sling will provide the smallest angle of spread between the sling legs.
6. Check Rated Capacity-Find out the sling's safe working load capacity. DO NOT guess, use Rated Capacity Chart. Double check that the length, type and diameter of the sling chosen will accommodate the load to be lifted.
7. Determine Leg Styles-Considering the capacity above, multi-part slings will be more flexible, more easily handled, than single-part slings and will often provide the only practical means for handling extremely heavy lifts.
8. Check Everything-Before attempting a lift, take a light strain on the rigging, checking to see that blocking, sling and load protection and all safety devices are in place and that the load is free of any restraints.
9. Put It Away!-After you've completed the job, check the sling for any damage. If it's damaged, red tag it immediately or advise the sling inspector. If it is undamaged, return it to the sling storage rack for safekeeping until the next usage. Slings should be stored where they will not be subject to damage.

I. SAFETY FACTOR

To guard against possible rope failure, the actual load on a sling should be only a fraction of the manufacturer's rated breaking strength. Applying a factor of safety to this value provides the margin of strength necessary to handle loads safely.

The maximum safe working load of a rope can be determined by dividing the manufacturer's rated breaking strength of the particular rope by the appropriate factor of safety (5:1, 3:1, 2:1). For rigging ropes, the minimum acceptable safety factor is 5; for ropes used to hoist personnel, the safety factor is 10.

<u>NOTE:</u> A factor of safety is NOT a reserve strength. It CANNOT be used to provide additional rope capacity; and it must NEVER be lowered.

When a rigger is confronted with a load problem and references for wire rope are not available, either of these two approximate methods will give safe serviceable results.

1. Change rope diameter into eighths (1/8's) of an inch; square the number of eighths; then multiply this result by 250 to determine working strength in pounds.
2. Square the diameter of the rope in inches; then multiply result by 8 to determine working strength in tons.

J. RATED LOAD

The working load limit is the same as the "Rated Load" which is indicated on the heavy duty tags attached to each type of sling at the time the component is manufactured. If the capacity tag is not attached, do not use the sling. A rated load can also be found on rigging hardware such as hooks and shackles.

K. PROOF TEST

This test is applied to a product solely to determine injurious material or manufacturing defects. As per API RP 2D the proof load, which is the force applied at a proof test, for single-leg slings with mechanical or poured attachments shall be twice the sling's vertical rated capacity. Slings with hand-tucked splice attachments shall be proof loaded to the vertical rated capacity. The proof load for multiple-leg bridle slings shall be applied to each of the individual legs.

L. DYNAMIC LOADS

Dynamic loads take place when cargo is on deck attached to a slack hoist line and the deck quickly falls from under the load, leaving the load hanging in mid air and resulting in a Shock Load. This causes a large jolt to be sent throughout the crane and its rigging. Under API 2C all offshore cranes must be equipped with a Dynamic Load Chart.

M. INSPECTION

Several industry standards including ANSI and API (The American Petroleum Institute) require inspections of Rigging Hardware. ANSI requires an "initial" inspection when rigging is originally purchased and placed into service, a "frequent" inspection prior to each day's activities, and a "periodic" inspection which must be conducted at least annually with record keeping.

The frequency of documenting sling inspections will be determined by the Owner based on the following criteria:

- Frequency of sling use
- Severity of service conditions
- Nature of type of lifts being made
- Experience based on service life of slings used in similar applications

Inspection records must be written, dated, initialed and kept readily available for a period of two years at an appropriate location. The person performing the inspection must be clearly identified on the inspection record.

Each person that uses rigging equipment such as slings and shackles must inspect them prior to use and should avoid assumptions that all <u>new</u> pieces of rigging

equipment are fully functional. Additionally, all riggers must be trained sufficiently to recognize the appropriate application for each piece of rigging equipment. A certified sling, regardless of age or newness, may not fit a specific application.

If you have any doubt about the safe condition of a piece of rigging equipment, do not use it.

Equipment should also be inspected daily before it is used and again before it is returned to storage. Some companies have a daily report where the condition of all rigging equipment is recorded at the end of a shift.

Do not try to repair defective equipment. If should be tagged with a warning and removed from service – either permanently or until it is repaired and proof tested by the manufacturer or another authorized person.

Never leave damaged or worn equipment where someone else might pick it up and use it.

N. GUIDELINE TO INSPECTIONS & REPORTS

1. Maintain all inspection records and reports for the length of time deemed appropriate.

2. Prior to each daily use, the following procedure is set as a guideline:
    a. Check all equipment functions.
    b. Lower load blocks and check hooks for deformation or cracks.
    c. During lowering procedure and the following raising cycle, observe the rope and the reeving. Particular notice should be paid to kinking, twisting, or other deformities.
    d. Check wire rope and slings for visual signs of anything causing them to be unsafe to use: broken wires, excessive wear, kinking or twisting. Particular attention should be given to a new damage during operation.

3. Monthly inspections are recommended with a signed report by an authorized competent inspector. The Monthly Reports should include the inspection of the following:
    a. All functional operating mechanisms for excessive wear of components, brake system parts and lubrication.
    b. Limit Switches.
    c. Crane hooks for excess throat opening or twisting along with a visual for cracks.
    d. Wire rope and reeving for conditions causing possible removal.
    e. Wire rope slings for excessive wear, broken wires, stretch, kinking, twisting, and mechanical abuse.

f. All end connections: hooks, shackles, turnbuckles, plate clamps, sockets, etc. for excessive wear, distortion and broken wires.

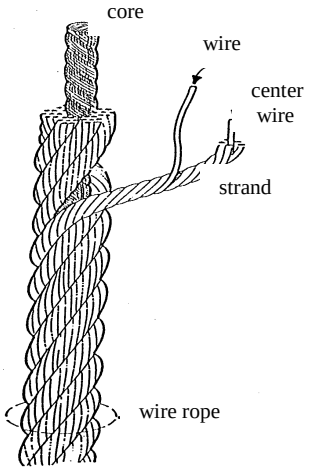
g. Electrical apparatus for signs of pitting or deterioration of controller containers, push button stations, limit switches and other electrical controls.

O. WIRE ROPE

Wire rope consists of a number of singles wires that are laid (not twisted) into a number of strands. These are often laid, or helically bent, around a core, which may be either of fiber (natural or synthetic) or of wire, and serves to support the outer strands and prevents them from crushing when the wire is wrapped around a drum. Also helps keep outer strands in proper position while in use.

Characteristics of Wire Rope

- Flexibility
- Strength
- Easy maintenance
- Easily inspected for wear



Three Basic Components of Wire Rope

P. CHAIN

Only alloy steel chain is suitable for slings used in overhead lifting and should have the letter **"A"** and/or the number **"8"** stamped on each link.

Currently available is grade 8 or 100 alloy steel chain rated by the National Association of Chain Manufacturing (NACM) which offers higher working load limits and is in compliance with OSHA standards.

Available in both single and multiple-leg style slings where ruggedness, high temperature and abrasion resistance are required.

Even though a chain is strong, it should **NEVER be welded** on or exposed to temperatures **above 600º F**: it will lose its rated strength.

Chains will also stretch under excessive loading. The links become elongated and ultimately will fall.

NOTE: Whenever a chain sling is hooked back on itself (into the chain, rather than to the master link) the capacity of the sling should be reduced by ¼. Thus choker hitch ratings according to manufacturer safe load ratings are less than the ratings for vertical hitches.

Q. SYNTHETIC WEBBING

Synthetic webbing is used primarily for rigging loads that must not be marred or scratched, such as finely machined, highly polished or painted surfaces. They have however a number of advantages over slings made of other materials.

- Softness and bearing width
- Flexibility
- Elasticity
- Long life
- Stability
- Non-sparking
- Non-rusting
- Minimize twisting
- Less likely to cause injury

Synthetic web sling capacities are based on:

- Proper fabrication efficiency
- Safety factor of 5:1
- Horizontal sling angle not less than 30°
- Type of hitch

They are available in one, two, three or four-ply webbing, with metal end fittings (triangle and choker, or triangles), standard eye and eye, twisted eye, and endless or grommet configuration.

Folding, bunching or pinching of synthetic slings, which occurs when used with improperly sized shackles, hooks or other misapplications, will reduce the rating.

For this reason web slings should not be constricted between the ears of a clevis or a shackle. Selecting a shackle for use with a web sling requires proper working load limit and enough room to allow the sling to fit without bunching.

Special fittings designed for synthetic web slings are available to eliminate bunching and to simplify use.

R. EFFECTS OF LOAD ANGLE

Any load angle other than 90 degrees decreases the rigging equipment's rated capacity.

Each corner of a square is a 90° angle. Most rigging equipment will support its full rated capacity at a 90° angle.

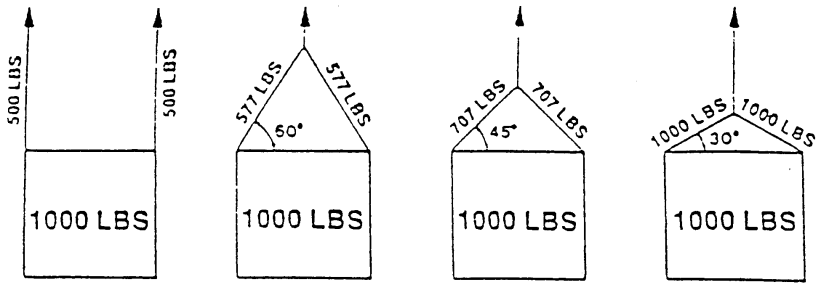
A diagonal between opposite corners of the square divides the 90-degree angle into two 45° angles. A sling rigged at a 45° angle to the load has only 70.7 % of its full lifting capacity.

In any triangle with all three legs the same size, each of the angles is 60°. A sling with a 60° load angle has on 86.6% of its full rated capacity.

Half of that 60° angle is 30° and should never be used to lift. The smallest load angle you should ever use for overhead lifting is 45°.

Effect of Sling Angle on the Rated Capacity of the Sling

Assumed Sling Angle	Assumed Load (Pounds per Leg)	Actual Angle	Actual Load (Pounds per Leg)	Error %
90°	500	85°	502	0.4%
75°	518	70°	532	2.8%
60°	577	55°	610	5.7%
45°	707	40°	778	9.1%
30°	1,000	25°	1,183	18.3%
15°	1,932	10°	2,800	49.0%



NOTE: When the pull is not vertical, the load in the leg is always increased.

S. CENTER OF GRAVITY

Any load should be rigged so the **center of gravity is directly beneath the hoist hook** and if possible, below or level with the attachment points.

If the center of gravity is not directly under the hook, the load will shift when it is picked up. If it is above the attachment points, the load may tip over.

A load's center of gravity is the **point where the weight is concentrated**. For most regular shapes, the center of gravity is in the middle of the load. But for an irregularly shaped load, or one that is composed of different materials, the center of gravity will probably not be at the physical center of the load. When rigging an irregular load, start by positioning the hook above the point where you estimate the center of gravity to be.

Each leg of the sling should be **strong enough to support the weight of the entire load**, just in case the load should slip. Whenever a load is off balance, the chances that something might go wrong are greatly increased.
When the load is rigged for the probable center of gravity, it should be raised just off of the ground to test its stability. If the **load shifts or tips more than 5 degrees**, it should be set down so the hitch can be **adjusted**. One or more of the sling legs may have to be lengthened or shortened.

T. LIFTING CAPACITY

Slings are rated with a lifting capacity for vertical, choker and basket hitches. However, this rated capacity is affected by the angle formed between the sling and the load. You can find the rated capacity of a sling on a table or on an **ID tag attached to the sling**. Rope may or may not be tagged. Other slings must be tagged.
Do not use a synthetic web, metal mesh, or chain sling if the ID tag is missing or illegible.

U. HARDWARE

The **hardware or end attachments** are as important as the wire rope itself. One must consider proper selection and capacity. Wire rope attachments do not always equal or have the same load capacity as the rope. The application determines the type of end attachment used. However, a safe working load should be stamped on the fitting. There are several types of end attachments we will discuss such as clips, shackles, hooks, wedges, etc.

a) CLIPS

The **most common method of making an eye** or attaching a wire rope to a piece of equipment is with the cable or crosby clip. These consist of the separate U-Bolt and saddle clip or the double saddle safety (fist grip) clip.

U-Bolts must be placed on the rope with the **U-Bolts** bearing on the short or **dead end** of the wire rope, and the **saddle on the long or live end** of the rope. These clips should be placed not less than six (6) diameters of the rope apart and in no case less than that recommended by manufacturer.

Clip efficiency will depend on the arrangement, care in tightening, and the number used:

1. Properly attached U-Bolts (80%efficiency) all on dead end)
2. Staggered clip attachment (75% efficiency)
3. U-Bolts (all on live or load end) (70% efficiency)
4. Improperly tightened nuts (50% efficiency)

Double saddled or fist grip type clips develop approximately **95% strength of the rope**, thus one less clip is required. Also, they can be **installed without regard to which part goes on live or dead end** of cable.

b) HOOKS

There are many different types of safety hooks used in rigging and it is recommended that you use only hooks made from forged alloy steel with the **rated capacity stamped on hook**.

Make sure that all hoisting hooks except grab and sorting types are **equipped with safety catches**.

Remember a hook's safe working load applies only when the load is **applied directly on the saddle of the hook**. The load placed anywhere else on the hook will reduce the hook's rated safe working load. There are several types of hooks used in the industry.

Hooks also need to be **inspected at regular intervals**. One needs to check for wear in the saddle, cracks, hooks that are sprung open, corrosion, twists, etc. Some inspection tests can be done with **x-ray, ultra-sound or magna-flux**.

All tests should be recorded when checking for overloading (most common problem). A measurement of the hooks throat opening should be taken when new, if overloaded the throat will show an increase in length. Anything **over a 15% increase** should be discarded**. Never use heat on a hook**.

c) SHACKLES

The two **(2) most common types** of shackles used in rigging operations are the **anchor (bow shaped)** and **the chain (D-shaped) shackles**. Both types are available with **screw pins, round pins, or bolt type closures**. Again, as with other types of end attachments, always use shackles made from forged alloy steel with the safe rated load stamped on the body of the shackles. Never use a shackle when the rated load is not stamped on it.

Always ensure that the load pulls evenly when using shackles. If it is pulled at an angle, the load capacity is reduced considerably. **Use washers or spacers to center the load** if necessary. Also, **never replace a shackle pin with a bolt and nut**. Use cotter pins with any round pin shackle. If there is a chance that the pin might roll when loaded, DO NOT use a screw type pin shackle, the rolling action could loosen the pin. Destroy all shackles that show wear greater than **10%** on the crown or pin from original diameter.

Shackles are sized by **diameter of the steel in the crown, not by pin size**. Only stainless and forged alloy steel types should be used. Safety shackles are required on loads with permanently attached slings (pre-rigged). All shackles must have the rated capacity clearly embossed.

REMEMBER!! Never replace a shackle pin with a bolt. Bolts are not intended to take the bending stress applied to the pin.

d) THIMBLES

Primarily used to **prevent the eye of the sling from spreading out** exposing the core and from cutting the fibers of the sling on the load.

Also used when connecting two straight lengths of rope together. Use clips to form an eye (with a thimble) in each end connecting the eyes together.

e) EYE BOLTS

Eye bolts are sometimes inserted into the load as attachment points for the sling. Check the condition of the:

1. **Shank:** The threads should be in good condition, and the shank should not be cracked or bent.

2. **Eye:** Check for damage or excessive wear.

3. **Hole:** You also need to check the hole the eye bolt is going to go into. The threads must be good, and it must be the correct diameter and depth for the eye bolt.

For a lift at any load angle **less than 90 degrees** it is best **to use a swivel eye bolt**. The ring turns to the correct lifting position as the load is applied. Swivel eye bolts must be torqued according to the manufacturer's recommendations.

If swivel eye bolts are not available for an angular pull, the eye bolt you use must have a shoulder on it, and the **shoulder must be flush with the surface of the load**. Do not use eye bolts if the angle between the sling and the load is less than 45 degrees.

If the hitch is not vertical, the angular pull on the eyebolt should be from the side of the eye bolt, not from the top. If necessary, use washers to shim the eye bolt so it can be turned in the right direction and still be flush with the surface of the load.

Never lift a load with the hook or sling run through the eye bolt. Use a shackle.

When attaching a sling to eye bolts, always pull on line with the bolt axis. When hitching too bolts screwed into or attached to a load, a side pull may break the bolts.

f) TURNBUCKLES

All turnbuckles used in rigging industry should be of **weldless construction** and fabricated from **alloy steel**. There are a variety of end fittings used on turnbuckles; some of these are:

- eye and eye
- hook and hook
- jaw and jaw
- hook and eye

All turnbuckles of comparable size have equal, rated load capacities, except hook end types which because of their configuration have lower ratings. It would be wise to make sure all hook ends are fitted with safety latches.

Also, if the turnbuckle is to be used in an application where vibration is present, it is extremely important to lock the frame to the end fittings to prevent loosening. Lock nuts or jam nuts are sometimes not effective and add greatly to the load in the screw thread.

g) SPREADER BARS

Slings are used most efficiently if load angles are as near 90^{o} as possible. The use of a spreader bar can definitely minimize unnecessary stress on your rigging equipment by increasing your sling load angle. Spreader bars are generally used on long loads such as pipe or beams.

Note: However, remember to add the weight of all spreader bar hardware into the load weight. The hoist hook must be able to support everything it is holding. Also, make sure that the weight of the load is within the S.W.L. (Safe Working Load) Capacity of the spreader bar.
Use a spreader bar with double basket hitches to reduce tendency of slings to slide together and to keep loads level. By adjusting the hook point and using a come-along or chain block to support the heavy end, the load can be kept level during the lift.

V. SAFE RIGGING PROCEDURES

It is extremely important to rig the load so that it is stable. Unless the center of gravity of the load is below the hook, the load will shift. A separate section dealing with centers of gravity has been included in this manual.

A. The safety of personnel involved in rigging and hoisting operations largely depends upon care and common sense. Remember these safe practices:

1. Always maintain good balance when handling any load, be especially cautious of finger and hand pinch points when attaching or un-hooking loads, and always have an escape route, don't put yourself in a position where you can get caught between loads.

2. Know the safe working load of the equipment and tackle being used. Never exceed this limit. (Fig 1)

3. Determine the load weight before rigging it.

4. Examine all hardware, equipment, tackle and slings before using it and <u>destroy</u> defective components. Discarded equipment may be used by someone not aware of the hazards or defects.

W. CRANE SIGNALS

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Revised 10/11

CRANE SIGNALS

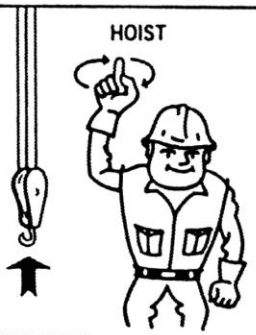
ALWAYS STAND IN CLEAR VIEW OF YOUR CRANE HOIST ENGINEER

BE SURE TO STAY A SAFE DISTANCE FROM HOOK, BLOCK OR BOOM

Published by
SPECIALIZED CARRIERS & RIGGING ASSOCIATION

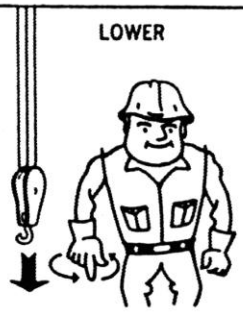
In accordance with the American National Standards Institute

HOIST



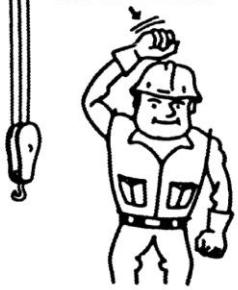
HOIST: With forearm vertical, forefinger pointing up, move hand in small horizontal circles.

LOWER



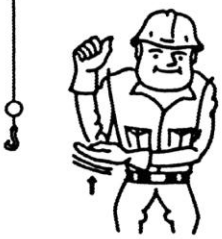
LOWER: With arm extended downward, forefinger pointing down, move hand in small horizontal circles.

USE MAIN HOIST



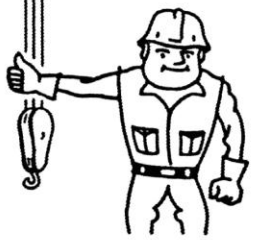
USE MAIN HOIST: Tap fist on head, then use regular signals.

USE WHIP LINE



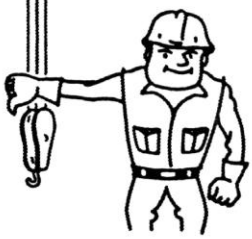
USE WHIP LINE: (Auxiliary Hoist) Tap elbow with one hand; then use regular signals.

RAISE BOOM



RAISE BOOM: Arm extended, fingers closed, thumb pointing upward.

LOWER BOOM



LOWER BOOM: Arm extended, fingers closed, thumb pointing downward.

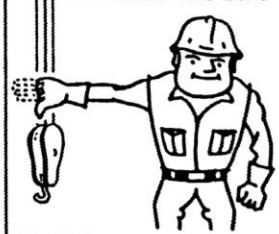
MOVE SLOWLY

MOVE SLOWLY: Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist slowly shown as example)

RAISE THE BOOM AND LOWER THE LOAD

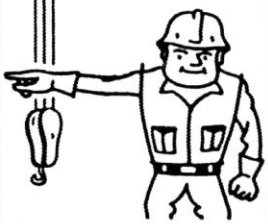
RAISE THE BOOM AND LOWER THE LOAD: With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.

LOWER THE BOOM AND RAISE THE LOAD



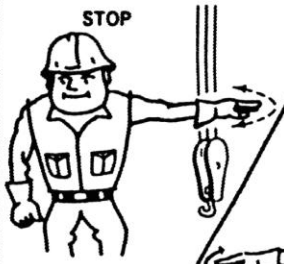
LOWER THE BOOM AND RAISE THE LOAD: With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.

SWING



SWING: Arm extended, point with finger in direction of swing of boom.

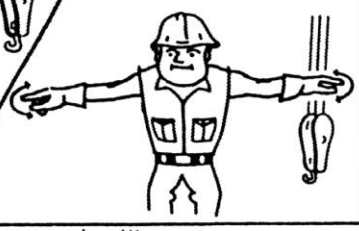
STOP



STOP: Arm extended, palm down, move arm back and forth horizontally.

EMERGENCY STOP

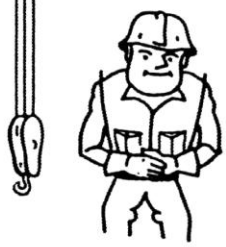
EMERGENCY STOP: Both arms extended, palms down, move arms back and forth horizontally.



TRAVEL

TRAVEL: Arm extended forward, hand open and slightly raised, making pushing motion in direction of travel.

DOG EVERYTHING



DOG EVERYTHING: Clasp hands in front of body.

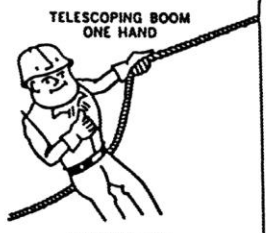
TELESCOPING BOOM TWO HANDS

EXTEND BOOM
BOTH FISTS IN FRONT OF BODY WITH THUMBS POINTING OUTWARD

TELESCOPING BOOM TWO HANDS

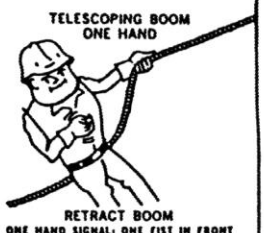
RETRACT BOOM
BOTH FISTS IN FRONT OF BODY WITH THUMBS POINTING TOWARD EACH OTHER

TELESCOPING BOOM ONE HAND



EXTEND BOOM
ONE HAND SIGNAL: ONE FIST IN FRONT OF CHEST WITH THUMB TAPPING CHEST

TELESCOPING BOOM ONE HAND



RETRACT BOOM
ONE HAND SIGNAL: ONE FIST IN FRONT OF CHEST, WITH THUMB POINTING OUTWARD AND HEEL OF FIST TAPPING CHEST