HOISTING, RIGGING, AND MATERIAL HANDLING

PURPOSE

Hoisting, rigging and material handling are essential tasks to CF operations. CF recognizes that these tasks can range from simple to complex and have a varying degree of risk. CF will ensure that the individuals involved in hoisting, rigging and material handling operations are competent to perform such tasks.

SCOPE

Hoisting, rigging and material handling activities can encompass a variety of tasks. This section of CF H&S program outlines the safe work practices and procedures required for but not limited to:

- Hoisting Equipment
  - Cranes, winches and hoists
  - Inspection requirements
- Rigging Hardware
  - Slings, chains, wire rope, hooks etc.
  - Rigging inspection
- Lift planning
  - Typical and complex lifts
- Material Handling
  - Equipment such as forklifts, concrete pump trucks, hydrovac, pile driving
  - Storage of material

Hoisting, Rigging and Material Handling

Only those qualified by knowledge, training, and experience shall perform Hoisting, Rigging and Material Handling activities.

Lifting Categories

Typical or Common Lift

A typical or common lift does not meet the Critical Load definitions as noted below. This includes routine or repetitive lift activities below 75% of the maximum capacity of the lifting device.

Critical Lift

- Tandem lift which requires multiple cranes, or two hooks on same crane and exceeds 75% crane capacity
- Centre of gravity is significantly off from center
- Load is difficult to balance and secure (e.g., liquid filled container/vessel)
- Load subjected to high winds or adverse weather conditions causing load instability
- Load must travel over operating equipment
- Public at risk
- See H&S_FORM_052 for Critical Lift Plan, if required

Lift Plan Review

If the Supervisor determines any of the following conditions apply to the proposed lift; then the Supervisor shall ensure an engineering review of the lift plan is performed.

- Two or more cranes are required to lift a load (mobile or fixed) and exceeds 75% crane capacity

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- Sling angle to eye bolt is less than 45 degrees, or 30 degrees for other lifting equipment
- Lift may be subject to adverse weather conditions or high wind loads causing instability
- Load weight or centre of gravity is unknown and difficult to determine.
- Lift will require the crane to be loaded to 95% of its capacity at any point in the travel of the load.
- Man basket attached to crane and worker must enter;

Special Considerations in Lift Planning

Crane or Load can swing within Limit of Approach of high voltage power lines.

- Have alternate lift/swing positions have been examined
- Is De-energizing lines/conductors feasible
- Must use a dedicated signal person designated to watch line / conductor clearance
- Signal person shall be readily identifiable and able to communicate effectively with the operator
- If voltage of power line is known safe limit of approach can be determined
- If voltage unknown either use maximum safe limit of approach or contact local electrical authority

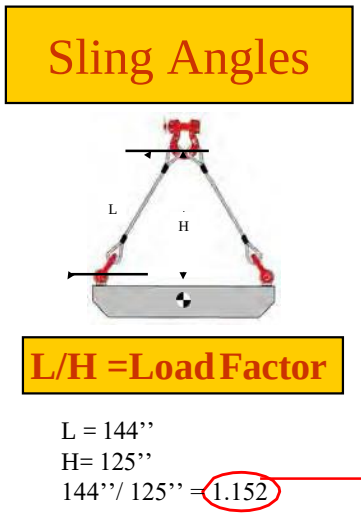
Lift on or over any type of live / process equipment or containers

- Are the contents or function of the equipment or containers known
- Ensure All workers clearly understand potential hazards
- Facilities housing personnel must be vacated and flagged
- Best and most practical crane communication signals to be used
- A Designated channel/frequency is available for critical radio communication

SLING ANGLES

Sling angles should be maintained at greater than 45 degrees from horizontal between the connection point and the hook. Stress on the connection point and sling increases exponentially as the sling angle decreases. The chart and basic equation below provide guidance on the amount of load increase on the connection point and sling.

Common Equation for Calculating Sling Tension



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

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Angle near 60°

10º	5.747
5º	11.490

The following formula may be used to calculate sling tension:

Example:
Load Weight (L): 5000 lbs Slings: 2 Sling Angle 45 Degrees
Load Angle Factor: 1.4 (from chart)
For m u l a : Sling Tension = L ÷ # of Slings x Load Angle Factor
Sling Tension = 5000 / 2 x 1.4 = 3500lbs - (Each sling receives 3500 lbs of tension/load)

Note: Above equation assumes Centre of Gravity is at approximate centre of load and 2 slings are used.

Hoisting and Rigging Equipment Inspection Requirements
Initial Inspection
This inspection is done at the time the product is first received to ensure that damage has not occurred during shipment. Verify that the goods are in compliance with the specification of the purchase order. Verify that all inspection and maintenance records are with the equipment and up to date before putting the unit into service.

Pre-use Inspection
This level of visual inspection should be done by the person handling the sling or device, or other specifically designated personnel. Hoisting Equipment Inspection Form, H&S_FORM_053 but Records are not required.
a) Normal service – daily when in use
b) Severe service – each use
c) Special or infrequent service – as recommended by a qualified person before and after each use.

Periodic Inspection / Annual Inspection
The periodic level of inspection is done by designated personnel at regular intervals. At a minimum this inspection must be carried out at the interval required by the manufacturer (Check manual for each piece of equipment)/ In addition the interval may be based upon the frequency of use, severity of service conditions, and information derived through the pre-use inspection process.

Inspection Records
Inspection must be conducted by a competent person. Inspection records must be documented. Slings must be individually identified and condition of sling at the time inspection must be recorded. Records shall be available at site or available to site.

Nylon Web Slings – Inspection Standard
Workers involved in the use of nylon web slings shall be familiar with their characteristics and the necessary safety precautions.

Procedure
The following defects seriously question the nylon web safety and are reason to remove the web from service:

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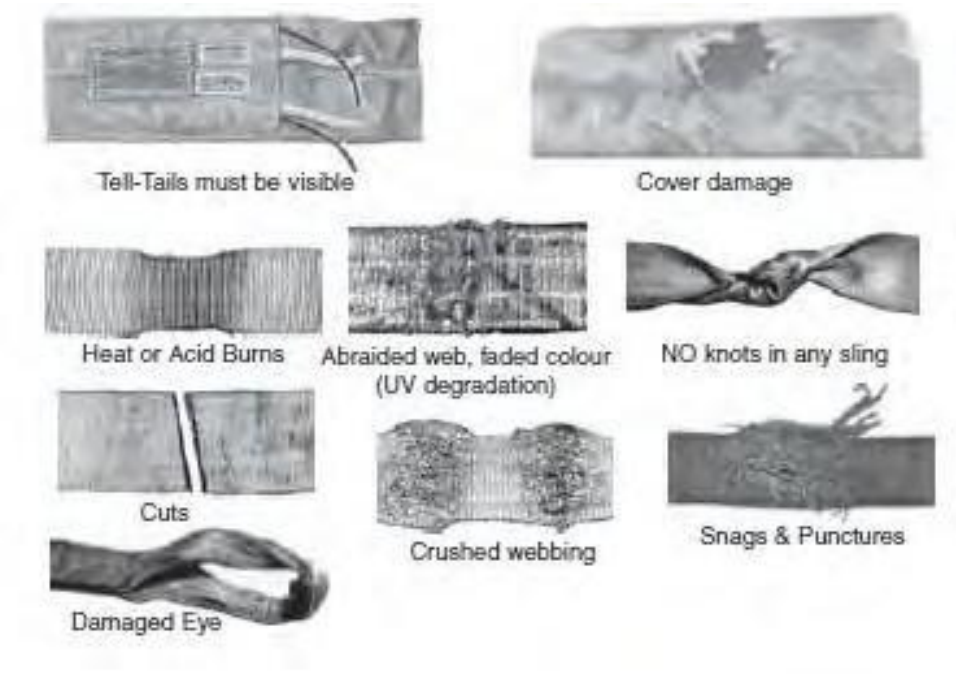
- Nylon web slings that are cut, torn, frayed, burned, or otherwise worn are no longer trustworthy. It is not possible to calculate the strength left in damaged slings.
- Chemical action, heat, sunlight, and acid fumes discolour the nylon and indicate a loss in strength.
- When stitching is broken, the sling will not take the load evenly, but will put greater stress on the remaining stitching.
- Holes in the web where fibers are separated are cause for replacement.
- Manufacturers tag must be legible and affixed to all slings.



Note: To prevent the above damage, sleeves or edge guards should be used. These protect the lifting capability of the sling and when cut or damaged are easily replaced. Wide sling angles cause the outside edge of the sling to tear.

Wire Rope – Inspection Standard

All Wire rope in continuous service shall be observed during normal operation and visually inspected on a weekly basis.

Procedure

The following defects seriously question the wire rope safety and are reason to remove the wire rope from service:

- Broken Wires
- 6 randomly distributed broken wires in one rope lay
- 3 or more broken wires in on strand
- One or more broken wires at end fitting

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- Worn or Abraded Wires
- If wear exceeds 1/3 of rope diameter
- Look for shiny flat areas
- Reduction in Diameter
- Normal wear reduces diameter

Wire Rope Nominal Size	Maximum Reduction in Diameter
Up to ¾"	3/64"
¾" to 1 ¼"	1/16"
1 ¼" to 1 ½"	3/32"

- Stretch
  - If lay is visibly lengthened
  - Compare to new sling/wire rope
  - Caused by overloading
- Corrosion
  - Exterior rust, pitting, discoloration
  - Interior damage is hidden
  - Corrosion at base of end attachment
- Kinking
  - Permanent bend/dog
  - Caused by faulty handling
- Bird-caging
  - Permanent "see-through" distortion
  - Caused by sudden release of tension
  - Never returns to original shape
- Core Protrusion
  - Core is visible
  - Caused by shock-loading
- Bulges
  - Isolated increases in diameter
  - Caused by core slippage
- Poor Lubrication
  - If grooves are packed with hard grease or dirt
  - If possible, clean groves and re-lubricate
  - Results in internal friction and wear
- Fittings
  - Distorted hooks, tings, sleeves, thimbles
  - Discard if wear exceeds 10% of any dimension from new
  - Discard if hook opening has increased by 10% from new
- Unbalanced Wear
- Hear Damage, Torch Burns, Electric Arc Strikes
- Anti-Rotating Wire Rope
  - Flex rope near ear and listen for clicking noise broken interior wires

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Repair of Wire Rope Slings
There shall be no repairs done to the wire used in a wire rope sling. Repairs shall be restricted to end attachments and fittings, which well be deemed ok by the manufacture.
Note: If any of the above defects are present, the wire rope/fitting shall be removed from service.

Chain Sling – Inspection Standard
Chain used for hoisting shall be observed during normal operation and visually inspected on a weekly basis. Only alloy chain shall be used for hoisting with an “8” or “T” embossed on the link.

Procedure
The following defects seriously question the chains suitability for hoisting and are reason to remove the chain from service:

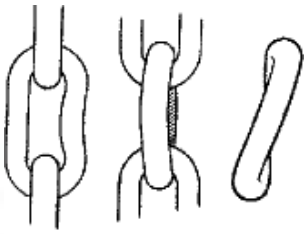
- Stretch
- Measure lengthening of links
- Stretched links will have an hourglass shape
- Stretched links tend to bind on each other
- Check for leg length by hanging sling
- If stretch exceeds 3% REPLACE the chain
- New chain should be carefully measured when new and its length should be recorded to use as a future standard.
- Link Wear
    - using calipers measure diameter at point of maximum wear
    - maximum wear is normally at a crack, gouge, chip or cut
    - If reduction in diameter is more than 10%, REPLACE the chain
    - Look for wear at bearing surfaces
- Shock Loading

- If chain is given a shock load, inspect carefully for cracks
- When chains fail due to shock loading, flying debris acts like a bullet

- Improper Use
  - Around sharp corners or edges with no softeners
  - Dragging chain from under loads
  - Hoisting when links are locked
  - Avoid dropping chain from heights
  - Do not hammer links to straighten them
  - Shorten a chain by using a shortening clutch. NO OTHER METHOD IS ACCEPTABLE.

PITTING & CORROSION

DEFORMED COMPONENTS



Repair of Chain Slings

Cracked, broken, or bent chain links shall not be repaired, they shall be replaced. All repaired chain slings must be proof tested to twice the Vertical rated capacity.

Nylon Web Slings – Operating Procedure Mechanical Considerations

- Determine the weight of the load
- Select sling having suitable characteristics for the type of load, hitch and environment
- Sling shall not be loaded in excess of the rated capacity. Consideration should be given to the angle from the horizontal (load to sling angle) which affects rated capacity.
- Slings with fittings which are used in a choker hitch shall be sufficient length to assure that the choking action is on the webbing.
- Slings used in a basket hitch shall have the load balanced to prevent slippage
- Slings shall not be dragged on the floor or over an abrasive surface.
- Slings shall not be twisted or tied into knots, or joined by knotting
- Slings shall not be pulled from under loads when the load is resting on the sling.
- Slings shall always be protected from being cut by sharp corners, sharp edges, protrusions or abrasive surfaces. Softeners and sling savers are the only acceptable materials to be used when lifting.
- Do not drop slings equipped with metal fittings.
- The opening in fittings shall be the proper shape and size to ensure that the fitting will seat properly in the hook or their attachments.
- All slings must be protected from damage while being moved, and properly stored when not in use.

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Environmental Considerations

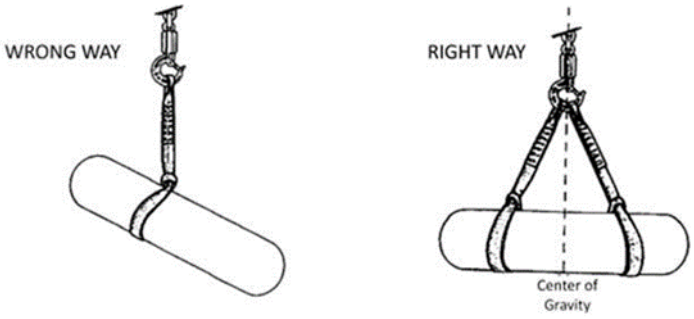
Slings should be stored in a cool, dry and dark place; and should not be exposed to ultra violet light (sunlight). Chemically active environments can affect the synthetic web slings in varying degrees ranging from none to total degradation. The sling manufacturer should be consulted before slings are used in a chemically active environment.

Style of Hitch to be Used

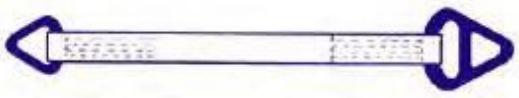
Slings can be used in any of the three Hitches illustrated. Some slings are designed to be used in a specific hitch application only.

Control and Balance

Use a hitch that will keep the load under control at all times and be sure the lifting device is directly over the center of gravity.

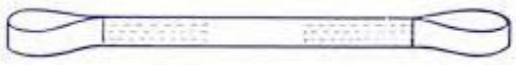


Type 1: Triangle & Choker (TC) - Hardware on each end produces the most effective choker hitch. Can also be used in vertical and basket hitches.

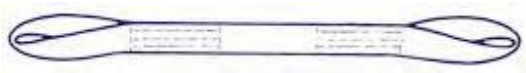


Type 2: Triangle & Triangle (TT) - Hardware on each end for use in basket or vertical hitch.

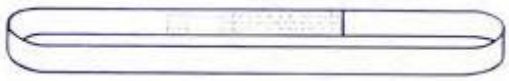
Type 3: Flat Eye & Eye (EE) - Popular, versatile sling used in vertical, choker & basket hitches. Easy to remove from underneath loads.



Type 4: Twisted Eye & Eye (EE) - Eyes turned at a right angle to sling body. Forms superior choker hitch & allows better fit on crane hook in basket hitch.



Type 5: Endless (EN) - Economical & adaptable sling with no fixed wear points. Used in all hitches.



Type 6: Reversed Eye (RE) - Extremely strong & durable for continuous &/or abusive applications. Wear pads on both sides of body.

Wire Rope and Chain Slings – Operating Procedure

Mechanical Considerations

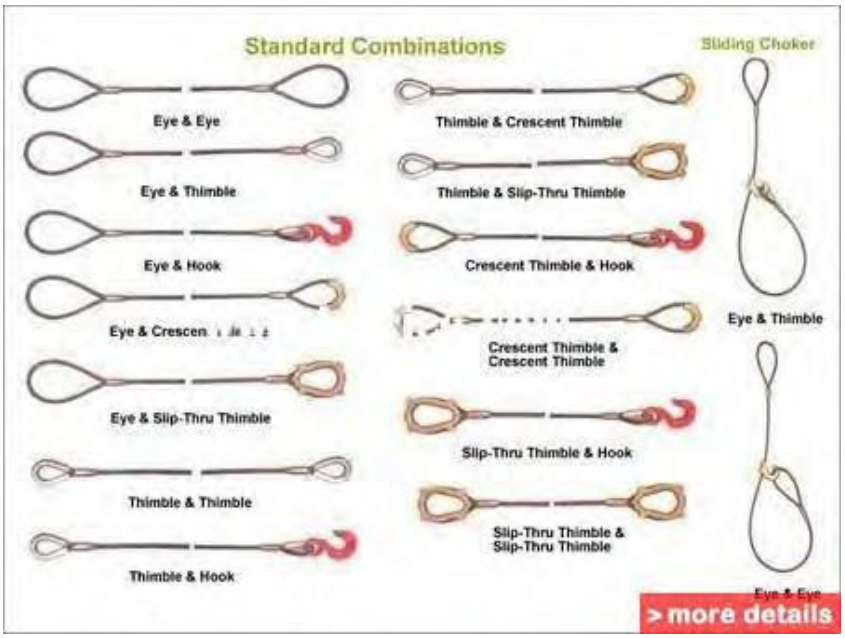
- Determine the weight of the load
- Select proper wire or chain sling having suitable characteristics for the type of load, hitch and environment. Only wire and chain slings with legible identification tags shall be used.
- Wire or Chain slings shall not be loaded in excess of the rated capacity. Consideration should be given to the angle from the horizontal (load to sling angle) which affects rated capacity.
- Only alloy chain shall be used for hoisting with an “8” or “T” embossed on the link.
- Wire or Chain slings with fittings which are used in a choker hitch shall be of sufficient length to assure that the choking action is on the sling and never on the fittings.
- Wire or Chain slings used in a basket hitch shall have the load balanced to prevent slippage.
- Wire or Chain slings shall not be twisted or tied into knots, or joined by knotting.
- Wire or Chain slings shall not be pulled from under loads when the load is resting on the sling.
- Consideration shall be given to the distribution of load weight on a multi-legged lift.
- Make shift fasteners, hooks, or links formed from bolts, rods, et., or other such components shall not be used
- Mechanical coupling links shall not be used within the body of an alloy chain sling to connect two pieces of chain
- Horizontal sling angles less than 30 degrees shall not be used except as per Engineering documentation.
- 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.
- 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 pointing loading.

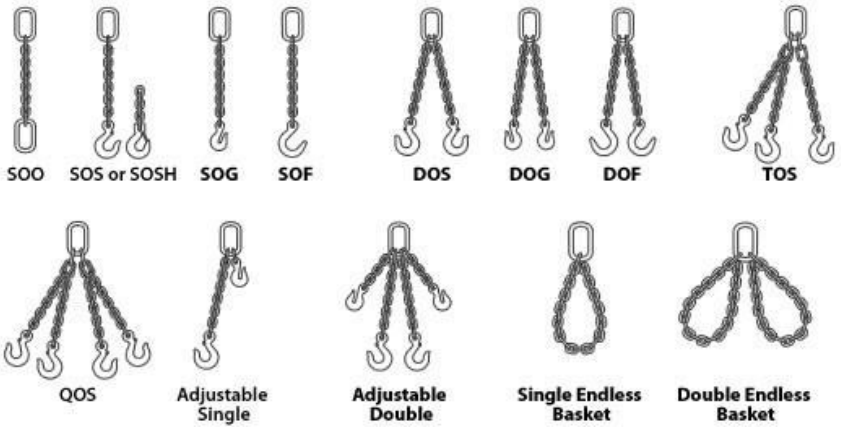
Environmental Considerations

The strength of the chain slings or wire rope slings can be degraded by chemically active environments. This includes exposure to chemicals in the form of the solids, liquids, gases vapors or fumes. The sling manufacturer or qualified person should be consulted before slings are used in the chemically active environments.

Sling shall be stored in an area where they will not be subjected to mechanical damage corrosive action, moisture,

and extreme temperatures or kinking.





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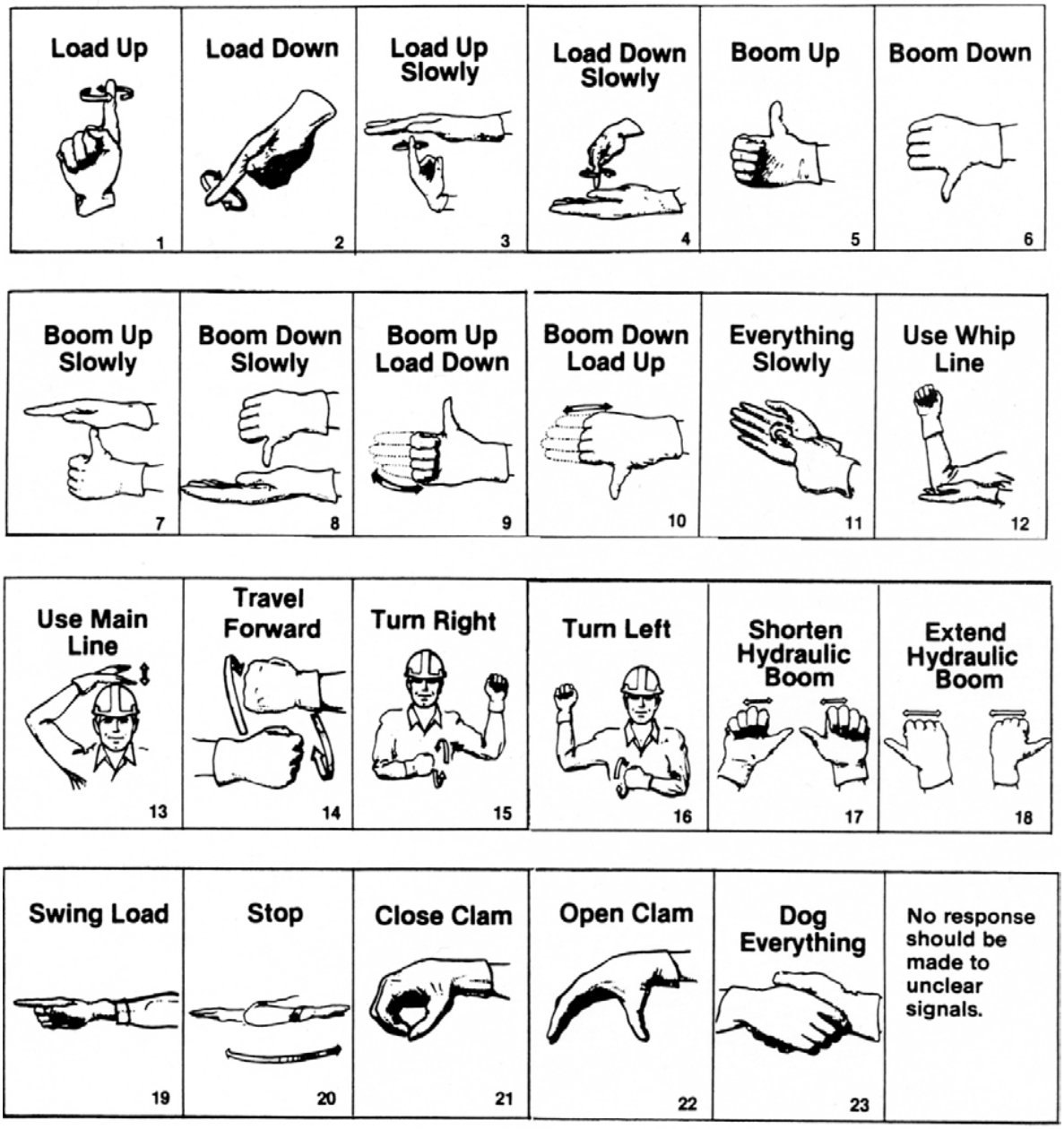
Hand Signals



HOISTING, RIGGING, AND MATERIAL HANDLING

Slings and Hitches

Standard

Workers involved in the use of chain, fiber rope, wire rope or nylon web slings shall be familiar with their characteristics and the necessary safety precautions.

Procedure

- Safe working loads are reduced as legs are spread. When the angle formed by the spreader leg and the horizontal is 45°, the safe working load is reduced by 1/4.
- When a choker hitch is used, the safe working load is reduced by 1/4.
- If a three-legged sling is used, the sling size selected should be based on a two- legged sling (the third leg does not carry its share of the load).
- If a four-legged sling is used, the two diagonally opposite legs take most of the load. The remaining two only balance; therefore, select sling size based on a two-legged sling.
- Hoisting chains must be alloy steel stamped on links with a “T” or “8”. NO OTHER CHAIN IS ACCEPTABLE for hoisting purposes.
- An example of a field calculation for fiber rope safe working loads are: Manila – number of eighths in diameter x itself x 20 = SWL (pounds) i.e.3/4" manila 6 x 6 x 20 = 720 pounds Chart SWL = 1,080 pounds
- Polypropylene –number of eighths in diameter x itself x 40 = SWL (pounds) i.e.3/4" polypropylene 6 x 6 x 40 = 1,440 pounds Chart SWL -1,700 pounds
- Nylon –number of eighths in diameter x itself x 60 = SWL (pounds) i.e.3/4" nylon 6 x 6 x 60 = 2,160 pounds Chart SWL –2,800 pounds
- An example of field calculations for nylon web safe working load is .8 ton (1,600 pounds) per h of webbing. i.e.8" nylon web .8 x 8" = 6.4 tons (12,800 pounds) Many manufacturers chart SWL = 12,000-12,800 pounds
- Field calculation is never as accurate as manufacturer's specifications, but can serve as a quick guideline. The above filed calculation observes a 5 to 1 safety factor on new material on a straight pull.

Hand Operated Chain Hoists Standard

Workers involved in the use of chain hoists shall be familiar with their characteristics and the necessary safety precautions.

Procedure

- Manually operated chain hoists may be:
    - spur drive
    - geared endless chain operated
    - worm drive
    - geared (screw geared) endless chain operated
    - differential endless chain operated
    - lever operated
- The chain on these tools is a special case-hardened product. It is not marked as alloy chain with a “T” or “8”.