MATERIALS HANDLING AND STORAGE
SUBPART N

More employees are injured in industry while moving materials than while performing any other single function. In every day operations, workers handle, transport, and store materials. They may do so by hand, by manually operated materials handling equipment, or by power operated equipment.

HANDLING MATERIALS - GENERAL - 1910.176

Use of Mechanical Equipment

Where mechanical handling equipment is used, sufficient safe clearance shall be allowed for aisles, at loading docks, through doorways, and whenever turns or passage must be made.

Permanent aisles and passageways shall be appropriately marked.

Secure Storage

Storage of material shall not create a hazard. All stored materials stacked in tiers shall be stacked, blocked, interlocked, and limited in height so that they are secure against sliding or collapse.

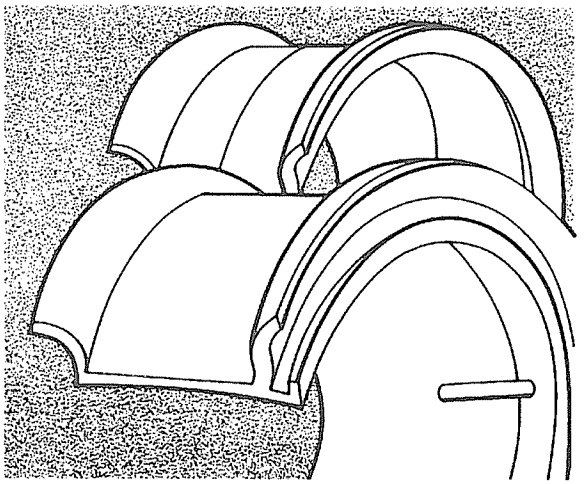
Housekeeping

Storage areas shall be kept free from accumulation of materials that constitute hazards from tripping, fire, explosion or pest harborage. Vegetation control will be exercised when necessary.

SERVICING MULTI-PIECE AND SINGLE-PIECE RIM WHEELS - 1910.177

Introduction

In 1984, OSHA amended the safety standard for the servicing of multi-piece rim wheels (29CFR 1910.177) to include requirements for the safe servicing of single-piece rim wheels used on large trucks, trailers, buses, and off-road machines.



Approximately 322,000 employees in over 100,000 workplaces service large vehicle tires that are mounted on either multi-piece or single-piece wheels.

There has been over a 70-percent reduction in multi-piece rim wheel servicing injuries since the original standard was issued in 1980 - based on a review of the record of multi-piece rim wheel accidents investigated by OSHA. Similar results have been experienced with the regulation of single-piece rim wheel servicing where workers also face a significant risk of serious injury or death.

In brief, the amended standard requires training for all tire servicing employees, the utilization of industry-accepted procedures that minimize the potential for employee injury, the use of proper equipment such as clip-on chucks, restraining devices or barriers to retain the wheel components in the event of an incident during the inflation of tires, and the use of compatible components.

Types of Wheels/Tires

A rim wheel is the component assembly of wheel (either multi-piece or single-piece), tire and tube, plus other components.

A single-piece wheel is the component of the assembly used to hold the tire, form part of the air chamber (with tubeless tires), and provide the means of attachment of the assembly to the vehicle axle. A multi-piece wheel is a vehicle wheel consisting of two or more parts, one of which is a side or locking ring that holds the tire and other components on the rim wheel by interlocking the components when the tire is inflated.

The standard does not apply to the servicing of rim wheels utilizing automobile tires or truck tires designated "LT."

Hazards

The principal difference between accidents involving single-piece rim wheels and those involving multi-piece rim wheels is the effect of the sudden release of the pressurized air contained in a single-piece rim wheel.

In a multi-piece rim wheel accident, the wheel components separate and are released from the rim wheel with violent force. The severity of the hazard is related not only to the air pressure but also to the air volume.

Single-rim wheel accidents occur when the pressurized air contained in the tire is suddenly released, whether by the bead breaking or the bead slipping over the rim flange. The principal hazards involve pressurized air which, once released, can either pick up and hurl an employee across the shop if the employee is in close proximity to the rim wheel and within the trajectory, or can propel the rim wheel in any potential path or route (basically along the axis of

the rim wheel) that a rim wheel component may travel during an explosive separation, or the area into which the airblast from a single-piece rim wheel may be released.

Employee Training

The employer must provide a program to train all employees who service rim wheels in the hazards involved and the safety procedures to be followed.

The employer must assure that no employee services any rim wheel unless the worker has been instructed in correct procedures of mounting, demounting, and servicing activities and the safe operating precautions for the type of wheel being serviced.

At a minimum, the training program must include the contents of the OSHA standard and the information in the manufacturer's rim manuals, or the OSHA charts. Charts are available from OSHA regional, area, or national offices.

The instruction must be conducted in an intelligible way. Employees who are unable to read the charts or rim manuals must be trained in the subject matter. The employer must assure that each worker demonstrates and then maintains the ability to service rim wheels safely by correctly performing the following tasks:

- Demounting tires, including deflation
- Inspecting and identifying rim wheel components
- Mounting tires, including inflating them with a restraining device or other safeguard

- Handling rim wheels
- Inflating tires when single-piece rim wheels are mounted on a vehicle
- Understanding the necessity of standing outside the trajectory during inflation of the tires and of inspecting the rim wheels following inflation
- Installing and removing rim wheels

The employer must regularly evaluate each employee's performance and provide additional training, as necessary, to assure that each employee maintains his or her proficiency.

The Servicing Equipment

The employer must furnish a restraining device for inflating a tire on a multi-piece wheel, and must provide a restraining device or barrier for inflating a tire on a single-piece wheel unless the single-piece rim wheel is bolted onto a vehicle during inflation.

The restraining device can be a cage, rack or an assemblage of bars and other parts that will constrain all rim wheel components during an explosive separation of the multi-piece rim wheel or during the sudden release of the contained air of a single-piece rim wheel.

A barrier can be a fence, wall, or other structure or object placed between a single-piece rim wheel and an employee during tire inflation to contain the rim wheel components in the event of the sudden release of contained air. Each barrier or restraining device must be able to withstand the maximum force of an explosive rim wheel separation or release of the pressurized air occurring at 150 percent of the maximum tire specification pressure for the rim wheel being

serviced.

Restraining devices showing any of the following defects must be immediately removed from service:

- Cracks at welds
- Cracked or broken components
- Bent or sprung components caused by mishandling, abuse, tire explosion, or rim wheel separation
- Component pitted due to corrosion or other structural damage that would decrease its effectiveness

Restraining devices or barriers removed from service must not be returned to service until they are repaired and reinspected. Restraining devices or barriers requiring structural repair such as component replacement or rewelding must not be returned to service until they are certified by either the manufacturer or a Registered Professional Engineer as meeting the strength requirements as stated above (the force of 150 percent of the maximum tire specification pressure).

Current charts or rim manuals containing instructions for the types of wheels being serviced must be available in the service area, including a mobile service unit.

Only tools that are recommended in the rim manual may be used for the type of wheel being serviced.

The employer must also supply air line equipment with a clip-on chuck with

sufficient length of hose between the chuck and in-line valve or regulator to allow the employee to stand outside the trajectory, as well as an in-line valve with a pressure gauge or a presettable regulator.

The size (bead diameter and tire/wheel width) and type of both the tire and wheel must be checked for compatibility prior to assembly of the rim wheel. Mismatching of half sizes such as 16-inch and 16.5 inch tires and wheel must be avoided.

Multi-piece wheel components must not be interchanged except as indicated in the applicable charts or rim manuals.

Multi-piece wheel components and single-piece wheels must be inspected prior to assembly. Any wheel or wheel component that is bent out of shape, pitted from corrosion, broken, or cracked must be marked or tagged "unserviceable" and removed from the service area. Damaged or leaky valves must be replaced.

Rim flanges, rim gutters, rings, and the bead-seating areas of wheels must be free of any dirt, surface rust, scale, or loose or flaked rubber buildup prior to tire mounting and inflation.

Safe Operating Procedures: Multi-Piece Rim Wheels

Employers must instruct employees to use the following steps for safe operating procedures:

1. The tire must be completely deflated by removing the valve core before a rim wheel is removed from the axle in the following situations:

    - When the tire has been driven underinflated at 80 percent or less of

its recommended pressure, or

- When there is obvious or suspected damage to the tire or wheel components

2. The tire must be completely deflated by removing the valve core before demounting.

3. A rubber lubricant must be applied to the bead and rim mating surfaces when assembling the wheel and inflating the tire unless the tire or wheel manufacturer recommends against its use.

4. If a tire on a vehicle is underinflated but has more than 80 percent of the recommended pressure, the tire may be inflated while the rim wheel is on the vehicle, provided remote control inflation equipment is used, and no employee remains in the trajectory during inflation.

5. The tire shall be inflated outside a restraining device only to a pressure sufficient to force the tire bead onto the rim ledge and create an airtight seal with the tire and bead.

6. Whenever a rim wheel is in a restraining device, the employee must not rest or lean any part of his/her body, or equipment, on or against the restraining device.

7. After tire inflation, the tire and wheel must be inspected while still within the restraining device to make sure that they are properly seated and locked. If further adjustment is necessary, the tire must be deflated by removing the valve core before the adjustment is made.

8. An attempt must not be made to correct the seating of side and lock rings

by hammering, striking, or forcing the components while the tire is pressurized.

9. Cracked, broken, bent, or otherwise damaged wheel components must not be reworked, welded, brazed, or otherwise heated. Heat must not be applied to a multi-piece wheel.

10. Whenever multi-piece rim wheels are being handled, employees must stay out of the trajectory unless the employer can show that performance of the servicing makes the employee's presence in the trajectory necessary.

Safe Operating Procedures: Single-Piece Rim Wheels

Employees must be instructed in and must use the following steps for safe operating procedures with single-piece wheels:

1. The tire must be completely deflated by removal of the valve core before demounting.

2. Mounting and demounting of the tire must be performed only from the narrow ledge side of the wheel. Care must be taken to avoid damaging the tire beads, and the tire must be mounted only on a compatible wheel of mating bead diameter and width.

3. A nonflammable rubber lubricant must be applied to bead and wheel mating surfaces before assembling the rim wheel, unless the tire or wheel manufacturer recommends against the use of any rubber lubricant.

4. If a tire changing machine is used, the tire may be inflated only to the minimum pressure necessary to force the tire bead onto the rim ledge and

create an airtight seal before removal from the tire changing machine.

5. If a bead expander is used, it must be removed before the valve core is installed and as soon as the rim wheel becomes airtight (when the tire bead slips onto the bead seat).

6. The tire may be inflated only when contained within a restraining device, positioned behind a barrier, or bolted on the vehicle with the lug nuts fully tightened.

7. The tire must not be inflated when any flat, solid surface is in the trajectory and within 1 foot of the sidewall.

8. The tire must not be inflated to more than the inflation pressure stamped in the sidewall unless a higher pressure is recommended by the manufacturer.

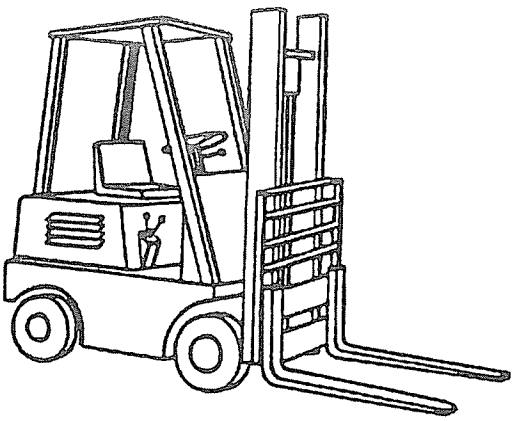
9. Employees must stay out of the trajectory when a tire is being inflated.

10. Heat must not be applied to a single-piece wheel.

11. Cracked, broken, bent, or otherwise damaged wheels must not be reworked, welded, brazed, or otherwise heated.

POWERED INDUSTRIAL TRUCKS - 1910.178

General Requirements



This section contains safety requirements relating to fire protection, design, maintenance, and use of fork trucks, tractors, platform lift trucks, motorized hand trucks, and other specialized industrial trucks powered by electric motors or internal combustion engines. This section does not apply to compressed air or nonflammable compressed gas-operated industrial trucks, nor to farm vehicles, nor to vehicles intended primarily for earth moving or over-the-road hauling.

Approved powered industrial trucks shall bear a label or some other identifying mark indicating approval by the testing laboratory.

Modifications and additions which affect capacity and safe operation of trucks shall not be performed by the user without manufacturers' prior written approval.

As used in this section, the term "approved truck" or "approved industrial truck" means a truck that is listed or approved for fire safety purposes for the intended use by a nationally recognized testing laboratory, using nationally recognized testing standards.

Designations

For the purpose of this standard, there are eleven different designations of industrial trucks or tractors as follows:

D, DS, DY, E, ES, EE, EX, G, GS, LP, LPS

1. The "D" designated units are diesel engine powered units having minimum acceptable safeguards against inherent fire hazards.

2. The "DS" designated units are diesel powered units that are provided with additional safeguards to the exhaust, fuel, and electrical systems.

3. The "DY" designated units are diesel powered units that have all the safeguards of the "DS" units and in addition do not have any electrical equipment including the ignition and are equipped with temperature limitation features.

4. The "E" designated units are electrically powered units that have minimum acceptable safeguards against inherent fire hazards.

5. The "ES" designated units are electrically powered units that, in addition to all the requirements for the "E" units, are provided with additional safeguards to the electrical system to prevent emission of hazardous sparks and to limit surface temperatures.

6. The "EE" designated units are electrically powered units that have, in addition to all of the requirements for the "E" and "ES" units, the electric motors and all other electrical equipment completely enclosed.

7. The "EX" designated units are electrically powered units that differ from the

"E", "ES", or "EE" units in that the electrical fittings and equipment are so designed, constructed and assembled so that the units may be used in certain atmospheres containing flammable vapors or dusts.

8. The "G" designated units are gasoline powered units having minimum acceptable safeguards against inherent fire hazards.

9. The "GS" designated units are gasoline powered units that are provided with additional safeguards to the exhaust, fuel, and electrical systems.

10. The "LP" designated unit is similar to the "G" unit except that liquefied petroleum gas is used for fuel instead of gasoline.

11. The "LPS" designated units are liquefied petroleum gas powered units that are provided with additional safeguards to the exhaust, fuel, and electrical systems.

Atmospheres or locations throughout the plant must be classified hazardous or non-hazardous prior to the consideration of industrial trucks being used therein. Refer to Table N-1 of §1910.178(c)(2) which is a summary table on use of industrial trucks in various locations.

Safety Guards

All high lift rider trucks shall be fitted with overhead guards where overhead lifting is performed unless operating conditions do not permit. In those cases where high lift rider trucks must enter, for example, truck trailers and the overhead guard will not permit this entry, the guard may be removed or a powered industrial truck without a guard may be used.

If a powered industrial fork truck carries a load that presents a hazard of falling

back onto the operator, it shall be equipped with a vertical load back rest extension.

Changing and Charging Storage Batteries

Workplaces using electrically powered industrial trucks will have battery-charging areas somewhere in the plant. In many cases, depending on the number of electrically powered industrial trucks, there will be more than one changing and charging area. This section only applies to storage battery changing and charging areas associated with powered industrial trucks. It does not apply to areas where other batteries, such as those used in motor vehicles (cars or trucks), are charged, although some of the same hazardous conditions may exist.

Some of the requirements specified in the regulation include:

- Battery charging installations shall be located in areas designated for that purpose.
- Facilities shall be provided for flushing and neutralizing spilled electrolyte, for fire protection, for protecting charging apparatus from damage by trucks, and for adequate ventilation for dispersal of air contaminants from gassing batteries.
- A conveyor, overhead hoist, or equivalent material handling equipment shall be provided for handling batteries.
- Smoking shall be prohibited in the charging area.
- Precautions shall be taken to prevent open flames, sparks, or electric arcs in battery charging areas.

Trucks and Railroad Cars

In plant receiving and shipping areas, powered industrial trucks are often utilized to load and unload materials from trucks and railroad cars. The brakes of highway trucks shall be set and wheelchocks placed under the rear wheels to prevent trucks from rolling while they are boarded with powered industrial trucks.

Wheel stops or other positive protection shall be provided to prevent railroad cars from moving during loading or unloading operations.

Fixed jacks may be necessary to support a semitrailer and prevent unending during the loading or unloading when the trailer is not coupled to a tractor.

Operator Training

No employee, including supervisory personnel, is permitted to operate a powered industrial truck unless properly trained and authorized to do so. Methods shall be devised by management to train operators in the safe operation of powered industrial trucks.

Truck Operations

Some of the requirements regarding industrial truck operations include:

- No person shall be allowed to stand or pass under the elevated portion of any truck, whether loaded or empty.

- Unauthorized personnel shall not be permitted to ride on powered industrial trucks. A safe place to ride shall be provided where riding of trucks is authorized.

- When a powered industrial truck is left unattended, load engaging means shall be fully lowered, controls shall be neutralized, power shall be shut off, and brakes set. Wheels shall be blocked if the truck is parked on an incline. A powered industrial truck is "unattended" when the operator is 25 ft. or more away from the vehicle which remains in his view, or whenever the operator leaves the vehicle and it is not in his view.

Traveling

This section contains requirements for traveling in powered industrial trucks. Some of these requirements include:

- All traffic regulations shall be observed, including authorized plant speed limits.

- The driver shall be required to slow down and sound the horn at cross aisles and other locations where vision is obstructed. If the load being carried obstructs forward view, the driver shall be required to travel with the load trailing.

- Railroad tracks shall be crossed diagonally whenever possible. Parking closer than 8 feet from the center of railroad tracks is prohibited.

- When ascending or descending grades in excess of 10 percent, loaded trucks shall be driven with the load upgrade.

- Dockboards or bridgeplates shall be properly secured before they are driven over. Dockboards or bridgeplates shall be driven over carefully and slowly and their rated capacity never exceeded.

Loading

Only stable or safely arranged loads shall be handled. Caution shall be exercised when handling off-center loads which cannot be centered.

Only loads within the rated capacity of the truck shall be handled.

Operation of the Truck

If at any time a powered industrial truck is found to be in need of repair, defective, or in any way unsafe, the truck shall be taken out of service until it has been restored to safe operating condition.

Fuel tanks shall not be filled while the engine is running. Spillage shall be avoided. Any spillage of oil or fuel shall be carefully washed away or completely evaporated and the fuel tank cap replaced before restarting the engine.

Open flames shall not be used for checking electrolyte level in storage batteries or gasoline level in fuel tanks.

Maintenance of Industrial Trucks

Any power-operated industrial truck not in safe operating condition shall be removed from service. All repairs shall be made by authorized personnel.

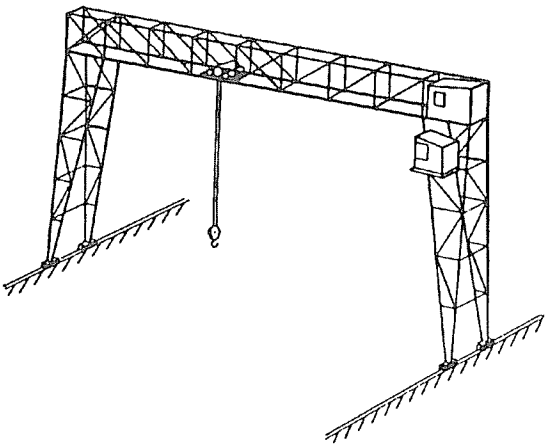
No repairs shall be made in Class I, II, or III locations. Those repairs to the fuel and ignition systems which involve fire hazards shall be conducted only in locations designated for such repairs.

Industrial trucks shall be examined before being placed in service, and shall not

be placed in service if the examination shows any condition adversely affecting the safety of the vehicle. Examinations shall be made at least daily. Where trucks are used on a round-the-clock basis, they shall be examined after each shift.

OVERHEAD AND GANTRY CRANES - 1910.179

General Requirements



This section applies to overhead and gantry cranes, including semi-gantry, cantilever gantry, wall cranes, storage bridge cranes, and others having the same fundamental characteristics.

Overhead and/or gantry cranes may not be modified and re-rated unless the modifications and the supporting structure are checked thoroughly for the new rated load by a qualified engineer or the equipment manufacturer. It will not be unusual to find instances of overhead or gantry cranes where it was claimed that the lifting capacity was increased simply by installing a new rated load sign on the bridge of the crane.

The rated loads of the crane shall be plainly marked on each side of the crane. If the crane has more than one hoisting unit, each hoist shall have its rated load marked on it or on its load block. The potential for overloading the crane increases if the hook-up man and/or the operator does not know the rated capacity.

Only employees selected or assigned by the employer or the employer's representative as being qualified to operate a crane shall be permitted to do so.

Cabs

A cab-operated crane is an overhead or gantry crane controlled by an operator in a cab located on the bridge or trolley. The general arrangement of the cab and the location of control and protective equipment shall be such that all operating handles are within convenient reach of the operator when facing the area to be served by the load hook, or while facing the direction of travel of the cab. The arrangement shall allow a full view of the load hook in all positions.

The access to all cab-operated cranes shall be checked very thoroughly. Serious injuries have occurred because of the following three conditions:

1. There was no conveniently placed fixed ladder, stairs, or platform provided to reach the cab or bridge footwalk. It is unacceptable and poses a significant hazard to allow employees to board a crane via climbing over guardrails, over, under, and around building structures, energized hot rails, portable ladders or movable platforms.

2. There was a gap exceeding 12 inches between a fixed ladder, stairs or platform and access to the cab or bridge footwalk.

3. The fixed ladder used as access to the crane did not meet the American National Standard Safety Code for Fixed Ladders, ANSI A14.3-1956. Usual conditions concerning the access ladders are: There are no cages provided for ladders over 20 feet in unbroken length, offset platforms are not provided, or the ladders themselves are not maintained in a safe condition.

Footwalks and Ladders

Where sufficient headroom is available on cab-operated cranes, a footwalk shall be provided on the drive side along the entire length of the bridge of all cranes having the trolley running on the top of the girders.

Significant hazards exist for maintenance and inspection personnel if no footwalk is provided. Some examples are work being performed from portable ladders, off the main bridge girder itself without protection against falling to the floor below, or from the trolley platform itself with the same potential for falling to the floor below. Maintenance managers and supervisors shall check very thoroughly the maintenance procedures followed in those cases where cab-operated cranes are not provided with bridge footwalks. This, of course, also applies to all other types of cranes where no footwalk is provided and in those cases where bridge footwalks cannot be provided because sufficient headroom is not available.

Bridge footwalks, where provided, shall be of rigid construction and designed to sustain a distributed load of at least 50 pounds per square foot. In many older workplaces, serious hazards are associated with the bridge footwalk itself. This area cannot be inspected from the floor and safety people must climb onto the crane to properly document the hazardous conditions. It is quite common to find bridge footwalks not continuous or permanently secured. It must be remembered that even though at the time of the inspection no employees may be on the bridge footwalks or cranes, maintenance employees, inspection personnel, and the crane operator must go on the bridge footwalk at various times. A common and serious hazard is one where standard railings have not been provided on all open sides of the bridge footwalk. In addition, toeboards shall be installed. The standard railing provisions apply to all sides of the bridge footwalk including the inside edge next to the bridge girders if a fall potential exists.

All gantry cranes shall be provided with a ladder or a stairway that extends from the ground to the footwalk or the cab platform. It is not permitted to board a gantry crane via portable ladders, structure of the crane, or any other method.

Any ladder provided on an overhead or gantry crane shall be permanently and securely fastened in place and also shall be in compliance with §1910.27 of the standards. Damaged, loose, improperly maintained, or unguarded fixed ladders are common.

Stops, Bumpers, Rail Sweeps and Guards

Stops

A "stop" is a device to limit travel of a trolley. This device normally is attached to a fixed structure and normally does not have energy-absorbing ability.

Every overhead or gantry crane where the trolley runs on top of the bridge girder shall be provided with stops at either end of the limits of the travel of the trolley. These stops shall be fastened to resist forces applied when contacted, and if the stop engages the tread of the wheel of the trolley, it shall be of a height at least equal to the radius of the wheel.

The obvious hazard concerned with improperly applied trolley stops or no trolley stops at all is that the trolley could be run off the trolley runway. The hazards associated with this condition are numerous and present serious injury potential to the employees on the floor below. The trolley itself could fall to the floor, parts of the trolley could come off the crane structure and hit employees below, the load itself could be dropped, or at a minimum, cause unexpected movement of the load, and finally, if the trolley contacted the bridge runway conductors, the entire crane could itself be energized. Again, the only practical method to inspect for this condition is the boarding of the overhead or gantry

crane and walking out on the bridge footwalk to look and see if the trolley stops are there and installed properly.

Modern cranes must meet or exceed the design specifications of the American National Standard Safety Code for Overhead and Gantry Cranes, ANSI B30.2.0-1967. Another similar hazardous condition is the failure to re-install crane runway stops at the ends of the limits of travel of the runway. Conditions that could and have occurred in many overhead crane installations are that the controllers have malfunctioned and become stuck in the open position, and the crane itself has run off the ends of the bridge runway, many times through the building wall.

Bridge and Trolley Bumpers

A "bumper" (buffer) is an energy-absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel, or when two moving cranes or trolleys come in contact.

Overhead or gantry crane bridges shall be provided with bumpers unless the crane travels at a slow rate of speed and has a faster deceleration rate due to the use of sleeve bearings, or is not operated near the end of bridge travel, or is restricted to a limited distance by the nature of the crane operation and there is no hazard of striking any object in this limited distance.

A common condition that will be observed on many overhead or gantry cranes is that bumpers were not provided where required. However, many times bumpers will be provided that do not have sufficient energy-absorbing capacity to stop the crane when traveling at a speed of at least 40% of the rated load speed or the bumpers are not designed and installed as to minimize parts falling from the crane in case of breakage. The hazards of not providing bridge bumpers with energy-absorbing capacities are that when an overhead or gantry crane contacts another crane on the same runway or contacts the bridge stops

at the ends of the runway, a shock load is transmitted to the lifting mechanisms which could cause a potential dropping of the load. In addition, the constant striking of a crane against another object without energy-absorption buffers causes weakening of the bridge and end structures which could eventually cause cracks in the webbing and lead to failure of the crane structure.

Trolleys shall also be provided with bumpers unless, 1) the trolley travels at a slow rate of speed, 2) it is not operated near the ends of the trolley travel, or, 3) it is restricted to a limited distance on the trolley runway and there is no hazard of striking any object in this limited distance. If there is more than one trolley operated on the same trolley runway, each trolley shall be provided with bumpers on its adjacent ends. If bumpers are installed on the trolley, they shall be designed and installed to minimize parts falling from the trolley in case of breakage, and shall be energy-absorbing. It must be emphasized that both trolley stops and bumpers shall be provided where required.

Rail Sweeps

Bridge end truck wheels shall be provided with sweeps which extend below the top of the rail and project in front of the truck wheels. Their lack is a very common condition. This requirement does not apply to the trolley end truck wheels.

The condition created by not having rail sweeps is one where maintenance equipment could be left on the bridge runway rails, and as the crane travels into this area, could be derailed, causing an unintended movement of the load, a shock load, and potential dropping of the load. This also applies to gantry and semi-gantry cranes where the truck wheels run on a rail usually located on the floor or working surface.

Guards

Hoisting ropes on overhead and gantry cranes must be inspected closely to make sure that they do not run near enough to other parts to make fouling or chafing possible. And if they do, guards shall be installed to prevent this condition.

The hazard here is obvious. If a hoisting rope is chafing over a long period of time, it will eventually wear through or break, and drop the load to the floor below. Also, guards shall be provided to prevent contact between bridge conductors and hoisting ropes if they could come into contact. The bridge conductors are almost always located on the inside flange of the bridge girders and provide the power to the trolley.

Another very common hazard on overhead or gantry cranes is that exposed moving parts are not properly guarded. Examples of this are gears on or near the bridge footwalk shaft ends on bridge motors usually located on the bridge footwalks, and chain and chain sprockets.

There have been several reported fatalities concerned with maintenance employees working on bridge footwalks being drawn into open gears, projecting shaft ends and chain and sprocket drives.

Brakes

Each independent hoisting unit of all cranes shall be provided with a holding brake, applied directly to the motor shaft or some part of the gear grain.

On cab-operated cranes with the cab on the bridge, a bridge brake shall be provided. On occasion, you will find operators of cab-operated overhead cranes that are not equipped with bridge brakes stopping the motion of the bridge by plugging. Plugging is reversing the direction of the bridge motor through the controller. This can be a hazardous practice especially if it is the only method

of stopping cranes. If power to the crane is lost for any reason, the crane will be unstoppable.

All floor, remote and pulpit-operated crane bridge drives shall be provided with a brake or non-coasting mechanical drive, i.e., the crane must be able to stop quickly. It should be noted that overhead or gantry cranes with a cab on the trolley shall also be provided with a trolley brake. However, under most conditions trolleys will not be required to have a brake.

Electrical Equipment

All wiring and equipment on overhead or gantry cranes shall comply with the applicable electrical sections of Subpart S.

On floor-operated cranes where a multiple conductor cable is used with a suspended push-button station, the station shall be supported in some manner that will protect the electrical conductor against strain. This condition can be abated simply by installing a chair or cable from an upper support to the push-button station to take the strain off the conductor.

Pendant control boxes also shall be clearly marked for identification of functions. Lack of clear labeling is quite common. The hazard is that inexperienced operators or supervisory personnel operating the pendant crane may not know the various functions of the push-button station and cause an unexpected movement of the crane. Only designated personnel are permitted to operate a crane per §1910.179(b)(8).

One of the most serious hazards associated with cranes concerns lack of compliance with the provision that the hoisting motion of all electric traveling cranes shall be provided with an over-travel limit switch in the hoisting direction. A "limit switch" is a switch which disconnects the power to the drive motor and stops the load if that load is raised above a certain point. Many

fatalities and serious injuries have occurred because a crane was not provided with a limit switch or the limit switch malfunctioned.

If a limit switch is not provided, or if there is a malfunctioning limit switch, the hoist block could run up into the lifting beam or rope drum, severing the cable and dropping the entire assembly and any load on the hook to the floor below.

All inspections of an overhead crane shall include a close examination of the limit switch.

Hoisting Equipment

Sheaves are grooved pulleys which carry the hoisting ropes on overhead cranes. Sheave grooves shall be smooth and free from surface defects.

Sheaves in the bottom blocks shall be equipped with close-fitting guards that will prevent ropes from becoming fouled when the block is lying on the ground with the rope loose. This common condition can be readily observed while watching the crane in operation. The hazard, if the guards are not installed, is that the hoisting rope can come off the sheave groove and become entangled on the shaft, creating binding or shaving of the hoisting rope.

Rope fouling can also occur when there is a slack cable condition, such as when a load block rests on top of a load.

One of the common conditions associated with cranes is the condition of the hoisting rope itself. It is required that the hoisting ropes have no less than two wraps remaining on the hoist drum when the hook is in its extreme low position. This is often not the case.

Inspection

Prior to initial use, all new and altered cranes shall be inspected to insure compliance with the provisions of this section.

Inspection procedure for cranes in regular service is divided into two general classifications:

1. Frequent inspection - daily to monthly intervals.
2. Periodic inspection - 1 to 12-month intervals.

Frequent Inspection

All functional operating mechanisms, air and hydraulic systems, chains, rope slings, hooks, and other lifting equipment shall be visually inspected daily.

Chains, cables, ropes, hooks, etc. on overhead and gantry cranes shall be visually inspected daily for deformation, cracks, excessive wear, twists, stretch, etc., and defective gear shall be replaced or repaired.

Hooks and chains shall be visually inspected daily; monthly with a certification record which includes the date of inspection, the signature of the person who performed the inspection, and the serial number or other identifier. Running ropes shall be inspected monthly with a certification record which includes the date of inspection, the signature of the person who performed the inspection, and the serial number or other identifier.

Periodic Inspection

Complete inspection of the crane shall be performed at 1 month to 12 month intervals depending on its activity, severity of service, and environmental conditions. The inspection shall include the following areas: Deformed, cracked, corroded, worn, or loose members or parts; the brake system; limit

indicators (wind, load, etc.); power plant; and electrical apparatus.

Testing

Prior to initial use, all new and altered cranes shall be tested to insure compliance with this section including the following functions:

- Hoisting and lowering
- Trolley travel
- Bridge travel
- Limit switches, locking and safety devices

The trip setting of hoist limit switches shall be determined by tests with an empty hook traveling in increasing speeds up to the maximum speed. The actuating mechanism of the limit switch shall be located so that it will trip the switch, under all conditions, in sufficient time to prevent contact of the hook or hook block with any part of the trolley.

Maintenance

A preventive maintenance program based on the crane manufacturer's recommendations shall be established.

Handling the Load

One of the most significant hazards associated with cranes is overloading. A crane shall not be loaded beyond its rated load capacity for any reason except test purposes. "Rated load" means the maximum load for which a crane or individual hoist is designed and built by the manufacturer as shown on the equipment name plate.

A common misconception is that a safety factor is built in and that an employer may exceed the rated load up to this safety factor. *This is not true.* A load means the total superimposed weight on the load block or hook and shall include any lifting devices such as magnets, spreader bars, chains and slings.

Every load lifted by a crane shall be well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches. In some cases, you will see a situation where a load is balanced but not secured.

To prevent swinging of a load, the hook shall be brought directly over the load when the attachment is made. In addition, no employee is permitted on the load or hook or lifting device while hoisting, lowering, or traveling.

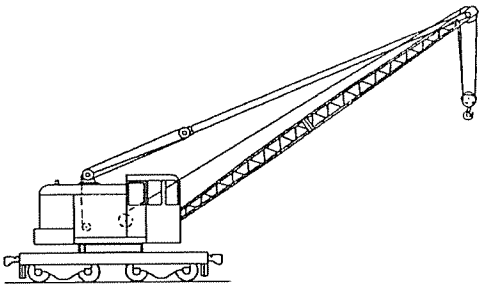
The operator of a crane shall avoid carrying loads over other personnel. This hazard is increased significantly when using a magnet or a vacuum device to lift scrap material.

Finally, operators of cranes are not permitted to leave their position at the controls while the load is suspended. This again includes suspended lifting devices such as magnets or vacuum lifts.

At the beginning of each operator's shift, the upper limit switch of each hoist shall be tried out under no-load conditions. Additionally, the hoist limit switch which controls the upper limit of travel of the load block shall never be used as an operating control.

CRAWLER LOCOMOTIVE AND TRUCK CRANES - 1910.180

General Requirements



This section applies to crawler cranes, locomotive cranes, wheel-mounted cranes of both truck and self-propelled wheel type, and any variations thereof which retain the same fundamental characteristics. This section includes only cranes of the above types, which are basically powered by internal combustion engines or electric motors and which utilize drums and ropes. Cranes designed for railway and automobile wreck clearances are excepted. The requirements of this section are applicable only to machines when used as lifting cranes.

All modern crawler, locomotive, and truck cranes shall meet the design specifications of the American National Standard Safety Code for Crawler, Locomotive, and Truck Cranes, ANSI B30.5-1968.

Only employees selected or assigned by the employer or the employer's representative as being qualified shall be permitted to operate a crane covered by this section.

Load Ratings

Where stability governs lifting performance, load ratings have been established for various types of mounting and are given in a table contained in §1910.180. A substantial and durable rating chart with clearly legible letters and figures shall be securely fixed in each crane cab in a location easily visible to the

operator while seated at the control station.

Inspection

Prior to initial use, all new and altered cranes shall be inspected to insure compliance with the provisions of this section.

Inspection procedure for cranes in regular service is divided into two general classifications:

1. Frequent inspection - daily to monthly intervals.
2. Periodic inspection - 1 to 12-month intervals.

Frequent Inspection

All functional operating mechanisms, control systems, safety devices, air and hydraulic systems, chains, rope slings, hooks, and other lifting equipment shall be visually inspected daily.

Cables, ropes, hooks, etc. shall be visually inspected daily for deformation, cracks, excessive wear, twists, stretch, etc., and defective gear shall be replaced or repaired.

Running ropes shall be inspected monthly with a certification record which includes the date of inspection, the signature of the person who performed the inspection and the serial number or other identifier.

Periodic Inspection

Complete inspection of the crane shall be performed at 1 month to 12 month intervals depending on its activity, severity of service, and environmental conditions. The inspection shall include the following areas: Deformed, cracked, corroded, worn, or loose members or parts; the brake system; limit

indicators (wind, load, etc.); power plant; electrical apparatus; and travel steering, braking and locking devices.

Inspection Records

Certification records which include the date of inspection, signature of the person who performed the inspection and the serial number, or other identifier, of the crane which was inspected shall be made monthly on critical items in use such as brakes, crane hooks, and ropes. This certification record shall be kept on file where readily available to appointed personnel.

Testing

Prior to initial use, all new production cranes shall be tested to insure compliance with the provisions of this section including the following functions:

- Hoisting and lowering mechanisms
- Swinging mechanism
- Travel mechanism
- Safety devices

Maintenance

After adjustments and repairs have been made, the crane shall not be operated until all guards have been reinstalled, safety devices reactivated, and maintenance equipment removed.

Handling the Load

Size of the Load

One of the most significant hazards associated with cranes is overloading. A crane shall not be loaded beyond its rated load capacity for any reason except

test purposes. "Rated load" means the maximum load for which a crane or individual hoist is designed and built by the manufacturer as shown on the equipment name plate.

A common misconception is that a safety factor is built in and that an employer may exceed the rated load up to this safety factor. *This is not true.* A load means the total superimposed weight on the load block or hook and shall include any lifting devices such as magnets, spreader bars, chains and slings.

Attaching the Load

The hoist rope shall not be wrapped around the load. The load shall be attached to the hook by means of slings or other approved devices.

Moving the Load

Some of the requirements for moving loads are stated below.

- The employer shall ensure that:
  - the crane is level and where necessary blocked properly.
  - the load is well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.

- Before starting to hoist, the following conditions shall be noted:
  - Hoist rope shall not be kinked.
  - Multiple part lines shall not be twisted around each other.
  - The hook should be brought over the load in such a manner as to prevent swinging.

- During hoisting, care shall be taken that there is no sudden acceleration or deceleration of the moving load and that the load does not contact any obstructions.

- Side loading of booms shall be limited to freely suspended loads. Cranes shall not be used for dragging loads sideways.

- The operator shall test the brakes each time a load approaching the rated load is handled by raising it a few inches and applying the brakes.

- Outriggers shall be used when the load to be handled at that particular radius exceeds the rated load without outriggers as given by the crane manufacturer.

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

- Before traveling a crane with a load, a designated person shall be responsible for determining and controlling safety.

- When rotating the crane, sudden starts and stops shall be avoided.

- When a crane is to be operated at a fixed radius, the boom-hoist pawl or other positive locking device shall be engaged.

Holding the Load

Operators shall not be permitted to leave their position at the controls while the load is suspended.

No person shall be permitted to pass under a load on the hook.

If the load must remain suspended for considerable time, the operator shall hold the drum from rotating in the lowering direction by activating the positive controllable means of the operator's station.

Operating Near Electric Power Lines

Clearances

Except where the electrical distribution and transmission lines have been deenergized and visibly grounded at the point of work or when insulating barriers not part of the crane have been erected to prevent physical contact with the lines, the minimum clearance between the lines and any part of the crane or load shall be as shown below.

- For lines rated 50 KV or below, 10 feet.
- For lines rated over 50 KV, 10 feet plus 0.4 inch for every KV over 50 KV, or twice the length of the line insulator but never less than 10 feet.
- In transit with no load and boom lowered the clearance shall be a minimum of 4 feet.

Notification

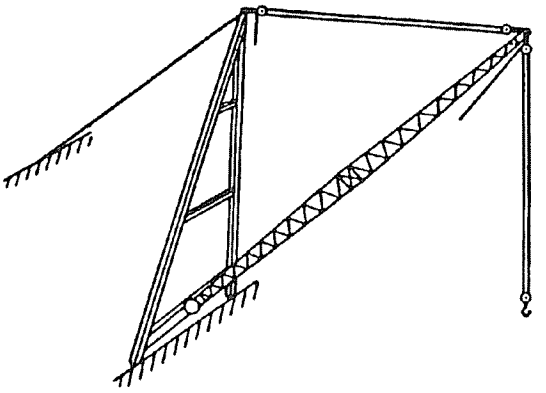
Before commencement of operations near electrical lines, the owners of the lines or their authorized representatives shall be notified and provided with all pertinent information.

Overhead Wire

Any overhead wire shall be considered to be an energized line unless and until the owner of the line or the electrical utility authorities indicate that it is not an energized line.

DERRICKS - 1910.181

A "derrick" is an apparatus consisting of a mast or equivalent member held at the head by guys or braces, with or without a boom, for use with a hoisting mechanism and operating ropes.



General Requirements

This section applies to guy, stiffleg, basket, breast, gin pole, Chicago boom, and A-frame derricks of the stationary type, capable of handling loads at variable reaches and powered by hoists through systems of rope reeving, used to perform lifting hook work, single or multiple line bucket work, grab, grapple, and magnet work. Derricks may be permanently installed for temporary use as in construction work. This section also applies to any modification of these types which retain their fundamental features, except for floating derricks.

All modern derricks shall meet the design specifications of the American National Standard Safety Code for Derricks, ANSI B30.6 - 1969.

Only employees selected by the employer or employee's representatives as being qualified shall be permitted to operate these derricks.

Load Ratings

Permanent Installations

For permanently installed derricks with fixed lengths of boom, guy, and mast, a durable and clearly legible rating chart shall be securely affixed where it is

visible to the operator. The chart shall include:

- Manufacturer's approval load ratings at corresponding ranges of boom angle or operating radii
- Specific lengths of components on which the load ratings are based
- Required parts for hoist reeving

Non-Permanent Installations

For non-permanent installations, the manufacturer shall provide sufficient information from which capacity charts can be prepared for the particular installation. The capacity charts shall be located at the derricks or the jobsite office.

Inspection

Prior to initial use, all new and altered derricks shall be inspected to insure compliance with the provisions of this section.

Inspection procedure for derricks in regular service is divided into two general classifications:

1. Frequent inspection - daily to monthly intervals.
2. Periodic inspection - 1 to 12-month intervals.

Frequent Inspection

All functional operating systems, control systems, safety devices, chords and lacing, tension in guys, plumb of the mast, air and hydraulic systems, rope reeving, hooks, and electrical apparatus shall be visually inspected daily.

Running ropes shall be inspected monthly and a certification record shall be kept on file where readily available.

Periodic Inspection

Complete inspection of the derrick shall be performed at 1 month to 12 month intervals depending on its activity, severity of service, and environmental conditions. The inspection shall include the following areas: Deformed, cracked, corroded, worn or loose members or parts; power plant; and foundation or supports.

Testing

Prior to initial use, all new and altered derricks shall be tested to insure compliance with this section including:

- Load hoisting and lowering
- Boom up and down
- Swing
- Operation of clutches and brakes of hoist

All anchorages shall be approved by the appointed person. Rock and hairpin anchorages may require special testing.

Maintenance

A preventive maintenance program based on the derrick manufacturer's recommendations shall be established.

Handling the Load

Size of the Load

No derrick shall be loaded beyond the rated load.

Attaching the Load

The hoist rope shall not be wrapped around the load. The load shall be attached to the hook by means of slings or other suitable devices.

Moving the Load

Some of the requirements for moving loads are stated below.

- The load shall be well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.

- Before starting to hoist, the following conditions shall be noted:
  - Hoist rope shall not be kinked.
  - Multiple part lines shall not be twisted around each other.
  - The hook shall be brought over the load in such a manner as to prevent swinging.

- During hoisting, care shall be taken that:
  - There is no sudden acceleration or deceleration of the moving load.
  - Load does not contact any obstructions.

- The operator shall test the brakes each time a load approaching the rated load is handled by raising it a few inches and applying the brakes.

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

Holding the Load

The operator shall not be allowed to leave his/her position at the controls while the load is suspended.

If the load must remain suspended for any considerable length of time, a dog, or pawl and ratchet, or other equivalent means, rather than the brake alone, shall be used to hold the load.

Securing Boom

Dogs, pawls, or other positive holding mechanism on the hoist shall be engaged. When not in use, the derrick boom shall be:

- Laid down
- Secured to a stationary member, as nearly under the head as possible, by attachment of a sling to the load block; or
- Hoisted to a vertical position and secured to the mast.

Other Requirements

Guards

Exposed moving parts, such as gears, ropes, setscrews, chains, chain sprockets, and reciprocating components, which constitute a hazard under normal operating conditions shall be guarded.

Operating Near Electrical Power Lines

Except where the electrical distribution and transmission lines have been deenergized and visibly grounded at the point of work or when insulating barriers not part of the derrick have been erected to prevent physical contact with the lines, the minimum clearance between the lines and any part of the

derrick or load shall be as shown below.

- For lines rated 50 KV or below, 10 feet
- For lines rated over 50 KV, 10 feet plus 0.4 inch for every KV over 50 KV, or twice the length of the line insulator but never less than 10 feet.

Notification

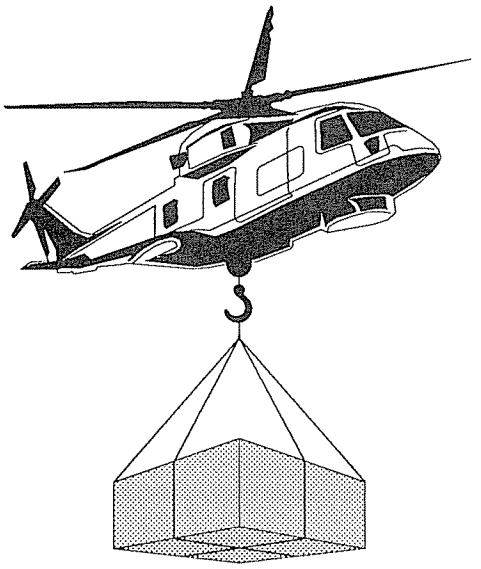
Before the commencement of operations near electrical lines, the owners of the lines or their authorized representatives shall be notified and provided with all pertinent information.

Overhead Wire

Any overhead wire shall be considered to be an energized line unless and until the owner of the line or the electrical utility authorities indicate that it is not an energized line.

HELICOPTERS - 1910.183

This section deals with helicopter crane operations. Some of the basic requirements are discussed below.



Helicopter Regulations

Helicopter cranes shall comply with any applicable regulations of the Federal Aviation Administration.

Briefing

Prior to each day's operation, a briefing shall be conducted that sets forth the plan of operation for the pilot and ground personnel.

Slings and Tag Lines

Loads shall be properly slung. Tag lines shall be of a length that will not permit their being drawn up into the rotors.

Cargo Hooks

All electrically operated cargo hooks shall have the electrical activating device so designed and installed as to prevent inadvertent operation. In addition, these cargo hooks shall be equipped with an emergency mechanical control for releasing the load.

The cargo hooks must be tested prior to each day's operation by a competent

person to determine that the release functions properly, both electrically and mechanically.

Personal Protective Equipment

Personal protective equipment (complete eye protection and hard hats secured by chin straps) shall be provided by the employer and used by employees receiving the load.

Loose-fitting clothing likely to flap in rotor downwash, and thus be snagged on the hoist lines, may not be worn.

Loose Gear and Housekeeping

All loose gear within 100 feet of the place of lifting the load or depositing the load, or within all other areas susceptible to rotor downwash, shall be secured or removed.

Good housekeeping shall be maintained in all helicopter loading and unloading areas.

Hooking and Unhooking Loads

Employees are not permitted to perform work under hovering craft except when necessary to hook or unhook loads.

Static Charge

Static charge on the suspended load shall be dissipated with a grounding device before ground personnel touch the suspended load, unless protective rubber gloves are being worn by all ground personnel who may be required to touch

the suspended load.

Signal Systems

The employer shall instruct the air crew and ground personnel on the signal systems to be used and shall review the systems with the employees before hoisting the load. This applies to both radio and hand signal systems. Hand signals, where used, are to be in conformance with Figure N-1 of §1910.183.

Approach Distance

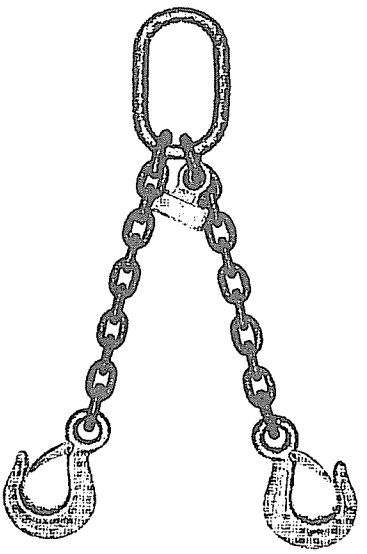
No employees shall be permitted to approach within 50 feet of the helicopter when the rotor blades are turning, unless their work duties require their presence in that area.

Communications

There shall be constant reliable communication between the pilot and a designated employee of the ground crew who acts as a signalman during the period of loading and unloading. The signalman shall be clearly distinguishable from other ground personnel.

SLINGS - 1910.184

This section applies to slings used in conjunction with other material handling equipment for the movement of material by hoisting, in employments covered by this part. The types of slings covered are those made from alloy steel chain, wire rope, metal mesh, natural or synthetic fiber rope (conventional three strand construction), and synthetic web (nylon, polyester, and polypropylene).



Safe Operating Practices

Whenever any sling is used, the following practices shall be observed:

- Slings that are damaged or defective shall not be used.
- Slings shall not be shortened with knots or bolts or other makeshift devices.
- Sling legs shall not be kinked.
- Slings shall not be loaded in excess of their rated capacities.
- Slings used in a basket hitch shall have the loads balanced to prevent slippage.
- Slings shall be securely attached to their loads.
- Slings shall be padded or protected from the sharp edges of their loads.

- Suspended loads shall be kept clear of all obstructions.
- All employees shall be kept clear of loads about to be lifted and of suspended loads.
- Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load.
- Shock loading is prohibited.
- A sling shall not be pulled from under a load when the load is resting on the sling.

Inspections

Each day before being used, the sling and all fastenings and attachments shall be inspected for damage or defects by a competent person designated by the employer. Additional inspections shall be performed during sling use, where service conditions warrant.

Damaged or defective slings shall be immediately removed from service.

Alloy Steel Chain Slings

Sling Identification
Alloy steel chain slings shall have permanently affixed durable identification stating size, grade, rated capacity, and reach.

Sling Use
Alloy steel chain slings shall not be used with loads in excess of the rated capacities prescribed in Table N-184-1 of §1910.184. Slings not included in this

table shall be used only in accordance with the manufacturer's recommendations.

Safe Operating Temperatures

Alloy steel chain slings shall be permanently removed from service if they are heated above 1000°F. When exposed to service temperatures in excess of 600°F, maximum working load limits permitted in Table N-184-1 of §1910.184 shall be reduced in accordance with the chain or sling manufacturer's recommendations.

Repairing Slings

Worn or damaged alloy steel chain slings or attachments shall not be used until repaired.

Effect of Wear

If the chain size at any point of any link is less than that stated in Table N-184-2 of §1910.184, the sling shall be removed from service.

Deformed Attachments

Alloy steel chain slings with cracked or deformed master links, coupling links or other components shall be removed from service.

Wire Rope Slings

Sling Use

Wire rope slings shall not be used with loads in excess of the rated capacities shown in Tables N-184-3 through N-184-14 of §1910.184. Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

Safe Operating Temperatures

Fiber core wire rope slings of all grades shall be permanently removed from

service if they are exposed to temperatures in excess of 200°F. When non-fiber core wire rope slings of any grade are used at temperatures above 400°F, or below minus 60°F, recommendations of the sling manufacturer regarding use at that temperature shall be followed.

Removal from Service

Wire rope slings shall be immediately removed from service if any of the following conditions are present:

- Ten randomly distributed broken wires in one rope lay, or five broken wires in one strand in one rope lay
- Wear or scraping of one-third the original diameter of outside individual wires
- Kinking, crushing, bird caging or any other damage
- Evidence of heat damage
- End attachments that are cracked, deformed or worn
- Hooks that have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook
- Corrosion of the rope or end attachments.

Metal Mesh Slings

Sling Marking

Each metal mesh sling shall have permanently affixed to it a durable marking

that states the rated capacity for vertical basket hitch and choker hitch loadings.

Handles

Handles shall have a rated capacity at least equal to the metal fabric and exhibit no deformation after proof testing.

Attachments of Handles to Fabric

The fabric and handles shall be joined so that:

- The rated capacity of the sling is not reduced.
- The load is evenly distributed across the width of the fabric.
- Sharp edges will not damage the fabric.

Sling Coatings

Coatings which diminish the rated capacity of a sling shall not be applied.

Sling Testing

All new and repaired metal mesh slings, including handles, shall not be used unless proof tested by the manufacturer or equivalent entity at a minimum of 1½ times their rated capacity. Elastomer impregnated slings shall be proof tested before coating.

Sling Use

Metal mesh slings shall not be used to lift loads in excess of their rated capacities as prescribed in Table N-184-15 of §1910.184. Slings not included in this table shall be used only in accordance with the manufacturer's recommendations.

Safe Operating Temperatures

Metal mesh slings which are not impregnated with elastomers may be used in a temperature range from minus 20°F to plus 550°F without decreasing the

working load limit. Metal mesh slings impregnated with polyvinyl chloride or neoprene may be used only in a temperature range from zero degrees to plus 200°F. For operations outside these temperature ranges or for metal mesh slings impregnated with other materials, the sling manufacturer's recommendations shall be followed.

Repairs

Metal mesh slings which are repaired shall not be used unless repaired by a metal mesh sling manufacturer or an equivalent entity.

Once repaired, records shall be maintained to indicate the date and nature of repairs and the person or organization who performed the repairs.

Removal from Service

Metal mesh slings shall be immediately removed from service if any of the following conditions are present:

- A broken weld or brazed joint along the sling edge
- Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion
- Lack of flexibility due to distortion of the fabric
- Distortion of the female handle so that the depth of the slot is increased more than 10 percent
- Distortion of either handle so that the width of the eye is decreased more than 10 percent
- A 15 percent reduction of the original cross sectional area of metal at any

point around the handle eye

- Distortion of either handle out of its plane

Natural and Synthetic Fiber Rope Slings

Sling Use

Fiber rope slings made from conventional three strand construction fiber rope shall not be used with loads in excess of the rated capacities prescribed in Tables N-184-16 through N-184-19 of §1910.184.

Fiber rope slings shall have a diameter of curvature meeting at least the minimums specified in Figures N-184-4 and N-184-5 of §1910.184.

Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

Safe-Operating Temperatures

Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range from minus 20°F to plus 180°F without decreasing the working load limit. For operations outside this temperature range and for wet frozen slings, the sling manufacturer's recommendations shall be followed.

Splicing

Spliced fiber rope slings shall not be used unless they have been spliced in accordance with minimum requirements specified in §1910.184 and with any additional recommendations of the manufacturer.

Removal from Service

Natural and synthetic fiber rope slings shall be immediately removed from service if any of the following conditions are present:

- Abnormal wear
- Powdered fiber between strands
- Variations in the size or roundness of strands
- Discoloration or rotting
- Distortion of hardware in the sling

Repairs

Only fiber rope slings made from new rope shall be used. Use of repaired or reconditioned fiber rope slings is prohibited.

Synthetic Web Slings

Sling Identification

Each sling shall be marked or coded to show the rated capacities for each type of hitch and type of synthetic web material.

Sling Use

Synthetic web slings illustrated in Figure N-184-6 shall not be used with loads in excess of the rated capacities specified in Tables N-184-20 through N-184-22 of §1910.184. Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

Environmental Conditions

When synthetic web slings are used, the following precautions shall be taken:

- Nylon web slings shall not be used where fumes, vapors, sprays, mists or liquids of acids or phenolics are present.

- Polyester and polypropylene web slings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

- Web slings with aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

Safe Operating Temperatures

Synthetic web slings of polyester and nylon shall not be used at temperatures in excess of 180°F. Polypropylene web slings shall not be used at temperatures in excess of 200°F.

Repairs

Synthetic web slings which are repaired shall not be used unless repaired by a sling manufacturer or an equivalent entity.

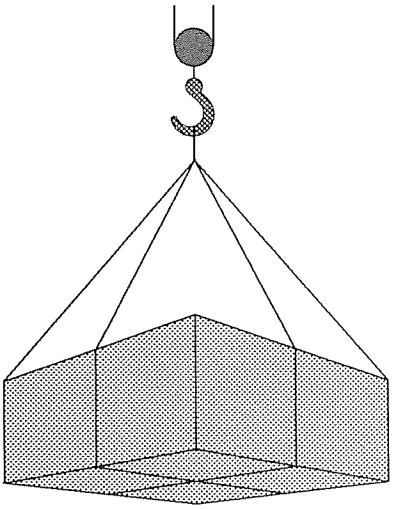
Removal from Service

Synthetic web slings shall be immediately removed from service if any of the following conditions are present:

- Acid or caustic burns;
- Melting or charring of any part of the sling surface;
- Snags, punctures, tears, or cuts;
- Broken or worn stitches; or
- Distortion of fittings.

SLING SAFETY

INTRODUCTION



The ability to handle materials - to move them from one location to another, whether during transit or at the worksite - is vital to all segments of industry. Materials must be moved, for example, in order for industry to manufacture, sell, and utilize products. In short, without materials-handling capability, industry would cease to exist.

All employees in numerous workplaces take part in materials handling, to varying degrees. As a result, some employees are injured. In fact, the mishandling of materials is the single largest cause of accidents and injuries in the workplace. Most of these accidents and injuries, as well as the pain and loss of salary and productivity that often result, can be readily avoided. Whenever possible, mechanical means should be used to move materials in order to avoid employee injuries such as muscle pulls, strains, and sprains. In addition, many loads are too heavy and/or bulky to be safely moved manually. Therefore, various types of equipment have been designed specifically to aid in the movement of materials. They include: cranes, derricks, hoists, powered industrial trucks, and conveyors.

Because cranes, derricks, and hoists rely upon slings to hold their suspended loads, slings are the most commonly used piece of materials-handling apparatus. This discussion will offer information on the proper selection, maintenance, and use of slings.

IMPORTANCE OF THE OPERATOR

The operator must exercise intelligence, care, and common sense in the selection and use of slings. Slings must be selected in accordance with their intended use, based upon the size and type of load and the environmental conditions of the workplace. All slings must be visually inspected before use to ensure that there is no obvious damage.

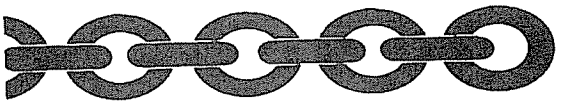
A well-trained operator can prolong the service life of equipment and reduce costs by avoiding the potentially hazardous effects of overloading equipment, operating it at excessive speeds, taking up slack with a sudden jerk, and suddenly accelerating or decelerating equipment. The operator can look for causes and seek corrections whenever a danger exists. He or she should cooperate with co-workers and supervisors and become a leader in carrying out safety measures - not merely for the good of the equipment and the production schedule, but, more importantly, for the safety of everyone concerned.

SLING TYPES

The dominant characteristics of a sling are determined by the components of that sling. For example, the strengths and weaknesses of a wire rope sling are essentially the same as the strengths and weaknesses of the wire rope of which it is made.

Slings are generally one of six types: chain, wire rope, metal mesh, natural fiber rope, synthetic fiber rope, or synthetic web. In general, use and inspection procedures tend to place these slings into three groups: chain, wire rope and mesh, and fiber rope web. Each type has its own particular advantages and disadvantages. Factors that should be taken into consideration when choosing the best sling for the job include the size, weight, shape, temperature, and sensitivity of the material to be moved, as well as the environmental conditions under which the sling will be used.

Chains



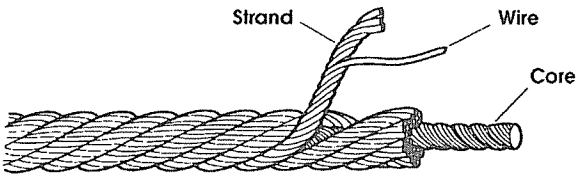
Chains are commonly used because of their strength and ability to adapt to the shape of the load. Care should be taken, however, when using alloy chain slings because they are subject to damage by sudden shocks. Misuse of chain slings could damage the sling, resulting in sling failure and possible injury to an employee.

Chain slings are your best choice for lifting materials that are very hot. They can be heated to temperatures of up to 1000°F; however, when alloy chain slings are consistently exposed to service temperatures in excess of 600°F, operators must reduce the working load limits in accordance with the manufacturer's recommendations.

All sling types must be visually inspected prior to use. When inspecting alloy steel chain slings, pay special attention to any stretching, wear in excess of the allowances made by the manufacturer, and nicks and gouges. These are all indications that the sling may be unsafe and is to be removed from service.

Wire Rope

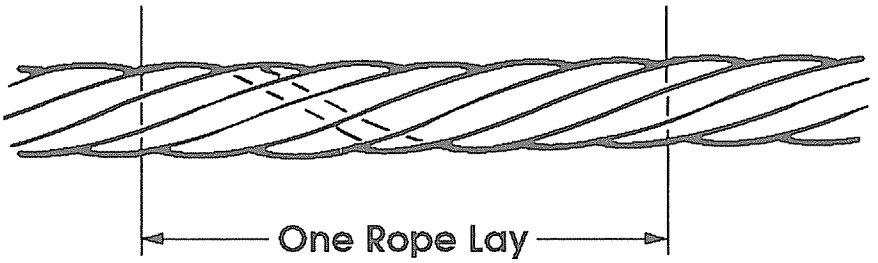
A second type of sling is made of wire rope. Wire rope is composed of individual wires that have been twisted to form strands. The strands are then twisted to form a wire rope. When wire rope has a fiber core, it is usually more flexible but is less resistant to environmental damage. Conversely, a core that is made of a wire rope strand tends to have greater strength and is more resistant to heat damage.



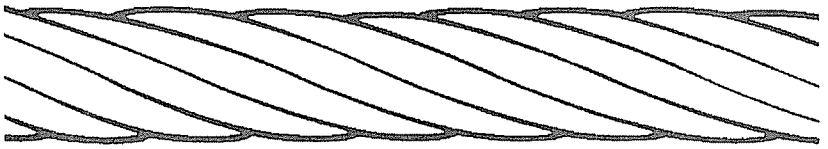
Rope Lay

Wire rope may be further defined by the "lay." The lay of a wire rope can mean any of three things:

1. *One complete wrap of a strand around the core:* One rope lay is one complete wrap of a strand around the core. See figure below.



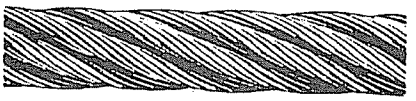
2. *The direction the strands are wound around the core:* Wire rope is referred to as *right lay* or *left lay*. A right lay rope is one in which the strands are wound in a right-hand direction like a conventional screw thread (see figure below). A left lay rope is just the opposite.



Right Lay

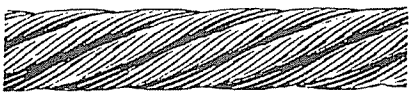
3. *The direction the wires are wound in the strands in relation to the direction of the strands around the core:* In *regular lay rope,* the wires in the strands are laid in one direction while the strands in the rope are laid in the *opposite* direction. In *lang lay rope,* the wires are twisted in the *same* direction as the strands. See figure below.

Right Lay, Regular Lay



Right Lay, Lang Lay

Left Lay, Regular Lay



Left Lay, Lang Lay

In *regular lay ropes,* the wires in the strands are laid in one direction, while the strands in the rope are laid in the opposite direction. The result is that the wire crown runs approximately parallel to the longitudinal axis of the rope. These ropes have good resistance to kinking and twisting and are easy to handle. They are also able to withstand considerable crushing and distortion due to the short length of exposed wires. This type of rope has the widest range of applications.

Lang lay (where the wires are twisted in the *same* direction as the strands) is recommended for many excavating, construction, and mining applications, including draglines, hoist lines, dredgelines, and other similar lines.

Lang lay ropes are more flexible and have greater wearing surface per wire than regular lay ropes. In addition, since the outside wires in lang lay rope lie at an angle to the rope axis, internal stress due to bending over sheaves and drums is reduced causing lang lay ropes to be more resistant to bending fatigue.

A *left lay rope* is one in which the strands form a left-hand helix similar to the threads of a left-hand screw thread. Left lay rope has its greatest usage in oil fields on rod and tubing lines, blast hole rigs, and spudders where rotation of right lay would loosen couplings. The rotation of a left lay rope tightens a standard coupling.

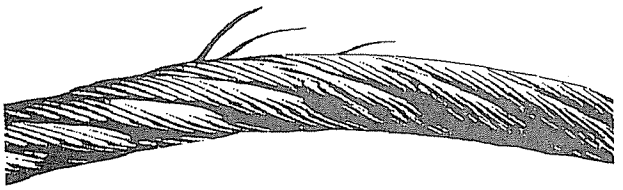
Wire Rope Sling Selection

When selecting a wire rope sling to give the best service, there are four characteristics to consider: strength, ability to bend without distortion, ability to withstand abrasive wear, and ability to withstand abuse.

1. Strength — The strength of a wire rope is a function of its size, grade, and construction. It must be sufficient to accommodate the maximum load that will be applied. The maximum load limit is determined by means of an

appropriate multiplier. This multiplier is the number by which the ultimate strength of a wire rope is divided to determine the working load limit. Thus a wire rope sling with a strength of 10,000 pounds and a total working load of 2,000 pounds has a design factor (multiplier) of 5. New wire rope slings have a design factor of 5. As a sling suffers from the rigors of continued service, however, both the design factor and the sling's ultimate strength are proportionately reduced. If a sling is loaded beyond its ultimate strength, it will fail. For this reason, older slings must be more rigorously inspected to ensure that rope conditions adversely affecting the strength of the sling are considered in determining whether or not a wire rope sling should be allowed to continue in service.

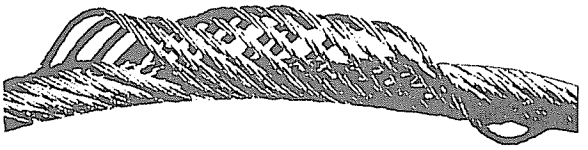
2. Fatigue — A wire rope must have the ability to withstand repeated bending without the failure of the wires from fatigue. Fatigue failure of the wires in a wire rope is the result of the development of small cracks under repeated applications of bending loads. It occurs when ropes make small radius bends. The best means of preventing fatigue failure of wire rope slings is to use blocking or padding to increase the radius of the bend.



Wire Rope Fatigue Failure

3. Abrasive Wear — The ability of a wire rope to withstand abrasion is determined by the size, number of wires, and construction of the rope. Smaller wires bend more readily and therefore offer greater flexibility but are less able to withstand abrasive wear. Conversely, the larger wires of less flexible ropes are better able to withstand abrasion than smaller wires of the more flexible ropes.

4. Abuse — All other factors being equal, misuse or abuse of wire rope will cause a wire rope sling to become unsafe long before any other factor. Abusing a wire rope sling can cause serious structural damage to the wire rope, such as kinking or bird caging which reduces the strength of the wire rope. (In bird caging, the wire rope strands are forcibly untwisted and become spread outward.) Therefore, in order to prolong the life of the sling and protect the lives of employees, the manufacturer's suggestion for safe and proper use of wire rope slings must be strictly adhered to.



Wire Rope "Bird Cage"

Wire Rope Life. Many operating conditions affect wire rope life. They are bending, stresses, loading conditions, speed of load application (jerking), abrasion, corrosion, sling design, materials handled, environmental conditions, and history of previous usage.

In addition to the above operating conditions, the weight, size, and shape of the loads to be handled also affect the service life of a wire rope sling. Flexibility is also a factor. Generally, more flexible ropes are selected when smaller radius bending is required. Less flexible ropes should be used when the rope must move through or over abrasive materials.

Wire Rope Sling Inspection. Wire rope slings must be visually inspected before each use. The operator should check the twists or lay of the sling. If ten randomly distributed wires in one lay are broken, or five wires in one strand of a rope lay are damaged, the sling must not be used. It is not sufficient, however, to check only the condition of the wire rope. End fittings and other components should also be inspected for any damage that could make the sling unsafe.

To ensure safe sling usage between scheduled inspections, all workers must participate in a safety awareness program. Each operator must keep a close watch on those slings he or she is using. If any accident involving the movement of materials occurs, the operator must immediately shut down the equipment and report the accident to a supervisor. The cause of the accident must be determined and corrected before resuming operations.

Field Lubrication. Although every rope sling is lubricated during manufacture, to lengthen its useful service life it must also be lubricated "in the field." There is no set rule on how much or how often this should be done. It depends on the conditions under which the sling is used. The heavier the loads, the greater the number of bends, or the more adverse the conditions under which the sling operates, the more frequently lubrication will be required.

Storage. Wire rope slings should be stored in a well ventilated, dry building or shed. Never store them on the ground or allow them to be continuously exposed to the elements because this will make them vulnerable to corrosion and rust. And, if it is necessary to store wire rope slings outside, make sure that they are set off the ground and protected.

Note: Using the sling several times a week, even at a light load, is a good practice. Records show that slings that are used frequently or continuously give useful service far longer than those that are idle.

Discarding Slings. Wire rope slings can provide a margin of safety by showing early signs of failure. Factors requiring that a wire sling be discarded include the following:

- Severe corrosion,
- Localized wear (shiny worn spots) on the outside,
- A one-third reduction in outer wire diameter,

- Damage or displacement of end fittings - hooks, rings, links, or collars - by overload or misapplication,
- Distortion, kinking, bird caging, or other evidence of damage to the wire rope structure, or
- Excessive broken wires.

Fiber Rope and Synthetic Web

Fiber rope and synthetic web slings are used primarily for temporary work, such as construction and painting jobs, and in marine operations. They are also the best choice for use on expensive loads, highly finished parts, fragile parts, and delicate equipment.

Fiber Rope

Fiber rope slings are preferred for some applications because they are pliant, they grip the load well and they do not mar the surface of the load. They should be used only on light loads, however, and must not be used on objects that have sharp edges capable of cutting the rope or in applications where the sling will be exposed to high temperatures, severe abrasion or acids.

The choice of rope type and size will depend upon the application, the weight to be lifted and the sling angle. Before lifting any load with a fiber rope sling be sure to inspect the sling carefully because they deteriorate far more rapidly than wire rope slings and their actual strength is very difficult to estimate.

When inspecting a fiber rope sling prior to using it, look first at its surface. Look for dry, brittle, scorched, or discolored fibers. If any of these conditions are found, the supervisor must be notified and a determination made regarding the safety of the sling. If the sling is found to be unsafe, it must be discarded.

Next, check the interior of the sling. It should be as clean as when the rope was new. A build-up of powder-like sawdust on the inside of the fiber rope indicates excessive internal wear and is an indication that the sling is unsafe.

Finally, scratch the fibers with a fingernail. If the fibers come apart easily, the fiber sling has suffered some kind of chemical damage and must be discarded.

Synthetic Web Slings

Synthetic web slings offer a number of advantages for rigging purposes. The most commonly used synthetic web slings are made of nylon, dacron, and polyester. They have the following properties in common:

- Strength — can handle load of up to 300,000 lbs.
- Convenience — can conform to any shape.
- Safety — will adjust to the load contour and hold it with a tight, non-slip grip.
- Load protection — will not mar, deface, or scratch highly polished or delicate surfaces.
- Long life — are unaffected by mildew, rot, or bacteria; resist some chemical action; and have excellent abrasion resistance.
- Economy — have low initial cost plus long service life.
- Shock absorbency — can absorb heavy shocks without damage.
- Temperature resistance — are unaffected by temperatures up to 180°F.

Each synthetic material has its own unique properties. Nylon must be used wherever alkaline or greasy conditions exist. It is also preferable when neutral conditions prevail and when resistance to chemicals and solvents is important. Dacron must be used where high concentrations of acid solutions — such as sulfuric, hydrochloric, nitric, and formic acids — and where high-temperature bleach solutions are prevalent. (Nylon will deteriorate under these conditions.) Do not use dacron in alkaline conditions because it will deteriorate; use nylon or polypropylene instead. Polyester must be used where acids or bleaching agents are present and is also ideal for applications where a minimum of stretching is important.

Possible Defects. Synthetic web slings must be removed from service if any of the following defects exist:

- Acid or caustic burns,
- Melting or charring of any part of the surface,
- Snags, punctures, tears, or cuts,
- Broken or worn stitches,
- Wear or elongation exceeding the amount recommended by the manufacturer, or
- Distortion of fittings.

SAFE LIFTING PRACTICES

Now that the sling has been selected (based upon the characteristics of the load and the environmental conditions surrounding the lift) and inspected prior to use, the next step is learning how to use it *safely*. There are four primary factors to take into consideration when safely lifting a load. They are (1) the size, weight, and center of gravity of the load; (2) the number of legs and the angle the sling makes with the horizontal line; (3) the rated capacity of the sling; and (4) the history of the care and usage of the sling.

Size, Weight, and Center of Gravity of the Load

The center of gravity of an object is that point at which the entire weight may be considered as concentrated. In order to make a level lift, the crane hook must be directly above this point. While slight variations are usually permissible, if the crane hook is too far to one side of the center of gravity, dangerous tilting will result causing unequal stresses in the different sling legs. This imbalance must be compensated for at once.

Number of Legs and Angle with the Horizontal

As the angle formed by the sling leg and the horizontal line decreases, the rated capacity of the sling also decreases. In other words, the smaller the angle between the sling leg and the horizontal, the greater the stress on the sling leg and the smaller (lighter) the load the sling can safely support. Larger (heavier) loads can be safely moved if the weight of the load is distributed among more sling legs.

Rated Capacity of the Sling

The rated capacity of a sling varies depending upon the type of sling, the size

of the sling, and the type of hitch. Operators must know the capacity of the sling. Charts or tables that contain this information generally are available from sling manufacturers. The values given are for *new* slings. Older slings must be used with additional caution. Under no circumstances shall a sling's rated capacity be exceeded.

History of Care and Usage

The mishandling and misuse of slings are the leading causes of accidents involving their use. The majority of injuries and accidents, however, can be avoided by becoming familiar with the essentials of proper sling care and usage.

Proper care and usage are essential for maximum service and safety. Slings must be protected from sharp bends and cutting edges by means of cover saddles, burlap padding, or wood blocking, as well as from unsafe lifting procedures such as overloading.

Before making a lift, check to be certain that the sling is properly secured around the load and that the weight and balance of the load have been accurately determined. If the load is on the ground, do *not* allow the load to drag along the ground. This could damage the sling. If the load is already resting on the sling, ensure that there is no sling damage prior to making the lift.

Next, position the hook directly over the load and seat the sling squarely within the hook bowl. This gives the operator maximum lifting efficiency without bending the hook or overstressing the sling.

Wire rope slings are also subject to damage resulting from contact with sharp edges of the loads being lifted. These edges can be blocked or padded to minimize damage to the sling.

After the sling is properly attached to the load, there are a number of good lifting techniques that are common to all slings:

- Make sure that the load is not lagged, clamped, or bolted to the floor.
- Guard against shock loading by taking up the slack in the sling slowly. Apply power cautiously so as to prevent jerking at the beginning of the lift, and accelerate or decelerate slowly.
- Check the tension on the sling. Raise the load a few inches, stop, and check for proper balance and that all items are clear of the path of travel. Never allow anyone to ride on the hood or load.
- Keep all personnel clear while the load is being raised, moved, or lowered. Crane or hoist operators should watch the load at all times when it is in motion.
- Finally, obey the following "nevers:"
  - — Never allow more than one person to control a lift or give signals to a crane or hoist operator except to warn of a hazardous situation.
  - — Never raise the load more than necessary.
  - — Never leave the load suspended in the air.
  - — Never work under a suspended load or allow anyone else to.

Once the lift has been completed, clean the sling, check it for damage, and store it in a clean, dry airy place. It is best to hang it on a rack or wall.

Remember, damaged slings cannot lift as much as new or well-cared for older slings. Safe and proper use and storage of slings will increase their service life.

MAINTENANCE OF SLINGS

Chains

Chain slings must be cleaned prior to each inspection, as dirt or oil may hide damage. The operator must be certain to inspect the total length of the sling, periodically looking for stretching, binding, wear, or nicks and gouges. If a sling has stretched so that it is now more than three percent longer than it was when new, it is unsafe and must be discarded.

Binding is the term used to describe the condition that exists when a sling has become deformed to the extent that its individual links cannot move within each other freely. It is also an indication that the sling is unsafe. Generally, wear occurs on the load-bearing inside ends of the links. Pushing links together so that the inside surface becomes clearly visible is the best way to check for this type of wear. Wear may also occur, however, on the outside of links when the chain is dragged along abrasive surfaces or pulled out from under heavy loads. Either type of wear weakens slings and makes accidents more likely.

Heavy nicks and/or gouges must be filed smooth, measured with calipers, then compared with the manufacturer's minimum allowable safe dimensions. When in doubt, or in borderline situations, do not use the sling. In addition, never attempt to repair the welded components on a sling. If the sling needs repair of this nature, the supervisor must be notified.

Wire Rope

Wire rope slings, like chain slings, must be cleaned prior to each inspection because they are also subject to damage hidden by dirt or oil. In addition, they must be lubricated according to manufacturer's instructions. Lubrication prevents or reduces corrosion and wear due to friction and abrasion. Before

applying any lubricant, however, the sling user should make certain that the sling is dry. Applying lubricant to a wet or damp sling traps moisture against the metal and hastens corrosion.

Corrosion deteriorates wire rope. It may be indicated by pitting, but it is sometimes hard to detect. Therefore, if a wire rope sling shows any sign of significant deterioration, that sling must be removed until it can be examined by a person who is qualified to determine the extent of the damage.

By following the above guidelines to proper sling use and maintenance, and by the avoidance of kinking, it is possible to greatly extend a wire rope sling's useful service life.

Fiber Ropes and Synthetic Webs

Fiber ropes and synthetic webs are generally discarded rather than serviced or repaired. Operators must always follow manufacturer's recommendations.

SUMMARY

There are good practices to follow to protect yourself while using slings to move materials. First, learn as much as you can about the materials with which you will be working. Slings come in many different types, one of which is right for your purpose. Second, analyze the load to be moved - in terms of size, weight, shape, temperature, and sensitivity - then choose the sling which best meets those needs. Third, always inspect all the equipment before and after a move. Always be sure to give equipment whatever "in service" maintenance it may need. Fourth, use safe lifting practices. Use the proper lifting technique for the type of sling and the type of load.