Safety Works for Industry
Module 6

Safety works! FOR YOU
The Ohio Bureau of Workers' Compensation

Revised: July 2004

Cranes & Slings

Overhead Crane Safe Operating Practices

No single factor can so affect crane safety or maintenance costs as the *skill or lack of skill* of the operator. Compliance with all of the applicable standards of design, construction, and maintenance *cannot* overcome incorrect operational practices.

An unskilled or reckless operator can greatly add to the operational cost by causing damage to the hoisting equipment. This is especially true for electrical equipment, which *can be damaged or destroyed by only a few hours of improper operation.*

A good crane operator can do much to reduce maintenance and prolong the life of the crane components by careful operation of the controls, allowing the motors to accelerate gradually which reduces shock loading of the crane's systems. Slow, smooth, even, uniform, unvarying, and regular are all synonyms for the crane operator's movements during operation of the hoisting equipment. Sudden stops by plugging [reversing the motor direction] or jamming the brakes imparts vast amounts of stresses into the machinery.

A thorough operator training program pays dividends. Many companies hire professional instructors to present a customized program at the cranes owner's site. This training includes, operating procedures, accident cause and prevention, and operator qualifications and responsibilities.

This section will provide basic recommendations which can serve as a base for, *but not replace*, operator training. These suggestions generally apply to all industrial type cranes.

Operator Qualifications

Overhead and gantry cranes should be operated only by qualified personnel, such as operators, trainees, and maintenance personnel [when necessary to perform their duties]. *No one* should be in the cab with the crane operator, except when training or maintenance duties require. Likewise, *no person* shall be on the bridge walkway(s) or on the trolley during normal operation.

The operators should be required to pass a written and/or oral examination after completion of training and should pass a periodic physical and visual examination.

An operator should be capable of exercising good judgment and extreme care when operating a crane. Alertness and concentration and a rigid adherence to proven operating rules and practices are vital.

Operating Procedures

Before operating a particular crane the operator should carefully read and study the operation manual supplied with the crane by the crane manufacturer and note any special instructions not given previously by the instructor or supervisor.

Before starting the crane, make sure all controllers are in the "off" position. Next, close the main line switch and press the "on" or "reset" button.

Handling The Bridge Travel Motion:

Before a load is lifted, the bridge should be brought in position so that it is directly over the load. Otherwise it will be impossible to "spot" the trolley and hoist hook over the load. Be sure the hook is high enough to clear any obstruction or person below.

Every bridge should have a brake, operated by a foot pedal for cab control or electrically operated for floor or remote control. The purpose of this brake is to permit stopping the bridge exactly where desired. After the operator has learned the distance that the bridge travels after power is shut off, he will be able to judge distances so that the need to empty the bridge brake will be greatly reduced. On floor or remote controlled cranes, the electric brake will set automatically when the control device is released. In order to drift into position, it is necessary to hold the device in the first step.

Start the bridge slowly, and bring it up to speed gradually. Approaching the place where it is desired to stop the bridge, reduce the bridge speed. If the operator finds that the bridge is going to over-travel, the desired stopping point, apply the bridge brake. For exact positioning follow the practice of jogging, namely: Move the operating device rapidly "on" and "off." This practice should be followed only as necessary because it causes extra wear on the controller contacts, the brakes, and extra heating of the motor.

Handling The Trolley Travel Motion:

Next, the trolley should be brought directly over the load that is to be handled, in the same manner as for the bridge.

If the trolley is not equipped with a brake, this motion may require more careful handling than other motions of the crane. As the operator becomes familiar with the trolley he can gauge the amount of "drift" and allow for it. In case of over travel, the operator can quickly reverse the trolley motor to bring the trolley to a stop.

If the trolley is equipped with a brake, follow the instructions given for controlling the bridge.

Handling The Hoist Motion:

After the hook has been brought over the load, lower it until the hooker on the floor can place the slings on the hook. As the hook approaches this level, reduce the speed so that lowering can be stopped smoothly and quickly.

After the slings are in place on the load and the operator is signaled to start hoisting, the hook should be started upward slowly until all slack has been taken out of the slings. *Then Stop*!! When the signal person signals to continue hoisting, the load should be lifted slowly until it is clear of all obstructions. The hoist should then be increased to full speed and maintained until the desired height is reached.

When lowering loads, the lowering speeds should be gradually increased to full speed and maintained until the load is near the place where it is to be stopped. The speed may then be reduced for final lowering into position. Final spotting should be accomplished by following the practice of jogging described in "Handling The Bridge Travel Motion."

When it is necessary that loads be raised or lowered extremely short distances, particularly when raising loads off the floor or out of tools, jogging may also be used.

At the beginning of the shift, the operator should try out the upper limit device of each hoist under no load. *Extreme care must be exercised*:

> The block should be "inched" into the limit or run in at slow speed. If the device does not operate properly, the operator should notify the supervisor.

Precautions: Good operators should remember and follow these simple rules:	
1.	Start all motions slowly, and move the operating device step by step until the fastest speed is reached.
2.	Stop slowly, by bringing the operating device to the "off" position step by step.
3.	Learn to judge the "drift" of each motion of the crane after the power is shut off. When this done, there will belittle use for the brakes, except for holding the load or the crane in place.
4.	Minimize the number of jogging operations.
5.	Do not operate any motion at less than full speed for more than fifteen (15) seconds, unless the electrical equipment has been specially designed for such service. extended low-speed operation will result in damage to motors, resistors and wiring. Electrical equipment for overhead and gantry cranes is designed on a short-time rated basis. The intermediate control points are intended for positioning and accelerating use only.

Operating Rules:

The following rules are based on *recommendations* made by the Crane Manufacturer's Association of America, by the American National Standards Institute, and by OSHA:

1.	Each crane operator should be held directly responsible for the operation of the crane. Whenever there is any doubt as to SAFETY, the crane operator should stop the crane and refuse to handle loads until (1) Safety has been assured, or, (2) The operator has been ordered to proceed by the Supervisor, who then assumes all responsibility for the SAFETY of the lift.
2.	The operator shall respond only to signals from the person who is directing the lift. When a signal person is not required as part of the crane operation, the operator is then responsible for the lifts. However, the operator shall obey a stop signal at all times, no matter who gives it.
3.	The operator shall not close the main disconnect switch until certain that no person is on or adjacent to the crane. If there is a warning sign or lock on the switch, it shall not be energized until the sign or lock is removed by the person who placed it there. Before closing the main switch, the operator shall see to it that all controllers are in the "off" position to prevent inadvertent starting. Prior to resuming normal operations, operating motions shall be checked for proper direction, in case phase reversal of the power supply may have occurred.
4.	The warning device shall be activated each time before traveling and intermittently when approaching workers.
5.	The crane operator should stand up when necessary to improve vision. Be especially alert for any unusual sounds or warnings. Danger may be present that the operation cannot see.
6.	The crane shall not be loaded beyond its Rated Load except for test purposes as provided in Section XIV, Part D. To do so is a violation of OSHA regulations.
7.	All controls including hoist limit switches shall be tested by the operator before beginning a shift. If any controls do not operate properly they should be adjusted or repaired before operations are started.
8.	Crane controls should be moved smoothly and gradually to avoid abrupt, jerky movements of the load. Slack must be carefully removed from the sling and hoisting ropes before the load is lifted.

Signals:

Signals to the operator should be in accordance with prescribed standards unless voice communication equipment [telephone, radio, or equivalent] is utilized. Signals should be discernible or audible at all times. Some special operations may require additions to, or modifications of, the basic signals. For all such cases, these special signals should be agreed upon and thoroughly understood by both the signal person and the operator, and should not be in conflict with the standard signals. Hand signals shall be posted conspicuously, as recommended by ANSI Standard B30.2.0.

Trolley Travel: The trolley movement in directions at *Right* angles to the crane runway.

Truck: The unit consisting of a frame, wheels, bearings, and axles which supports the bridge girders or trolleys.

9.	Center the crane over the load before staring the hoist to avoid swinging the load as the lift is started. Loads should not be swung by the crane to reach areas not under the crane. Crane hoist ropes should be kept vertical. Do Not make side pulls with the crane and Do Not drag loads or hitching equipment. Side pulls may cause hoist ropes to contact and burn on electric conductors or cause undue wear on ropes, drums, and other crane parts.
10.	Railroad cars should not be moved by the crane unless snatch blocks and ropes are properly rigged so that the crane is pulling straight.
11.	Do Not lower the block below the point where less than two full wraps of rope remain on the hoisting drum [except when a lower limit device is used]. Should all the rope be inadvertently unwound from the drum, be sure it is rewound in the correct direction or otherwise the rope will be damaged, and the hoist limit switch may not operate to stop the hoist in the high position.
12.	On near-maximum loads, the hoist brakes should be tested by moving the operating device to the "off" position after raising the load a few inches off the floor. If the load is held, then the brake is functioning properly. If the hoist brakes do not hold, do not operate the crane. Report the defect immediately.
13.	All slings should be removed from the crane hooks when not in use.
14.	The operator should not use a limit switch to stop motion under normal operating conditions. This is purely a protective device and is not to be used as an operating control.
15.	Never move loads carried by magnets over anyone. If electric power fails, the load will drop.
16.	Molten metal should never be carried over people.
17.	Contacts with runway stops or other cranes shall be made with extreme caution.
18.	Never move or bump another crane that has a warning sign displayed.
19.	Operators should be familiar with the operation and care of fire extinguishers on the crane.
20.	Operators of outdoor cranes should secure them when leaving. When a high-wind warning is given, the bridge or gantry on outside cranes should be parked and anchored promptly.

OPERATOR QUALIFICATIONS, PRACTICES, & CONDUCT

Compiled and Summarized From
ANSI B30.2, B30.11, B30.16, and B30.17

INTRODUCTION

Safe operation of an overhead hoist or a cab operated crane involves more than pulling the hand chain or a hand chain operated hoist, or depressing the *"Up"* or *"Down"* control button of a powered hoist. This fact is often overlooked. When we refer to the *Introduction* of the B30 Standards, we find that it emphasizes that the use of overhead hoists is subject to certain hazards that cannot be met by mechanical means, but only by the exercise of intelligence, care, common sense, and experience in anticipating the motions that will occur as a result of operating the controls.

This section is a compilation of all the recommendations as well as the mandatory requirements from ANSI Standards which address the issues of qualifying operators, proper operating practices, and operator conduct. Notably, OSHA's 1910.179 very closely follows these ANSI Standards in both form and content, but stops short at these very important issues. All statements which include mandatory language (*"Shall," "must," "require"*) could conceivably be *"incorporated by reference."*

Who May Operate Cab Or Pulpit Overhead Cranes?

Equipment *shall* be operated only by:

1. Designated Operators
2. Learners under direct supervision of a designated operator
3. Maintenance and test personnel performing their duties
4. Inspectors [crane]
5. And, *no one* else may operate or enter the cab, except people such as oilers and supervisors performing their duties, and with the knowledge of the operator.

What Are The Operator Qualifications For Cab Or Pulpit Overheads?

The following shall be required:

Testing and Experience:

1. Must pass a written or oral examination
2. Must pass a practical operating examination, [or evidence of qualifications & experience]
3. The qualification is limited to the type of equipment tested on

Physical Qualifications:

1. Vision corrected to 20/30 in one eye and 20/50 in the other
2. Sufficient strength, endurance, agility, coordination, & speed to meet the demands of equipment operation
3. Distinguish colors of red, green, yellow, regardless of position, [if necessary for operation]
4. Hearing 15/20 in ordinary conversation in one ear, [may use a hearing aid], and adequate for the specific operation.
5. Must not have epilepsy or disabling heart condition

The operator also should have normal depth perception, field of vision, reaction time, manual dexterity, and coordination. Physical defects and emotional instability which create a hazard, or interfere with safe performance, may be cause for disqualification.

Loss of physical control, or evidence of being subject to seizures shall be reason for disqualification.

What About For Floor Operated Cranes?

Operate only by:

1. Appointed Personnel
2. Maintenance and test Personnel
3. Inspectors

Testing required by Employer:

1. A practical examination is required
2. Qualification limited to the specific type of equipment

What About Remote Control Or Automatic Cranes?

When deciding who should operate, the service requirements vary so much that each installation should:

1. Be carefully analyzed
2. Review operations each month for the first six months
3. Determine if it should be run as a cab or floor-mounted crane

Except remote control cab cranes which shall be operated as above.

What Size Loads May I Handle?

Never load the crane beyond its rated capacity,
Except for purpose of testing, and then never more than 125%, or
Except for "*special heavy lifts*" with a single girder, top running bridge crane, with an underhung hoist.

What **Requirements** Are There For The Upper Load Limit Switch?

1. It must be tested at the beginning of each shift [slowly "*inch*" the hook into the switch]
2. ***Do Not*** use the switch as an operating control

What Shall Be Done Before Operating A Hoist?

1. Do become familiar with all operating controls
2. Do get instruction about warnings and safe hoisting practices in this section and in the manufacturer's operator's manual
3. Do report necessary adjustments and repairs to the appointed person
4. ***Do Not*** operate a hoist with an out-of-order sign [lock out/ tag out]
5. ***Do Not*** make adjustments or do repairs, unless qualified to perform maintenance on the hoist
6. ***Do Not*** use the rope or chain as a welding ground
7. ***Do Not*** touch a welding electrode to the chain or rope
8. Do operate a hand-operated hoist with only hand power, and with only one person

When May You Make Lifts In Excess Of The Rated Capacity?

When required from time to time for special purposes such as new construction or major repairs, exceeding the rated load *shall* be met:

1. Review the maintenance history of the crane
2. Review the reports of prior special lifts
3. Check the structural, mechanical, and electrical components of the crane design, by a qualified person using accepted standards or the manufacturer
4. A *"periodic"* inspection of the crane just prior to the lift
5. Inspect the supports, taking age and wear into account
6. Make the lift under controlled conditions
7. Make the lift under the direction of an appointed person
8. Alert all personnel in the area of the crane
9. Test the crane by lifting the load a short distance and setting the brake
10. File complete records of the lift, including distances, and keep it readily available to appointed personnel
11. Inspect all critical parts after the lift
12. ***Do Not*** perform 125% load tests for special heavy lifts.

What *MUST* I Do When Attaching A Load?

1. ***Do Not*** use kinked or twisted hoisting chains and ropes
2. ***Do Not*** wrap hoisting chains or ropes around the load
3. Attach the load to the block with a sling, or other approved device
4. Make certain that the sling clears all obstacles
5. Seat the slings properly in the saddle of the hook

What Is *REQUIRED* When Moving The Load?

Before starting to hoist:

1. The person directing the lift shall secure & balance the load in the sling before lifting more than a few inches
2. ***Do Not*** use kinked or twisted hoists ropes or chains
3. Multiple part lines must not be twisted around each other
4. Center the hook over the load to prevent swinging
5. Drums & sheaves should be checked after a slack rope condition

During hoisting:

1. *Do Not* suddenly start or stop moving the load
2. *Do Not* contact any obstructions
3. Contact with stops and trolleys should be avoided
4. *Do Not "side pull"* except when authorized by a responsible person who has determined the equipment will not be endangered
5. *Do Not* hoist, lower, or travel with anyone on the load or hook
6. Avoid swinging the load or hook when traveling
7. You *should* avoid carrying loads over people
8. Test the brakes before making a near capacity lift by raising it a few inches, and holding the load
9. Two wraps of rope is the minimum on the drum, except with a lower load limit switch where one wrap is allowed.
10. When lifting with two or more cranes, ***one and only one person*** shall be in charge who shall instruct everyone on proper rigging, moving, and positioning of the load
11. Sound a warning signal if available when approaching people

Parking The Load:

1. *Do Not* leave the controls with a load suspended, unless specific precautions have been instituted
2. Use care removing a sling from under a landed & blocked load
3. Position the load block above head level for storage

How Should Operators Conduct Themselves:

Before operating the crane, it is considered ***mandatory*** that:

1. *Do Not* close the emergency or main switch if it is found open, until you are sure that no one is working on it
2. *Do Not* remove *"Man Working"* signs, unless you placed it there
3. *Do Not* close the switch until the warning sign is removed by an appointed person.
4. Test all controls, except when completing an operation [Repair or adjust before operating]

During operation of the crane, the operator *shall:*

1. *Not* engage in anything that will divert your attention
2. *Not* operate if mentally or physically unfit
3. Respond to signals only from the appointed signalman, [with the exception of a stop signal from anyone]
4. Be held directly responsible for the safe operation of the equipment under his control, and may stop or refuse a lift
5. Be held responsible for the lift when there is no signalman

6. Sound a warning signal if present intermittently during and before travel, especially when near people.
7. If the power goes out, move all controllers to the *"off"* position [In a cab crane check operating motions for proper direction]
8. Use **extreme** caution if you contact stops or other equipment
9. Be very careful when pushing other equipment, and only after making sure that anyone on the other equipment is aware of what you are doing
10. Anchor an outside crane if the wind alarm is given

After operating the crane, the operation *shall*:

1. Land any suspended load
2. Place all controls in the *"off"* position
3. Open the main line switch for that particular crane

In General, the operator also *shall:*

1. Familiarize himself with his equipment and its proper care
2. Report necessary adjustments or repairs promptly
3. Notify the next operator if there are any deficiencies
4. Be familiar with the operation and care of fire extinguishers
5. Board or leave the cab at authorized and designated locations
6. Lock or tag the disconnect switch for maintenance unless power is required for the maintenance work.

How Should Signals Be Given:

1. These rules and standard signals ***should*** be used, unless there is voice communications equipment
2. Signals ***should*** be discernible or audible at all times
3. When special operations require special signals, they ***should*** be agreed upon, understood, and not conflict.

Chapter 14

Cranes and Mobile Industrial Equipment

The use of cranes and other mobile industrial equipment involves significant potential hazards. Special emphasis is necessary to prevent injuries.

Cranes and hoists involve special hazards primarily because of the danger of dropping a load. All cranes and hoists should be equipped with an automatic hoist safety stop—generally called a limit switch—to prevent the lift from striking the supporting structure and shearing off the hoist cables.

Operators should be required to test the limit switch each day before starting work to ensure that is functioning properly. Limit switches are safety stops and should never be used by operators to stop the hoisting operation; regular operating controls are provided for that purpose.

Wherever possible, crane and hoist hooks should be equipped with safety latches to ensure that the cable or chain will not become disengaged from the hook when the load is temporarily rested on a support, or if roll out or a shock load occurs.

Slings, chains, spreaders, rings and other auxiliary crane and hoist equipment should be examined carefully each day by operators before they are used. Wire-rope slings should receive special attention; manufactured slings are recommended. Rust, dirt and kinks can seriously weaken and shorten the safe and useful life of wire rope. For this reason, wire-rope slings should not be allowed to remain on the ground but should be placed on wall hooks or racks when not in use. An annual inspection should be conducted for all lifting devices, including slings, chains and hooks. It is important to maintain comprehensive records of all inspection results.

Hoist ropes, sheave wheels, brakes, control switches, axles, safety stops, running rails and supports for all cranes and hoists should be scheduled for a complete inspection each month, and all defects should be corrected immediately.

Overhead cranes should be operated on the basis of clear hand signals only. Lateral travel, hoisting and lowering of loads should never proceed without a signal from the person on the ground. Thereafter, the crane operator should proceed only after seeing that the area where the load is to be carried is clear. Loads should never be carried over personnel. Approved hand signals should be posted in the crane cab and at conspicuous locations on the ground or floor level.

Mobile equipment used in industrial plants, such as trucks and tow tractors, should be equipped with visual and/or audible warning devices. Operators should have a good field of vision for every direction of travel. The gasoline-powered equipment should be equipped with tanks that have explosion-proof fittings. Load capacity charts should be rigidly observed and no unauthorized counter-weights added to increase capacities. Attachments should be limited to those approved by the manufacturer.

All mobile equipment should be inspected prior to each shift to check steering, brakes and proper functioning of safety devices. All such equipment should be provided with ignition locks. Keys should be removed if the equipment is not in use. This prevents operation by untrained and unauthorized personnel. Operators should receive formal training in equipment operation and safety. This training should be documented.

To ensure that all cranes, hoists and mobile industrial equipment are inspected on a regular basis, a formalized inspection program is most effective. Reports submitted after each inspection should indicate the equipment inspected and the results of the inspection. Immediate follow-up action should be instituted to ensure that any defects are promptly corrected.

For further detailed information consult:
OSHA General Industry Standards, 29 CFR, 1910.176 - 1910.184
OSHA Construction Industry Standards, 29 CFR, 1926.550 and 1926.600
Ohio Administrative Code, All Workshops and Factories, Chapter 4121:1-5
Ohio Administrative Code, Construction, Chapter 4121:1-3.

What Are The Standard Hand Signals?

1.	***Hoist:***	With forearm vertical, forefinger pointing up, move hand in small horizontal circles
2.	***Lower:***	With arm and finger extended down, move hand in small horizontal circles
3.	***Stop:***	Arm extended, palm down, hold position
4.	***Emergency Stop:***	Same as stop but move hand rapidly right to left
5.	***Bridge Travel:***	Arm extended forward, hand open, slightly raised, make a pushing motion in direction of travel
6.	***Trolley Travel:***	Palm up, fingers closed, thumb pointing in direction of motion, jerk hand horizontally
7.	***Move Slowly:***	Give the signal with one hand, and hold the other hand in front of the hand giving the signal
8.	***Multiple Trolley Cranes:***	Hoist load blocks ***should*** have numbers on both sides; Crane trolleys ***should*** be numbered and legible from the floor, with the trolley near the cab number 1, and the trolley away from the cab number 2, [if the cab is in the center of the bridge, the trolleys & load blocks ***should*** still be numbered] Standard signals ***should*** be used after using one finger to designate #1 trolley, and two fingers to designate #2 trolley
9.	***Connecting & Disconnecting Magnet Leads:***	Upon request, the operator ***should*** open the magnet switch & the person on the ground ***should*** wait for the safe sign from the operator [spreading both hands apart palms up]

NACB
www.cranesafe.com
1-800-654-5640

OVERHEAD CRANE INSPECTION REPORT

Accredited by:
United States Dept. of Labor / OSHA under 29 CFR part 1919
State of California #CA-225 • State of Washington

Telephone: (407) 869-9970 • FAX: (407) 869-8778

CUSTOMER:	CONTACT:		JOB NO.:	INSPECTION NO.:
MFG/CAP. (Bridge):	LOCATION:	POWER SUPPLY:	INSPECTION DATE:	AUTHORITY: OSHA 1910.179 ☐ ANSI B 30.2 ☐ ________ ☐ ☐
MFG/CAP. (Hoist):	SER. NO.:	MODEL NO.:	UNIT NO.:	

	INSPECTION ITEMS	ITEM NO.	SAT.	UNSAT.	N/A
RECORDS	Applicable Repair Records	1			
	Applicable Preventive Maintenance Records	2			
	Applicable Inspection Records	3			
	Wire Rope & Hook Inspection Records	4			
		5			
		6			
SAFETY	Warning Device(s)	7			
	Safety and Machine Guards	8			
	Access Provisions (Railings, Stepover, etc.)	9			
	Overload/Travel Limits	10			
	Fire Extinguisher	11			
	Upper Limit (Hoist)	12			
		13			
		14			
ELECTRICAL SYSTEMS & CONTROL SYSTEMS	Electrical Components/Assemblies	15			
	Emergency Stop Switch	16			
	Master Switches or Drum Controller	17			
	Rev. Switches, Contactors, Relays	18			
	Mainline Disconnect (Lockout)	19			
	Conductors: Bar or Spanwires	20			
	Collectors: Brushes or Wheels	21			
	Festoon System	22			
	Mainline Contactor	23			
	Stat. Moveable & Auxiliar[illegible]ts	24			
	Resistors	25			
	Main Control (CAB)	26			
	Remote Control Station & [illegible]endant)	27			
	Control Enclosures and J-boxes	28			
	Wiring meets NEC 610	29			
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	Pendant Ground Wire	32			
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	Rotors - Slip Rings - Brushes	36			
	Shafts, Gearing, Coupling, Guards	37			
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	Seals	39			
	Sheave Assemblies/Equalizer	40			
	Lubrication	41			
	Brake(s) (holding)	42			
	Drum(s)	43			
	Hook Block Assembly(s)	44			
	Hook(s)	45			
	Brakes Mech./Eddy	46			
		47			
		48			

	INSPECTION ITEMS	ITEM NO.	SAT.	UNSAT.	N/A
HOIST SYSTEMS (AUX.)	Motors - Slip Rings - Brushes	49			
	Rotors - Slip Rings - Brushes	50			
	Brake Mech. / Eddy	51			
	Shafts, Gearing, Coupling, Guards	52			
	Bearing Assembly(s)	53			
	Seals	54			
	Sheave Assemblies / Equalizer	55			
	Lubrication	56			
	Brake(s)	57			
	Drum	58			
	Hook Bloc[illegible]embly(s)	59			
	Hook(s)	60			
		61			
		62			
		63			
		64			
BRIDGE & TRO[illegible]	M[illegible]s - Slip R[illegible] Brushes	65			
	Rotors - Slip R[illegible]shes	66			
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	[illegible]fts, [illegible]ing, Guards	68			
	[illegible]ing [illegible]	69			
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	[illegible]dge and Trolley Drives	72			
	Gear Box: All Gears and Pinions	73			
	Wheels: Idler: Drive: Rubber:	74			
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	Girder - Camber	77			
	Load Rating Markings	78			
	Lubrication	79			
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		81			
RUNWAY/CAB	Rails, Rail Alignment and Elevation	82			
	Rail Anchors, Bolts, Support Beams	83			
	Cab Support	84			
	Cab Access	85			
	Cab Doors	86			
	Cab Housekeeping	87			
		88			
		89			
WIRE ROPE & HOOK CONDITION REPORT	Main Hoist	90			
	Auxiliary Hoist	91			
	Jib Pendant	92			
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		95			
	All unsatisfactory wire rope shall be replaced as per original manufacturer's recommendations.				

SAMPLE FORM

NOTE:
As of this date ____________ the unit described above has been found to be in the above condition. It is understood that this inspection does not preclude the necessity to perform frequent and periodic inspections in conjunction with a regular maintenance program in accordance with manufacturer's specifications and/or federal, state or local guidelines, as applicable. This inspection does not constitute a warranty or guaranty of the performance of the above equipment.

☐ **SAT** ☐ **UNSAT.**

____________________ Company Representative ____________ Date

INSERT PAGE # HERE:
Page ______ of ______

____________________ Inspector ____________ Date

Corporate Copy: White **Regional Office Copy: Yellow** **Customer Copy: Pink**

0401OCIR01

U.S. Department of Labor
Occupational Safety & Health Administration
Washington, D.C. 20210

OSHA Instruction CPL 2-1.14B [Also see 184-e-1]

Office of Compliance Programming
SUBJECT: 29 CFR 1910.184 (e) (4),
Alloy Steel Chain Slings, Proof Testing

A. Purpose: This instruction provides guidelines for uniform enforcement of 29 CFR 1910.184 (e) (4) as it pertains to proof testing of alloy steel chain slings, fittings, coupling links, and other component parts.

B. Scope: This instruction applies OSHA-wide.

C. Cancellation: OSHA Instruction CPL 2-1.14A, November 14, 1980, is canceled.

D. Action: OSHA Regional Administrators/Area Directors shall ensure that the enforcement of 29 CFR 1910.184 (e) (4) is consistent with the guidelines in F. of this instruction.

E. Federal Program Change: This instruction describes a Federal program change which affects State programs. Each Regional Administrator shall:

1. Ensure that this change is forwarded to each State designee.

2. Explain the technical content of the change to the State designee as requested.

3. Ensure that the State designees are asked to acknowledge receipt of this Federal program change in writing, within 30 days of notification, to the Regional Administrator. This acknowledgment should include a description either of the State's plan to implement the change or of the reasons why the change should not apply to that State.

4. Review policies, instructions and guidelines issued by the State to determine that this change has been communicated to State program personnel. Routine monitoring activities [accompanied inspections and case file reviews] shall also be used to determine if this change has been implemented in actual performance.

F. Guidelines:

1. When an alloy steel chain sling is assembled with components that require welding in assembly, the completed sling must be ***proof tested*** by the sling manufacturer or equivalent entity, before the sling is used.

2. When an alloy steel chain sling is made up of welded components which were individually proof tested, and not further welding is required to assemble the sling, the assembled chain sling does not have to be proof tested. The sling manufacturer or equal entity assembling the sling shall attached a ***tag*** identification with appropriate information, and furnish an appropriate certificate to the purchaser or his representative which indicates the rated capacity.

3. Proof testing is not required when the sling is made up of components not requiring welding to assemble. The capacity of the sling shall be no greater than the rated capacity of the weakest component.

G. Background: OSHA has received letters from manufacturers of alloy steel chain and components requesting that a clarification of 29 CFR 1910.184(e)(4) be issued to the field pertaining to proof testing. Manufacturers of forged components comply with the following criteria:

1. The quality of forged components is confirmed by tensile and hardness tests that will verify material and heat treatment. A check analysis made from the drillings of the material will verify the chemical composition of the material.

2. Production quantities of the forging component are subjected to a rigid visual inspection and additional quality control procedures include magnetic particle and hardness testing.

3. Ultimate strength of material tests are made with the destructive testing performed on the basis of a statistical sampling procedure proven over the years.

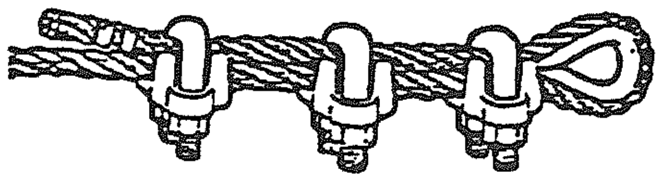
4. The nondestructive testing such as magnetic particle inspection and hardness tests may be performed on the basis of 100 percent of the lot, or again, may be performed on the basis of a sampling technique.

5. The forged components used in alloy steel chain slings are similar and in most instances identical to, if not the same as the forged components used on wire rope slings, which do not require proof testing. The rated capacity for wire slings, like alloy steel chain slings, is limited to the rated capacity of its weakest component.

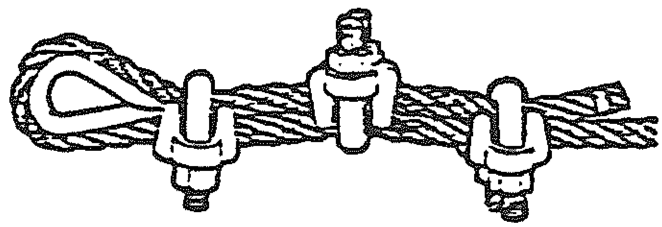
Thorne G. Auchter
Assistant Secretary
Distribution:
National, Regional and Area Offices
Compliance Officers
State Designees
NIOSH Regional Program Directors

INSTALLATION OF CABLE CLIPS

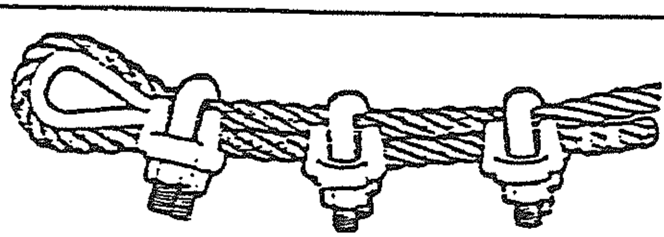
Right and Wrong Ways of Using Cable Clips



Correct
U-Bolt of all clips
on dead end of
rope

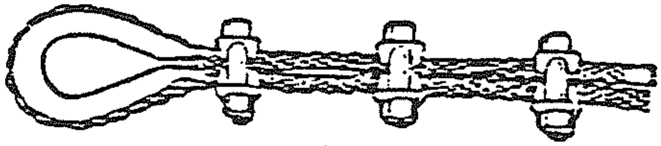


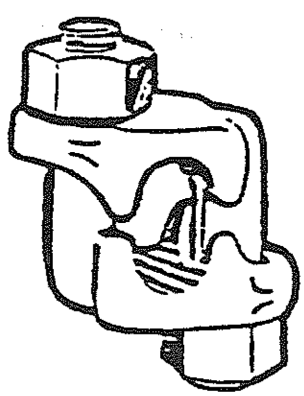
Incorrect
Do not stagger
clips



Incorrect
U-Bolt of all clips
on live end of
rope

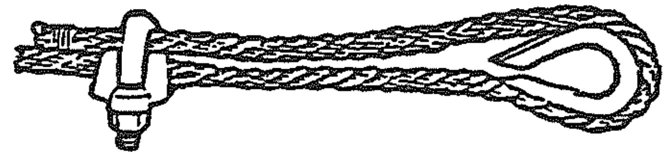
Double Saddle Clips (Fist Grip Clips)





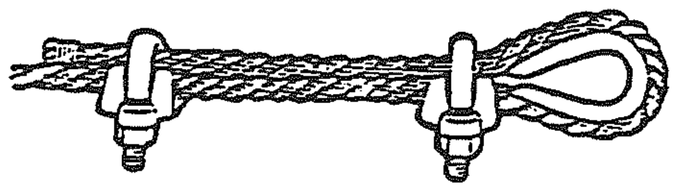
Proper Method of Installing Cable Clips

STEP 1



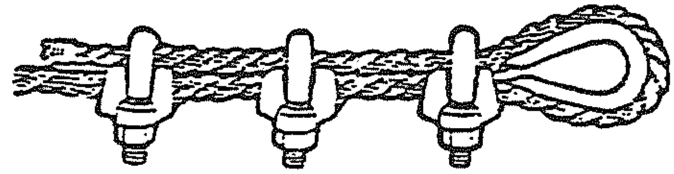
APPLY FIRST CLIP—one base width from dead end of wire rope—U-Bolt over dead end—live end rests in clip saddle. Tighten nuts evenly to recommended torque.

STEP 2



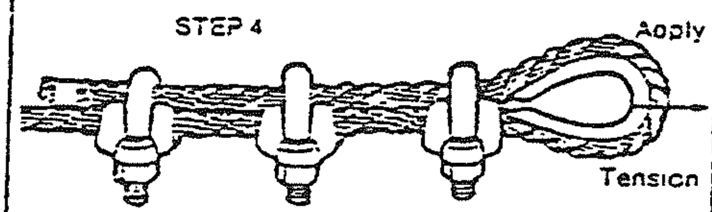
APPLY SECOND CLIP—nearest loop as possible—U-Bolt over dead end—turn on nuts firm but DO NOT TIGHTEN.

STEP 3



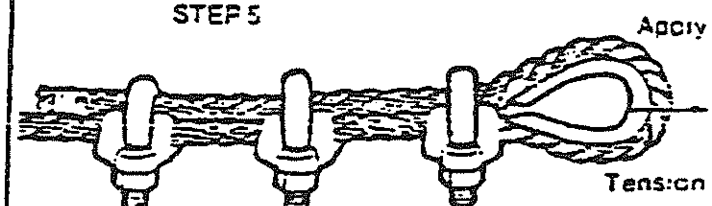
ALL OTHER CLIPS—Space equally between first two.

STEP 4



Apply tension and tighten all nuts to recommended torque.

STEP 5



Recheck nut torque after rope has been in operation.

ıpbel! Cnaın manufactures a complete line of
- ssemblies. Campbell chain slings are:

y aailable in standard and many miscellaneous types

Also manufactured to customer specifications.

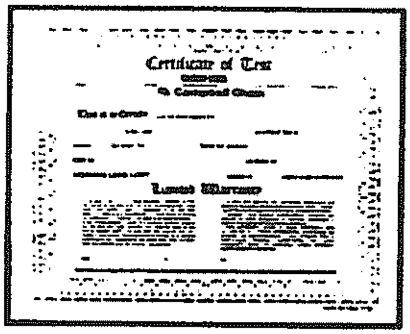
Manufactured in several locations, including York, Pennsylvania and Union City, California.

Campbell Chain Sling Service Centers are locatec in various strategic areas of the country.

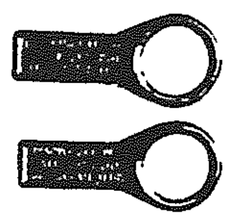
ıpbel! Chain provides information in several ıs that enables purchasers and users to operate y and effectively in conformity with OSHA uirements. The drop forged Identification Tag is hec to the Master Coupling link of each chain : and provides the following lifetime information:

- grade
- size
- reach
- type
- Working Load Limit (at a specific angle of lift)
- serial number

ertificate of Test is provided for every Campbell ıufacturec chain sling. The Campbell Certificate tains all of the information provided on the tification tag, and additionally gives the Proof load as required by OSHA regulations.



Certificate of Test



Identification Tag

---

ypes of chain slings are designated ghout the industry by the following symbols:

ingle Chain Sling with master link and hook, or ook each end.

ngle Choker Chain Sling with master link each nd. No hooks.

ouble Chain Sling with standard master link nd hooks.

iple Chain Sling with standard master link and ooks.

Quadruple Chain Sling with standard master link nd hooks.

Standard Oblong Master Link—Recommended tandard for all types.

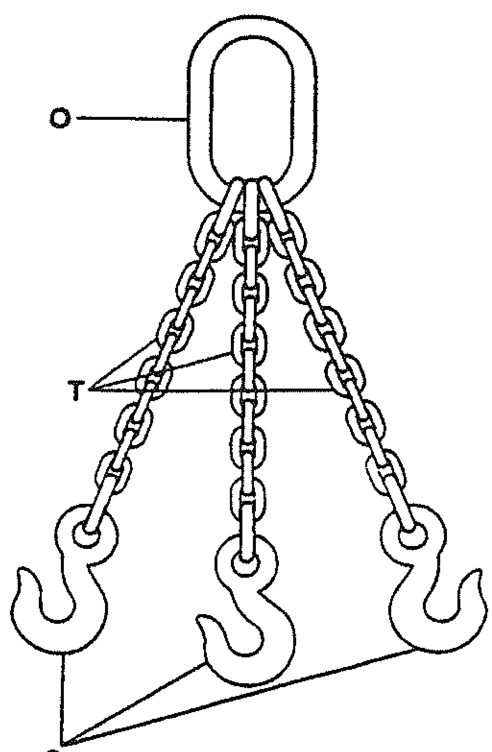
ear Shaped Master Link—Available on request.

laster Ring—Not recommended. Available on pecial quotation only.

ing Hook

Grab Hook

oundry Hook



Type TOS

______________________ Plant

Sling Inspection Report [Chain]

Location: ________________________ **Serial No.:** ____________

Type: __________ **Size:** __________ **Reach:** __________ **Load Limit:** ________

Chain

Localized Stretch or Wear __________

Grooving __________

Twisted or Bent Links __________

Cracks __________

Gouges __________

Corrosion Pits __________

Burns __________

Master Links and Hooks

Check Master Links and Hooks for any of the above Faults __________

Check Hook Throat Opening [15%] __________

Check Hook Twist [10°] __________

A Check Mark [ ] Indicates – No Fault

Date of Last Inspection: ______________________

Date of This Inspection: ______________________

Signature of Inspector: ______________________

NACB
1-800-654-5640
www.cranesafe.com

WIRE ROPE SLING CONDITION REPORT

Accredited by:
United States Dept. of Labor / OSHA under 29 CFR part 1919
State of California #CA-225 • State of Washington
Telephone: (407) 869-9970 • FAX: (407) 869-8778

INSPECTOR: ______________________ **DATE:** ____________

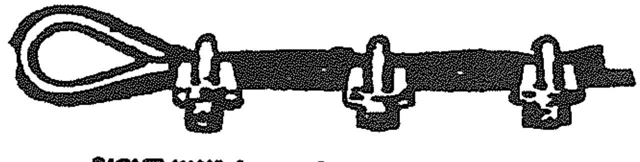
LOCATION OR SLING #	MEASURED DIAMETER	KINKS	CRUSHED	BIRDCAGE	BROKEN		HEAT DAMAGE	END ATTACHMENT FITTINGS	END ATTACHMENT BROKEN WIRES	HOOK CONDITION	SLING IS SERVICEABLE	SLING IS REJECTED	COMMENTS
					1 LAY	1 STRAND							

SAMPLE FORM

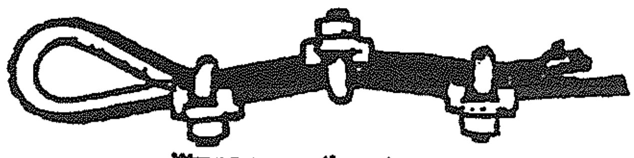
Wire Rope Sling Inspection Recommendations

INSPECTION: Slings shall be removed from service if any of the following are present:

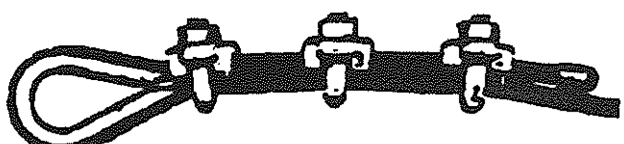
1. Ten (10) randomly distributed broken wires in one (1) lay or five (5) broken wires in one (1) strand in one (1) lay. (*Califomia - Six (6) randomly distributed broken wires in one (1) lay or three (3) broken wires in one (1) strand in one (1) lay.*)
2. Wear or scraping of one-third (1/3) the original diameter of outside individual wires.
3. Kinking, crushing, birdcaging or any other damage to wire rope structure.
4. Evidence of heat damage.
5. End attachments that are cracked, deformed or worn.
6. Corrosion of the rope or end attachments.
7. If hooks are cracked, have been opened more than 15% of the normal throat opening measured at the narrowest point or twisted more than 10° from the plane of the unbent hook.



RIGHT WAY for maximum rope strength



Wrong way: clips staggered



Wrong way: clips reversed

Number of clips suggested

Clip Size Inches	Minimum No. of Clips	Amount of Rope to Turn Back in Inches	Torque in Ft. Lbs.
1/8	2	3 1/4	4.5
3/16	2	3 3/4	7.5
1/4	2	4 3/4	15
5/16	2	5 1/4	30
3/8	2	6 1/2	45
7/16	2	7	65
1/2	3	11 1/2	65
9/16	3	12	95
5/8	3	12	95
3/4	4	18	130
7/8	4	19	225
1	5	26	225
1 1/8	6	34	225
1 1/4	6	37	360
1 3/8	7	44	360
1 1/2	7	48	360
1 5/8	7	51	430
1 3/4	7	53	590
2	8	71	750
2 1/4	8	73	750
2 1/2	9	84	750
2 3/4	10	100	750
3	10	106	1200

If a greater number of clips are used than shown in the table, the amount of rope turnback should be increased proportionately.

* Tabular data concerning Wire Rope Clips, courtesy of The Crosby Group, [illegible] of American Hoist & Derrick Co., Tulsa, Oklahoma.

Attaching clips

A termination made in accordance with the instructions and using the number of clips shown has an approximate 80% efficiency rating. This rating is based upon the catalog breaking strength of wire rope. If a pulley is used in place of a thimble for turning back the rope, add one additional clip.

The number of clips shown is based upon using right regular or lang lay wire rope, 6x19 class or 6x37 class, fiber core or IWRC, improved plow or extra improved plow. If Seale construction or similar large outer wire type construction in the 6x19 class is to be used for sizes 1 inch and larger, add one additional clip.

The number of clips shown also applies to right regular lay wire rope, 8x19 class, fiber core, improved plow, sizes 1½ inches and smaller; and right regular lay wire rope, 19x7 class, improved plow or extra improved plow, sizes 1¾ inches and smaller.

For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.

Suggested method of applying clips to get maximum holding power

1. *Turn back* the specified amount of rope from the thimble. Apply the first clip one base width from the dead end of the wire rope (U-bolt over dead end—live end rests in clip saddle). Tighten nuts evenly to suggested torque.

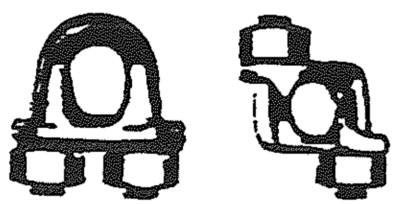
2. *Apply the next clip* as near the loop as possible. Turn nuts firm but do not tighten.

3. *Space additional clips*, if required, equally between the first two. Turn nuts—take up rope slack—tighten all nuts evenly on all clips to suggested torque.

4. NOTICE! *Apply the initial load* and retighten nuts to the suggested torque. Rope will stretch and shrink in diameter when loads are applied. Inspect periodically and retighten.

IMPORTANT—Failure to make a termination in accordance with aforementioned instruction or failure to periodically check and retighten to the suggested torque will cause a reduction in aforementioned efficiency rating.

Wire Rope clips



INSPECTION OF SHEAVES AND DRUMS

Under normal conditions, machines receive periodic inspections, and their over-condition is recorded. Such inspections usually include the drum, sheaves, and any other parts that may come into contact with the wire rope and subject it to wear. As an additional precaution, rope-related working parts, particularly in t areas described below, should be re-inspected prior to the installation of a new wire rope.

• The very first item to be checked when examining sheaves and drums, is t condition of the grooves (Figs. 29, 30, and 31). To check the size, contour and amount of wear, a *groove gage* is used. As shown in Figure 29, the gage should contact the groove for about 150° of arc.

Two types of groove gages are in general use and it is important to note which of these is being used. The two differ by their respective percentage *over nominal*.

For new or re-machined grooves, the groove gage is nominal plus the full oversize percentage. The gage carried by most wire rope representatives today used for worn grooves and is made nominal plus ½ the oversize percentage.

This latter gage is intended to act as a sort of "no-go" gage. Any sheave wi a groove smaller than this *must* be re-grooved or, in all likelihood, the existing rope will be damaged.

When the sheave is re-grooved it should be machined to the dimensions for "new and machined" grooves given in Table 11. This table lists the requirements f: new or re-machined grooves, giving the groove gage diameter in terms of the nominal wire rope diameter plus a percentage thereof. Similarly, the size of th "no-go" gage is given, against which worn grooves are judged. Experience has clearly demonstrated that the service life of the wire rope will be materially increased by strict adherence to these standards.

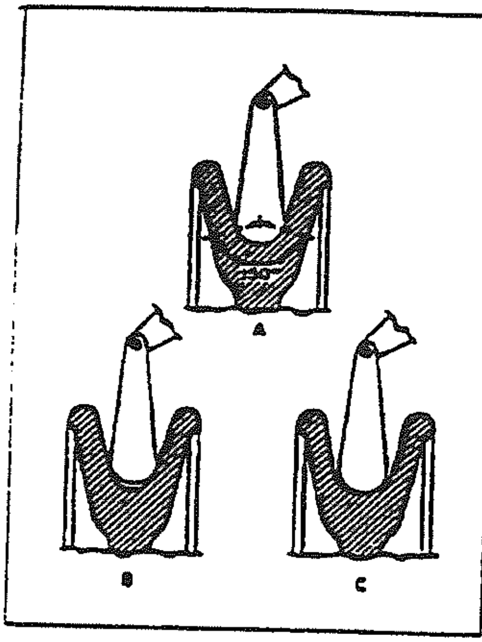


Figure 29. Cross-sections illustrating three sheave-groove conditions. A is correct, B is too tight, and C is too loose.

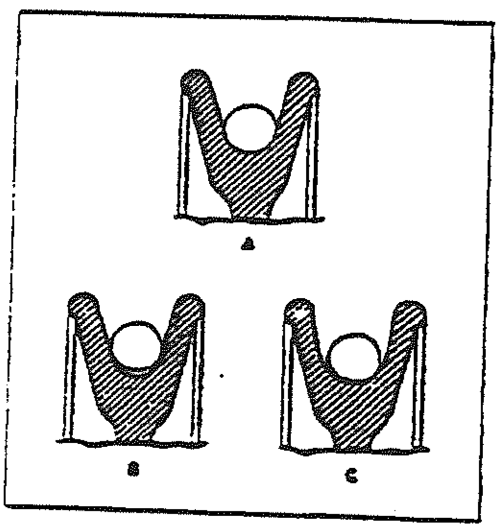


Figure 30. These sheave-groove cross-sections represent three wire rope seating conditions: A, a new rope in a new groove; B, a new rope in a worn groove; and C, a worn rope in a worn groove. (See also Figs. 29 and 31.)

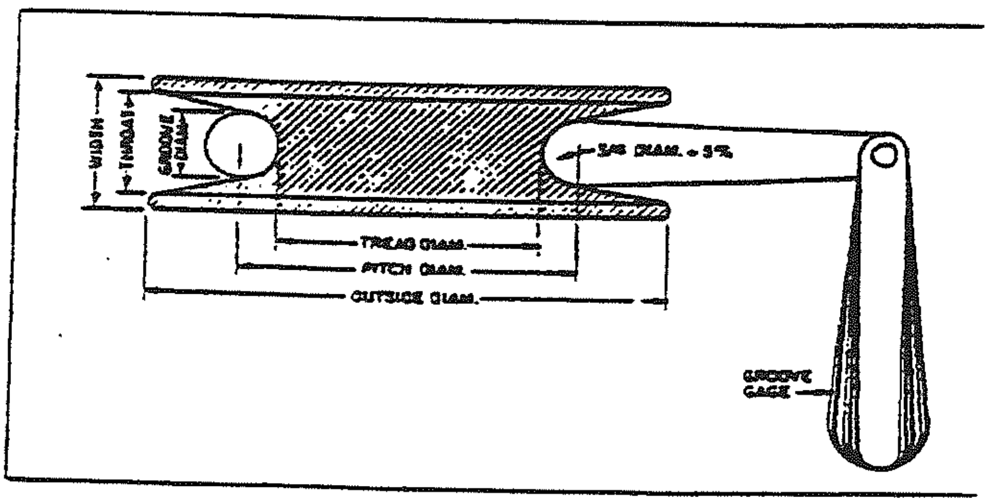


Figure 31. Illustrating the various dimensions of a sheave, and the use of a groove gage.

Jib Cranes

Daily Inspection

Condition of:______________________**Operation of:**______________________

---

1. Main Hoist Rope ______________________________
2. Spooling ______________________________
3. Anchoring ______________________________
4. Main Hook ______________________________
5. Safety Latches ______________________________
6. Markings ______________________________
7. Cleanliness ______________________________
8. Lubrication ______________________________
9. Brakes ______________________________
10. Limit Switches ______________________________
11. Trolley Stops ______________________________

Jib Cranes
Weekly Check List

Plant:____________________ **Department:**________________ **Date:**__________

Location:____________________ **Crane:**________________ **Mfg.:**__________

Condition of:____________________ **Operation of:**________________

		OK	*Needs Attention*
1.	Main Hoist Rope		
2.	Spooling		
3.	Anchoring		
4.	Main Hook		
5.	Hook Safety Latch		
6.	Cable Sheaves		
7.	Hoist Drums		
8.	Lubrication		
9.	Markings		
10.	Signs		
11.	Controllers		
12.	Switches		
13.	All Brakes		
14.	Limit Switches		
15.	Warning Device		
16.	Overload Device		
17.	Trolley Stops		

Inspected By:____________________

Comments:____

____

Jib Cranes
Monthly Inspection Report

Date:____________

Make:____________ Model:____________ S/N:__________ Location:____________

EQUIPMENT	*OK*	*FAULTY*	*EQUIPMENT*	*OK*	*FAULTY*
Supporting Structure			Hook Safety Latch		
Mountings			Load Brake Assemblies		
Capacity Markings			Bearings/Shafts		
Supporting Structure			Drum Assembly		
Hoist			Gears		
Load Block			Lubrication		
Power Supply			Guards		
Power Supply Cutout			Cleanliness		
Controls			Hand Signal Charts		
Warning Device			Operation Test		
Controls Identification			Overload Limit Switch		
Pendant Controls			Wire Rope / Chain		
Sheaves / Flanges			Load Block		
Hook					

***RECOMMENDATIONS*:**

Note Any Potential Hazards or Malfunctions to Supervision Immediately in Writing

Signature:____________________

OVERHEAD CRANE / HOIST OPERATOR CHECKLIST

NACB
www.cranesafe.com
1-800-654-5640

Accredited by:
United States Dept. of Labor / OSHA under 29 CFR part 1919
State of California #CA-225 • State of Washington

Telephone: (407) 869-9970 • FAX: (407) 869-8778

CRANE#	CAPACITY	LOCATION

WALK AROUND	S	U
WIRE ROPE / REEVING		
LOWER BLOCK & HOOK		
HOOK SAFETY LATCH		
GENERAL APPEARANCE		
SAFETY GUARDS		
NO LOOSE PARTS		
WALKS / LADDERS / HANDRAILS		

CONTROLS	S	U
PUSHBUTTON STATION		
PROPER MARKING		
REMOTE / RADIO		
LEVER TYPE CO[illegible]LL[illegible]		
START / ST[illegible] B[illegible]N		
PROPER S[illegible]OR[illegible]OR P / P[illegible]		

OPERATIONAL	S	U
LIMIT SWITCH		
HOIST TRAVEL		
TROLLEY TRAVEL		
BRIDGE TRAVEL		
BRAKE(S)		
ELECTRICAL DISCONNECT		

Remarks:	
	Operator's Signature
	Date
	Supervisor's Signature (if found unsatisfactory)
	Date

INSTRUCTIONS: Inspect all applicable items indicated, each shift. Suspend all operations immediately when observing an unsatisfactory condition which might create a hazard. In addition, suspend operation when any unsafe condition is observed and immediately notify supervisor. Other conditions affecting safety shall be noted under "REMARKS" and reported to supervisor.

1-800-654-5640
www.cranesafe.com

METAL MESH SLING CONDITION REPORT

Accredited by:
United States Dept. of Labor / OSHA under 29 CFR part 1919
State of California #CA-225 • State of Washington

Telephone: (407) 869-9970 • FAX: (407) 869-8778

INSPECTOR:_____________________________ **DATE:** ________________

BROKEN, WELDED OR BRAZED	REDUCTION IN WIRE DIAMETER	REDUCTION DUE TO CORROSION	LOSS OF FLEXIBILITY	BENT OR TWISTED BELT	DISTORTION OF EITHER HANDLE	REDUCTION OF CROSS SECTION AT HANDLE EYE	RATED CAPACITY EMBOSSED IN HANDLE	RETURN TO SERVICE	REMOVE FROM SERVICE				COMMENTS

Metal Mesh Sling Inspection Recommendations

INSPECTION: Sling shall be removed from service if any of the following are present:

1. A broken weld or brazed joint along sling edge.
2. Reduction in wire diameter of 25% due to abrasion or 15% due to corrosion.
3. Lack of flexibility due to distortion of the fabric in the sling body.
4. Distortion of the female handle so that the depth of the slot is increased more than 10%.
5. Distortion of either handle so that the width of the eye is decreased more than 10%.
6. A 15% reduction of the original cross sectional area of metal at any point around the handle eye.
7. Distortion of either handle out of its plane.

NACB
1-800-654-5640
www.cranesafe.com

SYNTHETIC WEB SLING CONDITION REPORT

Accredited by:
United States Dept. of Labor / OSHA under 29 CFR part 1919
State of California #CA-225 • State of Washington

Telephone: (407) 869-9970 • FAX: (407) 869-8778

INSPECTOR: ______________________________ DATE: ______________

SLING I.D.# RATED CAPACITIES	ACID BURNS	MELTING OR CHARRING	SNAGS	PUNCTURES	TEARS	CUTS	BROKEN STITCHES	WORN STITCHES	DISTORTED FITTINGS	WORN FITTINGS	RETURN TO SERVICE	REMOVE FROM SERVICE	COMMENTS

Synthetic Sling Inspection Recommendations

INSPECTION: Slings shall be removed from service if any of the following are present:

1. Acid or caustic burn.
2. Melting or charring of any of the sling surface.
3. Snags, punctures, tears or cuts.
4. Broken or worn stitches.
5. Distortion of fittings.

NACB
1-800-654-5640
www.cranesafe.com

ALLOY STEEL CHAIN CONDITION REPORT

Accredited by:
United States Dept. of Labor / OSHA under 29 CFR part 1919
State of California #CA-225 • State of Washington

Telephone: (407) 869-9970 • FAX: (407) 869-8778

INSPECTOR:____________________________ **DATE:** __________________

LOCATION	SER.#	TYPE	SIZE	REACH	COND.			STRETCHED	BENT/TWISTED	GOUGED	RUST/PITTED	WORN BELOW MIN.	HOOK DAMAGED		COMMENTS
					O.K.	REPAIR	SCRAP								

Alloy Steel Chain Sling Inspection Recommendations

INSPECTION: Sling shall be removed from service if any of the following are present:

1. Defective welds.
2. Chain link bending or elongation.
3. Refer to Table N-184-2 for minimum allowable chain size.
4. Cracked or deformed master links, coupling links or other components.
5. If hooks are cracked, have been opened more than 15% of the normal throat opening measured at the narrowest point or twisted more than 10° from the plane of the unbent hook.

WIRE ROPE & HOOK CONDITION REPORT

Accredited by:
United States Dept. of Labor / OSHA under 29 CFR part 1919
State of California #CA-225 • State of Washington

Telephone: (407) 869-9970 • FAX: (407) 869-8778

NACB 1-800-654-5640 www.cranesafe.com

INSPECTOR:______________________ DATE:__________ INSPECTION #:________

CUSTOMER:__________________________ UNIT# __________________________

CRANE MANUFACTURER:______________ CRANE LOCATION:______________

	WIRE ROPE			HOOK		
APPLICATION	MEASURED DIAMETER	ROPE DAMAGE	BROKEN WIRES	TRAM DIMENSION	NDT RESULTS	HOOK INSP.
MAIN HOIST						
AUX. HOIST						
AUX. HOIST						
PENDANTS						
PENDANTS						
JIB STAYS						
BOOM HOIST						

SAMPLE FORM

Wire Rope & Hook Condition Inspection Recommendation

INSPECTION: Wire shall be removed from service if any of the following are present:

1. A. Six (6) randomly distributed broken wires in one (1) lay or three (3) broken wires in one strand - mobile cranes.
   B. Twelve (12) randomly distributed broken wires in one (1) lay or four (4) broken wires in one strand in one lay -overhead cranes.
2. Wear or scraping of **one-third (1/3)** the original diameter of outside individual wires.
3. Kinking, crushing, birdcaging or any other damage to wire rope structure.
4. Evidence of heat damage.
5. End attachments that are cracked, deformed or worn.
6. Corrosion of the rope or end attachments
7. Hooks that have been opened more than 15% of the normal throat opening measured at the narrowest point or twisted more than 10° from the plane of the unbent hook.

A PROCEDURE FOR SLING CHAIN INSPECTION

A good sling chain inspection program should provide more than a physical check of the chains' condition. It should be a complete recorded history of each unit.

If conditions and time make it impossible to write such a history, the following two requirements are minimum essentials in any type of inspection program.

1. Positive identification of the chain as to the material from which it is made.

2. Evaluation of the condition of the chain.

After identification of chain is completed, a proper procedure for inspection can be conducted in the following manner:

1. A dirty chain should be cleaned so that defects may be detected more easily.

2. Hang chain in a vertical position for preliminary inspection and to measure length. When this is not possible, stretch chain out on level floor with all twist removed.

3. Record the serial number, current measured length, size, type and grade of material on your work sheet. If no serial number is available, an I. D. tag should be attached that shows the size, grade, reach, rated capacity and sling manufacturer.

4. Compare the new measured length with the length shown on the original I.D. tag. An increase in length may be due to stretch or wear, or a combination of both. If the new measurement is more than the original it should be analyzed as follows:

   a. Check for localized stretch or wear.

   b. Lift each link from its seat and check for grooving.

   c. Also during this point of inspection look for:

      (1) Twisted and bent links

      (2) Cracks and welded areas

      (3) Gouges or other marks

      (4) Corrosion pits

      (5) Burned links caused by welding "strings," buss bar or ground contacts

d. Check master link and hooks for any of the above faults. Hooks should be removed from service if they have been opened more than 15% of the normal throat opening, measured at the narrowest point or twisted more than 10° from the plane of the unbent hook.

In recent years some manufacturers have identified their chain links with appropriate marking to help you. Some alloy slings will have the letter "A" stamped on the hook(s), or three welded dots on the top coupling link(s).

<u>STRETCH OR WEAR</u>? It is important that an inspector realize the difference between stretch and wear. A chain with long service and frequent use will increase in length even if not overloaded. This increased length caused by wear should not be confused with stretch. It is also possible to get increased length due to stretch with little or no wear. At times there will be a combination of both conditions.

Remember that increased length due to wear is normal for a chain that has been in service for a long period of time. However, increased length due to stretch, with little or no wear, indicates a serious error in the lifting procedure.

An accurate manner to check stretch or elongation is to measure the inside length of the link(s). Deduct the wear (difference between original wire size and measured wire size) from the bearing points and divide this amount by the original length of the link.

EXAMPLE 1/2" alloy (when new) inside length 1.55

Measure link length 1-11/16" or 1.68
Measured bearing point wear 1/32"x2+1/16" or .06
Deducted from measured link length and take result, 1.62" divided by 1.55" = 1.05, or approximately 5% stretch

Although this method will provide you with the most accurate results, difficulties may be encountered because all manufacturers vary slightly in their link lengths. This method of computation should be followed only where the original link length is known. Therefore, when establishing your original inspection record cards, link lengths should be recorded after measurement before all new chains are put into service. A similar procedure should be conducted on any chain added after it has been repaired.

Normally wear will occur primarily at the bearing points, the inside ends of the links where the adjoining links are seated. Where wear is evident, measure the cross section of the link(s) at each end. If the amount of wear reduces the diameter below the following figures, the chain should be removed from service.

Gauges can easily be made showing these minimum figures. These gauges should be made so that they may be inserted at the bearing points. Gauges that will not fit into these areas will be of little value.

CHAIN SIZE, INCHES	MAXIMUM ALLOWABLE WEAR, INCH	CHAIN SIZE, INCHES	MAXIMUM ALLOWABLE WEAR, INCH
1/4	3/64"	1	3/16"
3/8	5/64"	1-1/3	7/32"
1/2	6/64"	1-1/4	1/4"
5/8	9/64"	1-3/8	9/32"
3/4	5/32"	1-1/2	5/16"
7/8	11/64"	1-3/4	11/32"

Chains that show signs of stretch or wear can be divided into four categories.

1. Stretch throughout the entire length of chain
2. Localized stretch
3. Combination of stretch and wear
4. Wear only

<u>STRETCH THROUGHOUT THE ENTIRE LENGTH OF CHAIN</u> can only be caused by overload. If chain is multi-legged, there is the possibility that extremely low angle lifts caused overload. If at all possible, angle between the chain branch and the horizontal of less than 30° should not be used in making lifts. Check applicable lifts vs working load figures for corresponding angles. Chances are that by increasing the size of your sling by one size you will be able to correct this problem.

<u>LOCALIZED STRETCH</u> differs from stretch throughout the entire length of chain inasmuch as in all probability the initial load was below the weight which would cause permanent deformation. This condition is often caused by either choking a load at low angles or using wrapped loads on sharp corners without proper padding or means of chain protection. Chains wrapped around sharp corners can cause stress to be applied to one or very few links rather than the entire length of chain. Here too, the angles of lift should be checked with applicable working load figures. Efforts should be made to protect chain on sharp corners.

WEAR ONLY should be investigated on the basis of severity of service, time in service and size of sling. For very severe applications inducing wear, it is often more economical to change to a sling made from larger material diameter or to consult your chain manufacturer concerning the advisability of changing heat treatment to provide a more abrasion resistant product.

COMBINATION OF STRETCH AND WEAR Prime attention when considering the worn portion of the chain should be given to the length of time the sling has been in service. If usage has been over a prolonged period of time, worn portions are probably normal and stretched links should be investigated as stated in previous paragraphs.

GOUGES AND NICKS are serious, but their location on a chain link is also important. A gouge or nick which runs across a link is more serious than one which runs parallel to the length of the link. Damage is most serious in the areas located on the inside and outside ends of a chain link. Sharp transverse nicks should be ground out with a hand grinder. When the depth of the nick or gouge is greater than 15% of the chain link wire diameter, the chain should be removed from service.

CHAINS THAT HAVE BEEN REJECTED BECAUSE OF GOUGES OR NICKS should be evaluated as in "LOCALIZED STRETCH." There are possibilities that the chains were used on sharp corners and that padding or other means of chain protection would help. The hardness of the chain should also be checked.

CHECK MASTER LINKS for wear and correct style. If a pear shaped master link is used on a large crane hook it may not seat properly if inverted. The pear shaped master link is normally used only with a single sling chain. In most instances an oblong master link is desirable with multi-legged slings.

ALLOY STEEL CHAINS and chain slings shall not be heated above 600° after being received from the manufacturer.

Should you have a problem where elevated temperatures are encountered, contact your chain manufacturer. There is a possibility that chains drawn at a higher temperature will help with your particular requirement.

UPON COMPLETION OF YOUR INSPECTION the inspection record cards should be reviewed. Information should now be available that could help reduce the number of future rejections.

STORAGE OF CHAINS chains should be hung on racks in the shop. If a survey reveals that there are excessive chains in a certain area, they should be removed to the store room or considered for usage in other parts of the plant. Good storage facilities will impress workers that chains must be given proper care at all times.

AND FINALLY, DO IT NOW! Don't allow chains with defects to lie around the plant upon completion of the inspection. Workers will be impressed with your surveys and their importance if you take immediate action.

SYNTHETIC WEB SLINGS

Requirements Applicable to All Types of Slings:

The following is a list of the requirements that apply in the use of ALL 5 major types of slings listed in the OSHA standard.

Safe Operation Practices - Whenever any sling is used the following practices shall be observed:

1. Slings that are damaged or defective shall not be used.
2. Slings shall not be shortened with knots or bolts or other makeshift devices.
3. Sling legs shall not be kinked.
4. Slings shall not be loaded in excess of their rated capacities.
5. Slings used in a basket hitch shall have the loads balanced to prevent slippage.
6. Slings shall be securely attached to their loads.
7. Slings shall be padded or protected from the sharp edges of their loads.
8. Suspended loads shall be kept clear of all obstruction.
9. All employees shall be kept clear of loads about to be lifted and of suspended loads.
10. Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load.
11. Shock loading is prohibited.
12. 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.

SYNTHETIC WEB SLINGS

The following are ADDITIONAL requirements that apply specifically to Synthetic Web Slings:

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

2. Slings must contain web that is of uniform thickness and width, and selvage edges must not be split from the webbing's width.

3. Fittings must be free of all sharp edges that could damage the webbing and must be of a minimum breaking strength equal to that of the sling.

4. Stitching shall be the only method used to attach end fittings to webbing and to form eyes.

5. Slings illustrated in OSHA figure N-184-6 must not be used with loads in excess of the rated capacities specified in OSHA table N-184-20 thru N-184-22. Slings not included in these tables must be used only in accordance with the manufacturer's recommendations.

6. Web slings must not be exposed to fumes, vapors, sprays, mists or liquids of the following chemicals:

    a. acids and phenolics - do not use nylon.

    b. caustics - do not use polyester, polypropylene, or slings with aluminum fittings.

7. Nylon and polyester slings must not be used at temperatures above 200°F.

8. Repaired slings must not be used unless they were repaired and proof tested by a sling manufacturer (or an equivalent entity). The proof test must be twice the rated capacity, and a certificate of the proof test must be available for examination. Slings which have been repaired in a temporary manner must not be used.

9. Slings shall be immediately removed from service if any of the following conditions are present:

   a. acid or caustic burns.

   b. melting or charring of any part of the sling surface.

   c. snags, punctures, tears or cuts.

   d. broken or worn stitches.

   e. distortion of fittings.

WIRE ROPE CARE

Wire rope, like any other complex mechanical device, gives service in direct ratio to the care it gets. Neglect and abuse are the most common causes of early failure.

A rope subjected to high impact stresses, excessive vibration, continual overloading, abrasion, or any other damaging condition cannot be expected to last long as one used properly by skilled operators. Nor can a neglected rope, exposed continually to fair and foul weather without proper lubrication and protection, be expected to deliver the life potential built into it.

Wire rope is a tough, flexible, and complex power transmission member made up of many individual wires. For example, a 6 x 39 rope with an independent wire rope core is composed of 343 wires, all subject to torsion, bending, tension, and compressive stresses. To give maximum performance, it requires adequate lubrication.

Good lubrication prevents corrosion and minimizes metal to metal contact between individual wires. It reduces wear on the rope and on the drums and sheaves the rope touches.

Oil preserves and protects fiber cores, insuring adequate support for the overlying steel strands.

During operation, stresses and pressures imposed on a rope tend to force lubricants to the rope surface. Through contact with rollers, sheaves, and drums, through erosion by the elements, and through contamination, both the quantity and effectiveness of the lubricants is reduced.

A corroded rope is reduced in strength for a number of reasons. Actual metal cross section area is lost. Damage to smooth wire surfaces results in uneven stress distribution, and stress concentrations are susceptible to failure through crack propagation. Corrosion also hinders normal slippage between wires, again causing uneven stresses and speeding the growth of corrosion fatigue fractures.

Systematic field lubrication is the best protection against corrosion. Intervals between applications depend on the type of rope, the load, the frequency of use, and the degree of exposure to corrosive elements, but the main thing is to keep the rope protected.

Observation is the best check. From time to time, sections of rope removed from service should be inspected internally to see how much lubricant remains.

(Rev. 1/9/90)

A good field lubricant must penetrate into the internal rope structure. It must adhere to the wires and resist squeezing out. Corrosion inhibitors having polar qualities are desirable additives.

Light bodied compounds with all these qualities are available. They can be applied cold, so that application can be by hand, by dipping or by spraying.

When rope must wind on a drum in more than one layer, the greatest wear is usually at the change of layers or at points of crossover. The life of the rope can be extended if the drum end is shortened periodically and reattached so that wear points are shifted.

Usual procedure is to remove a length of about 1 1/4 wraps; this shifts layer changes at least one wrap and crossovers about 90 degrees. On very large drums, a length of 3/4 wrap may be sufficient. Three or more such cuts should be made at even intervals during a rope life.

Fatigue often develops in a rope adjacent to the attachment; vibration damped there imposes excessive bending on the wires, and changes in tension lead to failure in torsion. This condition is most common at a zinc poured type socket.

Prevention of failure requires shortening of the rope and should be cut off. With a thimble and clip, or thimble and clamp attachment, the entire section in contact with thimble, clips, or clamps on both sides should be discarded.

Dragline ropes wear most rapidly near the bucket, and incline ropes in the 50 or 100 ft. section closest to the attachment. On cranes or other rigs where a rope is in contact with a small equalizer sheave, deterioration is most apt to occur at this point.

The best medicine for all these ills is to carry enough spare line to allow for periodic cutting and shifting of stress points. Another way is to turn the rope end for end, but this takes time and may cost more than a new rope.

With the improved efficiency and increased operating speeds that come with electronic controls, it becomes all the more important to keep sheaves and drums in proper condition. The role of equipment maintenance in prolonging the life of wire rope is greater than ever.

Not that a sheave has to be replaced or reworked immediately when its groove shows signs of being a bit smaller than that recommended for a new rope. Operating ropes pull down to a stable diameter soon after installation. This, and normal wear, reduces rope diameter to a point where a slightly worn groove easily accommodates it.

But anything harmful to the rope, such as a bad bearing, broken or worn sheave treads or flanges, bad rollers, or any condition that promotes excessive vibration should be corrected as soon as possible.

Accurate rope records should give a complete maintenance story, not only for the rope itself, but also for the equipment components that are in contact with the rope.

The key person in all this is the rig operator. Their skills and efforts pay dividends by reducing rope costs as well as maintenance costs for the entire unit.

APPENDIX "N-2e"

DAILY SLING INSPECTION REPORT

Date____________________ Inspected by:____________________

Department____________________ Sling Mfg.____________________

Cap/Reach____________________ Other Identification____________________

	O.K.	Maint.Rec'd.	Date Repaired
CHAIN SLINGS			
A. CHAIN			
1. Stretch or wear	___	___	___
2. Grooving	___	___	___
3. Cracks	___	___	___
4. Gouges	___	___	___
5. Corrosion	___	___	___
6. Burns	___	___	___
B. MASTER LINKS			
1. Stretch or wear	___	___	___
2. Twisted or bent	___	___	___
3. Cracks	___	___	___
4. Gouges	___	___	___
5. Corrosion	___	___	___
6. Burns	___	___	___
7. Hooks	___	___	___
Cracks or defects	___	___	___
Throat opening-15%	___	___	___
Twist-10%	___	___	___
C. OTHER ITEMS			
1. Identification tag	___	___	___
2. Proper grade (grade 8)	___	___	___
WIRE ROPE SLINGS			
A. WIRE ROPE			
1. Random broken wires/ lay (10)	___	___	___
2. Random broken wires/ strand (5)	___	___	___
3. Wear or scraping	___	___	___
4. Kinking	___	___	___
5. Crushing	___	___	___

	O.K.	Maint.Rec'd.	Date Repaired
6. Bird caging	___	___	___
7. Distortion of structure	___	___	___
8. Heat damage	___	___	___
9. Corrosion	___	___	___

B. END ATTACHMENTS

1. Proper wire rope clips	___	___	___
2. Cracked	___	___	___
3. Deformed	___	___	___
4. Worn	___	___	___
5. Corrosion	___	___	___

C. HOOKS

1. Defects or cracks	___	___	___
2. Throat opening-15%	___	___	___
3. Twist-10%	___	___	___

SYNTHETIC WEB SLINGS

A. WEBBING

1. Acid or caustic burns	___	___	___
2. Melting or charring	___	___	___
3. Snags	___	___	___
4. Punctures	___	___	___
5. Tears	___	___	___
6. Cuts	___	___	___
7. Broken or worn stitches	___	___	___

B. FITTINGS

1. Cracked	___	___	___
2. Deformed	___	___	___
3. Worn	___	___	___
4. Corrosion	___	___	___

C. HOOKS

1. Defects or cracks	___	___	___
2. Throat opening-15%	___	___	___
3. Twist-10%	___	___	___

METAL, MESH SLINGS

A. MESH

1. Broken weld	___	___	___
2. Broken brazed joint	___	___	___
3. Reduction in diameter	___	___	___

	O.K.	Maint.Rec'd.	Date Repaired
4. Lack of flexibility			
5. Distortion of either handle			

NATURAL AND SYNTHETIC FIBER ROPE SLINGS

1. Proper splices			
2. Abnormal wear			
3. Powdered fiber between strand			
4. Broken or cut fibers			
5. Variation in size			
6. Discoloration or rotting			
7. Distortion of hardware			

Required corrective action:____________________

COMMENTS:____________________

Received Plant Engineering: Name________________

Date________________

Standard Interpretations

08/04/2000 - Alloy steel chain slings must not be loaded beyond working load limit.

Standard Interpretations - Table of Contents

- **Standard Number:** 1926.251(b)(4); 1926.251(a)(2); 1926.550(a)(19)

August 4, 2000

Mr. David Miguel
Underground Specialist
Shoring and Supply Co., Inc.
Accutech Instruments
7700 Wedd Street
Overland Park, KS 66204

RE: 1926.251

Dear Mr. Miguel:

This is in response to your October 17, 1999, letter to the Occupational Safety and Health Administration (OSHA) in which you ask a question relating to the requirements of using alloy steel chains for material handling. We apologize for the delay in issuing a response.

Question: Is it acceptable to use a sling of less than Grade 80 alloy chain if the load is lifted off the ground but never over the heads of employees?

Answer Section 1926.251(a)(2) states that "rigging equipment shall not be loaded in excess of its recommended safe working load, as prescribed in Tables H-1 through H-20 . . ." (also, §1926.251(b)(4) states that the rated capacity for alloy steel chain slings shall conform to the values in Table H-1). Table H-1 prescribes rated capacities (working load limits) for alloy steel chain only. Therefore, the standard mandates that only alloy steel chain be used, and that such chain meet the Table H-1 rated capacities.

Section 1926.251 does not specify a particular grade of "alloy steel chain" for rigging material lifts. Nor does it list capacities for various grades of alloy steel chain. Rather, it lists capacity requirements for various sizes of alloy steel chain when used at various angles and configurations. So, whatever grade of alloy steel chain that is used, it must meet the capacity requirements listed in Table H-1. Therefore, steel alloy chain of less than Grade 80 can only be used if it meets the capacity requirements listed in 29 CFR 1926.251.

Many employers choose to use Grade 80 because it will meet or exceed the Table H-1 requirements for the various sizes, angles and configurations. A lesser grade is permitted to be used only if it meets the Table H-1 requirements.

You raise the issue of whether these requirements apply if the load is not lifted over the employees' heads. The standard, by its terms, does not condition the application of the requirements to overhead loads. In fact, §1926.550(a)(19) (general requirements for cranes and derricks) states that "all employees shall be kept clear of loads about to be lifted and of suspended loads." The rigging requirements apply equally when employees are kept clear in accordance with this requirement. Even employees who are not directly under a load can be exposed to the hazard of failed rigging. When a rigging chain brakes, the material will not always fall straight down; it can shift and/or swing and then fall over a fairly broad area, depending on the height, weight, type of load, etc. There are also situations where the falling load can collapse a working surface.

If you require any further assistance, please do not hesitate to contact us again by writing to: Directorate of Construction - OSHA, Office of Construction Standard and Compliance Assistance, Room N3468, 200 Constitution Avenue N.W., Washington D.C. 20210.

Sincerely,

Russell B. Swanson, Director
Directorate of Construction

Standard Interpretations - Table of Contents

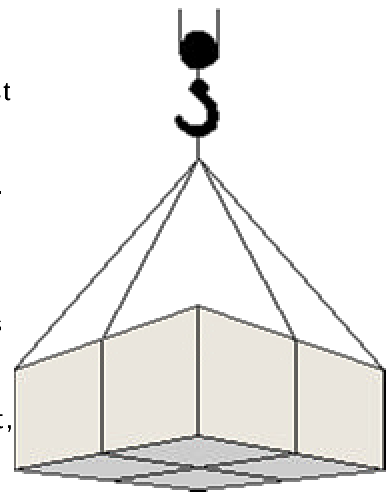
The following section on sling safety and the standard interpretation letter on fall protection for various lifting devices were created with construction as the primary emphasis. However, the information contained in these sections is also pertinent to industry and is therefore included in this manual.

Construction Safety and Health Outreach Program

U.S. Department of Labor
OSHA Office of Training and Education
May 1996

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.

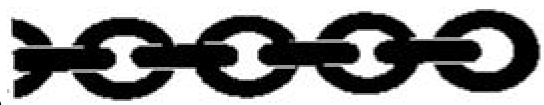
A well-trained operator can prolong the service life of equipment and reduce costs by avoiding the potentially hazardous effects of overloading equipment, operating it at excessive speeds, taking up slack with a sudden jerk, and suddenly accelerating or decelerating equipment. The operator can look for 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

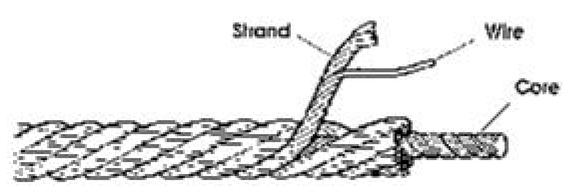


Chains are commonly used because of their strength and ability to adapt to the shape of the load. Care should be taken, however, when using alloy chain slings because they are subject to damage by sudden shocks. Misuse of chain slings could damage the sling, resulting in sling failure and possible injury 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^{o}F; however, when alloy chain slings are consistently exposed to service temperatures in excess of 600^{o}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

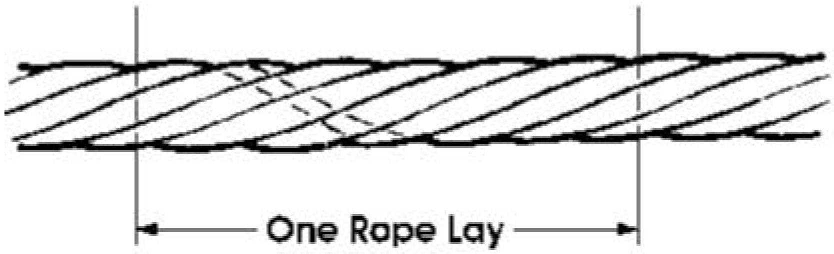


A second type of sling is made of wire rope. Wire rope is composed of individual wires that have been twisted to form strands. The strands are then twisted to form a wire rope. When wire rope has a fiber core, it is usually more flexible but is less resistant to environmental damage. Conversely, a core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

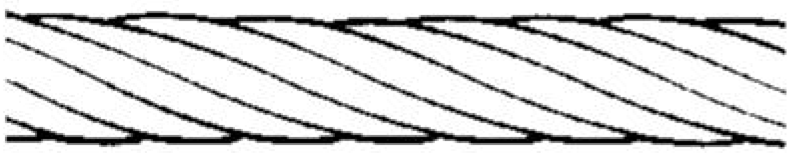
Rope Lay

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.

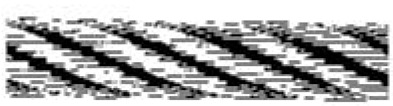


2. *The direction the strands are wound around the core:* Wire rope is referred to as *right lay* or *left lay*. A right lay rope is one in which the strands are wound in a right-hand direction like a conventional screw thread (see figure below). A left lay rope is just the opposite.



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, Long Lay

Left Lay, Regular Lay

Left Lay, Long 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.

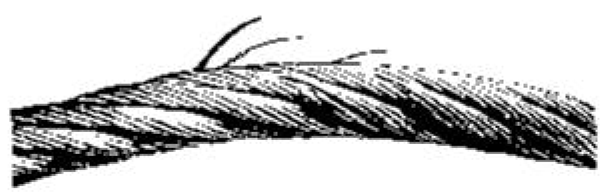
Lang lay ropes are more flexible and have greater wearing surface per wire than regular lay ropes. In addition, since the outside wires in lang lay rope lie at an angle to the rope axis, internal stress due to bending over sheaves and drums is reduced causing lang lay ropes to be more resistant to bending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



Wire Rope Fatigue Failure

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.

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.

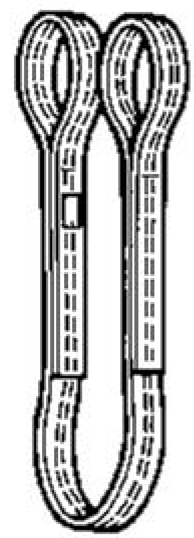
The choice of rope type and size will depend upon the application, the weight to be lifted and the sling angle. Before lifting any load with a fiber rope sling be sure to inspect the sling carefully because they deteriorate far more rapidly than wire rope slings and their actual strength is very difficult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

Aerial Lifts Safety

Standard Interpretations

08/14/2000 - Fall protection for various lift-devices; restraint, positioning, fall arrest and rescue requirements; maintenance vs. construction examples.

Standard Interpretations - Table of Contents

• **Standard Number:** 1926.451(g)(1)(vii); 1926.451(g)(4); 1926.453(b)(2)(v); 1926.500; 1926.502(d); 1919.502(d)(20)

August 14, 2000

Mr. Charles E. Hill
Chairman, National Telecommunications Safety Panel
Southwestern Bell Telephone Company
St. Louis, Missouri 63101

Dear Mr. Hill:

This is in response to your letter of July 28, 1998, in which, representing the National Telecommunications Safety Panel and the dozen large companies it represents, you asked for interpretations regarding the telecommunications industry and the applicable Occupational Safety and Health Administration's (OSHA) standards for fall protection in bucket trucks. You asked four questions regarding OSHA?s construction standards for scaffolds and fall protectio n as well as our general industry standards for powered platforms, manlifts, and vehicle-mounted work platforms. This letter responds only to the issues you raised regarding construction work. While we had hoped to be able to include answers in this letter to your general industry questions, OSHA is continuing to work with a number of industry groups on resolving those issues. Therefore, OSHA will address the general industry questions separately once that work is completed. We apologize for long time that this process has taken.

You ask us to describe the OSHA fall protection requirements for working from scissor lifts, aerial lifts and boom-type elevating work platforms. You also ask us to explain the difference between fall restraint systems, positioning systems, and fall arrest systems.

When Fall Protection On This Equipment Is Required in Construction Work

Aerial lifts/ boom-type platforms
Section 1926.453(b)(2)(v) of the Aerial Lift standard provides that workers in aerial lifts and boom-type platforms must be tied-off.

Scissor lifts
Workers on scissor lifts must either be tied-off or protected by guardrails. The Aerial Lift standard (§1926.453) applies to equipment covered in ANSI A92.2 (1969). Scissor lifts are not addressed in that ANSI standard; consequently, they are not covered by the Aerial Lift standard. Since they are a type of work platform, they are covered under the scaffold standard, §1926.451. Paragraph (g)(1)(vii) of §1926.451 requires that employees be protected by a personal fall arrest system or a guardrail system that meets the requirements of §1926.451(g)(4).

The options for tie-off are delineated below.

Restraint, Positioning and Fall Arrest Systems in Construction Work

Restraint Systems
A restraint system prevents a worker from being exposed to any fall. If the employee is protected by a restraint system, either a body belt or a harness may be used. When a restraint system is used for fall protection from an aerial lift or a boom-type elevating work platform, the employer must ensure that the lanyard and anchor are arranged so that the employee is not potentially exposed to falling *any* distance.

Positioning Devices: Construction Work
The only time a body belt may be used where there may be a fall is when an employee is using a “positioning device.” In §1926.500 of the construction standards for fall protection, a “positioning device system” is defined as a body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall (or a pole), and work with both hands free while leaning. Therefore, in construction work, a positioning device may be used only to protect a worker on a *vertical* work surface. These devices may permit a fall of up to 2 feet (0.6 m). They may be used in concrete form work, installation of reinforcing steel, and certain telecommunications work. Since construction workers in bucket trucks, scissor lifts and boom-type elevating work platforms are on a *horizontal* surface, a positioning device may not be used for those workers.

Fall Arrest Systems Used in Construction Work
A device that permits an arrested fall is considered a fall arrest system. In construction work a body harness must be used in these systems. A fall arrest system can only be used where the aerial lift or scaffold is designed to withstand the vertical and lateral loads caused by an arrested fall. Fall arrest systems used in construction must comply with §1926.502(d). That provision prohibits the use of a body belt in a fall arrest system, and instead requires the use of a body harness.

Construction Work: When Does The Rescue Provision -- §1926.502(d)(20) ? Apply?

You ask if employers must provide for self-rescue or prompt rescue when their employees are using a work positioning or restraint system. In light of the above definitions, we interpret your question as follows: first, must self-rescue or prompt rescue be provided where a harness and lanyard are set up so that the worker is not exposed to any fall (a restraint system)? The answer is no, since the worker would not be exposed to any fall.

Second, must the rescue provision be met where the worker is protected by a positioning system? The rescue provision applies where a fall arrest system is used while doing construction work. In construction work, a worker may use a positioning device only while working on a vertical work surface. Workers therefore may not use a positioning device while in a bucket truck or on a scissor lift. The only option other than a restraint system in that circumstance is a fall arrest system. If the lift can support the forces of an arrested fall and if a fall arrest system is used because the worker is exposed to a fall, the rescue provision does apply.

What Does The Rescue Provision Require

Prompt rescue, as required under §1926.502(d)(20), is not defined in the standard. The particular hazard that §1926.502(d)(20) addresses is being suspended by the fall arrest system after a fall. While an employee may be safely suspended in a body harness for a longer period than from a body belt, the word "prompt" requires that rescue be performed quickly -- in time to prevent serious injury to the worker.

You note that electrical utility and telecommunications workers sometimes work alone and that the employees? "status is maintained through normal work rules and operating procedures." We recognize that there are a wide range of variables and circumstances between worksites. The standard requires that, to the extent feasible, a reliable system be in place to ensure that rescue will be prompt. Precisely what is required to comply with this provision in a remote location will depend on what is feasible under the particular circumstances. The range of feasible options available in remote locations may be more limited than in more populated areas.

Applicability of Construction Standards to Electrical Utility and Telecommunications Work

You ask several questions relating to the applicability of OSHA construction standards to electrical utility and telecommunications work. Your questions ask us to distinguish between construction work, to which the OSHA construction standards apply, and maintenance work, where they do not apply. The following principles and examples apply in distinguishing between construction and maintenance:

(A) It is the activity to be performed, not the company?s standard industrial classification (SIC) code, that determines whether the construction standard applies;

(B) "Maintenance" means keeping equipment or a structure in proper condition through routine, scheduled or anticipated measures without having to significantly alter the structure or equipment in the process. For equipment, this generally means keeping the equipment working properly by taking steps to prevent its failure or degradation.

(C) Whether repairs are maintenance or construction depends on the extent of the repair and whether the equipment is upgraded in the process.

Example No. 1: Maintenance
Five percent of a company?s utility lines are downed in a storm and are repaired or replaced. In so doing, the service is restored, with the same capacity and capabilities it had before the damage. This is maintenance work because only a small part of the total system is repaired or replaced and the work returns the system to its original condition.

Example No. 2: Construction
Three quarters of a company?s lines are damaged and replaced. This is construction because

the work is done to a very large portion of the total system.

Example No. 3: Construction
A few lines are changed to upgrade service. This is construction work because this part of the system, though only a very small portion, is improved relative to its condition before the work was done.

Example No. 4: Maintenance
A small water shut-off valve in a large, complex chemical processing system is removed and replaced. Its replacement is part of the routine maintenance of the system and removing and replacing the valve is done without making major alterations to the rest of the system. The removal and replacement of the valve would be considered maintenance.

Example No. 5: Construction
A 36-inch valve that is one of three major components in a processing system is removed and replaced. To do the job, about half of all the parts in the system have to be cut, unbolted, moved, or otherwise altered or replaced. Removing and replacing this valve would be considered construction because the valve constitutes a major portion of the equipment it is in and a significant portion of the system?s parts must be moved or altered in the process of doing the job.

Unifying Parts 1910 and 1926

In your letter you suggest that the Agency unify the provisions of its parts 1910 and 1926 standards for fall protection and vehicle-mounted aerial lifts. We appreciate the need to simplify standards as much as possible and will keep your suggestion in mind in our upcoming rulemakings.

If you have additional questions, please do not hesitate to contact the Directorate of Construction, Office of Construction Standards and Compliance Assistance, Room N3468, 200 Constitution Avenue, N.W., Washington D.C. 20210.

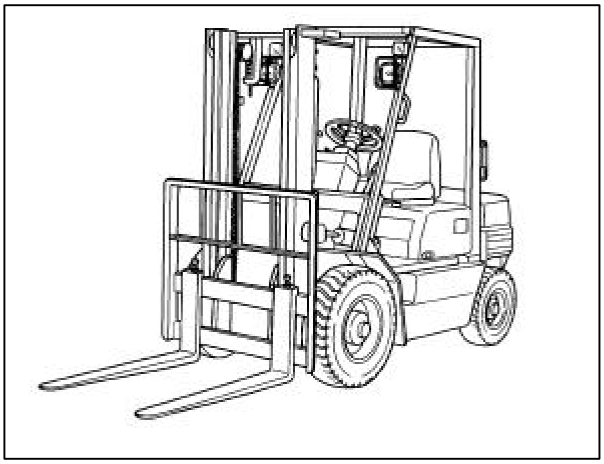
Sincerely,

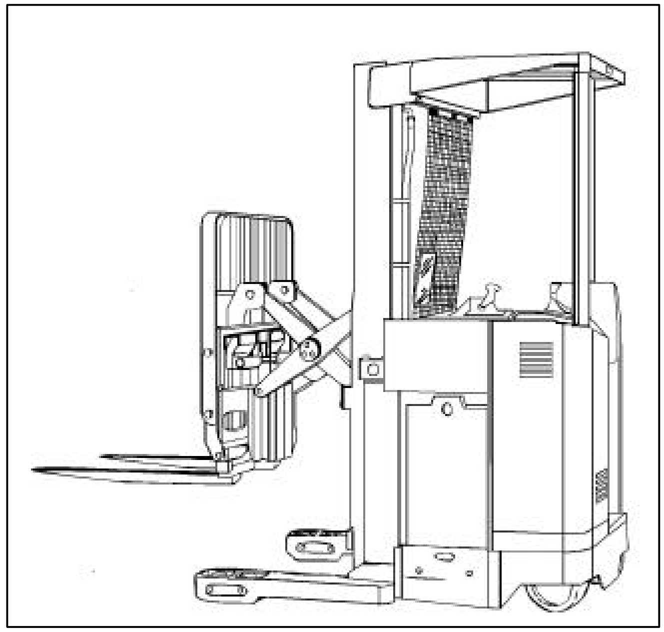
Russell B. Swanson, Director
Directorate of Construction

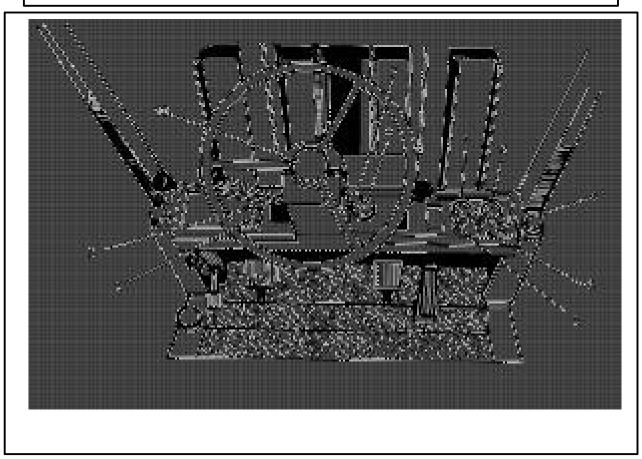
Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

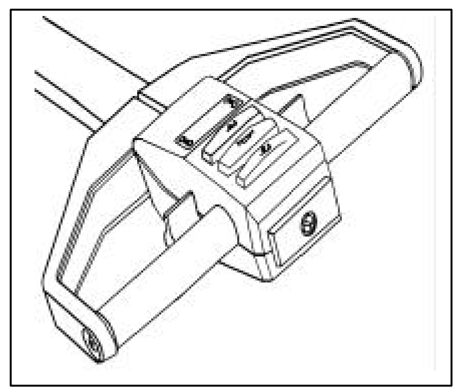
Fork Truck Training Requirements

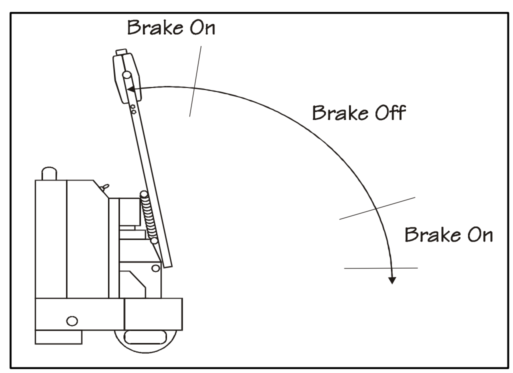
Understanding the New OSHA Powered Industrial Truck Standard 29 CFR 1910.178



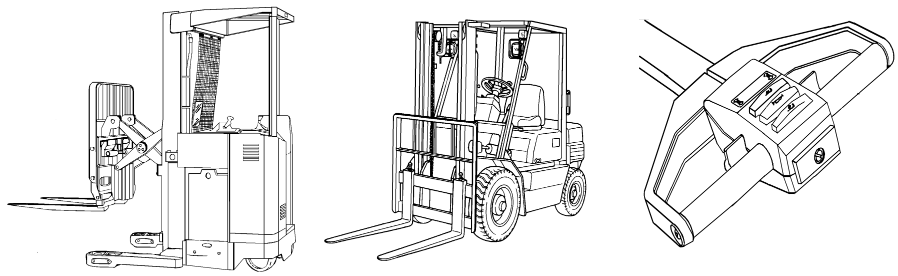








Powered Industrial Truck
29 CFR 1910.178
Final Rule



"1.5 million workers operating nearly 1 million powered industrial trucks."

Roughly 100 workers killed per year related to powered industrial truck operations :
95,000 Injured (lost work days) per year

Lack of training is one cause of powered industrial truck accidents. OSHA notes that many of the accidents listed could have been caused by improper training.

Powered Industrial Truck
Source: OSHA Analysis of Serious Accident Reports 1984-1991

- **Operator inattention --------------------- 59**
- **Overturn ----------------------------------- 53**
- **Unstable load------------------------------- 45**
- **Operator struck by load------------------ 37**
- **Elevated employees ---------------------- 26**
- **No training -------------------------------- 19**
- **Overload, improper use ---------------- 15**
- **Accident during maintenance-----------14**

Powered Industrial Truck
Source: OSHA Analysis of Serious Accident Reports 1984-1991 Cont.….

- **Improper equipment----------------------10**
- **Obstructed view -------------------------- 10**
- **Falling from platform or curb ----------- 9**
- **Carrying excess passenger--------------- 8**
- **Other employee struck by load---------- 8**
- **Falling from trailer ----------------------- 6**
- **Vehicle left in gear------------------------- 6**
- **Speeding ------------------------------------- 5**

Effective date: March 1, 1999

Compliance date: December 1, 1999

OSHA estimates that - after its regulations are fully effective late this year - the U.S. will begin saving 11 of those lives and avoiding 10% of the current toll of injuries in the U.S.

Or, one life a month.

Development of a Training Program

- ***1910.178 (L)(2)(ii)*-Training must consist of a combination of formal classroom instruction, operator practical exercises, and evaluation of the operator's performance in the workplace**
- ***1910.178 (L)(2)(iii)*-All operator training and evaluation shall be conducted by persons who have the knowledge, training, and experience to train powered industrial truck operators and evaluate their competence**

Training Program Content:
1910.178 (L)(3) -

Powered industrial truck operators shall receive initial training in the following topics, except in topics which the employer can demonstrate are not applicable to safe operation of the truck in the employer's workplace

Truck Related Topics Content:
1910.178 (L)(3)(i)-

- **(A) All operating instructions - warnings and precautions for the types of trucks the operator will be authorized to operate**
- **(B) Similarities to, and differences from the automobile:**

Forklift	***Automobile***
Narrow wheel track	Wide wheel track
Short wheelbase	Long wheelbase
High structure	Low structure
3-point suspension	4- point suspension
Center of Gravity is higher and moves in a significant range w/loads	Center of Gravity is low and moves in a narrow range
3 or 4 wheels, Steers from the rear	4 wheels , Steers from the front

Truck Related Topics Content: **1910.178 (L)(3)(i)-** Continued

- **(C) Controls & Instruments - Location, What they do, How they operate**
- **(D) Engine or Motor - operation and maintenance**
- **(E) Steering & Maneuvering**
- **(F) Visibility - including restrictions due to loading**
- **(G) Fork and attachments - adaptation operations and limitations**
- **(H) Vehicle capacity**
- **(I) Vehicle stability**

Truck Related Content Continued: **1910.178 (L)(3)(I)**

- **(J) Vehicle Inspection and maintenance / that the operator will be required to perform**
- **(K) Refueling and/or charging, recharging batteries**
- **(L) Operating limitations - and**
- **(M) Any other operating instructions, warnings or precautions listed in the operator's manual for the types of vehicles that the employee is being trained to operate**

Workplace Related Topics Content Continued: **1910.178 (L)(3)(ii)**

- **(A) Surface conditions where the vehicle will be operated**
- **(B) Composition of loads to be carried & load stability**
- **(C) Load manipulation, stacking , unstacking**
- **(D) Pedestrian traffic in areas where vehicle will be operated**
- **(E) Narrow aisles and other restricted places**
- **(F) Hazardous classified locations**

Workplace Related Content Continued: **1910.178 (L)(3)(ii)**

- **(G) Ramps and other sloped surfaces that could effect the vehicle's stability**
- **(H) Closed environments and other areas where insufficient ventilation or poor maintenance could cause a buildup of carbon monoxide or diesel exhaust**
- **(I) Other unique or potentially hazardous environmental conditions in the workplace that could affect safe operation**

Other Hazards

- **Falling Loads**
- **Falling from Platforms, Curbs, Trailers, etc..**
- **Obstructed Views**
- **Inattention**
- **Riders**
- **Vehicle Not Maintained**
- **Carbon Monoxide**
- **Rough - Uneven - Unleveled floors**
- **Unusual Loads**
- **Classified Areas**
- **Narrow Aisles**
- **Pedestrians**

Training program implementation

- ***1910.178 (L)(2)(i)*** **- Trainees may operate a powered industrial truck only:**
- ***1910.178 (L)(2)(i)(A)*** **- Under the direct supervision of a person who has the knowledge, training, and experience to train operators and evaluate their competence; and,**
- ***1910.178 (L)(2)(i)(B)*** **- Where such operator does not endanger the trainee or other employees**

Refresher Training
1910.178 (L)(4)(ii)

Refresher training in relevant topics shall be provided to the operator when:

- **A: The operator has been observed to operate the vehicle in an unsafe manner**
- **B: When the operator has been involved in an accident or a near miss incident**
- **C: When the operator has received an evaluation that reveals that the operator is not operating the truck**

Refresher Training Continued:
1910.178 (L)(4)(ii)

- **D: The operator is assigned to drive a different type of truck; or**
- **E: A condition in the workplace changes in a manner that could affect safe operation of the truck**

Refresher Training and Evaluation
1910.178 (L) (4)(i)

Refresher training , including an evaluation of the effectiveness of that training, shall be conducted as required by paragraph (L)(4)(ii) to ensure the operator has the skills needed to operate the powered industrial truck safely

Evaluation
1910.178 (L)(4)(iii)

- **An evaluation of each powered industrial truck operator's performance shall be conducted at least every three years**

Operator Qualification

- ***1910.178 (L)(1)(i)*** **- The employer shall ensure: each potential operator is competent to operate a powered industrial truck safely, as demonstrated by the successful completion of the training and evaluation specified in this paragraph (L)**
- ***1910.178 (L)(1)(ii)*** **- Prior to permitting an employee to operate a powered industrial truck (except for training purposes) the employee has successfully completed the training required by this paragraph (L), except as permitted by paragraph (L)(5)**

Certification
1910.178 (L)(6)

The employer shall certify that each operator has :

- **Has been trained and evaluated as required in paragraph (L)**
- **The certification shall include:**

Name of Trainee Operator

Date of Training

Date of the Evaluation

Identify the person(s) performing the training and evaluation

PART 1910--OCCUPATIONAL SAFETY AND HEALTH STANDARDS

1. The authority citation for subpart N of part 1910 would be revised to read as follows:

Authority: Secs. 4, 6, 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), 9-83 (48 FR 35736) or 1-90 (55 FR 9033), as applicable.

Section 1910.177 also issued under 5 U.S.C. 553 and 29 CFR part 1911.

Sections 1910.176, 1910.178, 1910.179, 1910.183, 1910.184, 1910.189, and 1910.190 also issued under 29 CFR part 1911.

2. Section 1910.178 would be amended by revising paragraph (l) and by adding appendices A and B at the end of the section to read as follows:

Sec. 1910.178 Powered industrial trucks.

* * * * *

(l) Operator training.

(1) Operator qualifications. (i) The employer shall ensure that each potential operator of a powered industrial truck is capable of performing the duties that are required of the job.

(ii) In determining operator qualifications, the employer shall ensure that each potential operator has received the training required by this paragraph (l), that each potential operator has been evaluated by persons who have the knowledge, training, and experience to train powered industrial truck operators and evaluate their competence, while performing the required duties, and that each potential operator performs those operations competently.

(2) Training program implementation.

(i) The employer shall implement a training program and ensure that only trained drivers who have successfully completed the training program are allowed to operate powered industrial trucks. Exception: Trainees under the direct supervision of persons who have the knowledge, training, and experience to train powered industrial truck operators and evaluate their competence, shall be allowed to operate a powered industrial truck provided the operation of the vehicle is conducted in an area where other employees are not near and the operation of the truck is under controlled conditions.

(ii) Training shall consist of a combination of classroom instruction (Lecture, discussion, video tapes, and/or conference) and practical training (demonstrations and practical exercises by the trainee).

(iii) All training and evaluation shall be conducted by persons who have the knowledge, training, and experience to train powered industrial truck operators and evaluate their competence.

(3) Training program content. Powered industrial truck operator trainees shall be trained in the following topics unless the employer can demonstrate that some of the topics are not needed for safe operation.

(i) Truck related topics.

(A) All operating instructions, warnings and precautions for the types of trucks the operator will be authorized to operate;

(B) Similarities to and differences from the automobile;

(C) Controls and instrumentation: location, what they do and how they work;

(D) Power plant operation and maintenance;

(E) Steering and maneuvering;

(F) Visibility (including restrictions due to loading);

(G) Fork and attachment adaption, operation and limitations of their utilization;

(H) Vehicle capacity;

(I) Vehicle stability;

(J) Vehicle inspection and maintenance;

(K) Refueling or charging, recharging batteries;

(L) Operating limitations; and

(M) Any other operating instruction, warning or precaution listed in the operator's manual for the type vehicle which the employee is being trained to operate.

(ii) Workplace related topics.

(A) Surface conditions where the vehicle will be operated;

(B) Composition of probable loads and load stability;

(C) Load manipulation, stacking, unstacking;

(D) Pedestrian traffic;

(E) Narrow aisles and other restricted places of operation;

(F) Operating in hazardous classified locations;

(G) Operating the truck on ramps and other sloped surfaces that could affect the stability of the vehicle;

(H) Other unique or potentially hazardous environmental conditions that exist or may exist in the workplace; and

(I) Operating the vehicle in closed environments and other areas where insufficient ventilation could cause a buildup of carbon monoxide or diesel exhaust.

(iii) The requirements of this section.

(4) Evaluation and refresher or remedial training.

(i) Sufficient evaluation and remedial training shall be conducted so that the employee retains and uses the knowledge, skills and ability needed to operate the powered industrial truck safely.

(ii) An evaluation of the performance of each powered industrial truck operator shall be conducted every three (3) years by persons who have the knowledge, training, and experience to train powered industrial truck operators and evaluate their competence.

(iii) Refresher or remedial training shall be provided when there is reason to believe that there has been unsafe operation, when an accident or a near-miss occurs or when an evaluation indicates that the operator is not capable of performing the assigned duties.

(5) Avoidance of Duplicative Training.

(i) Each current truck operator who has received training in any of the elements specified in paragraph (l)(3) of this section for the types of trucks the employee is authorized to operate and the type workplace that the trucks are being operated in need not be retrained in those elements if the employer certifies in accordance with paragraph (l)(5)(i) of this section that the operator has been evaluated to be competent to perform those duties.

(ii) Each new truck operator who has received training in any of the elements specified in paragraph (l)(3) of this section for the types of trucks the employee will be authorized to operate and the type of workplace in which the trucks will be operated need not be retrained in those elements before initial assignment in the workplace if the employer has written documentation of the training and if the employee is evaluated pursuant to paragraph (l)(4) of this section to be competent.

(6) Certification.

(i) The employer shall certify that each operator has received the training, has been evaluated as required by this paragraph, and has demonstrated competency in the performance of the operator's duties. The certification shall include the name of the trainee, the date of training, and the signature of the person performing the training and evaluation.

(ii) The employer shall retain the current training materials and course outline or the name and address of the person who conducted the training if it was conducted by an outside trainer.

Note to paragraph (l): Appendices A and B at the end of this section provide non-mandatory guidance to assist employers in implementing this paragraph (l).

* * * * *

Appendixes to 31910.178

Appendix A--Training of Powered Industrial Truck Operators

(Non-mandatory appendix to paragraph (l) of this section)

A-1. Operator Selection

A-1.1. Prospective operators of powered industrial trucks should be identified based upon their ability to be trained and accommodated to perform job functions that are essential to the operation of a powered industrial truck. Determination of the capabilities of a prospective operator to fulfill the demands of the job should be based upon the tasks that the job demands.

A-1.2. The employer should identify all the aspects of the job that the employee must meet/perform when doing his or her job. These aspects could include the level at which the employee must see and hear, the physical demands of the job, and the environmental extremes of the job.

A-1.3. One factor to be considered is the ability of the candidate to see and hear within reasonably acceptable limits. Included in the vision requirements are the ability to see at distance and peripherally. In certain instances, there also is a requirement for the candidate to discern different colors, primarily red, yellow and green.

A-1.4. The environmental extremes that might be demanded of a potential powered industrial truck operator include that ability of the person to work in areas of excessive cold or heat.

A-1.5. After an employee has been trained and appropriate accommodations have been made, the employer needs to determine whether the employee can safely perform the job.

A-2. The Method(s) of Training

A-2.1. Among the many methods of training are the lecture, conference, demonstration, test (written and/or oral) and the practical exercise. In most instances, a combination of these methods have been successfully used to train employees in the knowledge, skills and abilities that are essential to perform the job function that the employee is being trained to perform. To enhance the training and to make the training more understandable to the employee, employers and other trainers have used movies, slides, video tapes and other visual presentations. Making the presentation more understandable has several advantages including:

(1) The employees being trained remain more attentive during the presentation if graphical presentation are used, thereby increasing the effectiveness of the training;

(2) The use of visual presentations allows the trainer to ensure that the necessary information is covered during the training;

(3) The use of graphics makes better utilization of the training time by decreasing the need for the instructor to carry on long discussions about the instructional material; and

(4) The use of graphics during instruction provides greater retention by the trainees.

A-3. Training Program Content

A-3.1. Because each type (make and model) powered industrial truck has different operating characteristics, limitations and other unique features, an optimum employee training program for powered industrial truck operators must be based upon the type vehicles that the employee will be trained and authorized to operate. The training must also emphasize the features of the workplace which will affect the manner in which the vehicle must be operated. Finally, the training must include the general safety rules applicable to the operation of all powered industrial trucks.

A-3.2. Selection of the methods of training the operators has been left to the reasonable determination of the employer. Whereas some employees can assimilate instructional material while seated in a classroom, other employees may learn best by observing the conduct of operations (demonstration) and/or by having to personally conduct the operations (practical exercise). In some instances, an employee can receive valuable instruction through the use of electronic mediums, such as the use of video tapes and movies. In most instances, a combination of the different training methods may provide the mechanism for providing the best training in the least amount of time. OSHA has specified at paragraph (l)(2)(ii) of this section that the training must consist of a combination classroom instruction and practical exercise. The use of both these modes of instruction is the only way of assuring that the trainee has received and comprehended the instruction and can utilize the information to safely operate a powered industrial truck.

A-4. Initial Training

A-4.1. The following is an outline of a generalized forklift operator training program:

(1) Characteristics of the powered industrial truck(s) the employee will be allowed to operate:

(a) Similarities to and differences from the automobile;

(b) Controls and instrumentation: location, what they do and how they work;

(c) Power plant operation and maintenance;

(d) Steering and maneuvering;

(e) Visibility;

(f) Fork and/or attachment adaption, operation and limitations of their utilization;

(g) Vehicle capacity;

(h) Vehicle stability;

(i) Vehicle inspection and maintenance;

(j) Refueling or charging, recharging batteries.

(k) Operating limitations.

(l) Any other operating instruction, warning or precaution listed in the operator's manual for the type vehicle which the employee is being trained to operate.

(2) The operating environment:

(a) Floor surfaces and/or ground conditions where the vehicle will be operated;

(b) Composition of probable loads and load stability;

(c) Load manipulation, stacking, unstacking;

(d) Pedestrian traffic;

(e) Narrow aisle and restricted place operation;

(f) Operating in classified hazardous locations;

(g) Operating the truck on ramps and other sloped surfaces which would affect the stability of the vehicle;

(h) Other unique or potentially hazardous environmental conditions which exist or may exist in the workplace.

(i) Operating the vehicle in closed environments and other areas where insufficient ventilation could cause a buildup of carbon monoxide or diesel exhaust.

(3) The requirements of this OSHA Standard.

A-5. Trainee Evaluation

A-5.1. The provisions of these proposed requirements specify that an employee evaluation be conducted both as part of the training and after completion of the training. The initial evaluation is useful for many reasons, including:

(1) the employer can determine what methods of instruction will produce a proficient truck operator with the minimum of time and effort;

(2) the employer can gain insight into the previous training that the trainee has received; and

(3) a determination can be made as to whether the trainee will be able to successfully operate a powered industrial truck. This initial evaluation can be completed by having the employee fill out a questionnaire, by an oral interview, or by a combination of these mechanisms. In many cases, answers received by the employee can be substantiated by contact with other employees or previous employers.

A-6. Refresher or Remedial Training

A-6.1. (The type information listed at paragraph A-6.2 of this appendix would be used when the training is more than an on-the-spot correction being made by a supervisor or when there have been multiple instances of on-the-spot corrections having to be made.) When an on-the-spot correction is used, the person making the correction should point out the incorrect manner of operation of the truck or other unsafe act being conducted, tell the employee how to do the operation correctly, and then ensure that the employee does the operation correctly.

A-6.2. The following items may be used when a more general, structured retraining program is utilized to train employees and eliminate unsafe operation of the vehicle:

(1) Common unsafe situations encountered in the workplace;

(2) Unsafe methods of operating observed or known to be used;

(3) The need for constant attentiveness to the vehicle, the workplace conditions and the manner in which the vehicle is operated.

A-6.3. Details about the above subject areas need to be expanded upon so that the operator receives all the information which is necessary for the safe operation of the vehicle. Insight into some of the specifics of the above subject areas may be obtained from the vehicle manufacturers' literature, the national consensus standards [e.g. the ANSI B56 series of standards (current revisions)] and this OSHA Standard.

Appendix B--Stability of Powered Industrial Trucks

(Non-mandatory appendix to paragraph (l) of this section)

B-1. Definitions

To understand the principle of stability, understanding definitions of the following is necessary:

Center of gravity is that point of an object at which all of the weight of an object can be considered to be concentrated.

Counterweight is the weight that is a part of the basic structure of a truck that is used to offset the weight of a load and to maximize the resistance of the vehicle to tipping over.

Fulcrum is the axis of rotation of the truck when it tips over.

Grade is the slope of any surface that is usually measured as the number of feet of rise or fall over a hundred foot horizontal distance (this measurement is designated as a percent).

Lateral stability is the resistance of a truck to tipping over sideways.

Line of action is an imaginary vertical line through the center of gravity of an object.

Load center is the horizontal distance from the edge of the load (or the vertical face of the forks or other attachment) to the line of action through the center of gravity of the load.

Longitudinal stability is the resistance of a truck to overturning forward or rearward.

Moment is the product of the weight of the object times the distance from a fixed point. In the case of a powered industrial truck, the distance is measured from the point that the truck will tip over to the line of action of the object. The distance is always measured perpendicular to the line of action.

Track is the distance between wheels on the same axle of a vehicle.

Wheelbase is the distance between the centerline of the front and rear wheels of a vehicle.

B-2. General

B-2.1. Stability determination for a powered industrial truck is not complicated once a few basic principles are understood. There are many factors that influence vehicle stability. Vehicle wheelbase, track, height and weight distribution of the load, and the location of the counterweights of the vehicle (if the vehicle is so equipped), all contribute to the stability of the vehicle.

B-2.2. The ``stability triangle'', used in most discussions of stability, is not mysterious but is used to demonstrate truck stability in rather simple fashion.

B-3. Basic Principles

B-3.1. The determination of whether an object is stable is dependent on the moment of an object at one end of a system being greater than, equal to or smaller than the moment of an object at the other end of that system. This is the same principle on which a see saw or teeter-totter works, that is, if the product of the load and distance from the fulcrum (moment) is equal to the moment at the other end of the device, the device is balanced and it will not move. However, if there is a greater moment at one end of the device, the device will try to move downward at the end with the greater moment.

B-3.2. Longitudinal stability of a counterbalanced powered industrial truck is dependent on the moment of the vehicle and the moment of the load. In other words, if the mathematic product of the load moment (the distance is from the front wheels, the point about which the vehicle would tip forward) the system is balanced and will not tip forward. However, if the load-moment is greater than the vehicle-moment, the greater load-moment will force the truck to tip forward.

B-4. The Stability Triangle

B-4.1. Almost all counterbalanced powered industrial trucks have a three point suspension system, that is, the vehicle is supported at three points. This is true even if it has four wheels. The steer axle of most trucks is attached to the truck by means of a pivot pin in the center of the axle. This three point support forms a triangle called the stability triangle when the points are connected with imaginary lines. Figure 1 depicts the stability triangle.

BILLING CODE 4510-26-P

[GRAPHIC][TIFF OMITTED]TP14MR95.000

BILLING CODE 4510-26-C

B-4.2. When the line of action of the vehicle or load-vehicle falls within the stability triangle, the vehicle is stable and will not tip over. However, when the line of action of the vehicle or the vehicle/load combination falls outside the stability triangle, the vehicle is unstable and may tip over. (See Figure 2.)

BILLING CODE 4510-26-P

[GRAPHIC][TIFF OMITTED]TP14MR95.001

BILLING CODE 4510-26-C

B-5. Longitudinal Stability

B-5.1. The axis of rotation when a truck tips forward is the point of contact of the front wheels of the vehicle with the pavement. When a powered industrial truck tips forward, it is this line that the truck will rotate about. When a truck is stable the vehicle-moment must exceed the load-moment. As long as the vehicle-moment is equal to or exceeds the load-moment, the vehicle will not tip over. On the other hand, if the load-moment slightly exceeds the vehicle-moment, the truck will begin the tip forward, thereby causing loss of steering control. If the load-moment greatly exceeds the vehicle-moment, the truck will tip forward.

B-5.2. In order to determine the maximum safe load moment, the truck manufacturer normally rates the truck at a maximum load at a given distance from the front face of the forks. The specified distance from the front face of the forks to the line of action of the load is commonly called a load center. Because larger trucks normally handle loads that are physically larger, these vehicles have greater load centers. A truck with a capacity of 30,000 pounds or less capacity is normally rated at a given load weight at a 24 inch load center. For trucks of greater than 30,000 pound capacity, the load center is normally rated at 36 or 48 inch load center distance. In order to safely operate the vehicle, the operator should always check the data plate and determine the maximum allowable weight at the rated load center.

B-5.3. Although the true load moment distance is measured from the front wheels, this distance is greater than the distance from the front face of the forks. Calculation of the maximum allowable load moment using the load center distance always provides a lower load moment than the truck was designed to handle. When handling unusual loads, such as those that are larger than 48 inches long (the center of gravity is greater than 24 inches), with an offset center of gravity, etc., then calculation of a maximum allowable load moment should be undertaken and this value used to determine whether a load can be handled. For example, if an operator is operating a 3,000 pound capacity truck (with a 24 inch load center), the maximum allowable load moment is 72,000 inch-pounds (3,000 times 24). If a probable load is 60 inches long (30 inch load center), then the maximum weight that this load can weigh is 2,400 pounds (72,000 divided by 30).

B-6. Lateral Stability

B-6.1. The lateral stability of a vehicle is determined by the position of the line of action (a vertical line that passes through the combined center of gravity of the vehicle and the load) relative to the stability triangle. When the vehicle is not loaded, the location of the center of gravity of the truck is the only factor to be considered in determining the stability of the truck. As long as the line of action of the combined center of gravity of the vehicle and the load falls within the stability triangle, the truck is stable and will not tip over. However, if the line of action falls outside the stability triangle, the truck is not stable and may tip over.

B-6.2. Factors that affect the lateral stability of a vehicle include the placement of the load on the truck, the height of the load above the surface on which the vehicle is operating, and the degree of lean of the vehicle.

B-7. Dynamic Stability

B-7.1. Up to this point, we have covered stability of a powered industrial truck without consideration of the dynamic forces that result when the vehicle and load are put into motion. The transfer of weight and the resultant shift in the center of gravity due to the dynamic forces created when the machine is moving, braking, cornering, lifting, tilting, and lowering loads, etc., are important stability considerations.

B-7.2. When determining whether a load can be safely handled, the operator should exercise extra caution when handling loads that cause the vehicle to approach its maximum design characteristics. For example, if an operator must handle a maximum load, the load should be carried at the lowest position possible, the truck should be accelerated slowly and evenly, and the forks should be tilted forward cautiously. However, no precise rules can be formulated to cover all of these eventualities.

Forklift Safety Training

Tips for Improving Your Program

By GEORGE SWARTZ

Testing forklift operator knowledge and driving skills is essential to minimizing lift truck incidents and accidents.

Since the inception of the Occupational Safety and Health Act some 21 years ago, industry has relied on its own interpretation of the powered industrial truck/forklift training requirements spelled out in 1910.178. The standard reminds employers: "Operator training—only trained and authorized operators shall be permitted to operate a powered industrial truck. Methods shall be devised to train operators in the safe operation of powered industrial trucks."

The what, when and how of industrial truck training is left to industry to determine. Some organizations provide no training to operators. Others may require operators to read lift truck safety rules and, perhaps, view a film. Only a small percentage of companies, however, require regular classroom sessions, testing of overall forklift knowledge and safety rules, driver skill evaluations and operator certification. This type of in-depth training not only exceeds current OSHA requirements, but will likely be in compliance with new training mandates being considered.

BOTTOM-LINE EFFECTS

No doubt, forklift training is essential throughout industry. The Industrial Truck Assn.'s 1989 position paper on training standards stated, "The [OSHA] regulation has been in force since 1970 with little, if any, observable effect to lift truck accident rates." Everyone who operates any powered equipment should be thoroughly trained.

Each year, it is estimated that more than 37,000 forklift-related injuries occur in the U.S. In addition, industry claims its share of workplace fatalities associated with forklift operations. As a result, millions of dollars are spent on medical bills, lost wages, rehabilitation costs and attorney fees. This figure does not include the cost of suffering experienced by injured employees and their families. It makes sense for OSHA to require more specific training.

Behind accident statistics and related direct costs are indirect and hidden costs. For each related injury, numerous incidents involving damage to racking, overhead sprinklers, pipes, walls, machinery, and various other equipment and property also occur. In addition, millions of dollars are lost in damaged and destroyed product or missed shipments.

Organizations often fail to include all of these costs because they accrue individually, not collectively. While easy to focus on a major loss, the familiar, almost invisible low-cost incidents sometimes fail to arouse concern. To prevent these losses and preserve company assets, an organization must invest the time and expense to properly train its forklift operators.

AN OBVIOUS NEED

States require automobile operators to pass written and oral examinations and demonstrate highway driving skills. This license then must be renewed periodically. Unfortunately, this requirement for testing and validation of knowledge and driving skills is missing in many workplaces where powered industrial trucks are used.

Consider these key operating points: the typical forklift steers with its rear wheels, the opposite method of an automobile. This steering permits tighter maneuvering—and requires greater judgment and operating skills, as well as recognition of the ever-present danger to pedestrians. A lift truck can weigh two to three times more than an automobile; when fully loaded, the lift truck weighs hundreds or even thousands of pounds more. Couple this with rear wheel steering, loads being elevated, tight aisles, unstable loads, etc., and the need for operator training becomes more obvious.

It is not unusual to read an article in a local newspaper identifying a resident as a victim of a forklift accident. Common accidents involve individuals being struck by lift trucks, falls from a height while standing on a pallet, or falls from elevated forks. Many are injured while falling from a dock while operating the lift truck. The lift truck may drive off the dock or fall between the dock and an unchocked trailer, resulting in equipment damage, serious injury or death.

Empty or unmanned lift trucks can also cause harm. Employees trip over slightly elevated forks or walk into raised forks, striking knees, legs and, sometimes, faces. Many of these injuries and fatalities can be traced directly to insufficient or inadequate training and lack of safety rule enforcement.

QUALITY TRAINING: BEYOND OSHA

Many safety professionals feel that current OSHA lift truck training requirements do not go far enough. OSHA does identify many safe lift truck practices and operator requirements that training programs should follow. These training requirements are highly subjective, however, and can be ineffective in providing quality training. Quality training: 1) involves operators of all powered equipment; 2) meets or exceeds OSHA's lift truck guidelines; 3) meets equipment manufacturers' recommendations and requirements; and 4) prevents incidents and accidents.

Lift truck training programs should not be pursued merely to satisfy OSHA requirements. As mentioned, serious monetary factors, which definitely impact an organization's bottom line, must be considered. Rising workers' compensation costs continue to be a major issue within industry. In addition, every organization has a moral obligation to protect the well-being of its people.

Many lift truck manufacturers and distributors offer various training programs, and they often are commendable. In many cases, these programs include audio-visual and written materials that demonstrate safe use of their products.

According to one of the world's largest lift truck manufacturers, however, no more than 25 percent of new lift truck purchasers take advantage of training programs offered. In contrast, the June 1990 issue of *Material Handling Engineering* reports that in England the purchase price of a lift truck includes primary operator training. A definite opportunity is available to employers who utilize distributor-provided training programs.

Many industrial settings are unique in product being handled. As a result, trainees observing a forklift training video that illustrates a strange lifting device may have a difficult time focusing on the special attachment because, in their plant, they handle cases of glass bottles, lumber, steel coils or pallets of boxed appliances. Employees sometimes comment that these "canned" programs are not applicable to their specific operations. Employees seem to draw greater benefit from training when it duplicates their daily processes. This article describes several effective training programs that can be produced "in-house."

IN-HOUSE TRAINING DEVELOPMENT

Training programs should be tailored to an employee's work situation when possible. Developing audio-visual and written programs is not as difficult as many think, especially with quality planning and preparation. This may require an allocation of program planning, which may take several months to complete. Since this process will progress in stages, proper time can be apportioned to the program.

Consider the following training program suggestions:

Slides and Photos

A 35-mm camera is one basic, yet effective, tool for in-house program development. The program developer should first prepare a list of forklift topics and real-life plant situations. These lists can be the result of meetings with safety teams or committee members. Involved personnel should recommend real workplace situations or incidents they feel would provide operators with quality slide material.

Shoot slides to match selected topics and sequence the material. Shooting many rolls of slides permits a more selective choice. Most slides can be narrated by the trainer (without a written script) while being shown. (However, one should always prepare a brief narrative for each slide so other trainers can properly identify and discuss the material.)

A 35-mm camera can be equally effective in developing a forklift safety photo book. Again, a list of situations or topics can be developed by safety teams or committees. Photos can illustrate correct and incorrect methods. Participating employees can serve as models to illustrate safe techniques. The quantity of illustrations and a brief narrative under each photo should be thorough enough to properly present the program.

Such a photo book involves many employees and is an excellent tool for training new employees. Photos are easily understood and help eliminate language barriers.

A photo book can also be used to illustrate a complete step-by-step job hazard analysis (JHA)/job safety analysis (JSA) while using a lift truck. For those tasks that require a JHA/JSA, a comprehensive step-by-step photo book would benefit all power equipment operators and promote error-free operations. Employees should always receive written safety guidelines to enhance training efforts.

Video Productions

Video is another common medium for developing in-house programs. Many company-developed programs are well done. Obviously, cost differences between producing an in-house video and contracting an outside vendor are substantial. Through trial and error, a respectable in-house forklift safety video can be created. Involving employees in its development (as in other in-house safety programs) creates ownership of the safety goals or program.

When audiovisuals are used for training, employees should be tested on the material. Quiz questions can be developed to match the audiovisuals. This process, in which the trainee views safe/unsafe situations and is asked to select the proper true-false or multiple-choice answer from written materials, can be very effective.

Several written tests can be developed to complement different parts of the material. Tests can be administered several weeks or months apart. Completed quizzes should be reviewed with all operators before moving to the next program phase. Where operators may experience difficulty with written material or quiz-taking, consider holding group discussions and giving oral tests.

To further enhance training programs, a facility could establish a competitive atmosphere among forklift operators. Test scores could be recorded on a large tally sheet, which would keep everyone informed of program progress. Those employees obtaining the most points or perfect scores could receive t-shirts or other promotional items.

Supervisors should not be excluded from formal classroom training programs; they should be encouraged to actively participate. If someone is to enforce safety rules, he/she should first know and understand the rules. By including supervisors, one enhances the overall safety training program.

SKILLS DRIVING EVALUATIONS

A key dimension of operator training is driver certification. Rather than taking one's word for his/her ability to safely operate a lift truck, actual skills testing and written evaluation must occur. Each operator should be required to demonstrate these skills. Charts 1, 2 and 3 show sample operator skills rating sheets.

The first rating sheet (Chart 1) requires that the operator know and understand the unit's functional features. Because OSHA requires daily, pre-use inspections of powered industrial trucks, the operator being tested should be familiar enough with these daily check lists to answer this section properly.

Supervisors and safety committee members can assist in each evaluation. Physical examination of the lift truck requires "touch and tell" by the operator and receives a rating of 17 points, depending on truck model and characteristics. (Point values and items listed can be modified to suit particular needs.)

Chart 1 Forklift Truck Operators Safety Skills Rating

Truck Type:		Powered by:	
Sit Down	☐	Electric	☐
Stand Up	☐	Propane	☐
Rider Picker	☐	Gasoline	☐
Handjack	☐		

EMPLOYEE NAME: ____________

FACILITY/LOCATION: ____________

TESTING DATE: ____________

LIFT TRUCK NUMBER/ID: ____________

OBJECTIVE OF PAGE 1: The objective of this section of the rating sheet is to ensure that the employee has an understanding of the mechanics of the lift truck as well as all of those items that involve standard checking prior to driving the lift truck. (NOTE: This form can be used to evaluate a variety of powered equipment models.)

A. PHYSICAL EXAMINATION OF LIFT TRUCK (TOUCH AND TELL)

The operator should be familiar with the features of the lift truck. The operator must demonstrate and describe the following:

(one point each)

	CORRECT	INCORRECT	DNA*
1. Proper use of tilt.	☐	☐	☐
2. Proper use of raise/lower.	☐	☐	☐
3. Sounded the horn.	☐	☐	☐
4. Checked for oil leaks.	☐	☐	☐
5. Checked mast chains.	☐	☐	☐
6. Checked the brakes.	☐	☐	☐
7. Checked the tires/wheels.	☐	☐	☐
8. Checked the hour meter.	☐	☐	☐
9. Checked the scissors reach.	☐	☐	☐
10. Checked the warning light.	☐	☐	☐
11. Checked the rear view mirror.	☐	☐	☐
12. Checked battery retainer.	☐	☐	☐
13. Checked the discharge indicator.	☐	☐	☐
14. Checked the back up alarm.	☐	☐	☐
15. Checked hoses/hose reel.	☐	☐	☐
16. Checked the overhead guard's light.	☐	☐	☐
17. Knows the capacity of the lift truck.	☐	☐	☐

TOTAL POINTS THIS SECTION: ____________

* = Does not apply

Operators of powered industrial trucks must understand the functional features of the units they drive. A "touch and tell" test, as described above, is a good indicator of operator knowledge. Point values shown here can be adjusted to suit particular program needs.

Chart 2 Forklift Truck Operators Safety Skills Rating

B. KNOWLEDGE OF SAFEGUARDS WITHIN THE FACILITY

The operator is to be asked to identify as many safety items at the dock area, battery recharging area, and overall facility safety. (how many can the employee name, one point each)

DOCK AREA		BATTERY CHARGING		FIRE/SAFETY	
Wheel Chocking	☐	Protective Equipment	☐	Location of Extinguishers	☐
Dock Plate	☐	Acid Neutralizing	☐	How to use Extinguisher	☐
Trailer Lighting	☐	MSDS	☐	Type of Extinguisher to use	☐
Condition of trailer floor	☐	No smoking	☐		
Don't jump off dock	☐	Plug/Unplug Procedures	☐	Eye protection during banding	☐
Keep clear of others	☐	Clean-Up Procedures	☐	**PERSONAL SAFETY**	
Be aware of signs	☐	Eye Wash Station	☐	Use of Eye Protection During Banding Operations	☐
Correct height of empty pallets	☐	Commercial Battery Rules	☐		
				Other: ____________	☐

TOTAL POINTS THIS SECTION: ____________

C. OPERATING SKILLS EVALUATION

Determine the operating skills of the employee by making a full evaluation while they are driving the lift truck in a rodeo or actual on the job operation. (One point each)

	CORRECT	INCORRECT	DNA
1. Did the operator pull forward toward designated section of racking without striking anyone?	☐	☐	☐
2. Did the operator place the forks under the pallet properly?	☐	☐	☐
3. Did he raise or tilt the load properly?	☐	☐	☐
4. Did any part of the container strike any section of racking while removing the pallet?	☐	☐	☐
5. Did he lower the pallet before moving/backing out? (Don't drive + lower together.)	☐	☐	☐
6. Did he drive at a safe rate of speed?	☐	☐	☐
7. Did he slow down or stop at cross aisles?	☐	☐	☐
8. Did he sound his horn?	☐	☐	☐

In addition to knowing specific operating information about their units, forklift operators need to recognize safety factors present at the dock and battery recharge station, and be aware of the facility's general safety guidelines. Section B lists areas relevant to forklift activity.

Section B (Chart 2) of the skills testing requires that operators be familiar with specific department safety rules. This section permits the supervisor to ask the employee to identify important safety factors at a dock and battery recharge station, and/or general facility safety guidelines. For those items properly identified without coaching, a check is placed in the adjacent box. This indicates that the operator has identified those hazards related to daily lift truck operations.

Section C (Charts 2 & 3), the final rating section, requires an analysis of the operator's overall driving skills. This test can be administered during the actual job performance during the employee's work day. Determine what is needed for the employee's operational rating, inform the employee of these testing requirements, and mark the sheet appropriately during observation.

This random rating, conducted at the supervisor's convenience, allows testing and evaluations to be scheduled as time permits. This scheduling spreads evaluations over a manageable period of time. Ratings must be uniform and consistent for each operator, as must the evaluations from the person(s) performing the rating and scoring.

FORKLIFT RODEO

Another useful skills test is a planned driving course with pallets and other physical markings and obstacles. Course layout should be specific to plant operations and should challenge each individual's driving ability. Floor tape to mark lanes, stop signs and pallet locations are essential. Measuring tapes can determine proper pallet or obstacle layout distances as well as turn radiuses of various lift trucks.

To become familiar with this "obstacle course" layout, each operator should receive a "free test" with an empty and a loaded lift truck before an actual test. Depending on the types of powered equipment used, the course layout should be flexible enough to accommodate various unit shapes, sizes and types. One should complete one particular style of truck testing before changing course dimensions for the next piece of equipment.

Employees respond positively to these types of forklift rallies or rodeos because of the competitive spirit involved. Although this form of skills driving rates each operator individually, a facility-wide competition can greatly benefit all operators. Employees respond well to a challenge, especially if prizes are involved. The pride and prestige of "being the best" cannot be overlooked.

Obviously, the course should be set up to evaluate specific skills and abilities, such as turning, lifting and stacking, as well as compliance with OSHA and plant safety rules. Course testing should equate to specific skills needed during the operator's daily job. Judging should be fair, yet demanding.

Notify the operator that task performance will be timed during the rodeo; however, operating time should only be used to separate any scoring ties that occur. Obviously, industry is interested in employees performing jobs in a productive manner. Timing is not intended to require the operator to speed up, but rather to promote driving as safely and efficiently as possible when performing daily tasks. The saying, "Haste makes waste," becomes evident for those operators who use speed without exercising proper skills during testing. Employees with a high level of operating skills become clearly noticeable during testing.

The training coordinator should consider filming the rodeo so operators can later observe the action, review errors and reinforce positive driving skills.

The scoring sheet (Chart 3) allows for tallying point totals in all three sections. The employer should establish a point value for passing. In this example, 35 out of 56 points are required. This total can be adjusted, depending on program needs. The completed form should be kept in the employee's training file as program documentation.

Once the quiz and driving skills programs are complete, a ceremony should be held to acknowledge winners. Winners may be chosen on overall point totals, or for each specific piece of equipment driven.

Chart 3 Forklift Truck Operators Safety Skills Rating

(PART C – continued)	CORRECT	INCORRECT	DNA
9. Did he pull into the area of racking properly to place the pallet back in the racking?	☐	☐	☐
10. Did he strike any racking on the way up or going into the rack?	☐	☐	☐
11. Did he back out and lower his forks before moving?	☐	☐	☐
12. Did he **always** look behind him before backing up?	☐	☐	☐
13. Was he wearing his protective equipment?	☐	☐	☐
14. Did he drive around the block of wood or obstacle on the floor or get off the lift and remove it?	☐	☐	☐
15. Did he set the load flat on the floor before getting off?	☐	☐	☐
16. Did he put on a hardhat before getting off the lift truck?	☐	☐	☐
17. Did the operator perform any moves that were potentially dangerous?	☐	☐	☐

TOTAL POINTS THIS SECTION (C): ____________

TOTAL POINTS SECTION A: ____________

TOTAL POINTS SECTION B: ____________

TOTAL ALL THREE SECTIONS: ____________

An employee should score at least 35 total points from a potential grand total of 56 points.

NAME OF PERSONS CONDUCTING EVALUATION: ____________ DATE: ____________

____________ DATE: ____________

FORKLIFT DRIVER'S SIGNATURE: ____________ DATE: ____________

CONCLUSION

Employers can greatly enhance lift truck programs by requiring ongoing operator training, skills evaluation and certification. Some form of operator's license should be issued to document training completion or certification. This license can also highlight enforcement of plant operating rules. If an operator violates a plant rule, a hole can be punched in the license as a reminder to improve operating ability. Producing a hole-free license at each renewal serves as a positive indicator of operator performance.

Estimates indicate that nearly 25 percent of all workplace injuries are related to material handling. Through proper forklift training programs, an organization can reduce and minimize lift truck incidents and accidents.

By developing these programs in-house, additional benefits can be realized. What better way to involve and motivate employees than to involve them in developing and using these programs. ■

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George Swartz, CSP, is safety director for Midas International Corp. in Chicago, IL. Named ASSE Fellow in 1992, Swartz, a member of the Greater Chicago Chapter, serves as Construction Advisory Committee Chairman, and as a member of the Editorial Board and Standards Development Committee.

Operating skills evaluation can be conducted during actual job performance, or through a forklift rodeo. Such an event involves planned driving courses with pallets and other physical markings that mirror actual work conditions and challenge each operator's driving ability.

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THE INDUSTRIAL PEDESTRIAN: DANGER Is Just Around the Corner

By GEORGE SWARTZ

Wherever powered industrial trucks are operating, the potential for injury to pedestrians exists. Many such injuries are life-threatening; they can involve severe eye and leg injuries, amputation, paralysis and permanent disability. In addition, industrial pedestrians experience thousands of less-serious injuries on a daily basis.

In addition to the potential loss of life or injury, business spends thousands of dollars on events that could have been prevented. This article reviews data on injury to industrial pedestrians; describes scenarios that create danger; provides examples of likely injuries; and suggests preventive measures.

INJURY STATISTICS

Many studies provide information on the number of individuals killed or injured each year by powered industrial trucks. Some 25 individuals are killed each year due to forklift tipover—statistically the leading cause of fatalities for operators. The second-highest loss of life involves pedestrians being struck by the lift truck or the load being carried, or from secondary causes of being struck by loads. In total, 100 employees lose their lives each year due to incidents involving powered industrial trucks.

In addition, 95,000 powered-industrial-truck-related injuries occur each year. In every study OSHA conducted during development of its operator training standard, the pedestrian ranked near the top of the "in danger of serious injury or death" list. The following discussion reviews six research sources that identify injuries suffered by pedestrians.

Table 1 summarizes a Bureau of Labor Statistics study of fatalities between 1991 and 1992. Note #2, #3 and #5. According to the study, victims were struck by material, struck by forklift or pinned between objects. These incidents, many which involve pedestrians, represent 72 fatalities (42 percent) of the total. Combined, these three causes surpass the deaths associated with tipover (24 percent).

Data show that the truck operator can also be struck by a falling load or by falling objects such as racking, overhead lights and pallets. Openings at the top of the lift truck's overhead guard could allow product to penetrate through to the operator. In some cases, the operator exits the confines of the protective overhead guard only to be struck by falling objects.

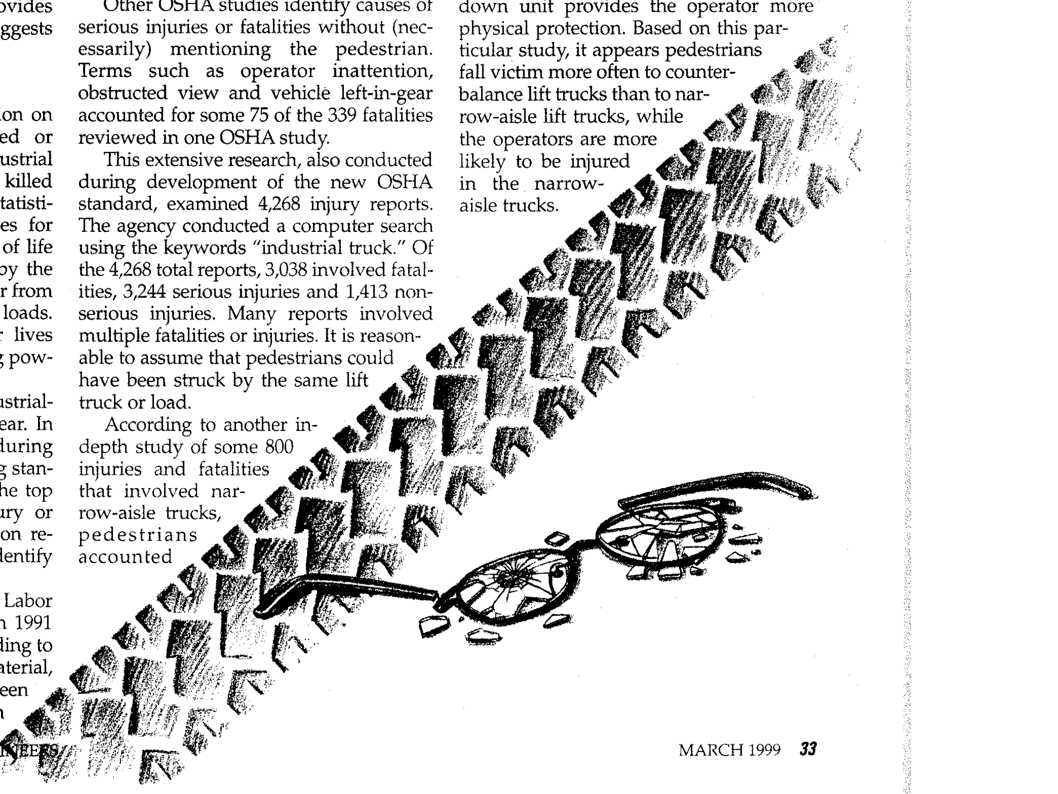
Other OSHA studies identify causes of serious injuries or fatalities without (necessarily) mentioning the pedestrian. Terms such as operator inattention, obstructed view and vehicle left-in-gear accounted for some 75 of the 339 fatalities reviewed in one OSHA study.

This extensive research, also conducted during development of the new OSHA standard, examined 4,268 injury reports. The agency conducted a computer search using the keywords "industrial truck." Of the 4,268 total reports, 3,038 involved fatalities, 3,244 serious injuries and 1,413 non-serious injuries. Many reports involved multiple fatalities or injuries. It is reasonable to assume that pedestrians could have been struck by the same lift truck or load.

According to another in-depth study of some 800 injuries and fatalities that involved narrow-aisle trucks, pedestrians accounted for eight percent of the total injury amount. This non-OSHA study was conducted between 1975 and 1993.

Narrow-aisle (stand-up) lift trucks are designed differently than counterbalanced (sit-down) lift trucks. In a narrow-aisle truck, the operator stands in an open compartment while operating the unit. Often, the operator may have a foot or leg (outside the compartment) that collides with a fixed object or other truck. In other cases, forks or other objects penetrate the operator compartment and inflict serious injury.

The pedestrian injuries identified are fewer in number than equivalent injury totals caused by sit-down lift trucks. A sit-down unit provides the operator more physical protection. Based on this particular study, it appears pedestrians fall victim more often to counterbalance lift trucks than to narrow-aisle lift trucks, while the operators are more likely to be injured in the narrow-aisle trucks.



...ETY ILLUSTRATION BY SALLY ONOPA

Many pedestrian injuries reported in this study were very serious. For example:

- run over by forklift; leg amputated;
- struck and killed by load inadvertently falling from forklift;
- standing at desk, struck by lift truck, major kidney damage;
- foot run over and crushed by forklift;
- foot run over by forklift; two toes crushed and amputated;
- leg broken after being struck by truck;
- fell into path of moving forklift; serious leg injury;
- fatally pinned by forklift;
- pushed through wall by forklift; severe internal injuries.

A 1987 report on forklift injuries published in California focused on 3,041 incidents. Thirty-one percent of the injuries occurred when forklifts ran over pedestrians. In another 23 percent of cases, workers were caught in, under or between a forklift and another object.

In a 1980 study conducted by the California Dept. of Industrial Relations, the most-common forklift injuries were:

- contusions and crushing injuries (31 percent);
- sprains and strains (21 percent);
- amputations (21 percent).

Neither of these studies distinguished between the types of powered equipment involved. It should be noted that injuries to pedestrians were a large part of these California studies.

Tables 2 and 3 highlight a comprehensive study of 3,322 forklift injuries that used three sources of data. Analysis of injury type indicates that pedestrians were involved in many incidents studied. This study identified 15 main injury categories and 46 separate injury types, as well as the activity in which the person injured was engaged. Other categories may have identified pedestrian injuries, but data could not be abstracted from this comparative analysis study. The percentages of pedestrian-related injuries identified in Table 3 represent those within that particular category, not the entire study.

MEANS BY WHICH FORKLIFTS INJURE PEDESTRIANS

When a moving lift truck—weighing four or five tons—strikes a pedestrian, the result will be serious. A lift truck moves about five to 10 mph—much faster than someone on foot; due to its weight and load (particularly if full), the truck is difficult to stop. Add to this mix operator reaction time, and it is possible that even the most-experienced operator could not stop in time should a pedestrian appear in the truck's path.

Truck design features also affect the ability to stop. The lift truck's small wheels, combined with only two braking wheels, do not always allow for a sudden stop. Furthermore, many models have no backup system to stop the vehicle should these systems fail.

Poor lift truck maintenance could also allow the braking systems to fail when needed most. Or, the operator may fail to properly inspect the vehicle before the shift or fail to report defects. Some operators may disregard pre-shift checks, or the firm's inspection program may be weak (or non-existent).

Operators must be continuously on the alert while the lift truck is in motion. A load carried high may block the operator's vision. In such situations, the operator should drive in reverse. However, many injuries occur when a pedestrian is struck by the load being carried or by a load that moves due to a quick stop, or the pedestrian is speared by the forks.

In addition, loads are not always uniform or secure. Long or wide objects, such as pipes or lumber, can easily strike the industrial pedestrian—even one not walking near the lift truck. Employees working with their backs to an aisle can be struck by the load. Furthermore, since lift trucks have no springs or shock absorbers, hitting even a small bump may dislodge an improperly stacked load.

Often, unsecured loads are dumped onto pedestrians when a lift truck speeds around a corner or brakes hard to avoid striking them. Speed, coupled with the loose load, usually produces some kind of incident. Remember, a lift truck carries and hoists loads in the front. If a pedestrian rushes around a corner, s/he might come face to face with the load before being aware of the truck.

Employees (and facility visitors) can be struck by falling product as well. A load can fall on someone in the area where a lift truck is operating. Employees may also walk under raised forks, rather than stay clear of the load that is being raised or lowered. In such situations, operator error or vehicle failure can result in serious injury or death. In addition, an operator may inadvertently push a load off a high section of racking.

Even a parked forklift can pose a hazard. How? Although a non-operating lift truck should be parked out of the way, with key removed and forks flat on the floor, some operators simply shut off the machine and leave the forks (and sometimes the load) elevated. A pedestrian could easily walk into the forks.

For example, a timekeeper entered a plant to retrieve time cards. She walked into the raised forks of a parked lift truck and fractured a knee cap. In another case, an operator left a truck's forks elevated about five feet above the floor. A fellow employee walked around a corner and into the forks, puncturing his eye.

Non-employees are also at risk. According to a 1997 article in the *Chicago Tribune*, a woman was killed while crossing a downtown street near a construction site. An eight-ton forklift ran over her. The forklift was carrying a load of mortar while making a right turn. The operator did not know he had struck the pedestrian.

Another design feature that can contribute to such incidents is the truck's counterweight. When a load is lifted with the forks, a heavy weight on the truck's backside allows for balance. To the unsuspecting, the truck's rear-end swing can be quick and unexpected. Consequently, many pedestrians have been pinned between the counterweight and a fixed object (i.e., steel beam or racking).

A large Midwest manufacturing company reported two serious injuries when employees were struck by the counterweight. In one location, an employee attempted to run behind a backing forklift. The operator did not see the employee, knocked him down and proceeded to run over his leg. The injury required extensive surgery and rehabilitation. Medical care costs surpassed $175,000, and the total claim cost nearly $235,000.

In another plant, an employee walking behind a backing forklift was knocked down. The operator did not see him. The leg and foot injuries involved extensive lost time, surgery and rehabilitation. The final cost of this claim exceeded $250,000.

This firm trained its operators each year. Equipment was well-maintained and trucks featured flashing lights and backup alarms. With all this in the firm's favor, how could these costly, disabling injuries occur? The firm's powered industrial truck training program had no session on pedestrian safety.

TRAINING AND PERCEPTIONS

Each employee must receive some form of powered industrial truck training, as well as pedestrian safety training. Historically, training programs developed by equipment manufacturers have not included pedestrian safety information. Recently, however, these programs have been greatly improved.

How do employees (pedestrians) and powered equipment operators feel about the concept of pedestrian safety? Management at one steel fabricating plant surveyed 100 operators and employees. The results offered no surprises.

Operators felt employees acted dangerously when walking in aisles—did not heed horns, stepped into aisles or crossed in front of trucks. They believed employees failed to take the presence of lift trucks seriously and, therefore, were responsible if struck or injured.

Employees believed the opposite—operators drove too fast, did not use their horns to warn, and disregarded stop signs and blind corners. Some employees believed certain operators were "aiming for them."

TABLE 1

HOW FATALITY OCCURRED	NUMBER	PERCENTAGE
1) Forklift overturned	41	24
2) Worker struck by material	29	17
3) Workers struck by forklift*	24	14
3) Worker fell from forklift*	24	14
5) Worker pinned between two objects	19	11
6) Forklift struck something or ran off the dock	13	8
7) Worker died during forklift repair*	10	6
7) Other cause of fatality*	10	6
*Tie	170	100

TABLE 2

SOURCES	# OF REPORTS	TIME OF STUDY
MSHA	1,170	1978-1986
California Dept. of Industrial Relations/Div. of Labor Statistics and Research	701	January - March 1970
Clark Equipment Co.	1,451	1966-1985

TABLE 3

INJURY	MSHA	CDIR	CLARK
Run over or struck by moving lift truck	19%	11%	9%
Caught between lift truck and fixed object	8%	6%	7%
Struck by object set in motion by vehicle	5%	3%	2%
Struck by shifting load	3%	2%	3%

Pedestrians have the right-of-way, but this does not mean they can disregard hazards. Operators cannot stop quickly and their field of vision may be limited by the load being carried or the mast design. Therefore, both parties must respect the other's position. Such awareness is developed via training and enforcement.

WORKPLACE SAFEGUARDS

Much can be done to protect pedestrians. Key safeguards include alarms, mirrors, signage, protective barriers, lighting and employee training.

Where feasible, counterbalance trucks should have backup alarms. Although no OSHA standard requires this equipment, alarms are a valuable in-plant safeguard. If a lift truck operates in a high-noise area, the alarm may blend in with the noise levels. Therefore, the alarm's decibel level should be adjusted so it can be heard. In addition, employees must not be allowed to modify or disengage these devices.

To warn operators that a pedestrian will be entering an aisle, the employer should install an alarm which activates when someone opens a door that leads into the traffic area. Operators near this area will hear the alarm and see the accompanying flashing light. To further enhance pedestrian safety, a floor-mounted alarm that activates when driven over by lift trucks can also be installed. Such an alarm might be placed near blind corners or in high-hazard areas. The alarm should always be accompanied by a flashing light.

It is the employer's responsibility to assess the need for pedestrian warning devices. This assessment is a critical component of the facility's safety program.

No single combination of pedestrian warning equipment can provide the means to the safest environment in all applications. Therefore, management must consider high-noise levels, poor lighting and aisle layout. Since some conditions may be difficult to change, management must focus on the most-effective warning devices for overall safety.

The forklift horn is another key safeguard. One facility recently received an OSHA citation because a truck horn was not functional. The compliance officer felt the truck could turn a blind corner and strike someone—without warning. OSHA held that, "A violation is serious if it creates a substantial probability of death or serious physical harm." Therefore, horns must be tested during the daily documented lift truck inspection.

However, operators must use horns only when necessary—to warn, not to startle employees. Horns are most effective when used at appropriate times. Overuse can cause workers to ignore the warning.

Mirrors placed strategically throughout the plant can help operators and pedestrians. Blind corners and intersections are the most-common places to mount these safeguards. Mirrors should be convex or provide a panoramic view. Most should be mounted high to provide a better view of the working area.

A convex mirror on a lift truck is another safeguard. Some operators fail to look behind before backing up. Or, they may check only one side. Occasionally, time may pass between looking and actually backing up. During this time lag, a pedestrian may approach the lift truck.

Signs that warn, "Caution (or Danger): Forklift Trucks" should be placed on doors leading to the plant, as well as on barriers at crosswalks. This alerts all pedestrians to the risk before they enter the production area. A large, colorful forklift sign can be placed on the floor adjacent to doors or openings as well. Facility visitors must also be reminded to be alert for powered equipment movement and to stay behind barriers and use designated walkways.

Protective barriers must be installed as well. Hand rails or barriers must be able to absorb the impact of a lift truck. Yellow paint helps identify these safeguards. Barriers should be mounted near walkways, along aisles, at door openings, and in front of offices and assembly areas.

If an office door opens directly onto a traffic lane, a barrier must be installed to prevent anyone from stepping into the lane. The barrier causes the pedestrian to step left or right before entering. As noted earlier, a flashing light and alarm alert operators when the door is opened.

Walkways and paths of travel for industrial trucks must be well-lit. The docking department is a busy place. At times, employees must enter poorly lit trailers. Equipment or a load being moved could easily strike someone. To prevent such incidents, management should consider installing lights on powered equipment. Fixed lighting at the dock can also be adjusted to illuminate trailers.

Parking lots and other outside areas of travel require special lighting as well. Pedestrians often use the same walking and driving areas. Therefore, appropriate signs are needed, as is proper lighting. In addition, these areas must be properly maintained. If roadways are designed to accommodate forklifts, separate walkways (with protective barriers) should be erected to protect those on foot.

As noted, training is crucial. OSHA's proposed operator training standard, as well as Ontario, Canada's new powered equipment guidelines, require pedestrian awareness training. Clearly, the high number of fatalities and injuries each year indicates that such training is necessary.

ADDITIONAL PEDESTRIAN SAFEGUARDS

Many other safeguards can be implemented as part of a facility's overall powered equipment program.

- Where possible, forklift operators should drive down the middle of the aisle. This allows for operator reaction time.
- Operators must be alert for employees taking short cuts or stepping out from between machines or product storage.
- Visitors may not heed a facility's safety rules. For some, it may be their first visit to a large production facility. Consequently, operators must always anticipate pedestrian error.
- Pedestrians should not be permitted into areas with unpredictable traffic patterns and no traffic lanes.
- When equipment is entering a building from outside, the operator must be prepared for pedestrians who may be in the path. Another caution: bright sun will affect the operator's eyesight; his/her eyes must adjust to the change in light before moving the powered equipment.
- Employees must never challenge a piece of powered equipment. A loaded truck may have to swerve to avoid a pedestrian. A load could be lost, and the lift truck may strike a person or object as a result of this erratic action.
- Unauthorized employees must not be allowed to operate lift trucks. In addition, no one other than the operator should occupy the equipment.
- Since operators cannot always rely on warning devices, they must constantly look in the direction of travel and to the sides of the unit.
- Operators must not move any load that requires other employees to balance, guide or keep in place. They should restack or band the load.
- Anyone working at a machine or near a fixed object should be asked to move when a lift truck enters the area.
- Operators must never jump off of a moving truck. In some cases, operators have jumped off, only to have the moving vehicle continue on and strike a co-worker. Operators must stop the truck, set the brake, lower the load, then exit the unit.
- When walking on a ramp, pedestrians must be alert for lift truck traffic. Ramps do not always allow for proper clearance.
- Employees must be aware of stacking procedures. Loads can fall if not secured.
- Proper housekeeping practices are essential. Cluttered aisles and walkways contribute to injuries and incidents.
- Provide separate pedestrian doors. Those on foot tend to use large, drive-through doors. Therefore, drive-through and walk-through doors should be clearly identified—and management must enforce their proper use.
- Where blind spots or areas that require special attention exist, operators should use spotters to guide the load and truck. The lift truck should not be moved unless approved by the spotter—and not until the spotter is clear of both the lift truck and load.
- Identify walkways with yellow or white striped paint. There must be at least three ft. on each side of the widest load carried to accommodate both powered equipment and pedestrians.
- Establish a waiting area for truck drivers, since they should not be allowed on the dock. However, if drivers must remain in the dock area, they should be accompanied by management, and operators alerted to their presence.
- Establish one clearly marked walkway from plant or warehouse to loading dock office. Ideally, this walkway should follow a wall and be located in a low-traffic area. Protective guard rails are a must.

CONCLUSION

A greater focus must be placed on pedestrian injury or death caused by powered equipment. OSHA statistics show that more than 20 pedestrians are killed each year in incidents involving powered industrial trucks. These numbers may be low, however, because OSHA's research did not single out all causes of pedestrian injury.

The safety of non-employees—both inside and outside the building—must also be considered. Many of these individuals are not very familiar with powered industrial trucks and their movements. However, since these incidents rarely make the headlines, industry may ignore the need for pedestrian safety.

Due to downsizing, many firms have closed facilities and moved more product into already-crowded warehouses. This congestion, combined with the need to move more product with fewer people, can tempt operators to speed and disregard safety rules. In other words, the competitive nature of the workplace can lead to unsafe behavior. "Doing more with less" does have drawbacks.

Incidents can be prevented through proper training, use of safeguards and management enforcement. Awareness of pedestrian safety is gaining momentum. OSHA has identified this need in its proposed operator training standard. In addition, many manufacturers have added this element to their training programs.

With more than 875,000 pieces of powered equipment in the workplace and some 1.2 million operators, training and safety cannot be stressed enough. Without a doubt, every facility must place a greater focus on the safety of employees or visitors who are on foot. ■

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George Swartz, CSP, is corporate director of safety, health and environment for Midas International Corp., Chicago, a position he has held since 1977. A former chair of ASSE's Editorial Board and a member of National Safety Council's Board of Directors, Swartz holds a B.A. in Social Sciences from the University of Pittsburgh, an M.S. in Industry and Technology Safety Studies from Northern Illinois University and an M.S. in Managerial Communications from Northwestern University. In 1992, Swartz was named a Fellow of ASSE, the Society's highest honor. He is a professional member of ASSE's Greater Chicago Chapter and a member of the Management Division.

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New study from the University of Utah stresses the need for lift truck operator training and seat belts.

Avoiding Rollover/Tipover

Table 1
Fatal Work-Related Injuries Investigated by OSHA 1984-89 Involving Lift Truck Tipover or Rollover

	On same level	On ramp, incline or ditch	Total
Agriculture/Forestry/Fishing	0	2	2
Construction	5	8	13
Manufacturing	18	23	41
Mining/Oil & Gas	1	0	1
Services	2	2	4
Wholesale & Retail Trade	14	5	19
Transport/Utilities	4	6	10
Other	2	1	3
Total	**46**	**47**	**93**

The leading category of fatal injury involving lift truck accidents is tipover or rollover, according to the National Institute for Occupational Safety and Health (NIOSH) (22% of deaths) and the Bureau of Labor Statistics Census of Fatal Occupational Injuries (24% of deaths) (see references).

Our research group at the University of Utah chose investigation data from the Occupational Safety and Health Administration (OSHA) to study the need for training and the various mechanisms related to lift truck tipover and rollover. Thanks to the efforts of OSHA's Management Information Systems staff, a printout of all fatalities investigated by OSHA for 1984-89 that had been entered into the federal OSHA database was obtained, coded and analyzed. A limitation of using OSHA data, compared to other sources such as data used by the BLS or by NIOSH, is that three states (CA, MI, WA) were not in the database for 1984-89. In addition, the data contain fewer reports of deaths than the other sources, since OSHA does not learn of all work-related deaths and does not have jurisdiction over all deaths. Nevertheless, since injuries involving lift trucks are usually under OSHA jurisdiction, we anticipated that OSHA would investigate the majority of such fatal injuries.

These OSHA reports provide valuable information on some factors related to fatal lift truck tipover or rollover. We must stress that this study was done using summaries of OSHA investigations, typically a few sentences to a paragraph in length, that are entered into the federal database, rather than by reading the entire investigation file for each case, which is not available in electronic form. OSHA compliance officers tend to include in the summary report items pertinent to OSHA standards, and so may not mention factors such as seniority, type of worker training or human factors such as fatigue from overtime.

Investigation findings

For the six-year period there were 93 fatalities involving lift trucks that rolled or tipped over, or 27% of all lift-truck-related deaths investigated by OSHA. Industries in which the fatalities occurred and location of the tipover or rollover are shown in Table 1. There were 46 deaths where the tipover or

Table 2 Fatal Work-Related Injuries Involving Lift Trucks Investigated by OSHA 1984-89
Characteristics of Victims of Tipover/Rollover Incidents

	Nr.	Mean Age	Covered by Collective Bargaining Agreements	Employer cited under OSHA 1910.178	Employer cited under OSHA 1910.178 (1)
Victims of tipover or rollover incidents	93	31.7* yrs.	21.5%	51%	34%*
All other victims	254	40.1* yrs.	32%	45%	22%*
All victims	347	37.9 yrs.	29%	46%	25%

* = p<.05

Table 3 Fatal Work-Related Injuries Involving Lift Trucks Investigated by OSHA 1984-89
Mechanism of Physical Injury from Tipover or Rollover

Operator's head "slapped" against floor (not struck by lift truck)	3 deaths
Mast or overhead protection structure struck victim	48 deaths
Part of lift truck other than mast or OPS struck victim	12 deaths
No mention of what struck victim	30 deaths
Total	**93**

rollover occurred on a level surface, and 47 on ramps or other inclined surfaces. Almost all (97%) the victims were lift truck operators. Injuries resulting from falls of lift trucks from loading docks were considered to be a different type of incident than tipover and rollover and were not included in either category.

Employers were cited by OSHA for one or more violations of the 1910.178 standard in 47 (51%) deaths. Victims of tipover or rollover incidents differed from victims of other types of fatal lift-truck-related injuries in that they were younger and more likely to be at a non-union site. Also, their employers were significantly more likely to be cited by OSHA for violation of the 1910.178 (1) lift truck operator training requirement (Table 2). We suspect that the rather low overall rate for citing the 1910.178 (1) training requirement (25%) is due to its vagueness and lack of requiring a written record of compliance.

The mechanism of physical injury to the victim of the tipping or rolling lift truck was mentioned in most of the OSHA reports and is shown in Table 3. There were three deaths in which the operator's head struck the floor surface with sufficient force to cause severe head injury. There were 48 incidents in which the victim was crushed by the mast or overhead protective structure, 12 in which another portion of the lift truck struck the victim, and 30 incidents in which the physical cause of injury was not specified in the report summary.

Other factors (Table 4) causing or contributing to the fatal incidents were speeding (13 deaths), traveling with the load elevated (9 deaths), and unauthorized operation (4 deaths). Because these factors were not noted in every OSHA report summary, they should be viewed as a minimum number.

Status of training

There is currently no requirement in the U.S. for licensing, certification or medical clearance of lift truck operators. There is a general requirement for training in the U.S. Occupational Safety and Health Administration (OSHA) standard CFR 1910.178 (1): *"Only trained and authorized operators shall be permitted to operate a powered industrial truck. Methods shall be devised to train operators in the safe operation of powered industrial trucks."*

In response to a petition from the Industrial Truck Association, OSHA has proposed more specific training requirements for lift truck operators, but the final rule has not been issued as this article goes to press. This proposal mentioned that when a lift truck tips over and the operator attempts to jump clear, he/she may be struck by the overhead guard of the tipping vehicle. OSHA noted, "Consequently, the operator of a rider truck should be trained to stay with the vehicle during a later tipover." (See Department of Labor references.) There was no mention of seat belts or other mechanisms for restraining the oper-

Table 4 Fatal Work-Related Injuries Involving Lift Trucks Investigated by OSHA 1984-89

Other Factors Mentioned in Some Incidents

Speeding	13
Traveling with load elevated	9
Unauthorized operator	4

ator in the cab area of rider trucks in case of tipover or rollover. The recommendation to stay with the vehicle is similar to the recommendation in the American Society of Mechanical Engineers (ASME *Safety Standard for Low Lift and High Lift Trucks:* "The operator should stay with the truck if lateral or longitudinal tipover occurs." The ASME standard also notes, "An active operator protection device or system, when provided, shall be used. Operator protection in the event of tipover is intended to reduce the risk of entrapment of the head and torso between the truck and ground ..." but does not specifically mention seat belts.

There is no requirement for providing sit-down lift trucks with seat belts. We find OSHA's comment about training the operator to remain with the lift truck when it tips instead of jumping out to be questionable as to whether anyone could do so without hands-on practice, which is neither safe nor practical. Some passive means for restraining the operator of a sit-down lift truck within the cab could be desirable. Nine of the OSHA reports mentioned whether the lift truck was equipped with seat belts; in four incidents it was and they were not worn. At least one nationally used training video on lift truck operation fails to show any truck equipped with seat belts.

Requiring licensing or certification of lift truck operators could be a means for assuring that training has been given and could provide a record of such training. Whether operators of lift trucks should be required to meet the same medical requirements as commercial truck drivers is unknown: OSHA report summaries contain no medical information concerning the operator involved in fatal accidents. It seems reasonable that medical conditions such as untreated epilepsy, poorly controlled diabetes and other conditions affecting alertness would affect the performance of lift truck operators. Adequate vision and hearing should be necessary for operation of lift trucks and other industrial trucks. These and other issues might be the subject of future research. Additional funding for OSHA to include information concerning human factors and medical conditions in these investigation reports would make such research feasible.

The study team acknowledges the assistance of Bruce Beveridge, Joseph Dubois, Sanford Hamilton and Thomas Tyburski of the U.S. Occupational Safety & Health Administration in providing reports and answering queries.

The Research Team

"Fatal Lift-Truck-Related Injuries from Tipover and Rollover" was prepared by Anthony Suruda, M.D.; Donald Bloswick, Ph.D.; Marlene Egger, Ph.D.; Howard Wing, MB BS; Dean Lillquist, Ph.D.

Suruda, Egger, Wing and Lillquist are associated with the Department of Family & Preventive Medicine, College of Medicine, University of Utah. Bloswick is associated with the Department of Mechanical Engineering, College of Engineering, University of Utah.

Address correspondence to: Anthony Suruda, M.D., RMCOEH Building 512, University of Utah, Salt Lake City, UT 84112. Telephone: (801) 581-3841. FAX: (801) 585-3759. Internet: asuruda@dfpm.utah.edu.

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Standard Number	1910.178
Subject	Clarification of whether the OSHA general industry powered industrial truck standard requires forklift operators to wear seat belts.
Information Date	October 09, 1996

October 9, 1996

Mr. George R. Salem, P.C.
Akin, Gump, Strauss, Hauer & Feld, L.L.P.
1333 New Hampshire Avenue, N.W.
Suite 400
Washington, D.C. 20036

Dear Mr. Salem:

Thank you for your letter dated September 5, requesting clarification of whether the Occupational Safety and Health Administration (OSHA) general industry powered industrial truck standard, 29 CFR 1910.178, require forklift operators to wear seat belts while operating forklifts.

American National Standards Institute (ANSI) B56.1-1969 Safety Standard for Powered Industrial Trucks, was adopted by OSHA under the procedures described in section 6(a) of the Occupational Safety and Health Act (OSH Act). OSHA's general industry standard for powered industrial trucks does not contain any provision which requires the use of seat belts. However, Section 5(a)(1) of the OSH Act requires employers to protect employees from serious and recognized hazards. Recognition of the hazard of powered industrial truck tipper and the need for the use of an operator restraint system is evidenced by certain requirements in the more current versions of ANSI B56.1 consensus standards for powered industrial trucks; ASME/ANSI B56.1a-1989 Addenda to ASME/ANSI B56.1-1988, and ASME B56.1-1993 - Safety Standard or Low Lift and High Lift Trucks. These consensus standards require the use of an active operator protection device or system when provided on a powered industrial truck. In addition, seat belts have been supplied by many manufacturers of counterbalanced, center control, high lift trucks which have a sit-down nonelevating operator position. Also, some manufacturers have instituted retrofit programs for the installation of operator restraint systems to older trucks.

OSHA's position in regard to the use of seat belts on powered industrial trucks is that employers are obligated to require operators of powered industrial trucks which are equipped with operator restraint devices or seat belts to use the devices. OSHA can enforce the use of such devices under Section 5(a)(1) of the OSH Act. OSHA may also cite Section 5(a)(1) of the OSH Act if an employer has not taken advantage of a manufacturer operator restraint system or seat belt retrofit program.

With regard to your comments concerning 1910.178(a)(2), ANSI B56.1-1969 contains three parts: Part I - Introduction; Part II – For the Manufacturer; and Part III - For the User. 1910.178(a)(2) require powered industrial trucks to meet the design and construction requirements established in Part II, ANSI B56.1-1969. Part III of ANSI B56.1-1969, which covers general safety practices, operating safety rules and practices, and maintenance for powered industrial trucks, was adopted by OSHA.

Thank you for your interest in occupational safety and health. If we can be of any further assistance, please contact Mr. Wil Epps of my staff at (202)219-8041.

Sincerely,

John B. Miles, Jr.,
Director
Directorate of Compliance Programs

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TOTAL OPERATOR TRAINING = EQUIPMENT + ENVIRONMENT

Lift truck operator training is more than learning the functions and controls. Concern for people, products, equipment and environment protects both employee and employer.

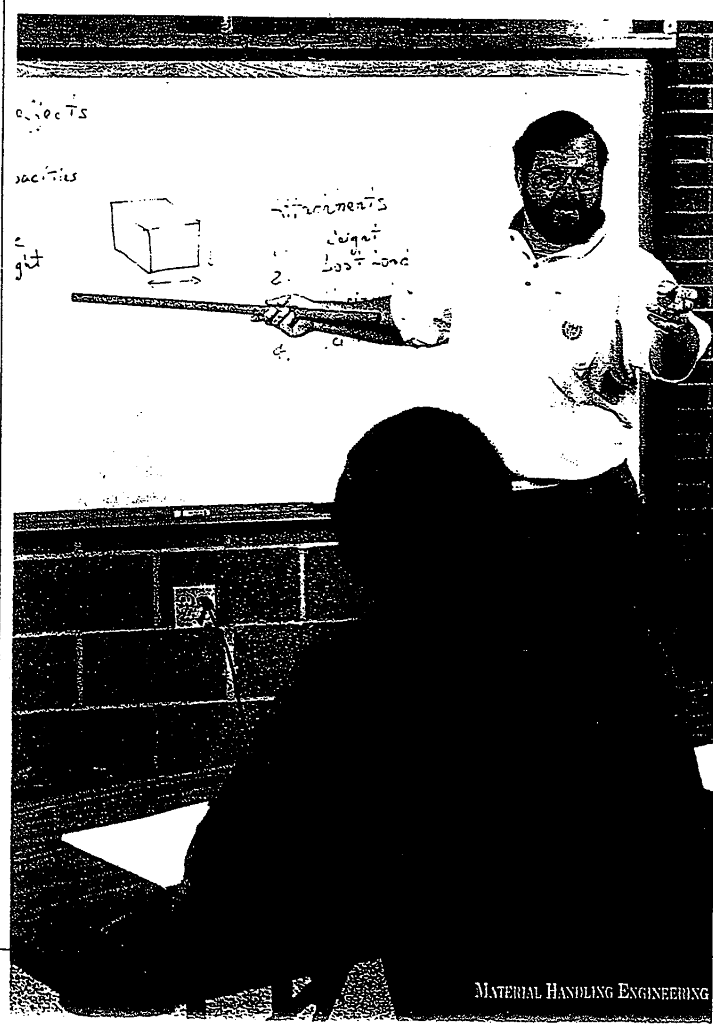
by Gene F. Schwind, executive editor

Anytime lift truck operator training takes place in an area that excludes the truck operating environment, you can bet that the operator is only half-trained. Changes in the OSHA operator training regulations coming in December will confirm this as they spell out training for the operating environment as well as for the equipment. (See page 47, OSHA Update: Lift Truck Operator Training.)

Perhaps you have no way of knowing if your training procedures are adequate or effective. Certainly your equipment and load damage should give you a clue.

Talking to providers of standard and custom training packages will give you some idea of what is available in training programs. Then you must pick one that covers all the key areas of training and evaluates the results.

Whether it is table saws, punch presses or lift trucks, operating the equipment is only a small part of the equation. The real thrust of training is teaching employees to work safely under day-to-day operating conditions. If this is accomplished, all of the benefits attributable to good training will follow naturally.



Four effects of a lift truck attachment on lift truck capacity are reinforced with the students. Here instructor Jim Shephard points out that attachment weight, lost load center, horizontal center of gravity and vertical center of gravity will alter operating safety.

A New Training Program To Protect You And Your Operators

The biggest difference between generic lift truck operator training programs and custom programs is that custom programs deal directly with your facility and how you operate. Programs that emphasize only vehicle operation plus general safety pointers will never detect or correct your improper operation.

Today, most customized training programs require that a program provider visit your site to observe how you operate. The designer then creates a tailored program suited to your operators and operations. Large, multi-site companies, with plant-wide diversity, usually approach training this way.

But now, even if yours is a small company, you can have a customized training program that not only satisfies OSHA regulations but also specifically addresses your company's safety aims and objectives. It will also reinforce your personnel policies relating to the workplace.

Shephard's Industrial Training Systems of Memphis offers such a program. It is a new, simpler approach to custom training.

Called Custom (Cooperative User-Specific Tailored Operating Methods), it is a way for smaller plants and warehouses to assist in developing their own programs that satisfy all areas of regulation and accountability.

The primary emphasis of the Custom program is safety as it relates to both a specific type of lift truck and the operating environment. The user gets a program that results in site-specific training texts, a trained trainer and tested, authorized and tracked lift truck operators.

Shephard's years of experience and core curriculum background development, plus their experience in safety and health surveys in hundreds of facilities, is incorporated into each training program without a site visit and at significant cost savings.

The steps you take to create such a program include:

- Completing an extensive survey;
- Taking rolls of 35mm slides or videotaping your site;
- Defining the equipment/operations that need training;
- Committing supervisors to training participation;
- Finding trainers among your employees;
- Designating a training place within your plant.

The survey will get company management, supervisors, safety and maintenance departments and other operations involved from the beginning and identify various goals.

Completing the survey form and taking a gate-to-gate video or camera tour produce a candid view of your operation. Videos and slides you provide are incorporated in the multi-media training package used to instruct the trainer(s) and operators you select.

Defining equipment makes you recognize the exact types of lift trucks and attachments the program should address. You soon realize how many different varieties of equipment there are at your site.

Committing supervisors as well as employees to a training program gets everyone signed on to safety. Every person in the plant must know about safe practices, rules and regulations, and support enforcement. Everyone then understands how the operation of mobile equipment affects safety.

Designating trainers from among the employee ranks creates program continuity and provides other pairs of safety-critical eyes on the plant or warehouse floor. Trainers become leaders and often help improve employee morale.

The steps taken with your information, to create a Custom program, include:

- A review and critique of your plant as captured by the camera;
- Incorporation of the critique into the training program;
- A training manual dedicated to the operation of the equipment involved;

These benefits include:

- Lower risk to employees;
- Less damage to equipment;
- Less product damage;
- Lower truck maintenance costs;
- Increased safety awareness;
- Protection for your company.

I reviewed some packaged and custom training programs. The packaged ones were largely concerned with the operation and the dynamics of the lift trucks in lifting, transporting, stacking and storing loads.

The packaged programs — if presented in the operating environment by safety or supervisory personnel who recognized the hazards and point them out to the operator — could be effective. If just the operating manual, videos and texts are used, the training falls short of what is needed. Program instruction results such as auditing and testing should also be developed to produce the necessary record trail.

There are a few custom programs written by individual companies for their own operations. They cover specific situations well, but their effectiveness cannot be judged unless the user's facility is also reviewed. It is unlikely that a program written for one plant would apply completely to another plant — even within the same company. Some company-developed programs fail by trying to make one program universal.

If, as the result of an accident, you and your operator wind up in court, your training records should be able to show that the operator knew better. — Shephard.

A facility-by-facility customized training program seems to offer the most benefits as well as protection for the employer and employee. "If, as the result of an accident you and your operator wind up in court, your training records should be able to show that the operator knew better," says Jim Shephard of Shephard's Industrial Training Systems of Bartlett, Tennessee.

But be aware that if you develop and train from within, you may be perpetuating and endorsing poor practices. Outside safety audits are worth the time and money. They can pick up overlooked safety problems.

According to Shephard, "We have con-

• Training and certifying an in-plant trainer;

• Trainer instruction in teaching, testing, and authorizing operators by facility;

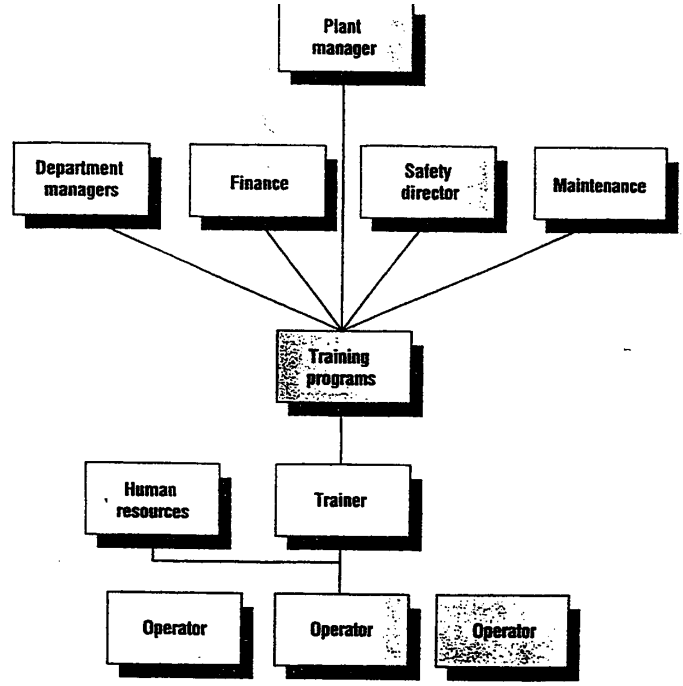
• Data-base-maintenance containing proof-of-training records;

• Trainer evaluation and conferred college credits.

Other multi-plant training programs are much more complex and involve a wide range of equipment from maintenance lifts to lift trucks, loaders and dozers. This program was developed to simplify the survey and review process so that small companies can afford a customized program that fully covers OSHA requirements for lift truck operator training and authorization.

A significant program benefit is the fact that an operator is not authorized unless he/she has passed the written test. This test verifies that each operator understands all regulations and procedures trained.

The operator is also evaluated by the trainer for hands-on performance in the work environment. This advantage is a significant benefit because it is specific to each individual operator. In the event of an accident, this thoroughness helps defend the company and its management against litigation.



The kickoff Custom training program is offered for sit-down internal combustion engine or battery-powered lift trucks and a choice of attachments. It includes a facility safety review as depicted in the film you take. It includes an customized trainer training program and a customized operator training program. For more information from Shephard's Industrial Training Systems, Inc., circle 560 on the reader service card.

ducted many generic training courses. Some in conjunction with Memphis State Technical College. On successful completion we can award a certificate that says the operator has successfully completed hands-on training on the equipment and has passed the safety knowledge tests. We do not authorize an operator to work anywhere in particular because we have no idea what his working environment will be like. When an operator is trained in a working facility, the operator's authorization is only for that facility in which he/she was trained and graded."

Some facilities are so large or so dangerous that an operator may be authorized to operate in only one or two departments.

A number of training programs offer authorization cards with make, model and capacity of the equipment on the back. The cards may also list restrictions. Glasses required, tunnel vision, poor depth perception, color blindness are some listed conditions, if not restrictions. These are found in lift truck operators in about the same proportion as the general population.

Guidelines for complete training

When you decide to opt for a training program, these are some of the key areas to cover.

Select a program that:

• Reflects the conditions where the truck will be used;

• Stresses lift truck dynamics;

• Emphasizes driver responsibility;

• Tests the operator after the training is completed;

• Tracks trainer effectiveness;

• Provides for site-by-site authorization;

• Offers a follow-up service.

Litigation: a potential problem

That's why proof of training is important. OSHA insists on accurate accident and injury records. Training and performance records can save you some headaches, too.

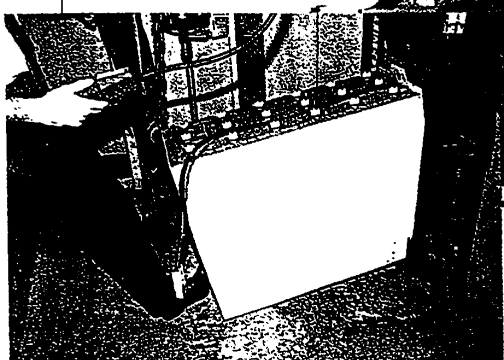
In the event of a lawsuit, you may be able to prove that the operator was trained and tests show he/she knew better. One lawsuit avoided can pay for the most expensive training program.

Accidents are preventable

With almost 70 percent of any good program dedicated to safety, you'll find that safety consciousness is the largest benefit of a good operator training program.

Videos can help. They can show, as in no other way, how accidents can happen and what went wrong. But videos by nature must be generic. They can explore,

A trainer demonstrates a common danger in stand-up truck operation. Operators often allow their left foot or leg outside of the confines of the operator's compartment. The result is that a leg could be crushed if the truck chassis comes too close to a rack or building column or other object.



How not to change a battery. Besides the imbalance of the battery suspended from one hoist hook, the trainer is demonstrating the danger of using his foot to put the battery into the truck's battery compartment. A proper battery spreader beam should be used to keep the battery under control at all times.

explain or amplify, but videos seldom cover exactly the lift truck in question and never the exact operating conditions found in your plant. Taking a test on the content of a video will only show if the operator got the point of the video.

Training as an opportunity

Operator training is a chance to teach and reinforce many lessons. A custom program is also a chance to reinforce your company policies on safety. You can empower employees to refuse to work under unsafe conditions.

You also get a chance to restate some personnel policies that are in the employee policy manual but may have been forgotten. Such subjects as horseplay, using equipment inappropriately, drinking on the job, work shoes, hard hats, operating in restricted areas, etc., can all be restated and even be made part of the final test.

Maintenance is key

Maintenance records can tell you a lot about your operators before and after training. Records can reveal the untrained or careless operators through things like frequency of breakdowns, brakes and tire wear. "After training, your short-term maintenance costs will go up," says Shephard. "This is because trained operators will spot deficiencies in their trucks and work environment and know that for their own safety these deficiencies should be corrected."

Each operator is different

Some drivers are set in their ways. Special consideration must be taken in changing their thinking to a new training program.

Other operators have a greater tendency to "hot dog," operate foolishly or race vehicles. Company policies, reporting and rules enforcement can curb such conduct.

The trainer's attitude makes a difference

Trainers must be selected because they are serious, interested, and have the respect of their peers. Classroom training for such trainers must include conduct because if they are not dead serious, they can never get trainees to be serious about safety.

Truck type makes a difference

If an operator simply changes the battery, it requires one kind of training. If the battery is put on charge and the water is topped up after charging, additional training is needed. There is a whole set of problems, precautions and hazards associated with motive power batteries that are not found with any other vehicles.

Safe refueling of gasoline, LP-gas and diesel trucks must be part of training. Each fuel has different properties and hazards associated with spills and leaks. The operator is usually the one on the scene when the spill occurs.

Training must teach operators to recognize and question unsafe conditions. Recognizing that exhaust fumes can cause drowsiness, for example. The fact that the truck or the operating environment has a problem will fall to the operator. The operator must report a hazardous condition and make certain it is corrected.

Training helps communication

One of the first benefits management gets is better communication. Employees will feel that management cares about their safety because they are being trained. With empowerment, employees feel that their opinion counts and operators will feed back information to management. Mutual concern can develop from this new shared responsibility. **MHE**

Machine Guarding
Power Presses
Publications
Training
Other Links
Compliance

Machine Guarding

What is machine guarding and why is it necessary?

Moving machine parts have the potential for causing severe workplace injuries, such as crushed fingers or hands, amputations, burns, blindness, just to name a few. Safeguards are essential for protecting workers from these needless and preventable injuries. Any machine part, function, or process which may cause injury must be safeguarded. When the operation of a machine or accidental contact with it can injure the operator or others in the vicinity, the hazards must be either eliminated or controlled.

This page contains general information on the various hazards of mechanical motion and techniques for protecting workers. Compliance information related to machine guarding is also included. For material on specific types of equipment, go to the following links:

- Power Presses

What resources are available to help me recognize machinery-related hazards and implement appropriate safeguarding techniques in my workplace?

- Publications
- Training Resources
- Other Links

What OSHA standards and other compliance information apply to my workplace?

Machine guarding and related machinery violations continuously rank among the top 10 of OSHA citations issued. Visit the Machine Guarding Compliance page for links to OSHA standards, interpretation letters, directives, and other compliance-related information.

Revision Date: 14 November 2001

This information found July 23, 2002 at
http://www.osha-slc.gov/SLTC/machineguarding/index.html

Machine Guarding

Power Presses

Publications

Training

Other Links

Compliance

Machine Guarding (continued)

Compliance

- **OSHA Standards**
  General Industry
  - 1910 Subpart O, Machinery and Machine Guarding (1910.211 to 1910.219). Includes definitions, general requirements, and requirements for different kinds of machinery.
  - 1910.262, Textiles. Paragraph (c)(3) contains a short statement on machine guarding requirements and a reference to 1910.219.
  - 1910.263, Bakery equipment. Paragraph (c) addresses general requirements for machine guarding.
  - 1910.268, Telecommunications. Paragraph (b)(1)(v) addresses some general requirements for machine guarding.

  Marine Terminals

  - 1917.151, Machine guarding.

  Longshoring

  - 1918.96, Maintenance and repair work in the vicinity of longshoring operations. Paragraph (e) contains general requirements for machine guarding.

  Construction

  - 1926 Subpart I, Tools - Hand and Power (1926.300 to 1926.307). Includes general machine guarding requirements and specific guarding requirements for different kinds of tools.

Agriculture

- [1928.57](), Guarding of farm field equipment, farmstead equipment, and cotton gins.

- **OSHA Directives**
  - STD 1-12.1, Defining Acceptable Guarding of Fan Blades (1978, October 30), 2 pages. Clarifies the applicability of 1910.212(a)(5) and directs answers to inquiries.
  - STD 1-12.4, 29 CFR 1910.213(h)(5), Caution Labeling of Radial Saws (1978, October 30), 2 pages. Provides guidance in the enforcement of the subject provision.
  - STD 1-12.5, 29 CFR Section 1910.212(a)(3)(ii), Acceptable Guarding for Circular Meat Cutting Saws (1978, October 30), 2 pages. Provides guidance on the acceptable methods for guarding meat cutting saws
  - STD 1-12.6, 29 CFR 1910.218, Forging Machines (1978, October 30), 2 pages. Clarifies appropriate enforcement of 29 CFR 1910.218.
  - STD 1-12.7, 29 CFR 1910.217 and 29 CFR 1910.212, Applicability of Platen Presses (1978, October 30), 2 pages. Provides specific clarifications on the applicability of 29 CFR 1910.217 and 29 CFR 1910.212 to platen presses.
  - STD 1-12.8, 29 CFR 1910.215(a)(4), Abrasive Wheel Machinery Work Rests (1978, October 30), 2 pages. Provides clarification on the acceptable methods for the use of work rests.
  - STD 1-12.9, 29 CFR 1910.212, General Requirements for all Machines (1978, October 30), 2 pages. Clarifies the intent of 29 CFR 1910.212 as applied to blade guards for chain saws.
  - STD 1-12.10, Application of 29 CFR

1910.212(a)(1) to Food Waste Disposal Equipment (1978, October 30), 2 pages. Assures uniformity in the application of the subject standard to point of operation guarding on food waste disposal equipment.

- STD 1-12.14, Clarification of 29 CFR 1910.219, the Terms "Enclosed" and "Fully Enclosed", as applying to Power Transmission Belts (1978, October 30), 2 pages. Provides clarification of the application of "enclosed" and "fully enclosed" as applying to power transmission belts, and guarding by location.
- STD 1-12.15, 29 CFR 1910.213(a)(4), Woodworking Machinery Requirements (1978, October 30), 2 pages. Provides guidance to the field on the applicability of 29 CFR 1910.213 (a)(4) in protecting employees from automatic cut-off saws that stroke continuously without the operator being able to control each stroke.
- STD 1-12.17, 29 CFR 1910.213(h)(1), Radial Saw Guards (1978, October 30), 2 pages. Provides clarification on the applicability of the subject standard as it relates to the saw mill industries.
- STD 1-12.18, 29 CFR 1910.213(c)(l) and (h)(1), Woodworking Machinery Guarding Requirements (1978, October 30), 2 pages. Specifies requirements for hand-fed ripsaws and swing cutoff saws and radial saws.
- STD 1-12.19, Application 1910.212(a)(1) to Sewing Machines in the Light Apparel Manufacturing Industries (1978, October 30), 3 pages. Provides a uniform means of evaluating the nip point and moving belt hazard on light and medium duty sewing machines such as those used in apparel manufacturing and sewing of light weight materials.
- STD 1-12.22, 29 CFR

1910.212(a)(3)(ii), Point of Operation Guarding for All Machines as Applied to the Hand-Fed Engraving Presses Used in the Engraved Stationery Manufacturing Industry (1979, January 2), 3 pages. Provides guidance in applying point of operation guarding requirements relative to hand-fed engraving presses in the engraved stationery industry, when using the face down method of printing.

- STD 1-12.23A, Guarding of Three-Roller Printing Ink Mills (1994, July 12), 3 pages. Clarifies the guarding requirements of the subject standard relative to the ingoing nip point on three-roller printing ink mills and to assure uniformity in the enforcement of the standard nationally.
- STD 1-12.25A, Awareness Barriers Installed on Metal Cutting Shears (1994, July 12), 2 pages. Provides guidance for applying awareness barrier safeguards as installed on metal cutting shears.
- STD 1-12.26A, Abrasive Operation Using Cutoff Wheels and Masonry Saws (1994, September 26), 3 pages. This instruction provides guidelines for violations related to guards for cutoff wheels and masonry saws.
- STD 1-12.28, Alternative Abatement Methods of 29 CFR 1910.212(a)(1) and (a)(2) As Applied to the Oil and Gas Drilling Industry (1983, February 7), 3 pages. Describes alternative techniques for preventing worker contact with rotating kelly bushings or kellys and exposed portions of rotary tables on oil and gas well drilling rigs in lieu of the physical guarding requirements. (STD 1-12.28 CH-1 incorporates a typographical error change, 2/14/1983).
- STD 1-13.1, Reduction of Air Pressure below 30 psi for Cleaning Purposes (1978, October 30), 2 pages. Includes requirements for chip guarding.

- STD 1-13.4, Portable Belt Sanding Machines as Covered by 29 CFR 1910.243(a)(3) and 29 CFR 1926.304(f) (1981, August 5), 2 pages. This instruction provides guidance to allow equitable enforcement of 29 CFR 1910.243 (a)(3) and 29 CFR 1926.304(f) as they pertain to the guarding of portable belt sanders.
- National Emphasis Program Amputation. CPL 2-1.33 (2001, November 09), 36 pages. This directive describes policies and procedures for implementing a National Emphasis Program (NEP) to identify and reduce or eliminate the workplace incidence of hazards which are causing or are likely to cause amputations.

- **Review Commission and Administrative Law Judge Decisions**
    - The Occupational Safety and Health Review Commission (OSHRC) is an independent Federal agency created to decide contests of citations or penalties resulting from OSHA inspections of American work places. To locate decisions related to this topic, search for keywords at the OSHRC site.

Revision Date: 23 January 2002

This information was found July 23, 2002 at
http://www.osha-slc.gov/SLTC/machineguarding/compliance.html

Bulletin #23
GUIDELINES FOR MACHINE SAFEGUARDING

The Occupational Safety and Health Administration (OSHA) requires that machine guarding be provided and maintained in a manner sufficient to protect machine operators and other persons present in machine areas from hazards associated with the operation of machines. Such hazards include those created by points of operation, in-going nip points, rotating parts, flying chips and sparks. The following information is provided to assist machine operators and machine shop supervisors and managers in carrying out their responsibilities for assuring machine safety through hazard identification and evaluation, safeguarding, training, and safe operation.

Types and Points of Hazardous Machine Operations

Motions

Rotating: in-running nip points, spindles, shaft ends, couplings
Reciprocating: back-and-forth, up-and-down
Transverse: movement in a straight, continuous line

Operations

Cutting: bandsaws, drills, milling machines, lathes
Punching: punch presses, notchers
Shearing: mechanical, pneumatic, or hydraulic shears

Bending: press brakes, tube benders, plate rolls

Safeguarding Requirements

Machine safeguards should be installed and maintained to ensure that they:

PREVENT CONTACT
Safeguards must minimize the possibility of the operator or another worker placing their hands into hazardous moving parts.

REMAIN SECURE
Workers should not be able to easily remove or tamper with the safeguard.

PROTECT FROM FALLING OBJECTS
Safeguards should ensure that no objects can fall into moving parts.

CREATE NO NEW HAZARDS
A safeguard defeats its purpose if it creates a hazard of its own.

CREATE NO INTERFERENCE
A safeguard should not create an unacceptable impediment for the worker.

ALLOW SAFE MAINTENANCE AND LUBRICATION
It should be possible to lubricate the machine without removing the safeguard.

Types of Machine Safeguards

- Barriers and guards that prevent contact with machinery
- Mechanical or electronic devices that restrict contact, such as presence-sensing, restraining, or tripping devices, two-hand controls, or gates.
- Feeding and ejection methods that eliminate part handling in the hazard zone.
- Aids such as awareness signs that do not provide physical protection, but warn of a danger area.

Training

Training is a necessary part of any effort to provide safeguarding against machine-related hazards. Supervisors are responsible for providing training to machine operators and maintenance personnel when any new safeguards are put into service or when workers are assigned to a new machine or operation. Training should involve instruction or hands-on training in the following areas:

- A description and identification of the hazards associated with the machine(s).
- A description of the safeguards and their functions.
- Instruction on how to use the safeguards.
- Instruction on how, and under what circumstances safeguards may be removed, and by whom.
- Instruction on what to do if a safeguard is missing, damaged, or inadequate.

Ongoing and Planned Activities at SLAC

The Mechanical Fabrication Department (MFD) is presently conducting a survey to inventory and identify machines and machine operators. This survey will provide the information necessary to determine which types of machine guards should be purchased or fabricated and installed throughout the site, and will help determine priorities for these efforts. The survey will also be used to identify training needs and to form the basis for development of machine safety training. MFD has already begun posting CAUTION signs and other awareness aids throughout the site. Specific information about the survey will be distributed by MFD to Department Heads and Group Leaders. However, a copy of the survey form is attached here to provide others an opportunity to respond if they choose.

Additional Resources

OSHA 3067 - Concepts and Techniques of Machine Safeguarding
29 CFR 1910, Subpart O
ANSI B11.6 and B11.8
SLAC ES&H Manual Chapter 39 (in preparation)

Matthew A. Allen, Associate Director for ES&H
SLAC Environment, Safety, and Health Division
3/6/92

This information found July 23, 2002 at
http://www-slac.slac.stanford.edu/esh/bulletins/b23.html

CONCEPTS AND TECHNIQUES OF MACHINE SAFEGUARDING

U.S. Department of Labor
Occupational Safety and Health Administration

OSHA 3067
1992 (Revised)

Table of Contents

Introduction

This manual has been prepared as an aid to employers, employees, machine manufacturers, machine guard designers and fabricators, and all others with an interest in protecting workers against the hazards of moving machine parts. It identifies the major mechanical motions and the general principles of safeguarding them. Current applications of each technique are shown in accompanying illustrations of specific operations and machines. The methods described here may be transferred, with due care, to different machines with similar hazards. To determine whether or not safeguarding meets the requirements of the standard, any mechanical motion that threatens a worker's safety should not remain unguarded.

The approaches to machine safeguarding discussed in this manual are not the only solutions which meet the requirements of the standard. Why? Because practical solutions to safeguarding moving machine parts are as numerous as the people working on them. No publication could keep pace with all of these solutions or attempt to depict them all.

In machine safeguarding, as in other regulated areas of the American workplace, to a certain extent OSHA standards govern function and practice. This text, however, is not a substitute for the standards. It is a manual of basic technical information and workable ideas which the employer may use as a guide to achieve compliance. It offers an overview of the machine safeguarding problem in the industrial setting, an assortment of solutions in popular use, and a challenge to all whose work involves machines.

Many readers of this manual already have the judgment, knowledge, and skill to develop effective answers to problems yet unsolved. Innovators are encouraged to find here stimulation to eliminate mechanical hazards facing America's workers today.

Go to Chapter 1

Chapter 1 - Basics of Machine Safeguarding

Basics of Machine Safeguarding

Crushed hands and arms, severed fingers, blindness -- the list of possible machinery-related injuries is as long as it is horrifying. There seem to be as many hazards created by moving machine parts as there are types of machines. Safeguards are essential for protecting workers from needless and preventable injuries.

A good rule to remember is: Any machine part, function, or process which many cause injury must be safeguarded. When the operation of a machine or accidental contact with it can injure the operator or others in the vicinity, the hazards must be either controlled or eliminated.

This manual describes the various hazards of mechanical motion and presents some techniques for protecting workers from these hazards. General information covered in this chapter includes -- where mechanical hazards occur, the hazards created by different kinds of motions and the requirements for effective safeguards, as well as a brief discussion of nonmechanical hazards.

Where Mechanical Hazards Occur

Dangerous moving parts in three basic areas require safeguarding:

The point of operation: that point where work is performed on the material, such as cutting, shaping, boring, or forming of stock.

Power transmission apparatus: all components of the mechanical system which transmit energy to the part of the machine performing the work. These components include flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, cranks, and gears.

Other moving parts: all parts of the machine which move while the machine is working. These can include reciprocating, rotating, and transverse moving parts, as well as feed mechanisms and auxiliary parts of the machine.

Hazardous Mechanical Motions and Actions

A wide variety of mechanical motions and actions may present hazards to the worker. These can include the movement of rotating members, reciprocating arms, moving belts, meshing gears, cutting teeth, and any parts that impact or shear. These different types of hazardous mechanical motions and actions are basic in varying combinations to nearly all machines, and recognizing them is the first step toward protecting workers from the danger they present.

The basic types of hazardous mechanical motions and actions are:

Motions

- rotating (including in-running nip points)
- reciprocating
- transversing

Actions

- cutting
- punching
- shearing
- bending

Motions

Rotating motion can be dangerous; even smooth, slowly rotating shafts can grip clothing, and through mere skin contact force an arm or hand into a dangerous position. Injuries due to contact with rotating parts can be severe.

Collars, couplings, cams, clutches, flywheels, shaft ends, spindles, meshing gears, and horizontal or vertical shafting are some examples of common rotating mechanisms which may be hazardous. The danger increases when projections such as set screws, bolts, nicks, abrasions, and projecting keys or set screws are exposed on rotating parts, as shown in Figure 1.

Figure 1. Examples of hazardous projections on rotating parts

In-running nip point hazards are caused by the rotating parts on machinery. There are three main types of in-running nips.

Parts can rotate in opposite directions while their axes are parallel to each other. These parts may be in contact (producing a nip point) or in close proximity. In the latter case the stock fed between the rolls produces the nip points. This danger is common on machines with intermeshing gears, rolling mills, and calenders. See Figure 2.

Figure 2. Common nip points on rotating parts

Nip points are also created between rotating and tangentially moving parts. Some examples would be: the point of contact between a power transmission belt and its pulley, a chain and a sprocket, and a rack and pinion. See Figure 3.

Figure 3. Nip points between rotating elements and parts with longitudinal motions.

Nip points can occur between rotating and fixed parts which create a shearing, crushing, or abrading action. Examples are: spoked handwheels or flywheels, screw conveyors, or the periphery of an abrasive wheel and an incorrectly adjusted work rest. See Figure 4.

Figure 4. Nip points between rotating machine components; (A - cover removed for clarity.)

Reciprocating motions may be hazardous because, during the back-and-forth or up-and-down motion, a worker may be struck by or caught between a moving and a stationary part. See Figure 5 for an example of a reciprocating motion.

Figure 5. Hazardous reciprocating motion.

Transverse motion (movement in a straight, continuous line) creates a hazard because a worker may be struck or caught in a pinch or shear point by the moving part. See Figure 6.

Figure 6. Example of transverse motion.

Actions

Cutting action may involve rotating, reciprocating, or transverse motion. The danger of cutting action exists at the point of operation where finger, arm and body injuries can occur and where flying chips or scrap material can strike the head, particularly in the area of the eyes or face. Such hazards are present at the point of operation in cutting wood, metal, or other materials.

Examples of mechanisms involving cutting hazards include bandsaws, circular saws, boring or drilling machines, turning machines (lathes), or milling machines. See Figure 7.

Figure 7. Examples of dangerous cutting hazards.

Punching action results when power is applied to a slide (ram) for the purpose of blanking, drawing, or stamping metal or other materials. The danger of this type of action occurs at the point of operation where stock is inserted, held, and withdrawn by hand.

Typical machines used for punching operations are power presses and iron workers. See Figure 8.

Figure 8. Typical punching operation.

Shearing action involves applying power to a slide or knife in order to trim or shear metal or other materials. A hazard occurs at the point of operation where stock is actually inserted, held, and withdrawn.

Examples of machines used for shearing operations are mechanically, hydraulically, or pneumatically powered shears. See Figure 9.

Figure 9. Shearing

Bending action results when power is applied to a slide in order to draw or stamp metal or other materials. A hazard occurs at the point of operation where stock is inserted, held, and withdrawn.

Equipment that uses bending action includes power presses, press brakes, and tubing benders. See Figure 10.

Figure 10. Bending

Requirements for Safeguards

What must a safeguard do to protect workers against mechanical hazards? Safeguards must meet these minimum general requirements:

Prevent contact: The safeguard must prevent hands, arms, and any other part of a worker's body from making contact with dangerous moving parts. A good safeguarding system eliminates the possibility of the operator or another worker placing parts of their bodies near hazardous moving parts.

Secure: Workers should not be able to easily remove or tamper with the safeguard, because a safeguard that can easily be made ineffective is no safeguard at all. Guards and safety devices should be made of durable material that will withstand the conditions of normal use. They must be firmly secured to the machine.

Protect from falling objects: The safeguard should ensure that no objects can fall into moving parts. A small tool which is dropped into a cycling machine could easily become a projectile that could strike and injure someone.

Create no new hazards: A safeguard defeats its own purpose if it creates a hazard of its own such as a shear point, a jagged edge, or an unfinished surface which can cause a laceration. The edges of guards, for instance, should be rolled or bolted in such a way that they eliminate sharp edges.

Create no interference: Any safeguard which impedes a worker from performing the job quickly and comfortably might soon be overridden or disregarded. Proper safeguarding can actually enhance efficiency since it can relieve the worker's apprehensions about injury.

Allow safe lubrication: If possible, one should be able to lubricate the machine without removing the safeguards. Locating oil reservoirs outside the guard, with a line leading to the lubrication point, will reduce the need for the operator or maintenance worker to enter the hazardous area.

Nonmechanical Hazards

While this manual concentrates attention on concepts and techniques for safeguarding mechanical motion, machines obviously present a variety of other hazards which cannot be ignored. Full discussion of these matters is beyond the scope of this publication, but some nonmechanical hazards are briefly mentioned below to remind the reader of things other than safeguarding moving parts that can affect the safe operation of machines.

All power sources for machines are potential sources of danger. When using electrically powered or controlled machines, for instance, the equipment as well as the electrical system itself must be properly grounded. Replacing frayed, exposed, or old wiring will also help to protect the operator and others from electrical shocks or electrocution. High pressure systems, too, need careful inspection and maintenance to prevent possible failure from pulsation, vibration, or leaks. Such a failure could cause, among other things, explosions or flying objects.

Machines often produce noise (unwanted sound) which can result in a number of hazards to workers. Noise can startle and disrupt concentration, and can interfere with communications, thus hindering the worker's safe job performance. Research has linked noise to a whole range of harmful health effects, from hearing loss and aural pain to nausea, fatigue, reduced muscle control, and emotional disturbance. Engineering controls such as the use of sound-dampening materials, and personal protective equipment, such as ear plugs and muffs, can help control the harmful effects of noise. Also, administrative controls that involve removing the worker from the noise source can be an effective measure when feasible.

Because some machines require the use of cutting fluids, coolants, and other potentially harmful substances, operators, maintenance workers, and others in the vicinity may need protection. These substances can cause ailments ranging from dermatitis to serious illnesses and disease. Specially constructed safeguards, ventilation, and protective equipment and clothing are possible temporary solutions to the problem of machinery-related chemical hazards until these hazards can be better controlled or eliminated from the workplace.

Training

Even the most elaborate safeguarding system cannot offer effective protection unless the worker knows how to use it and why. Specific and detailed training is therefore a crucial part of any effort to provide safeguarding against machine-related hazards. Thorough operator training should involve instruction or hands-on training in the following:

1. a description and identification of the hazards associated with particular machines;
2. the safeguards themselves, how they provide protection, and the hazards for which they are intended;
3. how to use the safeguards and why;
4. how and under what circumstances safeguards can be removed, and by whom (in most cases, repair or maintenance personnel only); and
5. what to do (e.g., contact the supervisor) if a safeguard is damaged, missing, or unable to provide adequate protection.

This kind of safety training is necessary for new operators and maintenance or setup personnel, when any new or altered safeguards are put in service, or when workers are assigned to a new machine or operation.

Protective Clothing and Personal Protective Equipment

Engineering controls, that eliminate the hazard at the source and do not rely on the worker's behavior for their effectiveness offer the best and most reliable means of safeguarding. Therefore, engineering controls must be the employer's first choice for eliminating machine hazards. But whenever engineering controls are not available or are not fully capable of protecting the employee (an extra measure of protection is necessary), operators must wear protective clothing or personal protective equipment.

If it is to provide adequate protection, the protective clothing and equipment selected must always be:

1. appropriate for the particular hazards;
2. maintained in good condition;
3. properly stored when not in use, to prevent damage or loss; and
4. kept clean, fully functional, and sanitary.

Protective clothing is, of course, available for different parts of the body. Hard hats can protect the head from the impact of bumps and falling objects when the worker is handling stock; caps and hair nets can help keep the worker's hair from being caught in machinery. If machine coolants could splash or particles could fly into the operator's eyes or face, then face shields, safety goggles, glasses, or similar kinds of protection might be necessary. Hearing protection may be needed when workers operate noisy machines. To guard the trunk of the body from cuts or impacts from heavy or rough-edged stock, there are certain protective coveralls, jackets, vests, aprons, and full-body suits. Workers can protect their hands and arms from the same kinds of injury with special sleeves and gloves. Safety shoes and boots, or other acceptable foot guards, can shield the feet against injury in case the worker needs to handle heavy stock which might drop.

It is important to note that protective clothing and equipment can create hazards. A protective glove which can become caught between rotating parts, or a respirator facepiece which hinders the wearer's vision, for example, require alertness and continued attentiveness whenever they are used.

Other parts of the worker's clothing may present additional safety hazards. For example, loose-fitting shirts might possibly become entangled in rotating spindles or other kinds of moving machinery. Jewelry, such as bracelets and rings, can catch on machine parts or stock and lead to serious injury by pulling a hand into the danger area.

Go to Chapter 2

Chapter 2 -
Methods of Machine Safeguarding

Methods of Machine Safeguarding

There are many ways to safeguard machines. The type of operation, the size or shape of stock, the method of handling, the physical layout of the work area, the type of material, and production requirements or limitations will help to determine the appropriate safeguarding method for the individual machine.

As a general rule, power transmission apparatus is best protected by fixed guards that enclose the danger areas. For hazards at the point of operation, where moving parts actually perform work on stock, several kinds of safeguarding may be possible. One must always choose the most effective and practical means available.

We can group safeguards under five general classifications.

1. Guards
   - A. Fixed
   - B. Interlocked
   - C. Adjustable
   - D. Self-adjusting
2. Devices
   - A. Presence Sensing
     - (1) Photoelectrical (optical)
     - (2) Radiofrequency (capacitance)
     - (3) Electromechanical
   - B. Pullback

C. Restraint

D. Safety Controls

(1) Safety trip control

(a) Pressure-sensitive body bar

(b) Safety tripod

(c) Safety tripwire cable

(2) Two-hand control

(3) Two-hand trip

E. Gates

(1) Interlocked

(2) Other

3. Location/Distance

4. Potential Feeding and Ejection Methods to Improve Safety for the Operator

A. Automatic feed

B. Semi-automatic feed

C. Automatic ejection

D. Semi-automatic ejection

E. Robot

5. Miscellaneous Aids

A. Awareness barriers

B. Miscellaneous protective shields

C. Hand-feeding tools and holding fixtures

Guards

Guards are barriers which prevent access to danger areas. There are four general types of guards:

Fixed: As its name implies, a fixed guard is a permanent part of the machine. It is not dependent upon moving parts to perform its intended function. It may be constructed of sheet metal, screen, wire cloth, bars, plastic, or any other material that is substantial enough to withstand whatever impact it may receive and to endure prolonged use. This guard is usually preferable to all other types because of its relative simplicity and permanence.

Examples of fixed guards...

In Figure 11, a fixed guard on a power press completely encloses the point of operation. The stock is fed through the side of the guard into the die area, with the scrap stock exiting on the opposite side.

Figure 11. Fixed guard on power press.

Figure 12 shows a fixed guard that protects the operator from a mechanism that folds cartons. This guard would not normally be removed except to perform maintenance on the machine. Figure 13 shows a fixed enclosure guard shielding the belt and pulley of a power transmission unit. An inspection panel is provided on top in order to minimize the need for removing the guard. To remain effective, the inspection panel cannot be removed while the mechanism is in operation. In Figure 14, fixed enclosure guards are shown on a bandsaw. These guards protect the operator from the turning wheels and moving saw blade. Normally, the only time for the guards to be opened or removed would be for a blade change or maintenance. It is very important that they be securely fastened while the saw is in use.

Figure 12. Fixed guard on egg carton folding machine.

Figure 13. Fixed guard enclosing belt and pulleys.

Figure 14. Fixed guards on a band saw.

A fixed guard is shown on a veneer clipper in Figure 15. This guard acts as a barrier, protecting fingers from exposure to the blade. Note the side view of the curved portion of the guard.

Figure 15. Fixed guards on veneer clipper.

Figure 16 shows both a fixed blade guard and a throat and gap guard on a power squaring shear. These guards should be removed only for maintenance or blade changes.

Figure 16. Fixed guard on a power squaring shear.

In Figure 17, a transparent, fixed barrier guard is being used on a press brake to protect the operator from the unused portions of the die. This guard is easy to install or remove.

Figure 17. Fixed guard providing protection from unused portion of die on a press brake.

Interlocked: When this type of guard is opened or removed, the tripping mechanism and/or power automatically shuts off or disengages, and the machine cannot cycle or be started until the guard is back in place.

An interlocked guard may use electrical, mechanical, hydraulic, or pneumatic power or any combination of these. Interlocks should not prevent "inching" by remote control if required. Replacing the guard should not automatically restart the machine. To be effective, all movable guards should be interlocked to prevent occupational hazards. (See also Figure 13.)

Figure 18 shows an interlocked barrier guard mounted on an automatic bread bagging machine. When the guard is removed, the machine will not function.

Figure 18. Interlocked guard on automatic bread bagging machine

In Figure 19, the beater mechanism of a picker machine (used in the textile industry) is covered by an interlocked barrier guard. This guard cannot be raised while the machine is running, nor can the machine be restarted with the guard in the raised position.

Figure 19. Interlocked guard on picker machine

In Figure 20, an interlocked guard covers the rotating cylinder of the dividing head of a roll make-up machine used for making hamburger and hot-dog rolls.

Figure 20. Interlocked guard on roll make-up machine

Adjustable: Adjustable guards are useful because they allow flexibility in accommodating various sizes of stock.

Figure 21 shows a bandsaw with an adjustable guard to protect the operator from the unused portion of the blade. This guard can be adjusted according to the size of stock.

Figure 21. Adjustable guard on horizontal bandsaw.

In Figure 22, the bars adjust to accommodate the size and shape of the stock. Figures 23 and 24 show guards that can be adjusted according to the thickness of the stock.

Figure 22. Adjustable guard on power press.

Figure 23. Adjustable guard on router.

Figure 24. Adjustable guard on shaper.

In Figure 25, the guard adjusts to provide a barrier between the operator and the blade.

Figure 25. Adjustable guard on table saw.

Figure 26 shows an adjustable enclosure guard on a bandsaw.

Figure 26. Adjustable guard on bandsaw.

Self-Adjusting: The openings of these barriers are determined by the movement of the stock. As the operator moves the stock into the danger area, the guard is pushed away, providing an opening which is only large enough to admit the stock. After the stock is removed, the guard returns to the rest position. This guard protects the operator by placing a barrier between the danger area and the operator. The guards may be constructed of plastic, metal, or other substantial material. Self-adjusting guards offer different degrees of protection.

Examples of self-adjusting guards...

Figure 27 shows a radial arm saw with a self-adjusting guard. As the blade is pulled across the stock, the guard moves up, staying in contact with the stock.

Figure 27. Self-adjusting guard on radial arm saw.

Figure 28 shows a twin-action, transparent, self-adjusting guard. The first guard rises as the stock enters, then returns to its rest position as the stock moves ahead to raise the second guard.

Figure 28. Self-adjusting guard on table saw.

A self-adjusting guard is shown in Figure 29. As the blade moves through the stock, the guard rises up to the stock surface.

Figure 29. Self-adjusting guard on circular saw.

Figure 30 shows a self-adjusting enclosure guard mounted on a jointer. This guard is moved from the cutting head by the stock. After the stock is removed, the guard will return, under spring tension, to the rest position.

Figure 30. Self-adjusting guard on a jointer

Another type of self-adjusting guard mounted on a jointer is illustrated in Figure 31. The guard moves two ways. An edging operation causes the guard to move horizontally. If the stock is wide enough during a surfacing operation, the stock may be fed under the guard, causing it to move vertically.

Figure 31. Self-adjusting guard on a jointer

Guards

Method	Safeguarding Action	Advantages	Limitations
Fixed	Provides a barrier	Can be constructed to suit many specific applications In-plant construction is often possible Can provide maximum protection Usually requires minimum maintenance Can be suitable to high production, repetitive operations	May interfere with visibility Can be limited to specific operations Machine adjustment and repair often require its removal, thereby necessitating other means of protection for maintenance personnel

Interlocked	Shuts off or disengages power and prevents starting of machine when guard is open; should require the machine to be stopped before the worker can reach into the danger area	Can provide maximum protection Allows access to machine for removing jams without time consuming removal of fixed guards	Requires careful adjustment and maintenance May be easy to disengage jams
Adjustable	Provides a barrier that may be adjusted to facilitate a variety of production operations	Can be constructed to suit many specific applications Can be adjusted to admit varying sizes of stock	Hands may enter danger area -- protection may not be complete at all times May require

			frequent maintenance and/or adjustment The guard may be made ineffective by the operator May interfere with visibility
Self-adjusting	Provides a barrier that moves according to the size of the stock entering the danger area	Off-the-shelf guards are often commercially available	Does not always provide maximum protection May interfere with visibility

May require frequent maintenance and adjustment

Devices

A safety device may perform one of several functions. It may stop the machine if a hand or any part of the body is inadvertently placed in the danger area; restrain or withdraw the operator's hands from the danger area during operation; require the operator to use both hands on machine controls, thus keeping both hands and body out of danger; or provide a barrier which is synchronized with the operating cycle of the machine in order to prevent entry to the danger area during the hazardous part of the cycle.

Presence-Sensing

The photoelectric (optical) presence-sensing device uses a system of light sources and controls which can interrupt the machine's operating cycle. If the light field is broken, the machine stops and will not cycle. This device must be used only on machines which can be stopped before the worker can reach the danger area. The design and placement of the guard depends upon the time it takes to stop the mechanism and the speed at which the employee's hand can reach across the distance from the guard to the danger zone.

Figure 32 shows a photoelectric presence-sending device on a part-revolution power press. When the light beam is broken, either the ram will not start to cycle, or, if the cycle has begun, the stopping mechanism will be activated so that the press stops before the operator's hand can enter the danger zone.

Figure 32. Photoelectric presence-sensing device on power press.

A photoelectric presence-sending device used with a press brake is illustrated in Figure 33. The device may be swung up or down to accommodate different production requirements.

Figure 33. Photoelectric presence-sensing device on press brake

The radiofrequency (capacitance) presence-sending device uses a radio beam that is part of the machine control circuit. When the capacitance field is broken, the machine will stop or will not activate. Like the photoelectric device, this device shall only be used on machines which can be stopped before the worker can reach the danger area. This requires the machine to have a friction clutch or other reliable means for stopping.

Figure 34 shows a radiofrequency presence-sensing device mounted on a part-revolution power press.

Figure 34. Radiofrequency presence-sensing device on a power press

The electromechanical sensing device has a probe or contact bar which descends to a predetermined distance when the operator initiates the machine cycle. If there is an obstruction preventing it from descending its full predetermined distance, the control circuit does not actuate the machine cycle.

Figure 35 shows an electromechanical sensing device on an eyeletter. The sensing probe in contact with the operator's finger is also shown.

Figure 35. Electromechanical sensing device on an eyeletter.

Pullback

Pullback devices utilize a series of cables attached to the operator's hands, wrists, and/or arms. This type of device is primarily used on machines with stroking action. When the slide/ram is up between cycles, the operator is allowed access to the point of operation. When the slide/ram begins to cycle by starting its descent, a mechanical linkage automatically assures withdrawal of the hands from the point of operation.

Figure 36 shows a pullback device on a straight-side power press. When the slide/ram is in the "up" position, the operator can feed material by hand into the point of operation. When the press cycle is actuated, the operator's hands and arms are automatically withdrawn. Figure 37 shows a pullback device on a smaller press.

Figure 36. Pullback device on a power press.

Figure 37. Pullback device on a power press.

A pullback device on a press brake is illustrated in Figure 38.

Figure 38. Pullback device on press brake

Restraint

The restraint (holdout) device in Figure 39 utilizes cables or straps that are attached to the operator's hands at a fixed point. The cables or straps must be adjusted to let the operator's hands travel within a predetermined safe area. There is no extending or retracting action involved. Consequently, hand-feeding tools are often necessary if the operation involves placing material into the danger area.

Figure 39. Restraint device on power press

Chapter 3 -
Guard Construction

Chapter 3

Guard Construction

Today many builders of single-purpose machines provide point-of-operation and power transmission safeguards as standard equipment. However, not all machines in use have built-in safeguards provided by the manufacturer.

Guards designed and installed by the builder offer two main advantages:

- They usually conform to the design and function of the machine.
- They can be designed to strengthen the machine in some way or to serve some additional functional purposes.

User-built guards are sometimes necessary for a variety of reasons. They have these advantages:

- Often, with older machinery, they are the only practical safeguarding solution.
- They may be the only choice for mechanical power transmission apparatus in older plants, where machinery is not powered by individual motor drives.
- They permit options for point-of-operation safeguards when skilled personnel design and make them.
- They can be designed and built to fit unique and even changing situations.
- They can be installed on individual dies and feeding mechanisms.
- Design and installation of machine safeguards by plant personnel can help to promote safety consciousness in the workplace.

However, they also have disadvantages:

- User-built guards may not conform well to the configuration and function of the machine.
- There is a risk that user-built guards may be poorly designed or built.

Point-of-Operation Guards

Point-of-operation safeguarding is complicated by the number and complexity of machines and also by the different uses for individual machines. For these reasons, not all machine builders provide point-of-operation guards on their products. In many cases a point-of-operation guard can only be made and installed by the user after a thorough hazard analysis of the work requirements. Poorly designed, built or installed guards may create a hazard rather than eliminate one. To be effective they must safeguard the employee while allowing the work to continue with minimum disruption to the production process.

Mechanical Power Transmission Apparatus Guarding

A significant difference between power transmission guards and point-of-operation guards is that the former type needs no opening for feeding stock. The only openings necessary for power transmission guards are those for lubrication, adjustment, repair, and inspection. These openings should be provided with interlocked covers that cannot be removed except by using tools for service or adjustment.

To be effective, power transmission guards should cover all moving parts in such a manner that no part of the operator's body can come in contact with them.

Guard Material

Under many circumstances, metal is the best material for guards. Guard framework is usually made from structural shapes, pipe, bar, or rod stock. Filler material generally is expanded or perforated or solid sheet metal or wire mesh. It may be feasible to use plastic or safety glass where visibility is required.

Guards made of wood generally are not recommended because of their flammability and lack of durability and strength. However, in areas where corrosive materials are present, wooden guards may be the better choice.

Go to Chapter 4

Chapter 4 - Machinery Maintenance and Repair

Machinery Maintenance and Repair

Good maintenance and repair procedures contribute significantly to the safety of the maintenance crew as well as that of machine operators. The variety and complexity of machines to be serviced, the hazards associated with their power sources, the special dangers that may be present during machine breakdown, and the severe time constraints often placed on maintenance personnel all make safe maintenance and repair work difficult.

Training and aptitude of people assigned to these jobs should make them alert for the intermittent electrical failure, the worn part, the inappropriate noise, the cracks or other signs that warn of impending breakage or that a safeguard has been damaged, altered, or removed. By observing machine operators at their tasks and listening to their comments, maintenance personnel may learn where potential trouble spots are and give them early attention before they develop into sources of accidents and injury. Sometimes all that is needed to keep things running smoothly and safely is machine lubrication or adjustment. Any damage observed or suspected should be reported to the supervisor; if the condition impairs safe operation, the machine should be out of service for repair. Safeguards that are missing, altered, or damaged also should be reported so appropriate action can be taken to insure against worker injury.

If possible, machine design should permit routine lubrication and adjustment without removal of safeguards. But when safeguards must be removed, and the machine serviced, the lockout procedure of 29 CFR 1910.147 must be adhered to. The maintenance and repair crew must never fail to replace the guards before the job is considered finished and the machine released from lockout..

Is it necessary to oil machine parts while a machine is running? If so, special safeguarding equipment may be needed solely to protect the oiler from exposure to hazardous moving parts. Maintenance personnel must know which machines can be serviced while running and which cannot. "If in doubt, lock it out." Obviously, the danger of accident or injury is reduced by shutting off and locking out all sources of energy.

In situations where the maintenance or repair worker would necessarily be exposed to electrical elements or hazardous moving machine parts in the performance of the job, there is no question that all power sources must be shut off and locked out before work begins. Warning signs or tags are inadequate insurance against the untimely energizing of mechanical equipment.

Thus, one of the first procedures for the maintenance person is to disconnect and lock out the machine from all of its power sources, whether the source is electrical, mechanical, pneumatic, hydraulic, or a combination of these. Energy accumulation devices must be "bled down."

Electrical: Unexpected energizing of any electrical equipment that can be started by automatic or manual remote control may cause electric shock or other serious injuries to the machine operator, the maintenance worker, or others operating adjacent machines controlled by the same circuit. For this reason, when maintenance personnel must repair electrically powered equipment, they should open the circuit at the switch box and padlock the switch (lock it out) in the "off" position. This switch should be tagged with a description of the work being done, the name of the maintenance person, and the department involved. When more than one worker is to be engaged in the servicing/maintenance function a typical lockout hasp to which each may affix a personal lock is shown in Figure 69.

Figure 69. Lockout hasp

Mechanical: Figure 70 shows safety blocks being used as an additional safeguard on a mechanical power press, even though the machine has been locked out. The safety blocks prevent the ram from coming down under its own weight.

Figure 70. Safety blocks installed on power press

Pneumatic and hydraulic: Figure 71 shows a lockout valve. The lever-operated air valve used during repair or shutdown to keep a pneumatic-powered machine or its components from operating can be locked open or shut. Before the valve can be opened, everyone working on the machine must use his or her own key to release the lockout. A sliding-sleeve valve exhausts line pressure at the same time it cuts off the air supply. Valves used to lock out pneumatic or hydraulic-powered machines should be designed to accept locks or lockout adapters and should be capable of "bleeding off" pressure residues that could cause any part of the machine to move.

Figure 71. Lockout valve

In shops where several maintenance persons might be working on the same machine, multiple lockout devices accommodating several padlocks are used. The machine cannot be reactivated until each person removes his or her lock. As a matter of general policy, lockout control is gained by the procedure of issuing personal padlocks to each maintenance or repair person; no one but that person can remove the padlock, thereby each worker controls the power systems.

Whenever machines or equipment are serviced, there are hazards encountered by the employees performing the servicing or maintenance which are unique to the repair or maintenance procedures being conducted. These hazards may exist due to the failure of the employees doing the servicing or maintenance to stop the machine being worked on. Even if the machine has been stopped, the machine can still be hazardous due to the possibility of the machine becoming reenergized or restarting.

In order to prevent these hazards, each machine or piece of equipment should be safeguarded during the conduct of servicing or maintenance by: (1) notifying all affected employees (usually machine or equipment operators or users) that the machine or equipment must be shut down to perform some maintenance or servicing; (2) stopping the machine; (3) isolating the machine or piece of equipment from its energy source;

(4) locking out or tagging out the energy source; (5) relieving any stored or residual energy; and (6) verifying that the machine or equipment is isolated from the energy source. Although this is the general rule, there are exceptions when the servicing or maintenance is not hazardous for an employee, when the servicing which is conducted is minor in nature, done as an integral part of production, and the employer utilizes alternative safeguards which provide effective protection as is required by 29 CFR 1910.212 or other specific OSHA standards.

When the servicing or maintenance is completed, there are specific steps which must be taken to return the machine or piece of equipment to service. These steps include (1) inspection of the machine or equipment to ensure that all guards and other safety devices are in place and functional, (2) checking the area to ensure that energization and start up of the machine or equipment will not endanger employees, (3) removal of the lockout devices, (4) reenergization of the machine or equipment, and (5) notification of affected employees that the machine or equipment may be returned to service.

The steps to lockout described above are only a part of the total energy control program which must exist in the workplace. In addition, the employee should have written procedures for all machines and equipment, employees must be trained in their duties and responsibilities under the energy control program and periodic inspections must be conducted to maintain the effectiveness of the program.

Figure 72 provides a functional flow diagram of the functions necessary during the conduct of a viable servicing/maintenance operation during which the equipment must be isolated and locked out.

Figure 72. Functional flow diagram for implementation of lockout/tagout requirements

The maintenance and repair facility in the plant deserves consideration here. Are all the right tools on hand and in good repair? Are lubricating oils and other common supplies readily available and safely stored? Are commonly used machine parts and hardware kept in stock so that the crews are not encouraged (even obliged) to improvise, at the risk of doing an unsafe repair, or to postpone a repair job? And don't overlook the possibility that maintenance equipment itself may need guarding of some sort. The same precaution applies to tools and machines used in the repair shop. Certainly, the maintenance and repair crew are entitled to the same protection that their service provides to the machine operators in the plant.

Go to Chapter 5

Chapter 5 -
The Utilization of Industry Consensus Standards

The Utilization of Industry Consensus Standards

OSHA uses industry consensus standards, related to the safe operation of equipment, as guidance of the industry accepted practice for safe operations. Industry consensus standards which describe equipment configuration or design but which do not describe safe and/or healthful use and operation of the equipment are of limited assistance to OSHA. In any event, even when an industry consensus standard addresses safety/health considerations, OSHA may determine that the safety/health practices described by that industry consensus standard are deficient when related to the requirement(s) set forth by the pertinent OSHA regulation(s). However, many of the various ANSI safety standards devoted to the safe use of equipment and machines are pertinent and provide valuable guidance as they relate to the multitude of safe operating procedures regularly discussed in ANSI safety standards.

All of the requirements of 29 CFR 1910.212, are applicable to machines found in industry. Paragraph (a)(1), requires that employees be protected from the hazards created by the point of operation, ingoing nip points, and rotating parts. Paragraph (a)(2), describes the manner in which guards shall be affixed. The proper application of devices are not described; therefore, other similar OSHA or pertinent industry standards must be referred to for guidance. Paragraph (a)(3) describes, with particularity, the requirements for safeguarding the point of operation.

The OSHA standard specifically requires that at the point of operation, "the guarding device shall be in conformity with any appropriate standards therefore, or in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle. "Applicable standards include any similar OSHA standard or any OSHA adopted industry consensus standard(s) which provide for the safety of the operator during the operating cycle. However, any specific industry consensus standard, such as an ANSI standard for the particular machine or equipment, should be used for guidance relative to the accepted procedures for safeguarding workers and operators from the recognized hazards of the equipment.

Employers who comply with the requirements of an industry consensus standard rather than a specific OSHA standard, where such compliance deviates from the OSHA requirements but provides for a more conservative safeguarding concept, are categorized as having created a de minimis violation of the specific OSHA standard. (A de minimis violation is a violation of an OSHA standard that has no direct or immediate relationship to safety or health. Such de minimis violations require no correction and result in no penalty.)

OSHA encourages employers to abide by the more current industry consensus standards since those standards are more likely to be abreast of the state of the art than an applicable OSHA standard may be. Furthermore, the industry consensus standards will usually discuss a variety of techniques for averting exposure to the identified hazards of the machine or process.

Listing of Specific ANSI Safety Standards

ANSI B11.1-1982	Mechanical Power Presses
ANSI B11.2-1982	Hydraulic Power Presses
ANSI B11.3-1982	Power Press Brakes
ANSI B11.4-1983	Shears
ANSI B11.5-1988	Iron Workers
ANSI B11.6-1984	Lathes
ANSI B11.7-1985	Cold Headers and Cold Formers
ANSI B11.8-1983	Drilling, Milling, and Boring Machines
ANSI B11.9-1975	Grinding Machines
ANSI B11.10-1983	Metal Sawing Machines
ANSI B11.11-1985	Gear Cutting Machines
ANSI B11.12-1983	Roll Forming and Roll Bending Machines
ANSI B11.13-1983	Single- and Multiple-Spindle Automatic Screw/Bar and Chucking Machines
ANSI B11.14-1983	Coil Slitting Machines/Equipment
ANSI B11.15-1984	Pipe, Tube, and Shape Bending Machines
ANSI B11.17-1982	Horizontal Hydraulic Extrusion Presses
ANSI B11.18-1985	Machinery and Machine Systems for the Processing of Coiled Strip, Sheet, and Plate
ANSI B11.19-1990	Machine Tools, Safeguarding
ANSI B11.20-1991	Manufacturing Systems/Cells

(ANSI B15.1-1994/6)	Power Transmission Apparatus
ANSI B19.1-1990	Air Compressor Systems
ANSI B19.3-1986/90	Compressors for Process Industries
ANSI B20.1-1990	Conveyors and Related Equipment
ANSI B24.1-1985	Forging Machinery
ANSI B28.6-1983	Rubber Machinery, Hose
ANSI B28.7-1983	Rubber Machinery, Hose
ANSI B28.8-1983	Rubber Machinery, Hose
ANSI B28.9-1983	Rubber Machinery, Hose
ANSI B28.10-1986	Rubber Machinery, Endless Belt
ANSI B30.16-1987	Overhead Hoists
ANSI B151.1-1990	Plastics Injection Molding Machinery, Horizontal
ANSI B151.2-1982/88	Plastics Machinery, Film Casting
ANSI B151.3-1982/88	Plastics Machinery, Screen Changers
ANSI B151.4-1982/88	Plastics Machinery, Blown Film Takeoff & Auxiliary Equipment
ANSI B151.5-1982/88	Plastics Machinery, Film & Sheet Winding
ANSI B151.6-1982/88	Plastics Machinery, Slit Tape & Monofilament Postextrusion Equipment
ANSI B151.7-1982/88	Plastics & Rubber Extrusion Machinery
ANSI B151.11-1982	Plastics Machinery, Granulators, Pelletizers, & Dicers
ANSI B151.15-1985	Plastics Machinery, Extrusion Blow Molding
ANSI B151.21-1986	Plastics Machinery, Injection Blow Molding

ANSI B151.25-1988	Plastics Machinery, Injection Molding
ANSI B152.2-1982	Permanent-Mold Casting Machines (Other than Gray Iron)
ANSI B153.1-1990	Automotive Lifts
ANSI B155.1-1986	Packaging Machinery
ANSI B169.1-1990	Envelope Manufacturing Machinery
ANSI B176-1985	Copper-Alloy Diecasting
ANSI B177.2-1977/82	Printing Ink Vertical Post Mixers
ANSI/NEMA ICS2:225.95-1983	Interlocking Control Circuits for Personnel Protection
ANSI/NFPA 79-1991	Electrical Standard for Industrial Machinery
ANSI/RIA R15.06-1986	Industrial Robots and Robot Systems
ANSI Z8.1-1972	Commercial Laundry & Dry-Cleaning Equipment
ANSI Z241.1-1989	Foundry, Sand Prep., Molding, & Core-Making
ANSI Z241.2-1989	Foundry, Melting & Pouring of Metals
ANSI Z241.3-1989	Foundry, Cleaning & Finishing of Castings
ANSI Z245.1-1984	Refuse Collecting & Compacting Equipment
ANSI Z245.3-1977/83	Stability of Refuse Bins
ANSI Z245.5-1982	Bailing Equipment
ANSI Z268.1-1082	Metal Scrap Processing Equipment

Go to Chapter 6

Chapter 6 -
Robotics in the Workplace

Robotics in the Workplace

Robot Applications

Robots are machines that load and unload stock, assemble parts, transfer objects, or perform other tasks.

Robots are used for replacing humans who were performing unsafe, hazardous, highly repetitive, and unpleasant tasks. They are utilized to accomplish many different types of application functions such as material handling, assembly, arc welding, resistance welding, machine tool load/unload functions, painting/spraying, etc.

Studies in Sweden and Japan indicate that many robot accidents have not occurred under normal operating conditions but rather during programming, program touch-up, maintenance, repair, testing, setup, or adjustment. During many of these operations, the operator, programmer or corrective maintenance worker may temporarily be within the robot's working envelope where unintended operations could result in injuries.

All industrial robots are either servo or non-servo controlled. Servo robots are controlled through the use of sensors which are employed to continually monitor the robot's axes for positional and velocity feedback information. This feedback information is compared on an on-going basis to pre-taught information which has been programmed and stored in the robot's memory.

Non-servo robots do not have the feedback capability of monitoring the robot's axes and velocity and comparing with a pre-taught program. Their axes are controlled through a system of mechanical stops and limit switches to control the robot's movement.

Type of Potential Hazards

The use of robotics in the workplace also can pose potential mechanical and human hazards.

Mechanical hazards might include workers colliding with equipment, being crushed, or trapped by equipment, or being injured by falling equipment components. For example, a worker could collide with the robot's arm or peripheral equipment as a result of unpredicted movements, component malfunctions, or unpredicted program changes.

A worker could be injured by being trapped between the robot's arm and other peripheral equipment or being crushed by peripheral equipment as a result of being impacted by the robot into this equipment.

Mechanical hazards also can result from the mechanical failure of components associated with the robot or its power source, drive components, tooling or end-effector, and/or peripheral equipment. The failure of gripper mechanisms with resultant release of parts, or the failure of end-effector power tools such as grinding wheels, buffing wheels, deburring tools, power screwdrivers, and nut runners to name a few.

Human errors can result in hazards both to personnel and equipment. Errors in programming, interfacing peripheral equipment, connecting input/output sensors, can all result in unpredicted movement or action by the robot which can result in personnel injury or equipment breakage.

Human errors in judgment result frequently from incorrectly activating the teach pendant or control panel. The greatest human judgment error results from becoming so familiar with the robot's redundant motions that personnel are too trusting in assuming the nature of these motions and place themselves in hazardous positions while programming or performing maintenance within the robot's work envelope.

Robots in the workplace are generally associated with the machine tools or process equipment. **Robots are machines,** and as such must be safeguarded in ways similar to those presented for any hazardous remotely controlled machine.

Various techniques are available to prevent employee exposure to the hazards which can be imposed by robots. The most common technique is through the installation of perimeter guarding with interlocked gates. A critical parameter relates to the manner in which the interlocks function. Of major concern is whether the computer program, control circuit, or the primary power circuit, is interrupted when an interlock is activated. The various industry standards should be investigated for guidance; however, it is generally accepted that the primary motive power to the robot should be interrupted by the interlock.

The ANSI safety standard for industrial robots, ANSI/RIA R15.06-1986, is very informative and presents certain basic requirements for protecting the worker. However, when a robot is to be used in a workplace, the employer should accomplish a comprehensive operational safety/health hazard analysis and then devise and implement an effective safeguarding system which is fully responsive to the situation. (Various effective safeguarding techniques are described in ANSI B11.19-1990.)

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Chapter 7 -
Cellular Manufacturing Systems

Cellular Manufacturing Systems

A recent development in manufacturing technology has given rise to a manufacturing concept known as Manufacturing Systems/Cells, or Cellular Manufacturing Systems. These systems of integrated industrial machines, linked by a material handling system and operated by (controlled by) a programmable electronic system (computer) are capable of manufacturing discrete parts or assemblies. The safety of employees exposed to these systems is of first order importance.

Because a system is to be safeguarded it is logical that a system hazard analysis will yield the parameters of the safeguarding system required. Figures 73 through 75 depict typical cellular system concepts and safeguarding considerations.

ANSI B11.20-1991, should be referred to for assistance when a cellular manufacturing system is envisioned.

Figure 73. Typical manufacturing system/cell using a robot as the material handling system showing perimeter marking/barrier, fixed barriers with interlocked gates, presence sensing devices, warning devices, and additional system emergency stop devices.

Figure 74. Manufacturing system composed of several cells.

Figure 75. Areas to be considered for safeguarding.

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Chapter 8 - Ergonomic Considerations of Machine Safeguarding

Chapter 8

Ergonomic Considerations of Machine Safeguarding

The ergonomic considerations of machine safeguarding are as significant to the safety and health of the worker as are the multitude of techniques to accomplish safety and health in the workplace. Worker stress and fatigue can be averted by creditable work setups and well integrated safeguarding. The various industry consensus standards are only now beginning to address this issue. Future evaluations of safeguarding are likely to devote more attention to this aspect.

Go to Chapter 9

Chapter 9 - Cooperation and Assistance

Cooperation and Assistance

Safety in the workplace demands cooperation and alertness on everyone's part. Supervisors, operators, and other workers who notice hazards in need of safeguarding, or existing systems that need repair or improvement, should notify the proper authority immediately.

Supervisors have these additional, special responsibilities with regard to safety in the workplace; encouraging safe work habits and correcting unsafe ones; explaining to the worker all the potential hazards associated with the machines and processes in the work area; and being responsive to employer requests for action or information regarding machine hazards. The first-line supervisor plays a pivotal role in communicating the safety needs of the worker to management and the employer's safety rules and policies to the worker.

Sometimes the solution to a machine safeguarding problem may require expertise that is not available in a given establishment. The readers of this manual are encouraged to find out where help is available and, when necessary, to request it.

The machine's manufacturer is often a good place to start when looking for assistance with a safeguarding problem. Manufacturers can often supply the necessary literature or advice. Insurance carriers, too, will often make their safety specialists available to the establishments whose assets they insure. Union safety specialists can also lend significant assistance.

Some government agencies offer consultation services, providing for on-site evaluation of workplaces and the recommendation of possible hazard controls. OSHA funds one such program, which is offered free of charge to employers in every state. Delivered by state governments or private contractors, the consultation program is completely separate from the OSHA inspection effort; no citations are issued and no penalties are proposed. The trained professional consultants can help employers recognize hazards in the workplace and can suggest general approaches for solving safety and health problems. In addition, the consultant can identify sources of other available help, if necessary.

Anyone with questions about Federal standards, about the requirements for machine safeguarding, or about available consultation services should contact OSHA. (See the list of OSHA Regional Offices in the back of this publication.)

Machine Guarding Checklist

Machine Guarding Checklist

Answers to the following questions should help the interested reader determine the safeguarding needs of his or her own workplace, by drawing attention to hazardous conditions or practices requiring correction.

Requirements for all Safeguards

	Yes	No
1. Do the safeguards provided meet the minimum OSHA requirements?	____	____
2. Do the safeguards prevent workers' hands, arms, and other body parts for making contact with dangerous moving parts?	____	____
3. Are the safeguards firmly secured and not easily removable?	____	____
4. Do the safeguards ensure that no object will fall into the moving parts?	____	____
5. Do the safeguards permit safe, comfortable, and relatively easy operation of the machine?	____	____
6. Can the machine be oiled without removing the safeguard?	____	____

7. Is there a system for shutting down the machinery before safeguards are removed? ____ ____

8. Can the existing safeguards be improved? ____ ____

Mechanical Hazards

The point of operation:

1. Is there a point-of-operation safeguard provided for the machine? ____ ____
2. Does it keep the operator's hands, fingers, body out of the danger area? ____ ____
3. Is there evidence that the safeguards have been tampered with or removed? ____ ____
4. Could you suggest a more practical, effective safeguard? ____ ____
5. Could changes be made on the machine to eliminate the point-of-operation hazard entirely? ____ ____

Power transmission apparatus:

1. Are there any unguarded gears, sprockets, pulleys, or flywheels on the apparatus? ____ ____

2. Are there any exposed belts or chain drives? ____ ____

3. Are there any exposed set screws, key ways, collars, etc.? ____ ____

4. Are starting and stopping controls within easy reach of the operator? ____ ____

5. If there is more than one operator, are separate controls provided? ____ ____

Other moving parts:

1. Are safeguards provided for all hazardous moving parts of the machine including auxiliary parts? ____ ____

Nonmechanical Hazards

1. Have appropriate measures been taken to safeguard workers against noise hazards? ____ ____

2. Have special guards, enclosures, or personal protective equipment been provided, where necessary, to protect workers from exposure to harmful substances used in machine operation? ____ ____

Electric Hazards

1. Is the machine installed in accordance with National Fire Protection Association and National Electrical Code requirements? ____ ____
2. Are there loose conduit fittings? ____ ____
3. Is the machine properly grounded? ____ ____
4. Is the power supply correctly fused and protected? ____ ____
5. Do workers occasionally receive minor shocks while operating any of the machines? ____ ____

Training

1. Do operators and maintenance workers have the necessary training in how to use the safeguards and why? ____ ____
2. Have operators and maintenance workers been trained in where the safeguards are located, how they provide protection, and what hazards they protect against? ____ ____
3. Have operators and maintenance workers been trained in how and under what circumstances guards can be removed? ____ ____
4. Have workers been trained in the procedures to follow if they notice guards that are damaged,

missing, or inadequate? ____ ____

Protective Equipment and Proper Clothing

1. Is protective equipment required? ____ ____
2. If protective equipment is required, is it appropriate for the job, in good condition, kept clean and sanitary, and stored carefully when not in use? ____ ____
3. Is the operator dressed safely for the job (i.e., no loose-fitting clothing or jewelry)? ____ ____

Machinery Maintenance and Repair

1. Have maintenance workers received up-to-date instruction on the machines they service? ____ ____
2. Do maintenance workers lock out the machine from its power sources before beginning repairs? ____ ____
3. Where several maintenance persons work on the same machine, are multiple lockout devices used? ____ ____
4. Do maintenance persons use appropriate and safe equipment in their repair work? ____ ____
5. Is the maintenance equipment itself properly

guarded? ____ ____

6. Are maintenance and servicing workers trained in the requirements of 29 CFR 1910.147, lockout/tagout hazard, and do the procedures for lockout/tagout exist **before** they attempt their tasks? ____ ____

Go to Worker Rights and Responsibilities

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Go to States with Appoved Plans

Related Publications

Related Publications

ANSI/ASME Standards

B11.2	Hydraulic Presses 1982
B11.3	Power Press Brakes 1982
B11.10	Metal Sawing Machines 1990
B11.11	Gear Cutting Machines 1985
B11.12	Roll-forming and Roll-bending Machines 1983
B11.14	Coil Slitting Machines 1983
B11.15	Pipe, Tube, and Shape Bending Machines 1984
B11.16	Metal Powder Compacting Presses 1988
B11.17	Horizontal Hydraulic Extrusion Presses 1982
B11.18	Coiled Steel Sheet & Plate Processing Machines 1985

Copies of the above can be obtained from the American National Standards Institute, 7 West 42nd Street, New York, NY 10036, 13th Floor.

OSHA Publications

OSHA 2056 All About OSHA

OSHA 2019 Catalogue

OSHA 3000 Employer Rights & Responsibilities Following an OSHA Inspection

OSHA 3074 Hearing Conservation

OSHA 3021 OSHA: Employee Workplace Rights

A single free copy of the above materials can be obtained from OSHA field offices or OSHA Publications Office, Room N3101, Washington, DC 20210, (202) 523-9667. Please send a self-addressed label with your request.

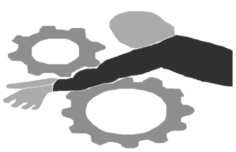
"SafeWorks." A one page periodic news sheet that provides a brief summary of the results of a small business employer's request for workplace safety and health assistance from OSHA-funded consultation services in all of the states and U.S. territories.

"ErgoFacts." A one page news sheet that provides a brief summary of ergonomic hazards and the need for workplace safety and health assistance.

The above publications can be obtained from the U.S. Department of Labor,

Subpart O Machine Guarding

- 1910.211 Definitions
- 1910.212 General Requirements for all Machines.
- 1910.213 Woodworking Machinery



Subpart O

- 1910.215 Abrasive Wheel Machinery
- 1910.216 Mills and Calendars
- 1910.217 Mechanical Power Presses
- 1910.218 Forging Machinery
- 1910.219 Mechanical Power-Transmission

1910.212 General Requirements

1910.212 Machine Guarding

- Types of guarding. One or more methods of machine guarding shall be provided to protect the operator and **<u>other employees</u>** in the machine area from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips and sparks.

1910.212 General Requirements

1910.212(a)(2)

- General requirements for machine guards. Guards shall be affixed to the machine where possible and secured elsewhere if for any reason attachment to the machine is not possible. The guard shall be such that it does not offer an accident hazard in itself.

1910.212 General Requirements

1910.212(a)(3)(i)

- Point of operation is the area on a machine where work is actually performed upon the material being processed

1910.212(a)(3)(ii)

- The point of operation of machines whose operation exposes an employee to injury, shall be guarded. The guarding device shall be in conformity with any appropriate standards therefore, or, in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle.

1910.212 General Requirements

1910.212(a)(3)(iii)

- Special hand tools for placing and removing material shall be such as to permit easy handling of material without the operator placing a hand in the danger zone. Such tools shall not be in lieu of other guarding required by this section, but can only be used to supplement protection provided.

1910.212 General Requirements

The following are some of the machines which usually require point of operation guarding:

- Guillotine Cutters.
- Shears.
- Alligator Shears.
- Milling Machines.
- Portable Power Tools.
- Forming Rolls and Calendars.
- Jointers.
- Power Saws.
- Power Presses.

1910.212 General Requirements

1910.212(a)(4)

- Barrels, containers, and drums. Revolving drums, barrels, and containers shall be guarded by an enclosure which is interlocked with the drive mechanism, so that the barrel, drum, or container cannot revolve unless the guard enclosure is in place.
- i.e. Paint can mixer @ Hardware Store

1910.212 General Requirements

1910.212(a)(5)

- Exposure of blades. When the periphery of the blades of a fan is less than seven (7) feet above the floor or working level, the blades shall be guarded. The guard shall have openings no larger than one-half (1/2) inch.

1910.212(b)

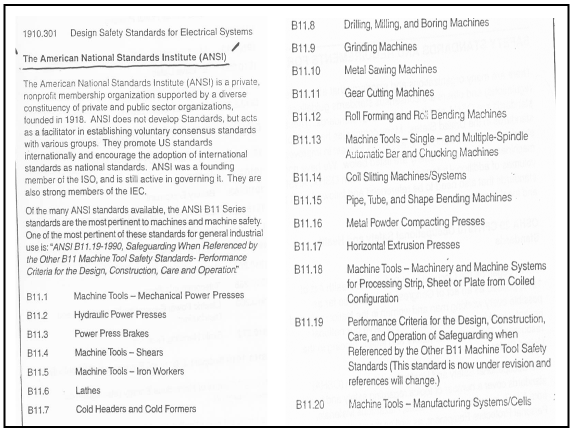
- Anchoring fixed machinery. Machines designed for a fixed location shall be securely anchored to prevent walking or moving.

Safety Color Code 1910.144

Red shall be the basic color for the identification of:

iii) Stop. Emergency stop bars on hazardous machines such as rubber mills, wire blocks, iron workers, etc. shall be red. Stop buttons or electrical switches which letters or other markings appear, used for emergency stopping of machinery shall be red.

ANSI – red mushroom button with yellow background



1910.301 Design Safety Standards for Electrical Systems

The American National Standards Institute (ANSI)

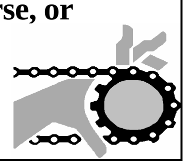
The American National Standards Institute (ANSI) is a private, nonprofit membership organization supported by a diverse constituency of private and public sector organizations, founded in 1918. ANSI does not develop Standards, but acts as a facilitator in establishing voluntary consensus standards with various groups. They promote US standards internationally and encourage the adoption of international standards as national standards. ANSI was a founding member of the ISO, and is still active in governing it. They are also strong members of the IEC.

Of the many ANSI standards available, the ANSI B11 Series standards are the most pertinent to machines and machine safety. One of the most pertinent of these standards for general industrial use is: "*ANSI B11.19-1990, Safeguarding When Referenced by the Other B11 Machine Tool Safety Standards- Performance Criteria for the Design, Construction, Care and Operation*."

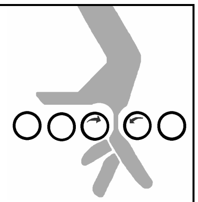
B11.1	Machine Tools – Mechanical Power Presses
B11.2	Hydraulic Power Presses
B11.3	Power Press Brakes
B11.4	Machine Tools – Shears
B11.5	Machine Tools – Iron Workers
B11.6	Lathes
B11.7	Cold Headers and Cold Formers
B11.8	Drilling, Milling, and Boring Machines
B11.9	Grinding Machines
B11.10	Metal Sawing Machines
B11.11	Gear Cutting Machines
B11.12	Roll Forming and Roll Bending Machines
B11.13	Machine Tools – Single – and Multiple-Spindle Automatic Bar and Chucking Machines
B11.14	Coil Slitting Machines/Systems
B11.15	Pipe, Tube, and Shape Bending Machines
B11.16	Metal Powder Compacting Presses
B11.17	Horizontal Extrusion Presses
B11.18	Machine Tools – Machinery and Machine Systems for Processing Strip, Sheet or Plate from Coiled Configuration
B11.19	Performance Criteria for the Design, Construction, Care, and Operation of Safeguarding when Referenced by the Other B11 Machine Tool Safety Standards (This standard is now under revision and references will change.)
B11.20	Machine Tools – Manufacturing Systems/Cells

Basics Areas of Safeguarding

- **The point of operation**
- **Power transmission apparatus**
- **Other moving parts (reciprocating, transverse, or rotating)**

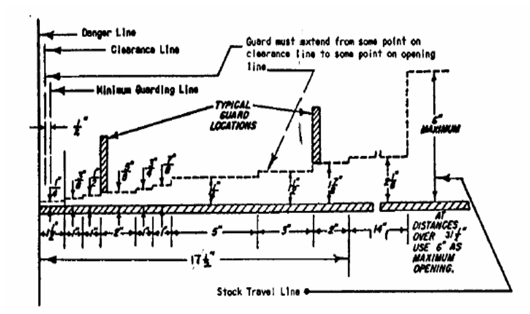


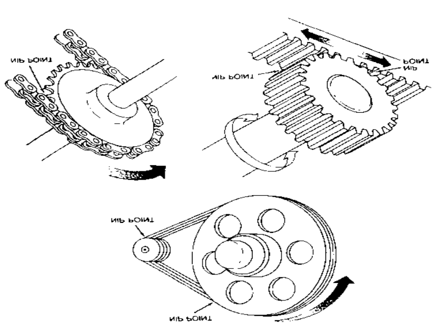
Motions



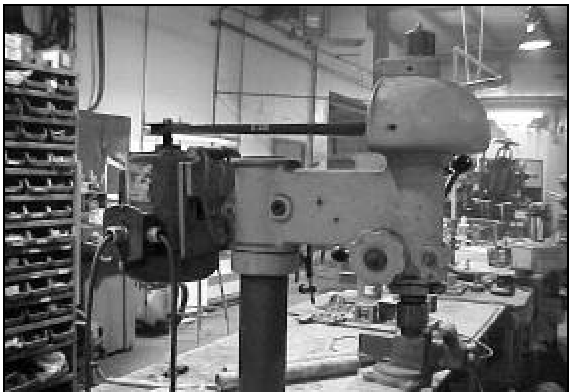
- **Motions**
  1) **Rotating (including in-running nip points.**
  2) **Reciprocating**
  3) **Transverse**

Safety Distance

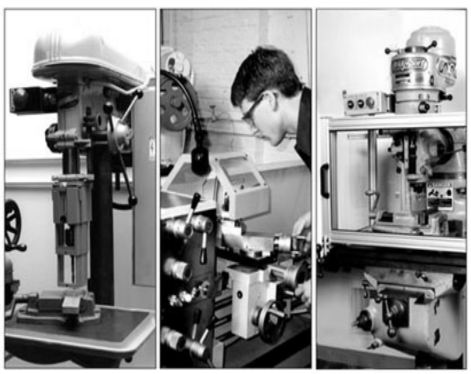




Nip Points

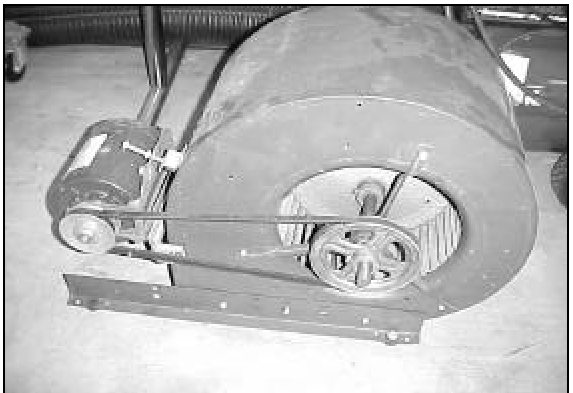


• Use of SO Cord Grips– No Romex

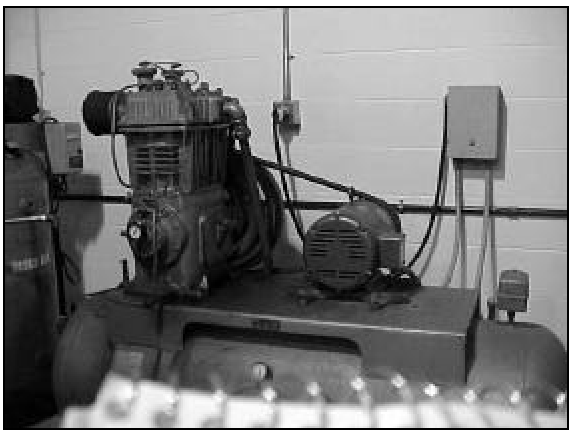


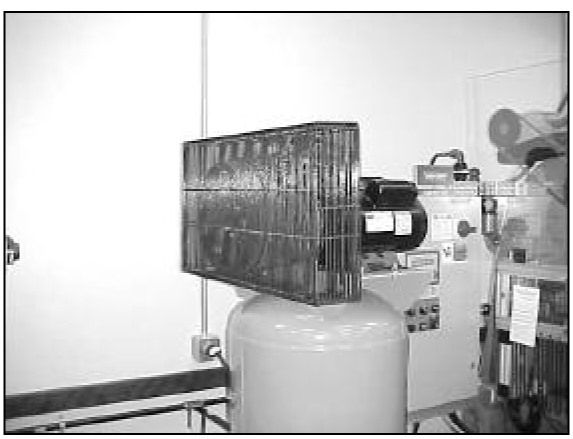
Drill Press Guarding

•Unguarded belt •Cracked pulley

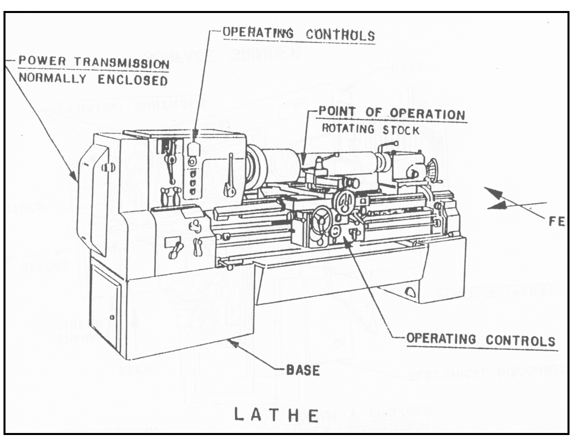


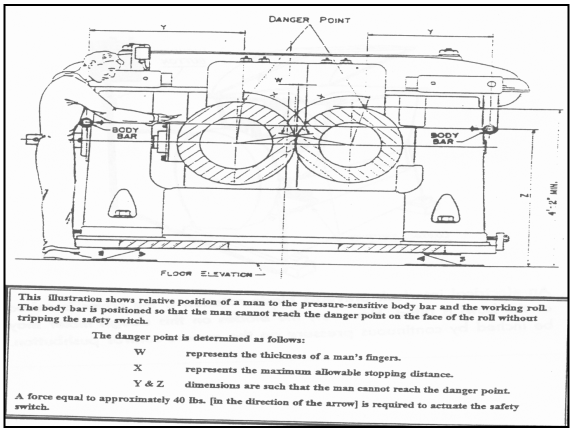
•Not Grounded •Not Listed for Portable Use

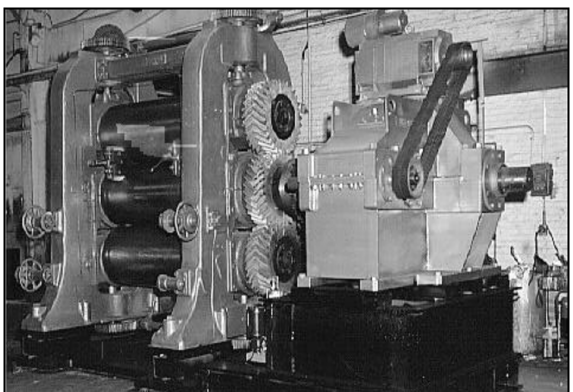




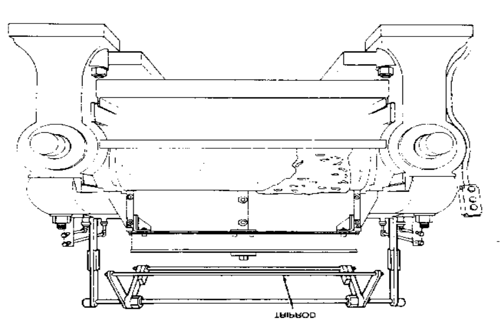
•Over, Under or Through Guard



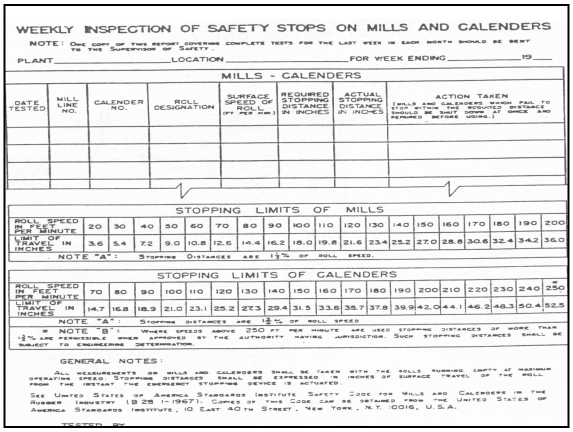




1910.216 Rolls and Calendars



Safety Triprodon a Rubber Mill



WEEKLY INSPECTION OF SAFETY STOPS ON MILLS AND CALENDERS

NOTE: One copy of this report covering complete tests for the last week in each month should be sent to the Supervisor of Safety.

PLANT ________ LOCATION ________ FOR WEEK ENDING ________ 19____

MILLS - CALENDERS

DATE TESTED	MILL LINE NO.	CALENDER NO.	ROLL DESIGNATION	SURFACE SPEED OF ROLL (FT PER MIN)	REQUIRED STOPPING DISTANCE IN INCHES	ACTUAL STOPPING DISTANCE IN INCHES	ACTION TAKEN (Mills and calenders which fail to stop within the required distance should be shut down at once and repaired before using.)

STOPPING LIMITS OF MILLS

ROLL SPEED IN FEET PER MINUTE	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
LIMIT OF TRAVEL IN INCHES	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0	19.8	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0

NOTE "A": Stopping Distances are $1\frac{1}{2}$% of roll speed.

STOPPING LIMITS OF CALENDERS

ROLL SPEED IN FEET PER MINUTE	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250*
LIMIT OF TRAVEL IN INCHES	14.7	16.8	18.9	21.0	23.1	25.2	27.3	29.4	31.5	33.6	35.7	37.8	39.9	42.0	44.1	46.2	48.3	50.4	52.5

NOTE "A": Stopping distances are $1\frac{1}{2}$% of roll speed.

* NOTE "B": Where speeds above 250 ft. per minute are used stopping distances of more than $1\frac{1}{2}$% are permissible when approved by the authority having jurisdiction. Such stopping distances shall be subject to engineering determination.

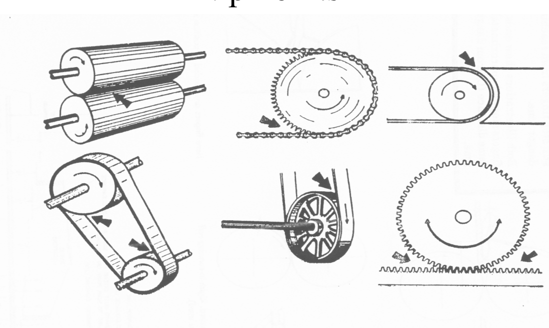
GENERAL NOTES:

All measurements on mills and calenders shall be taken with the rolls running empty at maximum operating speed. Stopping distances shall be expressed in inches of surface travel of the roll from the instant the emergency stopping device is actuated.

See United States of America Standards Institute Safety Code for Mills and Calenders in the Rubber Industry (B 28 1-1967). Copies of this Code can be obtained from the United States of America Standards Institute, 10 East 40th Street, New York, N.Y. 10016, U.S.A.

TESTED BY

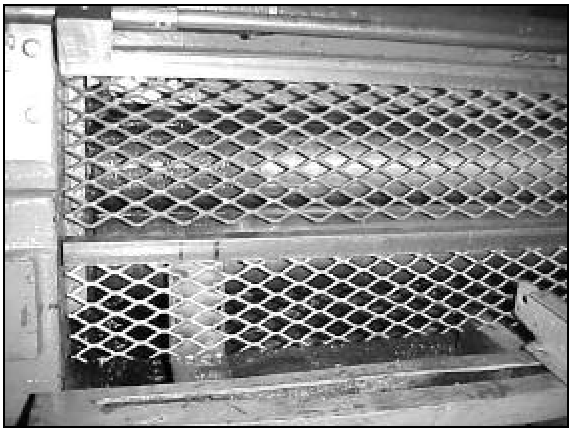
Nip Points

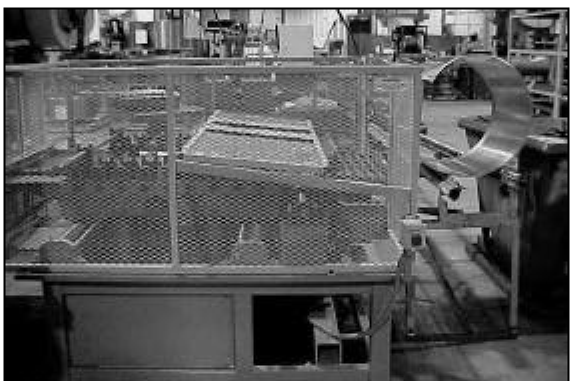


TYPICAL INRUNNING NIP POINTS: PROTECTION AGAINST SUCH HAZARDS IS OF PRIME IMPORTANCE TO PREVENT ACCIDENTS

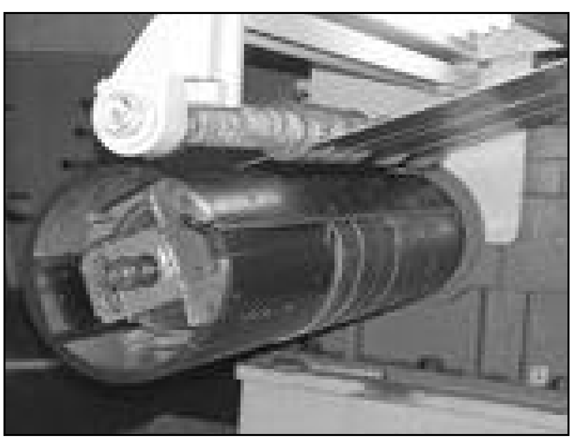
• No E-Stop • No Kick Plate • No Trip Wire

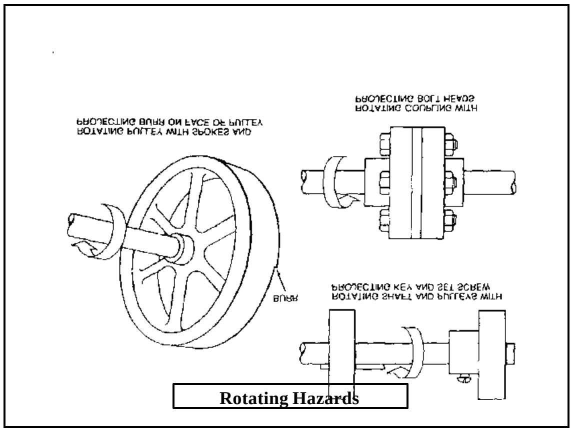
•Guard not Secured • Need Interlock • Glove Size
(Guards cannot be secured with wing nuts)

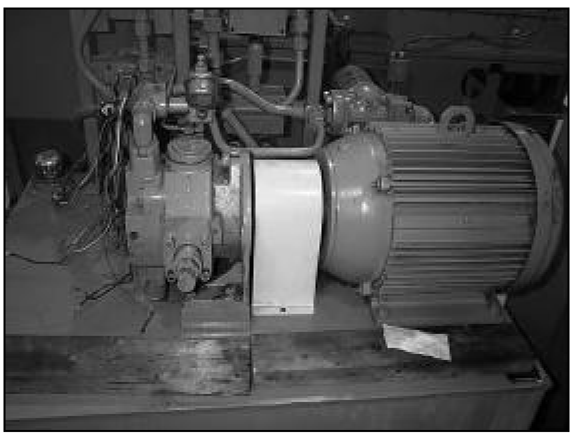


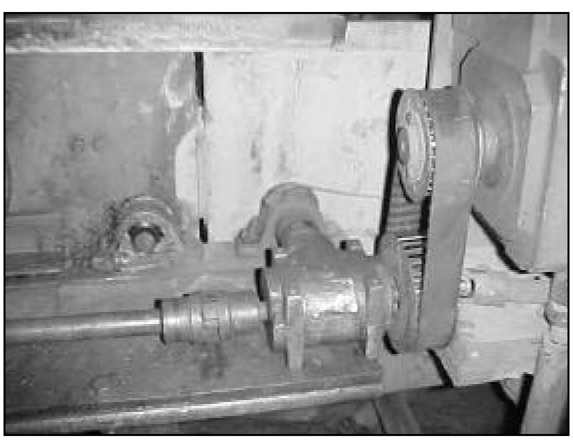


• Correct E-Stop




Rotating Hazards

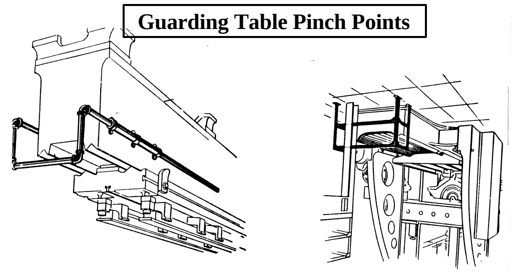




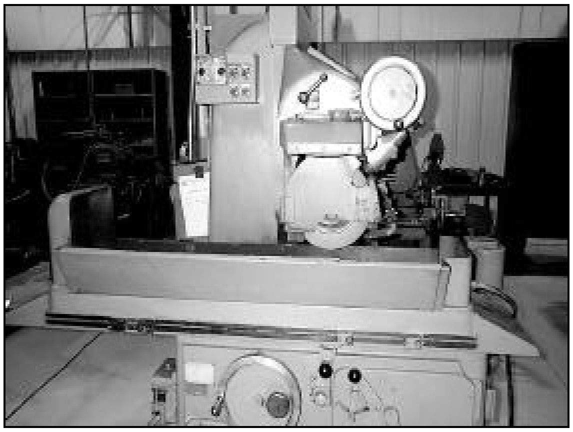
• Need to Maintain Guard • No 7 ft Rule

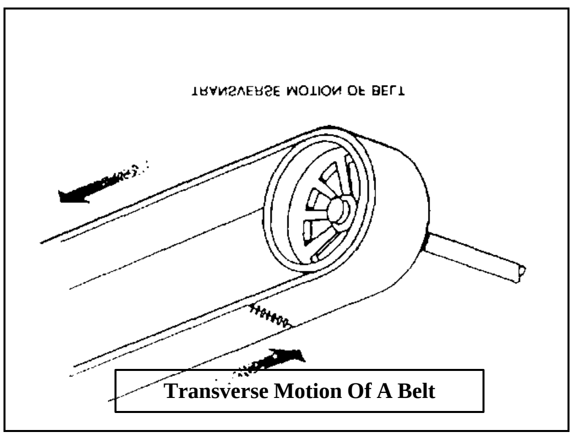
• Guard Shaft with Collapsible Tube Guard

Guarding Table Pinch Points

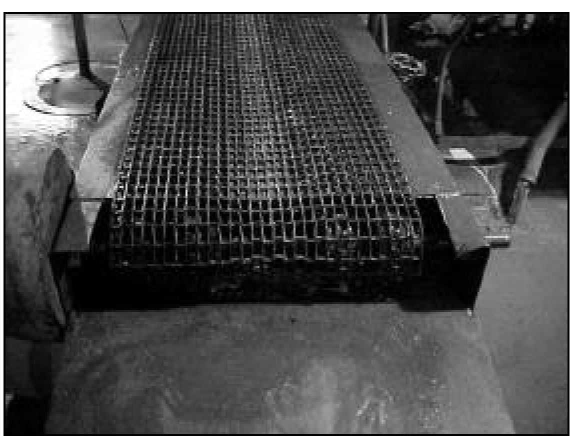


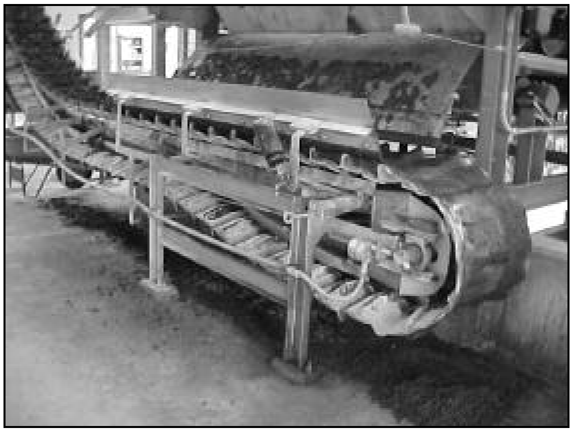
• 28 inch Minimum



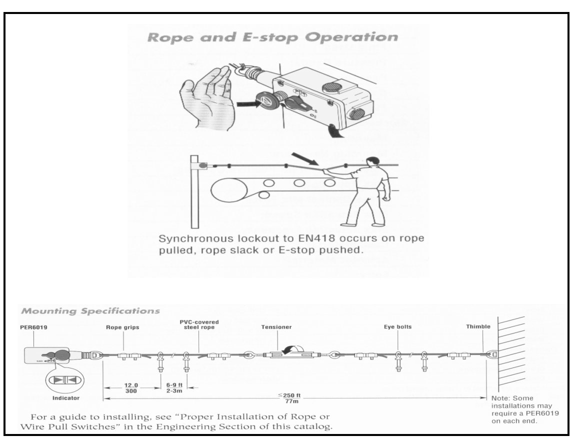


Transverse Motion Of A Belt



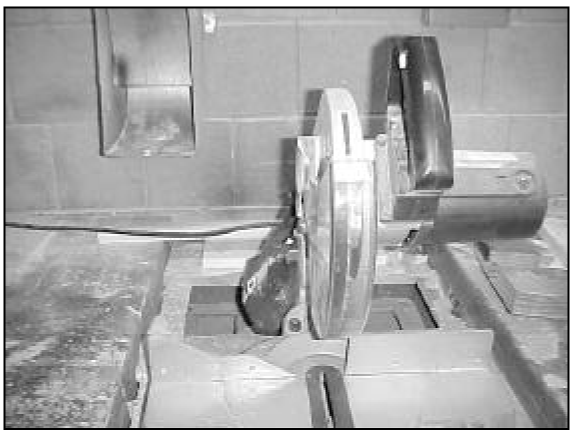


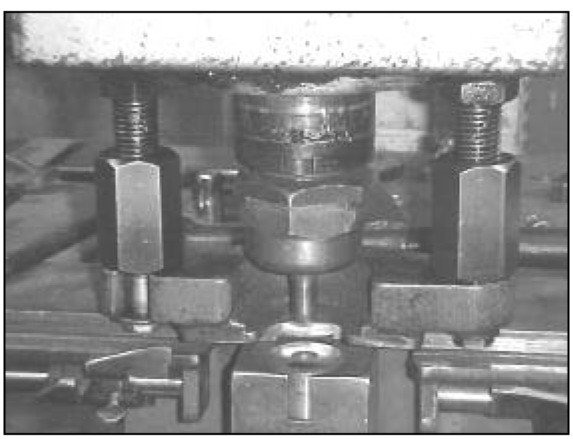
• 3” Deflection • Wire not Straight (over & under)

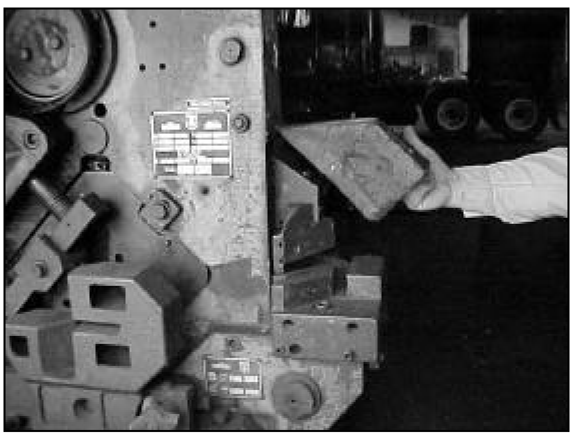


Actions

- Cutting
- Punching
- Shearing
- Bending



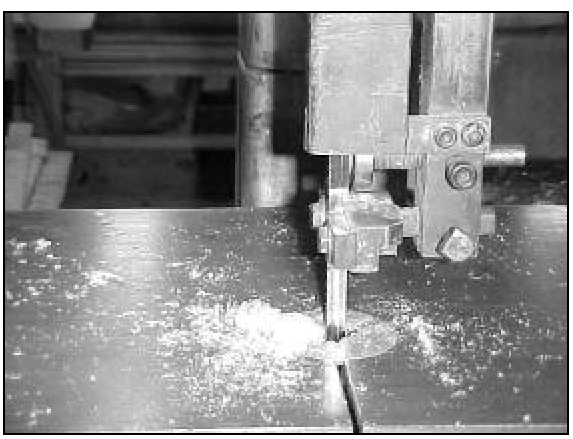




• Brake with Light Curtains

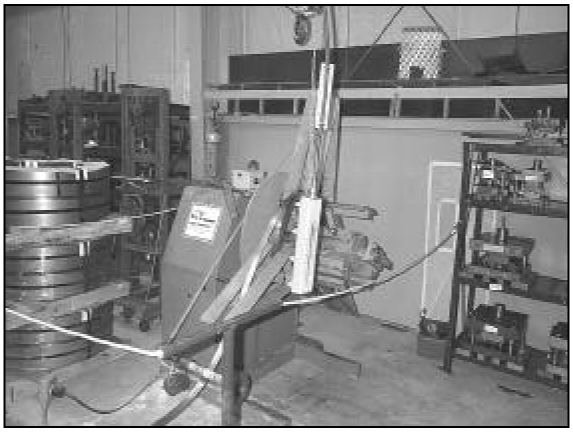
Guards

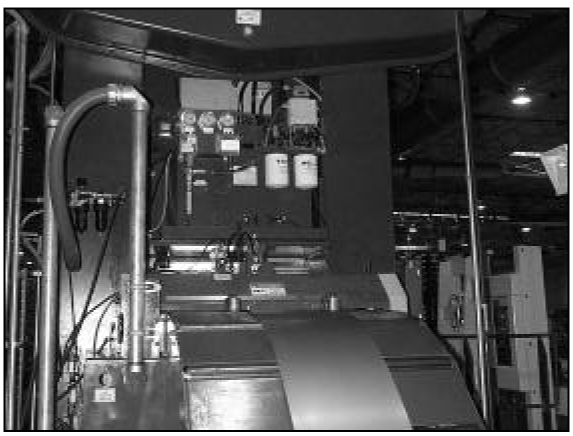
- **Fixed**
- **Interlocked**
- **Adjustable**
- **Self-adjusting**

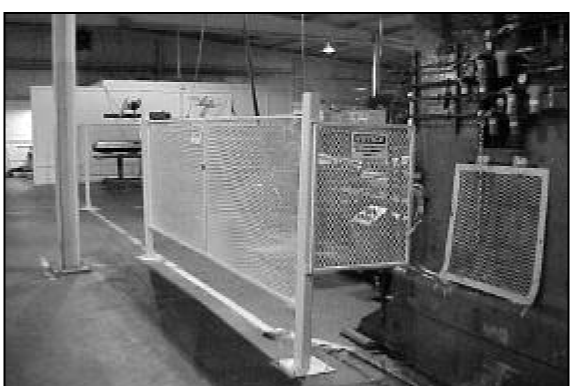


•Easily Defeated Interlock

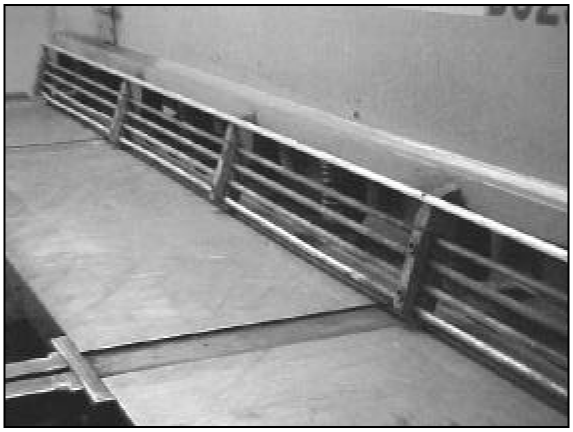
• Back of Press Guarding





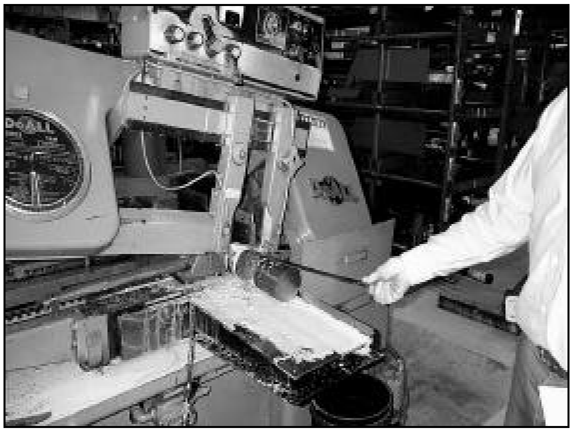


• Gate Height (12”) • Hinged Guard



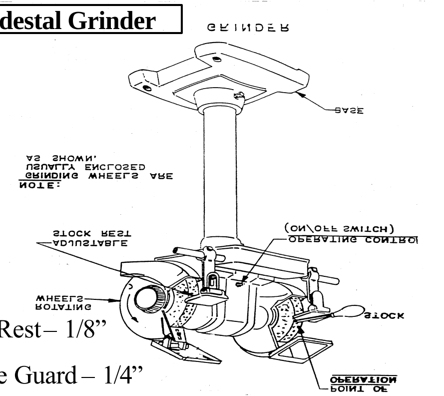
•Ends and Unused Portions of Press Brake Guarded
• Light Curtains

• Minimum for Back Guarding



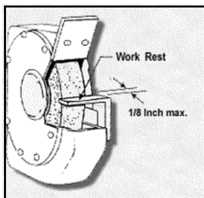
• Auger Not Guarded • Lockout Concerns

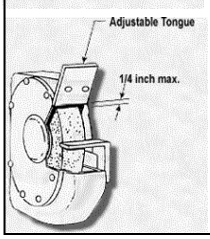
Pedestal Grinder



Work Rest – 1/8”

Tongue Guard – 1/4”



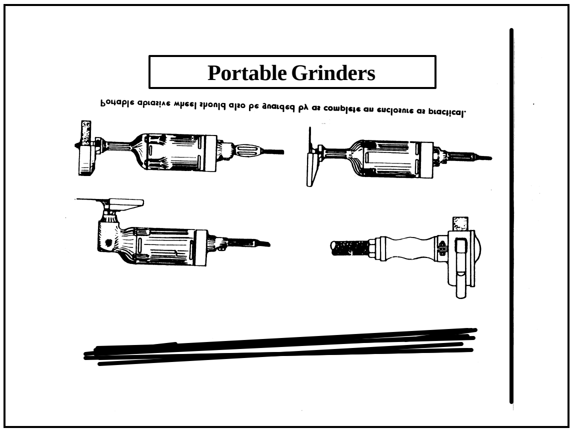


29CFR 1910.215

Work rests must be 1/8” from wheel

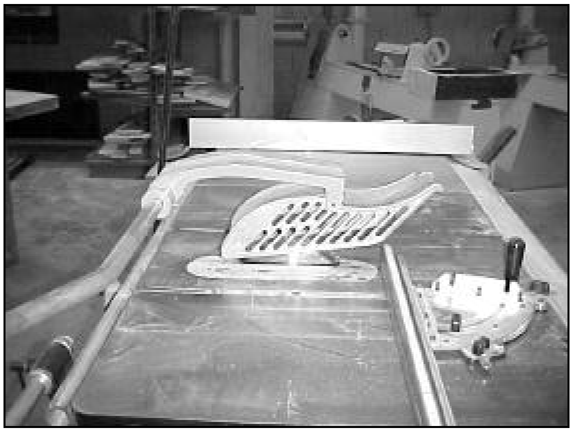
Tongue guard must be 1/4” from wheel
All guards must be present

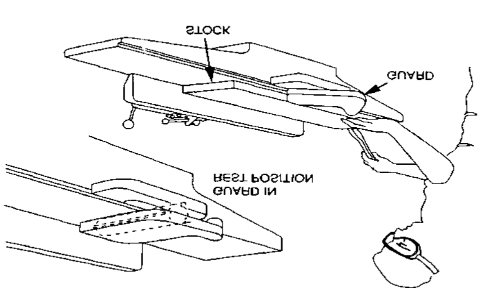
• Bulb Unguarded • Wheel Unguarded


Portable Grinders
Portable abrasive wheel should also be guarded by as complete an enclosure as practical.


•Self Adjusting Guard • Auto Return
• Table Edge • Magnetic Starter


• Need to Cover Unused Outlets



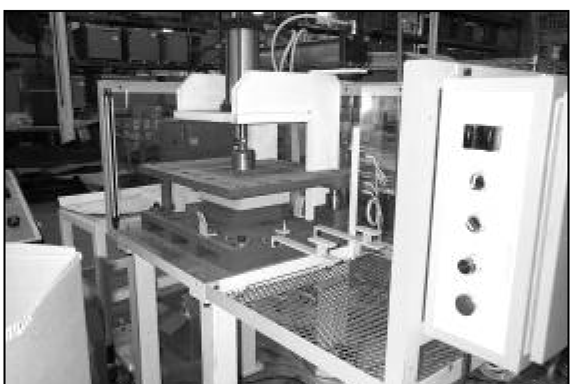


Self-Adjusting Guard On Jointer

Devices

- **Presence Sensing**
  1) **Photo-electrical**
  2) **Radio-frequency**
  3) **Electromechanical**
- **Pullback**
- **Restraint**

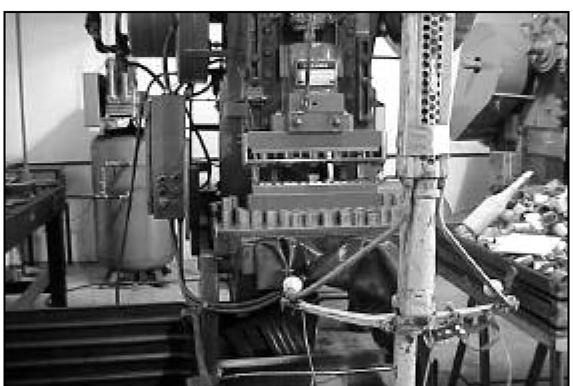
•Light Curtain on Ball Sizer



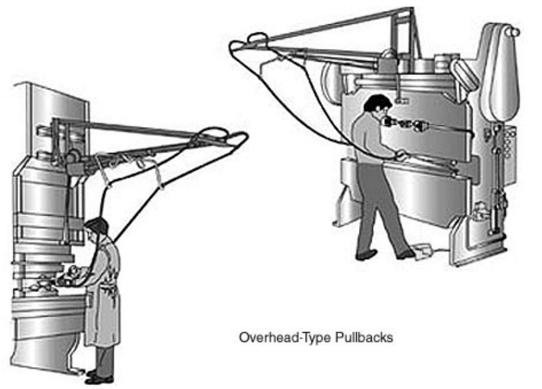
• Light Curtain & Fixed Guard

•Electromechanical Sensing Device on a Riveter

•Radio Frequency Device on a Power Press



• Improper Repair – Duct Tape

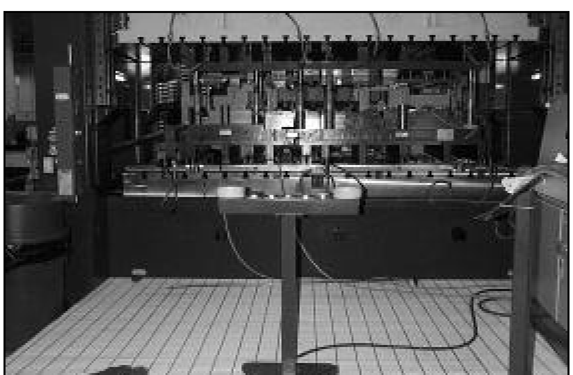


Restraints/Holdouts

Restraints & Two Hand Controls

Devices

- Safety Controls
    1) Safety trip control
        (a) Pressure-sensitive body bar
        (b) Safety triprod
        (c) Safety tripwire cable
- Two-hand control
- Two-hand trip

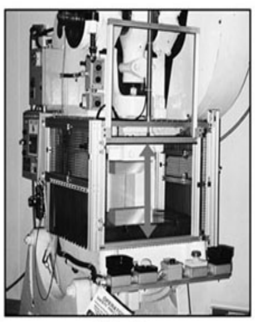


• Two Hand Controls

Devices

- **Gates**
  1) **Interlocked**
  2) **Other**
- **Location/Distance**

Gate Guard

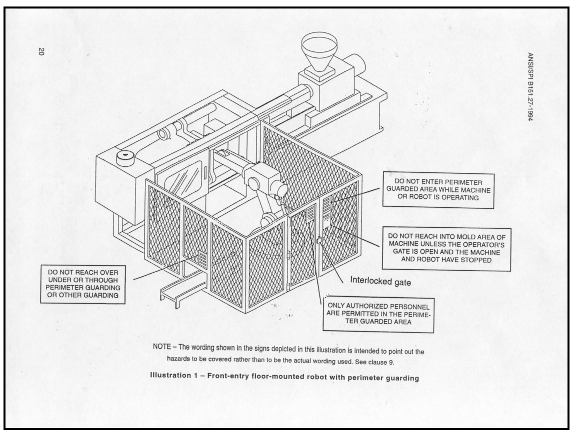


Gate Open

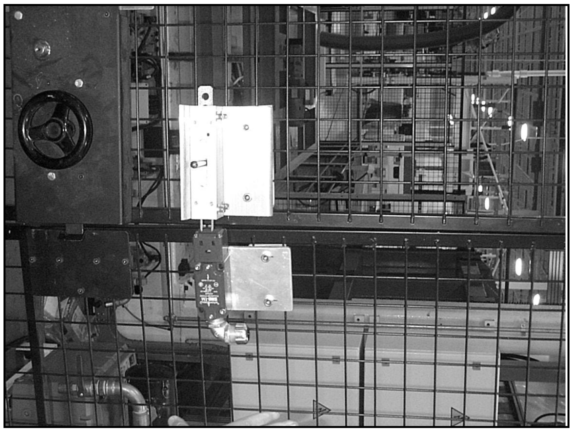
Gate Closed

Guarding by Location

• Robot Cell (ANSI R15.06)



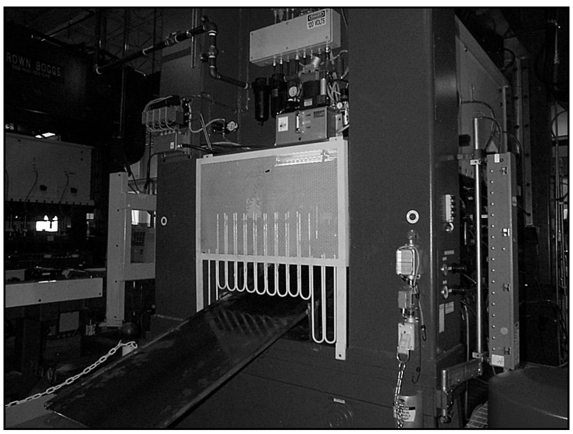
• Interlocked Gate



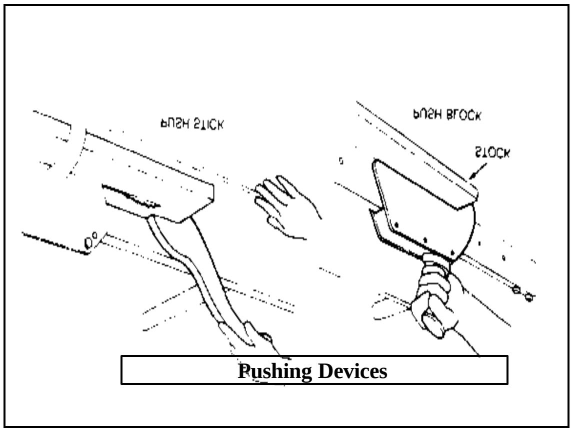
•Size Requirements

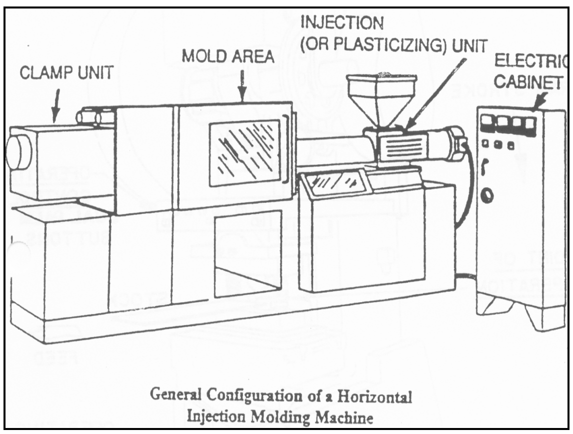
Potential Feeding and Ejection Methods to Improve Safety for the Operator

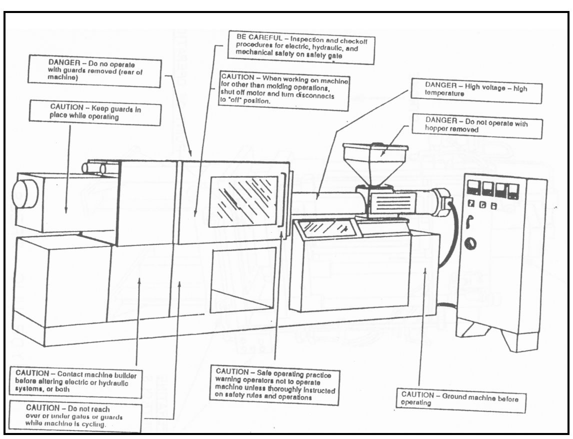
- **Automatic feed**
- **Semi-automatic feed**
- **Automatic ejection**
- **Semi-automatic ejection**

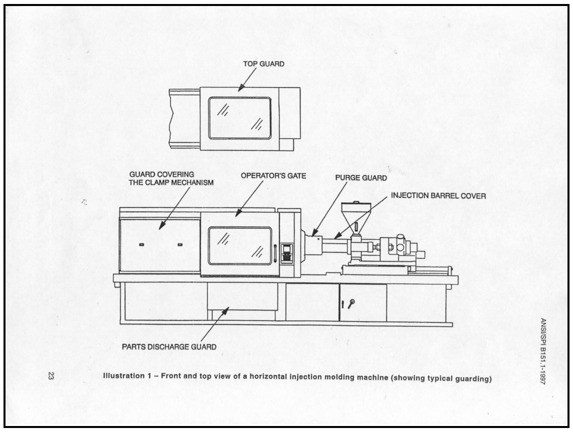


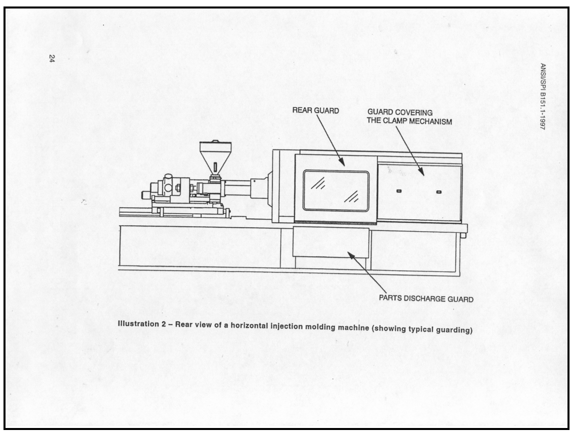
•Hand Tools

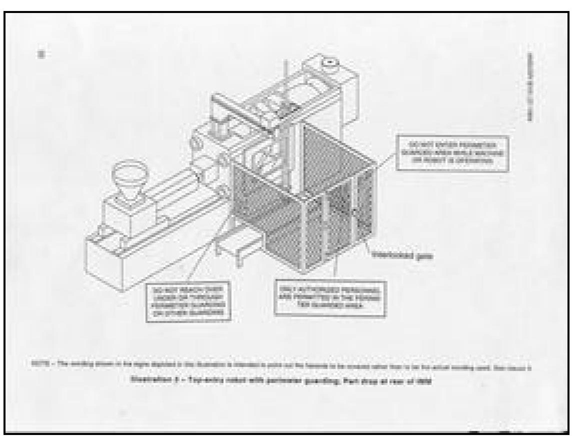

PUSH STICK
PUSH BLOCK
STOCK
Pushing Devices

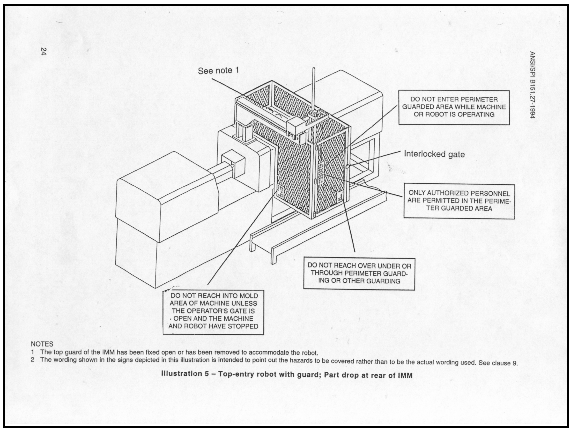

CLAMP UNIT
MOLD AREA
INJECTION
(OR PLASTICIZING) UNIT
ELECTRIC
CABINET
General Configuration of a Horizontal
Injection Molding Machine


DANGER – Do no operate with guards removed (rear of machine)
CAUTION – Keep guards in place while operating
BE CAREFUL – Inspection and checkoff procedures for electric, hydraulic, and mechanical safety on safety gate
CAUTION – When working on machine for other than molding operations, shut off motor and turn disconnects to "off" position.
DANGER – High voltage – high temperature
DANGER – Do not operate with hopper removed
CAUTION – Contact machine builder before altering electric or hydraulic systems, or both
CAUTION – Do not reach over or under gates or guards while machine is cycling.
CAUTION – Safe operating practice warning operators not to operate machine unless thoroughly instructed on safety rules and operations
CAUTION – Ground machine before operating


TOP GUARD
GUARD COVERING
THE CLAMP MECHANISM
OPERATOR'S GATE
PURGE GUARD
INJECTION BARREL COVER
PARTS DISCHARGE GUARD
23
Illustration 1 – Front and top view of a horizontal injection molding machine (showing typical guarding)
ANSI/SPI B151.1-1997


24
ANSI/SPI B151.1-1997
REAR GUARD
GUARD COVERING
THE CLAMP MECHANISM
PARTS DISCHARGE GUARD
Illustration 2 – Rear view of a horizontal injection molding machine (showing typical guarding)


Interlocked gate
Illustration 3 – Top-entry robot with perimeter guarding; Part drop at rear of IMM



OSHA

National Emphasis Program on Amputations

3 S's and a P

- Shears
- Saws
- Slicers
- Presses