



MACHINE GUARDING BASICS

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INTRODUCTION

Machine safety research by the U.S. Bureau of Labor Statistics (BLS) indicates that 589 workers died in 2017, while operating and maintaining machinery. This is the lowest number since 2003. According to the BLS, 5,290 machine related occupational amputations occurred in 2018. Machine guarding has been an Occupational Safety and Health Administration (OSHA) "National Emphasis Program" (NEP) target for the past several years and continues to be with the renewal of the NEP in December 2019.

Machine hazards create the potential for worker injuries in any business with mechanical equipment. To prevent machine-related injuries, machine hazards must be effectively guarded.

This Risk Bulletin provides you with important information on how to:

- Identify machine hazards
- Assess machine hazards
- Guard machine hazards

We also provide a Machine Hazard Checklist and reference information to assist you in protecting your workers and business.

MACHINE HAZARD IDENTIFICATION

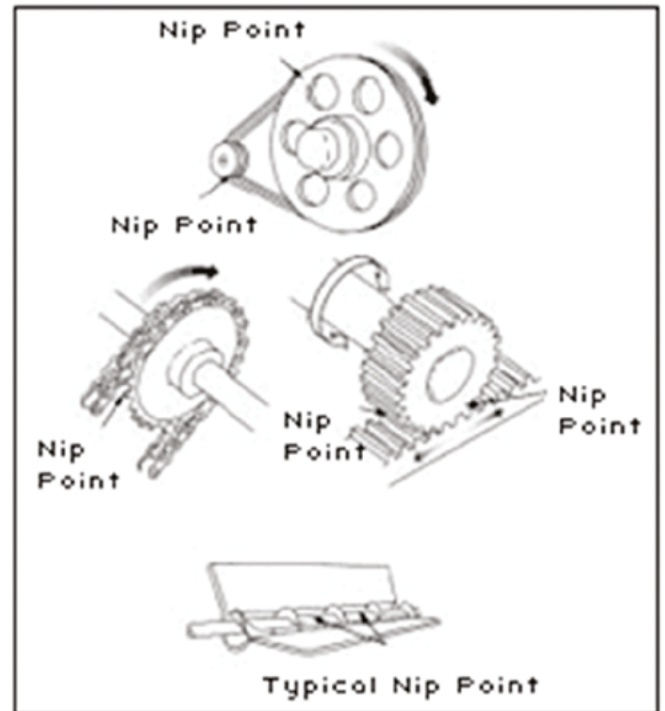
Dangerous moving parts in three basic areas require safeguarding:

1. Point of Operation – that point where work is performed on the material, such as cutting, shaping, boring, or forming of stock.
2. Power Transmission – all components of the mechanical system that transmit energy to the part of the machine performing the work. These include flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, cranks, and gears.
3. Other Moving Parts – all parts of the machine which move while the machine is working.
These include reciprocating, rotating, and transverse moving parts, as well as feed mechanisms and auxiliary parts of the machine.

The basic machine hazards to consider include the following:

In-running Nip Points exist through the action of rotating objects whenever the components rotate toward each other. Belts on pulleys and chains on sprockets are typical examples:

IN-RUNNING NIP POINT EXAMPLES



Occupational Safety and Health Administration (OSHA) diagram

Pinch Points exist where moving parts come close enough together so that a part of a person's body could be compressed. Pinch points are present where two parts come together or where a single component advances near a stationary object. Examples include screw conveyors and grinding wheels.

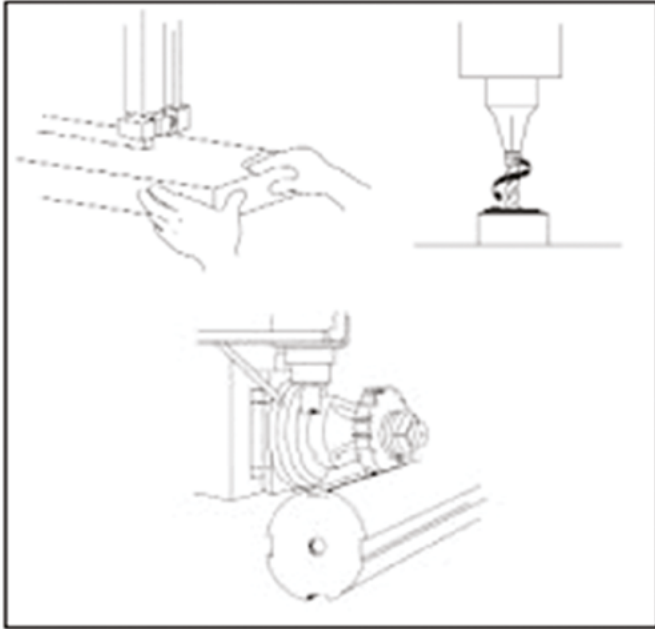
PINCH POINT EXAMPLES



Occupational Safety and Health Administration (OSHA) photo

Cutting actions exist when machine components physically separate solid materials through tooling such as blades, chisels, drills, grinding wheels, etc. Table saws, band saws, milling machines, paper and metal shear machines, and drill presses are examples of machines with cutting hazards.

CUTTING ACTION EXAMPLES



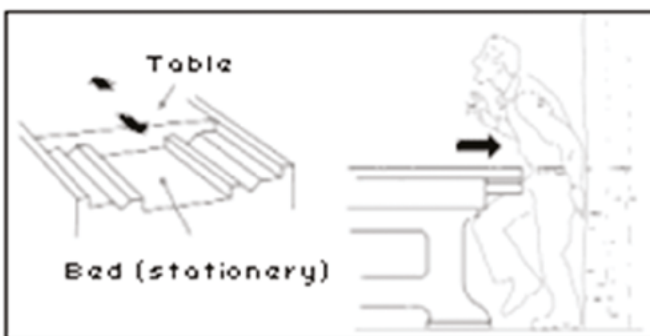
Occupational Safety and Health Administration (OSHA) diagram

Reciprocating/Transverse Hazards exist when a machine component moves in a straight line or back and forth resulting in a worker being caught in or struck by a moving object.

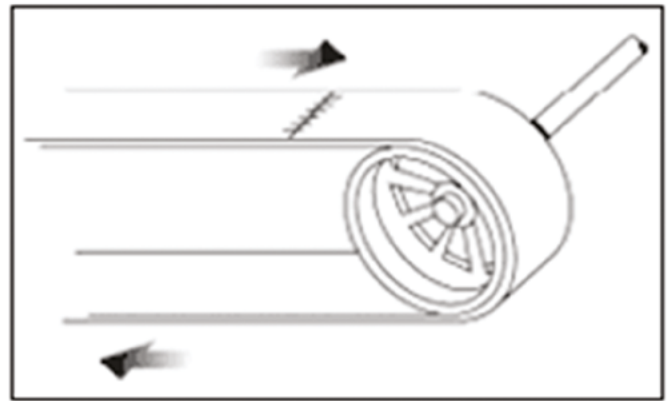
Examples where this may occur include the areas between the table of a surface grinder and an adjacent wall, post, column, work table, or storage rack.

RECIPROCATING/TRANSVERSE HAZARD EXAMPLES

RECIPROCATING



TRANSVERSE



Occupational Safety and Health Administration (OSHA) diagrams

Rotating Hazards exist when parts make complete revolutions. Hair or loose clothing can be caught and wrapped onto rotating parts. Open shafts and wheels are typical components where this hazard exists.

ROTATING HAZARD EXAMPLES



Occupational Safety and Health Administration (OSHA) diagram

Flying Object and Chemical Splash Hazards exist when objects are machined or shaped, or when chemicals are used in the machining process. Dust from grinders and cutting oil splashes are examples.

MACHINE HAZARD ASSESSMENT

Once machine hazards are identified, they must be assessed. Machine hazard assessment involves asking one critical question:

“Is the present machine arrangement and guarding adequate to prevent someone from reaching the danger point(s)?”

In order to fully answer this question you must observe all visible operating parts of the machine. This observation should be done at a safe distance. An efficient and focused way to complete this is to break down the observations by machine components.

Watch the movement of each component for several cycles or as many as needed to determine if a hazard exists. If you identify an unprotected or inadequately protected hazard, further safeguards are needed.

The Machine Hazard Checklist will help you complete a machine hazard assessment.

MACHINE GUARDING METHODS

Hazards can be controlled primarily through the use of guards or devices. Changing the location of the hazard or increasing the distance between the worker and the hazard may also protect workers.

Guards provide physical barriers between the worker and the machine hazard.

Devices protect workers by:

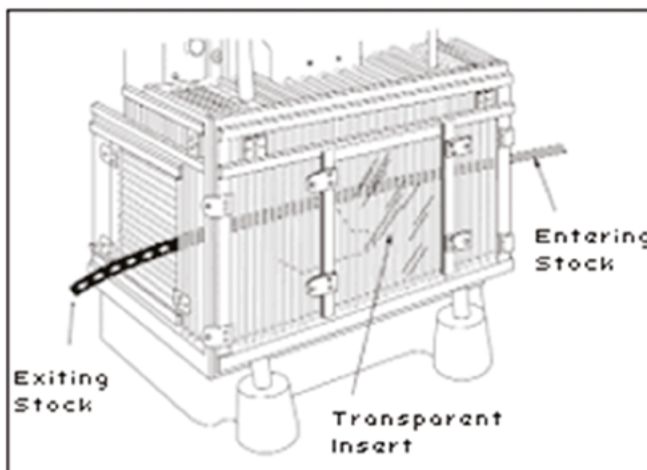
- Stopping the machine or interrupting the machine cycle if a body part is placed in the danger zone; or
- Requiring the operator to perform a task (such as using both hands to cycle a machine) which keeps body parts out of the danger zone(s)

Here are some of the more commonly used guards and devices:

GUARD TYPES

Fixed Barrier Guards are permanent parts of a machine. They are firmly fixed and must not be adjustable nor have hinged or movable sections. They may be constructed of sheet metal, screen, wire cloth, bars, plastic, or any other material sturdy enough to withstand the impact it may receive during prolonged use.

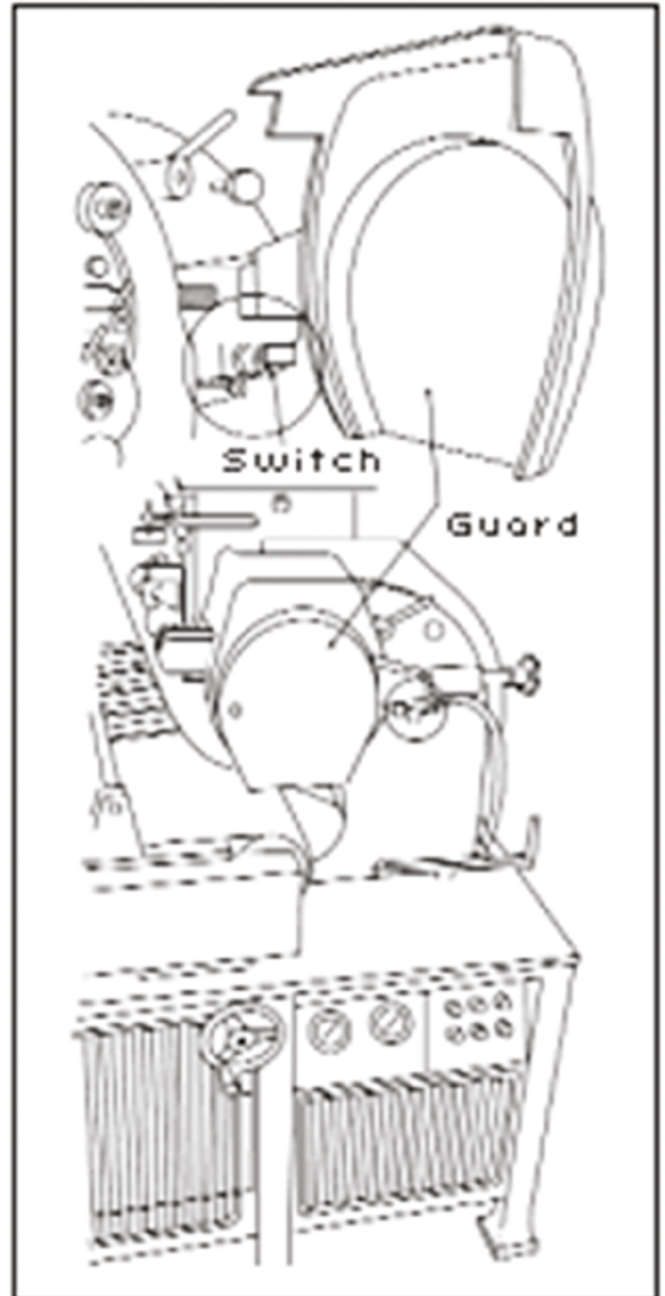
FIXED GUARDING ON A POWER PRESS



Occupational Safety and Health Administration (OSHA) diagram

Interlocked Barrier Guards are hinged or moveable and are used when fixed barrier guards are impractical to use (e.g., gears requiring frequent lubrication). When this guard is opened or removed, the tripping mechanism and/or power automatically shuts off or disengages and the machine can't cycle until the guard is back in place.

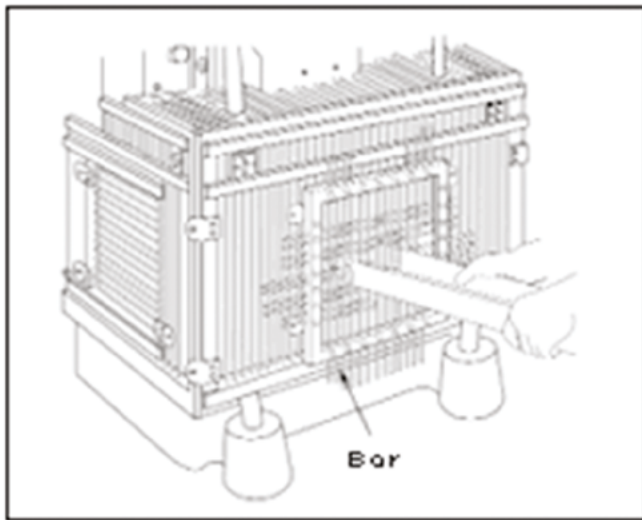
INTERLOCKED GUARD ON A ROLL MAKE-UP MACHINE



Occupational Safety and Health Administration (OSHA) diagram

Adjustable Guards can be adjusted to accommodate different material widths and thicknesses. They are generally moved during machine set-up. A power press guard is an example of an adjustable guard.

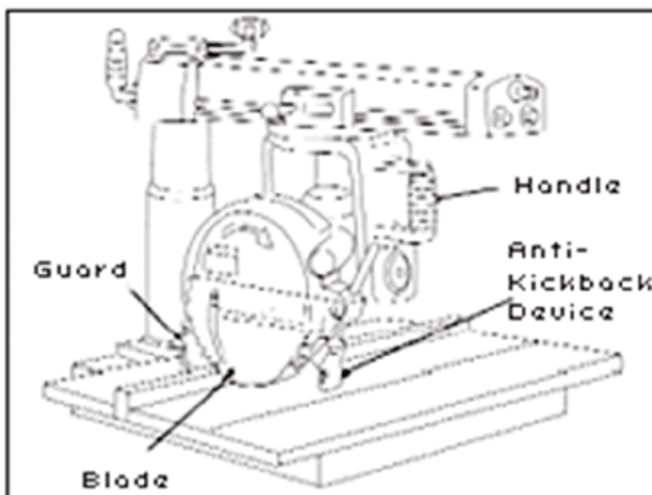
ADJUSTABLE BARRIER GUARD



Occupational Safety and Health Administration (OSHA) diagram

Self-adjusting Guard openings are determined by the movement of the material. As the operator moves the material into the danger area, the guard is pushed away. This provides an opening that is only large enough to admit the material. After the material is removed, the guard returns to the rest position. Table saw, radial saw and wood jointer blade guards are examples.

SELF-ADJUSTING GUARD ON A RADIAL SAW

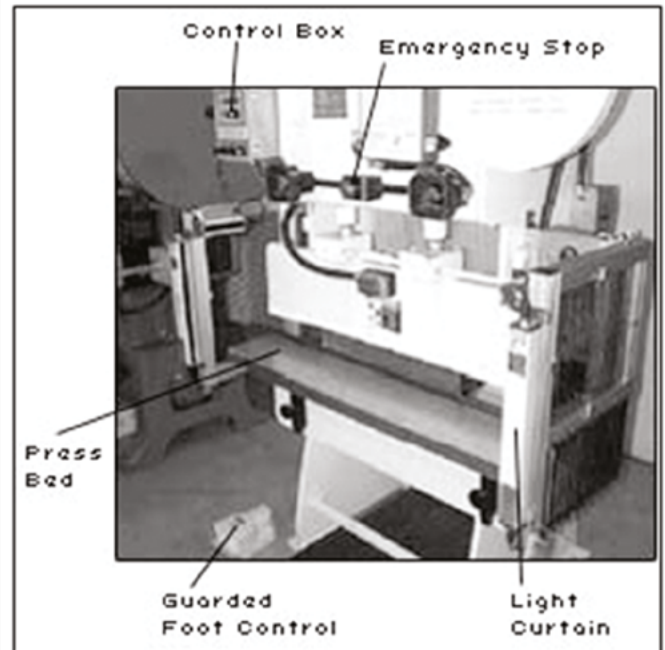


Occupational Safety and Health Administration (OSHA) diagram

DEVICE TYPES

Presence-Sensing Devices typically use photoelectric light curtains or radio frequency sensing field units to protect a hazardous area. Any object, such as a hand, that enters the area between the sensing devices will automatically cause the machine to shut down and stop. Another type of presence-sensing device is a pressure-sensing floor mat that can be placed in front of a hazardous area. When the mat senses pressure, such as an operator standing on the mat, a signal is sent to the machine to disengage the cycle.

PRESENCE SENSING DEVICE ON A POWER PRESS



Occupational Safety and Health Administration (OSHA) photo

Pull Back and Restraint Devices are attached to the operator's hands and to the machine. When the devices are adjusted properly, the operator's hands are pulled back from the hazard area as the machine is cycled. This is used only as a last resort due to the intense maintenance and adjusting required to ensure proper operation.

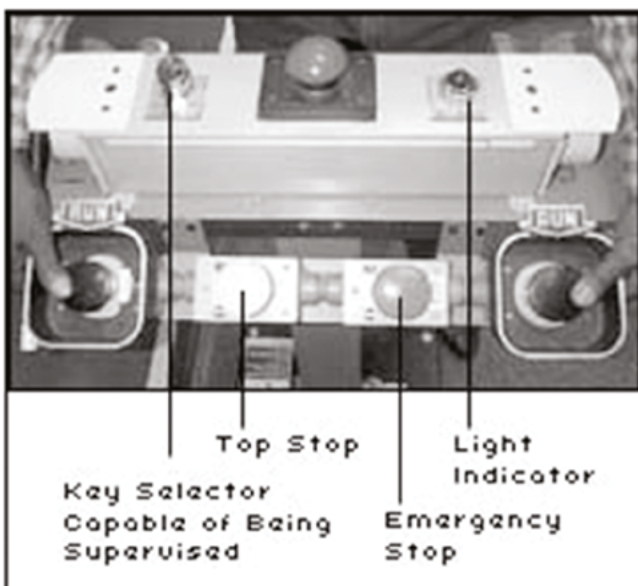
PULL BACK DEVICE ON A PRESS



Occupational Safety and Health Administration (OSHA) diagram

Two-Hand Controls are machine actuation devices that, if located at a sufficient distance, prevent the operator from getting into the point of operation hazard should the controls be released. These controls require concurrent pressure from both of the operator's hands during a substantial portion of the machine cycle. They also have a reset feature that requires release of the two hand control buttons between each cycle.

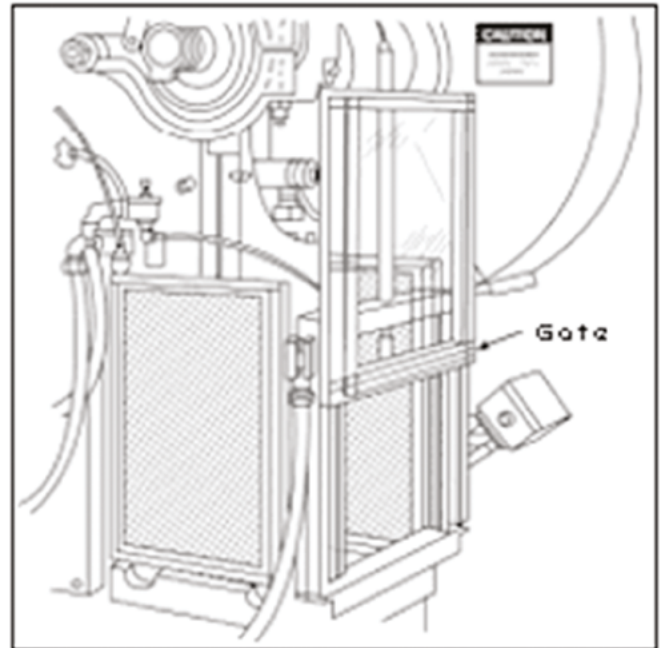
TWO-HAND CONTROL SYSTEM



Occupational Safety and Health Administration (OSHA) photo

Gates are barriers designed to automatically move into place to protect the worker from a point of operation hazard before the cycle is started.

POWER PRESS WITH A GATE



Occupational Safety and Health Administration (OSHA) diagram

LOCATION/DISTANCE

For a machine hazard to be safeguarded based on location or distance, it must be positioned so that it doesn't present a hazard to a worker during the normal operation of the machine.

Enclosure walls or fences, with any access openings protected by interlock devices, can restrict access to machines. Another solution is to have dangerous parts located high enough to be out of the normal reach of any worker.

The positioning of the operator's control station provides another potential approach to safeguarding by location. Operator controls may be located at a safe distance from the machine if there is no reason for the operator to tend it.

MACHINE GUARDING CONSIDERATIONS

Each guard and device has unique characteristics, advantages and disadvantages. When it comes to machine guarding, one size doesn't fit all. The following factors should be considered when determining which control methods are best suited for your machines.

- Cost
- Effects on production and quality
- Ease of maintenance
- Machine set up
- Auxiliary controls needed
- Durability
- Training
- Employee acceptance

It's important to refer to OSHA guidelines and other specifications to determine the appropriate approach for your machines. Safety equipment manufacturer representatives may also provide additional insights.

CONTROL OF HAZARDOUS ENERGY (LOCK OUT/TAGOUT) PROGRAM

A machine guarding discussion wouldn't be complete without mentioning the need for a comprehensive Lockout/Tagout program. Employees become exposed to machine hazards from non-routine tasks such as machine set up and maintenance. Often, these tasks require disabling safety devices and /or removing guards. When this occurs, it's necessary to assure that the machinery is in a "zero energy" or "zero mechanical" state (unable to release hazardous energy).

The OSHA standard for The Control of Hazardous Energy (Lockout/ Tagout), title 29 Code of

Federal Regulations (CFR) Part 1910.147 addresses the practices and procedures necessary to disable machinery or equipment to prevent the release of hazardous energy while employees perform servicing and maintenance activities.

Web link to OSHA 1910.147:

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=1792&p_table=DIRECTIVES&p_search_str=1910.147%20&p_search_type=CLOBTEXTPOLICY&p_status=CURRENT&p_text_version=FALSE

MACHINE HAZARD CHECKLIST

REQUIREMENTS FOR ALL SAFEGUARDS

- Do the safeguards provided meet the minimum OSHA requirements?
- Do the safeguards prevent workers' hands, arms, and other body parts from making contact with dangerous moving parts?
- Are the safeguards firmly secured and not easily removable?
- Do the safeguards ensure that no objects will fall into the moving parts?
- Do the safeguards permit safe, comfortable, and relatively easy operation of the machine?
- Can the machine be oiled without removing the safeguard?
- Is there a system for shutting down the machinery and locking/tagging out before safeguards are removed?
- Can the existing safeguards be improved?

MECHANICAL HAZARDS

POINT OF OPERATION

- Is there a point-of-operation safeguard provided for the machine?
- Does it keep the operator's hands, fingers, body out of the danger area?
- Is there evidence that the safeguards have been tampered with or removed?
- Could you suggest a more practical, effective safeguard?
- Could changes be made on the machine to eliminate the point-of-operation hazard entirely?

POWER TRANSMISSION APPARATUS

- Are there any unguarded gears, sprockets, pulleys, or flywheels on the apparatus?
- Are there any exposed belts or chain drives?
- Are there any exposed set screws, key ways, collars, etc.?
- Are starting and stopping controls within easy reach of the operator?
- 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?

NON-MECHANICAL 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?

ELECTRICAL HAZARDS

- Is the machine installed in accordance with National Fire Protection Association and
- National Electrical Code requirements?
- Are there loose conduit fittings?
- Is the machine properly grounded?
- Is the power supply correctly fused and protected?
- Do workers occasionally receive minor shocks while operating any of the machines?

ADDITIONAL MACHINE GUARDING INFORMATION

A variety of resources are available to assist you with your machine guarding management endeavors. Some include:

U.S. Occupational Health and Safety Administration (OSHA) On-Line Resources

Mechanical power press information

<https://www.osha.gov/SLTC/etools/machineguarding/presses/mechanical.html>

Machine guarding publications

<https://www.osha.gov/SLTC/etools/machineguarding/guards.html>

Links to OSHA machine guarding standards and compliance information

<https://www.osha.gov/SLTC/etools/machineguarding/standards.html>

Related OSHA technical links

https://www.osha.gov/SLTC/etools/machineguarding/additional_references.html

APPLICABLE ANSI AND CEMA STANDARDS

- ANSI B5.52M-1980 (R1994), *Presses, General Purpose, Single Point, Gap Type, Mechanical Power (Metric)*
- ANSI B5.37-1970 (R1994), *External Cylindrical Grinding Machines-Centerless*
- ANSI B5.42-198 (R1994), *External Cylindrical Grinding Machines-Universal*
- ANSI B7.1-2000, *Use, Care, and Protection of Abrasive Wheels*
- ANSI B11.1-2001, *Safety Requirements for Mechanical Power Presses*
- ANSI B11.3-2002, *Safety Requirements for the Construction, Care, and Use of Power Press Brakes*
- ANSI B11.4-2003, *Safety Requirements for Construction, Care, and Use of Shears*
- ANSI B11.8-2001, *Safety Requirements for Manual Milling, Drilling and Boring Machines with or without Automatic Control*
- ANSI B11.9-1975 (R2005), *Safety Requirements for the Construction, Care, and Use of Grinding Machines*
- ANSI B11.12-1996, *Safety Requirements for Construction, Care, and Use of Roll-Forming and Roll-Bending Machines*
- ANSI B11.14-1996, *Coil Slitting Machines Safety Requirements for Construction, Care and Use*
- ANSI B11.19-2003, *Performance Criteria for Safeguarding*
- ANSI B20.1-57, *Safety Code for Conveyors, Cableways, and Related Equipment [incorporated by reference in 1926.555(a)(8)]*
- ANSI B65.1-2005, *Safety Standard-Printing Press Systems*
- ANSI B65.2-2005, *Binding and Finishing Systems*
- ANSI O1.1-2004, *Safety Requirements for Woodworking Machinery*
- ANSI/CEMA 350-2003, *Screw Conveyors for Bulk Material*
- ANSI/CEMA 401-2003, *Unit Handling Conveyors-Roller Conveyors-Non-powered*
- ANSI/CEMA 402-2003, *Unit Handling Conveyors-Belt Conveyors*
- ANSI/CEMA 403-2003, *Unit Handling Conveyors-Belt Driven Live Roller Conveyors*
- ANSI/CEMA 404-2003, *Unit Handling Conveyors-Chain Driven Live Roller Conveyors*
- ANSI/CEMA 405-2003, *Unit Handling Conveyors-Slat Conveyors*
- ANSI/CEMA 406-2003, *Unit Handling Conveyors-Line-shaft Driven Live Roller Conveyors*
- ANSI/ASME B20.1-2003, *Safety Standard for Conveyors and Related Equipment*

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