

MACHINE GUARDING AND TOOL SAFETY

The intent of machine guarding is to minimize machine-operator contact, such as making contact with the machine, making contact with parts via flying chips, sparks, chemical and hot metal splashes, saw kickbacks, etc., or contact with a machine part as a result of machine malfunction. All machinery, machine parts and tools are to be used, stored and maintained in a safe manner consistent with this program in order to prevent workplace injuries to employees. (OSHA reference 29 CFR 1910.211 to 1910.222.)

RESPONSIBILITIES

Employees shall have defined responsibilities as follows:

Manager Role

- Ensure all machinery is properly guarded.
- Provide training to employees on machine guard rules.
- Ensure new equipment meets the machine guard requirements prior to use.
- Provide correct tools for an assigned task.
- Ensure tools are maintained and stored safely.
- Provide maintenance repair.
- Monitor and inspect to ensure machine guards remain in place and functional.
- Immediately correct machine guard deficiencies.

Employee Role

- Do not remove machine guards unless equipment is locked and tagged.
- Only trained and authorized employees may remove machine guards.
- Replace machine guards properly.
- Report machine guard problems to supervisor immediately.
- Report tool deficiencies and malfunctions.
- Do not operate equipment unless guards are in place and functional.
- Follow proper tool safety guidelines.
- Properly store tools when work is completed.

HAZARDS

Injuries can occur from mechanical motions such as the movement of rotating members, reciprocating arms, moving belts, meshing gears, cutting teeth, and parts that impact or shear. These parts are basic to most machines and recognizing them is the first step at protecting workers from danger.

Use of machinery with inadequate guards or damaged controls can result in injuries such as:

- Amputation
- Skin burns
- Cuts
- Fractures
- Death

Controls should be in place to prevent injuries, such as:

- Machine guards

- Interlocks
- Gates
- Properly designed tools
- Employee training
- Use of Personal Protective Equipment (PPE)
- Two hand controls
- Controlled access to equipment and tool areas
- Tool sharpening program training

3 areas that need safeguarding from dangerous moving parts:

- The point of operation - The point where the movement of a machine meets the work to be done (such as cutting, grinding, shaping, boring, shaping, forming of stock, etc.).
- Power transmission apparatus – All components of the mechanical system which transmit energy to the part of the machine performing the work (such as flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, cranks, and gears).
- Other moving parts – All parts of the machines which move while the machine is working (such as reciprocating, rotating, and transverse moving parts, feed mechanisms, and auxiliary parts of the machine).

Types of hazardous machine motions and actions are as follows:

- MOTIONS: Rotating (including in-running nip points), reciprocating, transverse: Rotating motions can be dangerous, even slow rotating can grip clothing or force an entire arm into a dangerous position. Examples of common rotating mechanisms that can be dangerous include collars, couplings, cams, clutches, flywheels, shaft ends, spindles, and shafting. There is added danger when bolts, nicks, abrasions, projecting keys, or set screws are exposed on rotating parts of machinery.
- ACTIONS: Cutting (rotating, reciprocating, or transverse motion), punching, shearing, bending: The danger of cutting actions exists at the point of operation where injuries and occur and where flying parts can strike the eye or face. Such hazards are present at the point of operation when cutting wood, metal, or other materials. Machines which include cutting hazards include bandsaws, boring or drilling machines, circular saws, or turning machines (lathes), or milling machines.

SAFEGUARDS

Safeguards must meet these minimum general requirements:

- Prevent contact – Safeguards must be in place to prevent any part of a body or clothing from making contact with dangerous moving parts.
- Secure – Workers should not be able to easily remove or tamper with the safeguard. A safeguard that can easily be removed or made ineffective is no safeguard at all. Guards should be made of durable materials and firmly secured to machine.
- Protect from falling objects – The safeguard should ensure that no objects can fall into moving parts. They could easily become projectiles.
- 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 that can cause a laceration. For example, the edges of guards should be rolled or bolted so they don't have sharp edges.
- Create no interference – Any safeguard which prevents a worker from performing the job quickly and comfortably might soon be overridden or disregarded. Proper safeguarding can actually enhance efficiency if the worker is no longer worried about injury.

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

One or more method of guarding should be used against hazards such as those created by point of operation, ongoing nip-points, rotating parts, flying chips and sparks. General guidelines that apply to all machines:

- Guards should be securely affixed and not create a hazard.
- The point of operation must be guarded.
- Revolving drums, barrels and containers should be guarded by an enclosure which is interlocked with a drive mechanism.
- When the periphery of the blades of a fan is less than 7 feet above the floor or working level, the blades should be guarded with guards having openings no larger than ½ inch.
- Machines designed for a fixed location should be securely anchored to prevent moving.
- If power failures are a possibility, provisions shall be made to prevent machines from automatically starting up upon restoration of power. If a machine was not manufactured with a restart switch, one can be added on “inline” requiring it to be reset upon restoration of power.

All woodworking machinery must be guarded from hazards inherent in their operation (table saws, swing saws, radial arm saws, band saws, jointers, tenoning, boring and mortising machines, shapers, planers, lathes, sanders, veneer cutters, and other woodworking machinery).

Safety guards must never be removed when a tool is being used. An upper guard must cover the entire blade of a saw. A retractable guard must cover teeth of the saw, except when it makes contact with the material. The lower guard must automatically return to the covering position when the tool is withdrawn from the work.

MACHINE SAFETY

Power Tool Safety

Power tools can be hazardous when improperly used. There are several types of power tools, based on the power source they use: electric, pneumatic, liquid fuel, hydraulic and powder-actuated. The following general precautions should be observed:

- Never carry a tool by the cord or hose.
- Never yank the cord or the hose to disconnect it from the receptacle.
- Do not use a tool if the electrical cord is frayed or damaged.
- Keep cords and hoses away from heat, oil and sharp edges.
- Disconnect tools when not in use, before servicing and when changing accessories such as blades, bits and cutters.
- All observers should be kept away, at a safe distance.
- Secure work with clamps or a vise, freeing both hands to operate the tool.
- Avoid accidental starting. Do not hold finger on switch button while carrying a plugged in tool.
- Tools shall be maintained with care and kept clean for the best performance. Follow all manufacturer instruction for lubricating and changing accessories.
- Keep good footing to maintain good balance.
- Wear proper apparel. Loose clothing, ties or jewelry can become caught in moving parts.
- Tools that are damaged shall be removed from use and tagged **DO NOT USE**.
- Tools shall be operated within their design limitations.

- Gloves, safety footwear and other proper PPE are required during use of electrical tools.
- When not in use, store tools in a dry place.
- Do not use electric tools in damp or wet locations.
- Work areas shall be well lighted.

Some hand held powered tools such as circular saws having a blade diameter greater than 2 inches, chain saws and percussion tools without positive accessory holding means must be equipped with a constant pressure switch that will shut off power when the pressure is released.

Among the chief hazards of electric-powered tools are burns and slight shock, which can lead to injuries or even heart failure. A shock can also cause the user to fall off a ladder or other elevated work surface. To protect the user from shock, tools must have a three-wired cord with ground and be grounded, be double insulated, or be powered by a low voltage isolation transformer. Three wire cords contain two current carrying conductors and a grounding conductor. One end of the grounding conductor connects to the tool's metal housing. The other end is grounded through a prong on the plug. Anytime an adapter is used to accommodate a two-holed receptacle, the adapter wire must be attached to a known ground. The third prong shall never be removed from the plug. Double insulation is more convenient. The user and the tools are protected in two ways:

- By normal insulation on the wires inside.
- By a housing that cannot conduct electricity to the operator in the event of a malfunction.

Safety Switches

The following hand held tools are to be equipped with a momentary contact *ON-OFF* switch. These tools may be equipped with a lock-on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on:

- Drills
- Tappers
- Fastener drivers
- Horizontal, vertical and angle grinders with wheels larger than 2 inches in diameter
- Disc and belt sanders
- Reciprocating saws, saber saws
- Other similar tools

The following hand held tools are to be equipped with only a positive on-off control switch:

- Platen sanders
- Disc sanders with discs 2 inches or less in diameter
- Grinders with wheels 2 inches or less in diameter
- Routers
- Planers
- Laminate trimmers
- Nibblers
- Shears
- Scroll saws and jigsaws with blade shanks ¼ inch wide or less

Other hand held powered tools such as circular saws having a blade diameter greater than 2 inches, chain saws and percussion tools without positive accessory holding means must be equipped with a constant pressure switch that will shut off power when the pressure is released.

Abrasive Wheel Tools

Powered abrasive grinding, cutting, polishing and wire buffing wheels create special safety problems because they may throw off flying fragments. If improperly mounted, the wheel can literally explode. An employee shall never stand directly in front of a wheel during start up, due to the possibility of a wheel disintegrating.

Abrasive wheel - mounting:

- Because of the possibility that the wheel could explode, inspect the wheel and check the speed of the spindle.
- Immediately before mounting, all wheels should be inspected and sounded (ring tested) by gently striking the wheel and listen for any abnormal sounds. This is to ensure the new wheel has not been damaged. If they sound cracked or dead, they must not be used. A sound an undamaged wheel will give is a clear metallic tone or ring.
- The spindle speed of the machine should be checked before mounting the wheel to ensure it does not exceed the maximum operating speed marked on the wheel.
- Always follow manufacturer's recommendations on mounting the wheel.
- The operator should always ensure that the machine guards are in place.
- To prevent the wheel from cracking, the user shall be sure it fits freely on the spindle.
- The spindle nut must be tightened enough to hold the wheel in place, without distorting the flange.
- Care must be taken to assure that the spindle wheel will not exceed the abrasive wheel specifications.

Abrasive wheel – guards:

Abrasive wheels can only be used on machines that have safety guards which normally cover the spindle end, nut and flange projections. Exceptions to this guard requirement includes machines with:

- Wheels used for internal work being ground while within the work.
- Mounted wheels, used in portable operations, 2 inches and smaller in diameter.
- Type 16, 17, 18, 18R, and 19 cones, plugs and threaded hole pot balls where the work offers protection.
- Guards can be constructed so that the spindle end, nut, and outer flange are exposed on all operations where the work provides a suitable measure of protection to the operator.
- Work practices that entirely cover the side of the wheel. In that case, the side covers of the guard may be omitted.
- The spindle end, nut, and outer flange may be exposed on machines designed as portable saws.

Abrasive wheel – work rests:

For offhand grinding machines, there must not only be machine guards, but adjustable work rests of rigid construction to support the work. Work rests shall be adjusted close to the wheel with a maximum opening of 1/8 inch to prevent the work from being jammed between the wheel and the rest. Breakage could result if jamming were to occur.

Abrasive wheel – angular exposure and exposure adjustment:

Abrasive wheel safety guards for bench stands, floor stands, and cylindrical grinders should not expose the grinding wheel periphery for more than 65 degrees above the horizontal plane of the wheel spindle. The protecting member of the abrasive wheel safety guard should be adjustable for variations in wheel size so that the distance between the

wheel periphery and the adjustable tongue or the end of the peripheral member at the top must not exceed ¼ inch.

Radial saws:

- The upper hood should completely enclose the upper portion of the blade down the point that includes the end of the saw arbor.
- The sides of the blade's lower exposed portion should be guarded to the full diameter of the blade by a device that will automatically adjust itself to the thickness of the stock and remain in contact with the stock being cut.
- Radial arm saws used for ripping should have non-kickback fingers.
- An adjustable stop should be provided to prevent the forward travel of the blade beyond the position necessary to complete the cut in repetitive operations.
- The front end of the unit should be slightly higher than the rear. This will cause the cutting head to return gently to the starting position when released.

Table saws:

- Circular table saws should have a guard over the portion of the blade that is above the table. The guard must automatically adjust itself to the thickness of and remain in contact with the material being cut.
- Should have a spreader aligned with the blade, spaced no more than ½ inch behind the largest blade mounted in the saw. The requirement of having a spreader installed does not apply while grooving, dadoing, or rabbeting.
- If used for ripping, should have non-kickback fingers.
- Feed rolls and blades of self-feed circular saws should be protected by a hood or guard to prevent the hand of the operator from coming into contact with the in-running rolls at any point.

Swing or sliding cut-off saws:

- Hood should completely enclose the upper half of the saw.
- Limit stops should be provided to prevent swing or sliding type cut-off saws from extending beyond the front and back edges of the table.
- Should be provided with a protective device to return the saw automatically to the back of the table when released at any point of travel.
- Inverted sawing or swing cut-off saws should be provided with a hood that covers the part of the saw protruding above the top of the table or material being cut.

Bandsaws and band resaws:

- All require safety devices must be in place.
- All portions of the saw blade should be enclosed or guarded, except for the working portion of the blade between the bottom of the guide rolls and the table.
- Contact also can occur during machine repair or cleaning if care is not taken to de-energize the machine with lockout/tagout procedures.
- Bandsaw wheels shall be fully encased. The outside periphery of the enclosure shall be solid, and the front and back should be either solid or made of wire mesh or perforated metal.

Jointers:

- Each hand fed jointer, with a horizontal cutting edge, shall be equipped with an automatic guard that covers the entire section of the head on the working side of the fence or gage.

Mechanical power presses:

- Ensure the usage of point-of-operation guards are properly applied and adjusted to prevent hands and fingers into the point of operation by reaching through, over, under and around the guard for every operation performed on a mechanical power press. This requirement does not apply when the point of operation opening is $\frac{1}{4}$ inch or less.
- A substantial guard should be placed over the treadle on foot operated presses. Pedal counterweights on foot operated presses should have the travel path of the weight enclosed.
- Machines using full revolution clutches should incorporate a single stroke mechanism, except when automatically fed in continuous operation and the points of operation are fully safe-guarded by a fixed barrier guard.
- Regular inspection should ensure safe operator conditions, and must maintain a record of inspections and maintenance work.
- All point of operation injuries must be reported to OSHA within 30 days.

Mechanical power-transmission apparatus:

- This apparatus refers to all components of the mechanical system that transmit energy from the prime mover (power source) to the part of the machine performing the work. These components include flywheels, pulleys, belts, connecting rods, shafting, couplings, cams, spindles, chains, cranks and gears.
- Ensure that employees are safeguarded from injuries caused by rotating members, in-running nip points, sprockets, pulleys, etc.
- Guards should be made of metal or other suitable materials. Wood guards may be used in woodworking or chemical industries, in industries where atmospheric conditions would rapidly deteriorate metal guards, or where temperature extremes make metal guards undesirable.
- All pulleys, belts, sprockets, chains, flywheel, shafting, and shaft projections, gears, and couplings, or other rotating or reciprocating parts, or any portion thereof within 7 feet of the floor or working platform should be effectively guarded.
- All guards for inclined belts should conform for the standards of construction for horizontal belts, and should be arranged in such a manner that a minimum clearance of 7 feet is maintained between the belt and floor at any point outside the guard.
- Flywheels protruding through a working floor should be guarded.
- The guard should extend at least 15 inches above the belt where both runs of horizontal belts are 7 feet or less from the floor or working surface.
- Gear guards, where required, should extend 6 inches above the mesh point by a band guard covering the face, or otherwise be completely enclosed.
- Couplings with bolts, nuts, or set screws extending beyond the flange of the coupling should be guarded by a safety sleeve.
- Belts, pulleys and shafting in rooms used exclusively for power-transmission apparatus need not be guarded when all the following exist:
 - Rooms are locked against unauthorized entry.
 - Vertical clearance in passageways between the floor and power transmission beams, ceiling, or any other objects is not less than 5 feet 6 inches.
 - Route followed by the oiler is protected to prevent injury.

Pneumatic Tools

Pneumatic tools are powered by compressed air and include chippers, drills, hammers and sanders. There are several dangers encountered in the use of pneumatic tools. The primary danger is getting hit by one of the tools attachments or by some kind of fastener the employee is

using with the tool. Eye protection is required to be worn and face protection is recommended for employees working with pneumatic tools. Working with noisy tools such as jackhammers requires proper, effective use of hearing protection.

When using pneumatic tools, employees shall check to see that they are fastened securely to the hose to prevent them from becoming disconnected. A short wire or positive locking device attaching the air hose to the tool will serve as an added safeguard.

A safety clip or retainer must be installed to prevent attachments from being unintentionally shot from the barrel.

Screens must be set up to protect nearby employees from being struck by flying fragments around chippers, riveting guns, staplers or air drills.

Compressed air guns shall never be pointed toward anyone. Users shall never *dead-end* it against themselves or anyone else.

Powder-Actuated Tools

Powder actuated tools operate like a loaded gun and should be treated with the same respect and precautions.

- Powder actuated tools shall not be used in an explosive or flammable atmosphere.
- Before using the tool, the employee shall inspect it to determine that it is clean, moving parts operate freely and barrel is free from obstruction.
- The tool shall never be pointed at anyone.
- The tool shall not be loaded unless it is to be used immediately.
- A loaded tool shall not be left unattended.
- Hands shall be kept clear of the barrel end.
- To prevent the tool from being fired accidentally, two separate motions are required for firing; one to bring the tool into position, and another to pull the trigger.
- The tools shall not be able to be operated until they are pressed against the work surface with a force of at least 5 pounds greater than the total weight of the tool.

If a powder actuated tool misfires, the employee shall wait at least 30 seconds, and then try firing it again. If it still will not fire, the user shall wait another 30 seconds so that the faulty cartridge is less likely to explode, and then carefully remove the load. The bad cartridge shall be put in water.

Proper PPE shall be used and it is essential when using a powder-actuated tool.

The muzzle end of the tool must have a protective shield or guard centered perpendicularly on the barrel to confine any flying fragments or particles that might otherwise create a hazard when the tool is fired. The tool must be designed so that it will not fire unless it has this kind of safety device.

All powder-actuated tools must be designed for varying powder charges so that the user can select a powder level necessary to do the work without excessive force.

If the tool develops a defect during use, it shall be tagged and taken out of service immediately until it is properly repaired.

When using powder-actuated tools to apply fasteners, there are specific precautions to consider:

- Fasteners must not be fired into material that would let them pass through to the other side.
- The fastener must not be driven into materials like brick or concrete any closer than 3 inches to an edge or corner.
- In steel the fastener must not come any closer than ½ inch from the corner or edge.
- Fasteners must not be driven into very hard or brittle materials, which might clip or splatter or make the fastener ricochet.

An alignment guide shall be used when shooting a fastener into an existing hole. A fastener shall not be driven into a spalled area caused by an unsatisfactory fastening.

Hydraulic Power Tools

The fluid used in hydraulic power tools shall be an approved fire-resistant fluid and shall retain its operating characteristics at the most extreme temperatures to which it will be exposed. The manufacturer's recommended safe operating pressure for hoses, valves, pipes, filters and other fittings must not be exceeded.

Jacks

All jacks, lever and ratchet, screw and hydraulic, shall have a device that stops them from jacking too high. In addition, the manufacturer's load limit shall be permanently marked in a prominent place on the jack and shall not be exceeded.

A Jack shall never be used to support a lifted load. Once a load has been lifted, it must be immediately blocked up. Use wooden blocking under the base if necessary to make the jack level and secure. If the lift surface is metal, place a 1-inch thick hardwood block or equivalent between it and the metal jack head to reduce the danger of slippage.

To set up a jack, make certain of the following.

- The base rests on a firm level surface.
- The jack is correctly centered.
- The jack head bears against a level surface.
- The lift force is applied evenly.

Proper maintenance of jacks is essential for safety. All jacks must be inspected before each use and lubricated regularly. If a jack is subjected to an abnormal load or shock, it shall be thoroughly inspected to make sure it has not been damaged.

TRAINING

Even the most elaborate safeguarding system cannot offer effective protection unless the worker knows how and why to use it. Training is crucial. This kind of training is required for new operators, maintenance, set up operators when any new or altered safeguard are put into service, or whenever a worker is assigned to a new machine or operation. Annual refresher training should be provided to all applicable employees. Training should include instruction and hands on training in the following areas:

- How and why to use the safeguards.
- Description and identification of the hazards with the machines.
- The safeguards themselves, how they provide protection, and the hazards for which they are intended.

- How and under what circumstances safeguards can be removed (usually by repair and maintenance personnel only).
- What to do (i.e. contact a manager) if the safeguard is disabled, damaged or unable to provide proper protection.

DEFINITIONS

OSHA has identified the following definitions regarding machine safety:

Cutting actions	Cutting actions result when rotating, reciprocating or transverse motion is imparted to a tool so that the material being removed is in the form of chips. Exposed points of operation must be guarded to protect the operator from contact with cutting hazards, being caught between the operating parts and from flying particles and sparks.
Dadoing	To cut a groove or rectangular section for receiving the end of a board.
Enclosures	Mounted physical barriers that prevent access to moving parts of machinery or equipment.
Guards	Barriers that prevent employees from contact with moving portions or parts of exposed machinery or equipment, which could cause physical harm to the employee.
Grooving	Creating a long, narrow cut or indentation in a surface such as a cut in a board to receive another board (tongue-and-groove joint).
Jointer	Any tool used to prepare, make, or simulate joints, such as a plane for smoothing surfaces prior to joining them.
Mortising	The process of creating a notch, hole, groove, or slot in a piece of wood or the like, to receive a tenon of the same dimensions.
Nip Pints	In-running machine or equipment parts, which rotate towards each other, or where one part rotates toward a stationery object.
Nonkickback Fingers or Dogs	An anti-kickback device used to hold material being cut in place on circular table saws.
Point of Operation	The area on a machine or piece of equipment, where work is being done and materials is positioned for processing or change by the machine.
Power transmission	Any mechanical parts that transmit energy and motion from a power source to the point-of-operation.
Rabbeting	Forming a deep notch in or near one edge of a board, framing timber, etc., so that something else can be fitted into it.
Reciprocating Motion	Reciprocating motions are produced by back and forth movements of certain machine or equipment parts. This motion is hazardous, when exposed, offering pinch or shear points to an employee. A fixed enclosure such as a barrier guard is an effective method against this exposure.
Rotating motions	An exposed mechanism that is dangerous unless guarded, that can grasp clothing or hair upon contact and force an arm or other bodily part into a dangerous position. Affixed or hinged guards protect against this exposure.
Shear points	The reciprocal (back and forth) movement of a mechanical part past a fixed point on a machine.
Shearing action	The danger of this type of action lies at the point of operation where materials are actually inserted, maintained and withdrawn. Guarding is accomplished through fixed barriers, interlocks, remote control placement (2 hand controls), feeding or ejection.

Tenoning	The process of creating a projection at the end of the piece of wood or the like, used for insertion into a mortise of the same dimensions.
Transverse motions	Transverse motions are hazardous due to straight-line action and in-running nip points. Pinch and shear points also are created with exposed machinery and equipment parts operating between a fixed or other moving object. A fixed or hinged guard enclosure provides protection against this exposure.
Treadle	A lever of the like worked by continual action of the foot to impart motion to a machine.

SEE ALSO

For locations that utilize Grinders or Drill Press machines, see the additional policies in the Safety Manual entitled "Grinders and Drill Press Machines."