

UC Merced

Machine Guarding & Shop Safety



Revised: 7/1/2021

Table of Contents

Section	Page
1.0 PURPOSE	3
2.0 APPLICABILITY/SCOPE	3
3.0 ROLES/RESPONSIBILITIES	3
<i>3.1 All UC Merced Staff, Faculty, Students, and/or Authorized Equipment Operators</i>	<i>3</i>
<i>3.2 EH&S</i>	<i>4</i>
4.0 PROGRAM REQUIREMENTS/OPERATOR PROCEDURES	4
<i>4.1 General Safety Tips</i>	<i>4</i>
4.1.1 Machinery Safety	4
<i>4.2 Equipment-specific Guidelines</i>	<i>5</i>
4.2.1 Drill Press	5
4.2.2 Table Saw	6
4.2.3 Band Saw	8
4.2.4 Bench or Pedestal Grinder	10
4.2.5 Milling Machine	12
<i>4.3 Hand & Power Tool Guidelines</i>	<i>14</i>
4.3.1 Basic Safety Guidelines	14
4.3.2 Hand Tools	14
4.3.3 Power Tools	15
4.3.4 Electrical Tools	15
4.3.5 Pneumatic Tools	16
4.3.6 Liquid Fuel Tools	16
4.3.7 Hydraulic Tools	17
4.3.8 Powder-Actuated Tools	18
5.0 MACHINE MAINTENANCE, REPAIRS AND INSPECTION	18
<i>5.1 Who can repair machinery?</i>	<i>18</i>
<i>5.2 What type of machinery must have routine inspections?</i>	<i>19</i>
<i>5.3 How do I report a machine in need of maintenance or repairs?</i>	<i>19</i>
6.0 ISSUED BY AND NEXT REVIEW DATE	19

1.0 PURPOSE

This program provides information, and outlines safety requirements, as mandated by the California Occupational Safety and Health Administration (Cal/OSHA) for identifying and guarding hazardous locations on machines and equipment used by University of California, Merced (UC Merced) employees, students and contractors in carrying out their work duties. It assigns responsibilities for ensuring machine/equipment safety through hazard identification and evaluation, safeguarding, training, maintenance and operation of all kinds of machinery and equipment. This program works in conjunction with other Environmental Health & Safety (EH&S) programs, such as Energy Isolation – Lockout/Tagout, Confined Space, Aerial Lift and Elevating Work, etc.

2.0 APPLICABILITY/SCOPE

This program applies to anyone who operates UC Merced-owned machines or equipment, and/or research equipment developed and used on University property, regardless of their affiliation to the University. Additionally, this program extends to all machines and equipment used in education, research, operations, and maintenance activities, whether the equipment was purchased turnkey or designed/built by UC Merced affiliates.

3.0 ROLES/RESPONSIBILITIES

3.1 All UC Merced Staff, Faculty, Students, and/or Authorized Equipment Operators

Any person who must operate a machine as part of their work must:

- Ensure the proper machine guards are in place before using the machine by inspecting machines before each use
- Complete required training and be authorized by their supervisor prior to operating machines
- Understand and practice approved machine safeguarding methods
- Observe and follow all safety guidelines, signage and operating instructions
- Wear all appropriate personal protective equipment (PPE)
- Report machine safeguarding malfunctions or problems to a supervisor
- Do not defeat or remove guards or safety devices
- Do not operate machines without safeguards in place
- Do not operate machines that are broken or damaged or otherwise unguarded
- Lock and/or Tagout broken/damaged equipment so that others cannot accidentally use it, and make the broken/damaged condition known to a supervisor

3.2 EH&S

EH&S manages this program for UC Merced and is responsible for all aspects of managing and implementing this program including the following:

- Provides machine-guarding consultation services to UC Merced departments
- Provides training on implementation/adoption of this program to all affected personnel
- Develops specific machine guarding procedures, processes, and training
- Assists in the selection of appropriate guards, safeguarding methods, and PPE
- Conducts periodic inspections to ensure machine guarding safety guidelines are adhered to
- Reviews this program periodically, or whenever there is a change to the governing regulations

4.0 PROGRAM REQUIREMENTS/OPERATOR PROCEDURES

4.1 General Safety Tips

Safe work practices in shops are critical to preventing work-related injuries. Safety must become second nature to you. Crushed hands and arms, severed fingers, and blindness can occur when shop work is done carelessly. Machine parts, functions, or processes that may cause injury must always be controlled or eliminated whenever possible.

Never use machinery without proper training or appropriate guards. Ask your supervisor for training if you do not know how to use a piece of machinery or a power tool. Stay alert when working and keep others at a safe distance when using a machine. If you see a co-worker having difficulty working (e.g. from being over-medicated, ill, or excessively tired), let your supervisor know so they can attend to the situation.

Always use Lockout/Tagout procedures when inspecting or repairing machines. And make sure you report any equipment that is unsafe or needs repair.

4.1.1 Machinery Safety

1. Get trained before using machines
2. Follow instruction manuals
3. Select the appropriate machine/tool for the job
4. Use required PPE and guards
5. Set up before starting. Change dull blades, clamp work, secure bits, and remove chuck keys
6. Make sure operating controls are clearly labeled and easy to reach. Turn off machinery when unattended

4.2 Equipment-specific Guidelines

4.2.1 Drill Press

4.2.1.1. What is a Drill Press?

A drill press is used to drill holes of various sizes in wood, metal, and other materials. Usually mounted or bolted to the floor or work bench, it consists of a base, column, table, spindle, and drill head, which is usually driven by an electric motor. The head has a set of turning handles that move the spindle and chuck vertically. The table can also be adjusted vertically and is usually moved by a rack and pinion (see Figure 4.1).

4.2.1.2. Requirements and Safeguards UC Merced policies and State regulations require that all drill presses be guarded at all times, secured to the floor or bench, and be in good working condition. Guards are required for all moving parts, including the point of operation where the work is performed, at all power transmission components, and at all other moving parts on the machine. The adjustable debris guard must always be adjusted and in place before attempting any type of cut.

4.2.1.3. Training and PPE

You must receive specific training and PPE before working with a drill press. Training must include instruction from an experienced user on how to operate press, review of the standard operating procedure (SOP), and the proper use of guards, and PPE.

At a minimum, you must always wear safety glasses when operating a drill press. Face shields are recommended for added protection whenever feasible.

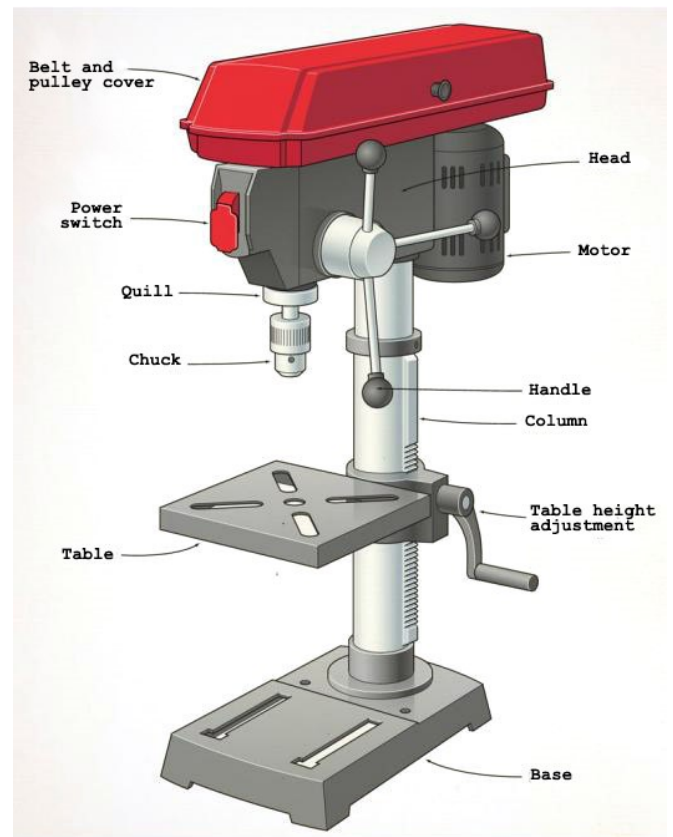


Figure 4.1. Drill Press



Debris Guard



Safety Glasses



Face Shield

4.2.1.4. Safety Tips

1. Select round, hex, or triangular shank bits
2. Secure bits and remove chuck before turning on machine
3. Work at a speed appropriate for bit size and material
4. Position work to avoid drilling into table
5. Clamp work to table
6. Feed bit evenly into work piece
7. Back out of deep holes
8. Clear off chips with brush after turning off machine
9. Never hold work piece by hand
10. Always clamp sheet metal to table before drilling

4.2.2 Table Saw

4.2.2.1. What is a Table Saw?

A table saw consists of a circular saw blade that is driven by an electric motor. The blade protrudes through the surface of a table, which provides support for the material being cut. The height of the blade determines the depth of the cut that is made in the material, and the angle of the cut is controlled by adjusting the angle of the blade (see Figure 4.2).

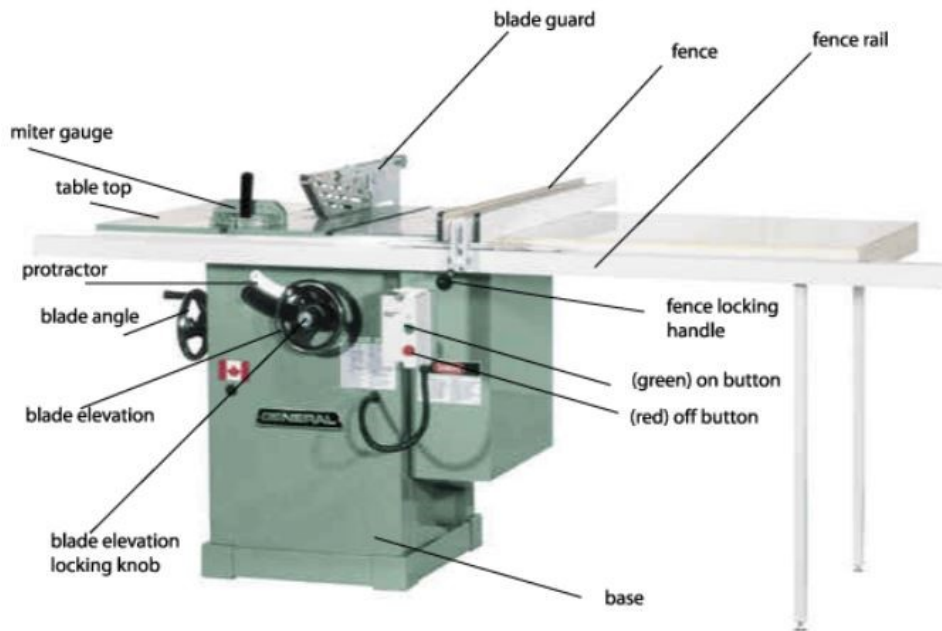


Figure 4.2. Table saw

4.2.2.2. Requirements and Safeguards

All table saws used in UC Merced shops must be in good operating condition and be securely mounted. All rotating or moving parts must be guarded. Portions of circular saws that extend beyond or behind a table must be covered with a guard, such as a crown guard, or with an exhaust hood if an exhaust system is required. Anti-kickback devices, hood guards, and spreaders are required. Push sticks and push shoes are highly recommended to keep hands away from blades.

All moving parts (belts and gears) and the point of operation must be guarded. Circular table saws must have a hood (crown guard) that completely covers the blade projecting above the table. The guard must ride the thickness of the stock being cut, adjusting to the thickness of the stock.

Keep the blades' guards, spreaders, and anti-kickback devices in place. Align the spreader with the blade. Check their action to make sure they operate properly before cutting.

4.2.2.3. Training and PPE

You must receive specific training and PPE before working with table saws. Training must include instruction by an experienced user on how to operate a table saw. Training must include a review of the SOP, and the proper use of guards and PPE.

You must wear safety glasses, goggles, or face shields when operating a table saw. If the cutting operation is dusty, wear a dust mask. Do not wear gloves, ties, dangling jewelry,

long sleeves, or any other loose-fitting clothing that could get caught in the blade. Non-slip footwear is also essential.



Crown Guard



Push Sticks



Safety Goggles



No Gloves

4.2.2.4. Safety Tips

1. Set blade height maximum 1/16th inch above stock. This ensures that if your hand slips, you will get a slight cut rather than lose a limb.
2. Position guides
3. Make sure tabletop is smooth and polished. Dirty, rough tables require extra force to push the stock through the blade. This can increase your chance of slipping or losing your balance.
4. Stand balanced and avoid awkward movements to avoid falling into the blade.
5. Check stock for nails, knots, screws, stones, etc. These items can become projectiles and cause injury.
6. Release work only after it has gone past the blade.
7. Use a push stick to cut stock that is less than 6" (150mm) wide.
8. Make sure that the blade has stopped turning before you adjust the table.
9. Do not leave the saw until the blade has come to a complete stop.

4.2.3 Band Saw

4.2.3.1. What is a Band Saw?

Band saws have blades with continuous bands of metal with teeth along one edge and are used to cut a variety of materials, including wood and metal. Workpieces are fed into the cutting edge of the blade on vertical machines powered by electric motors. The metal band blade rides on two wheels rotating in the same plane. Band sawing produces uniform cutting as a result of an evenly distributed tooth load. Band saws can be used to produce straight cuts and are also particularly useful for cutting irregular or curved shapes (see Figure 4.3).

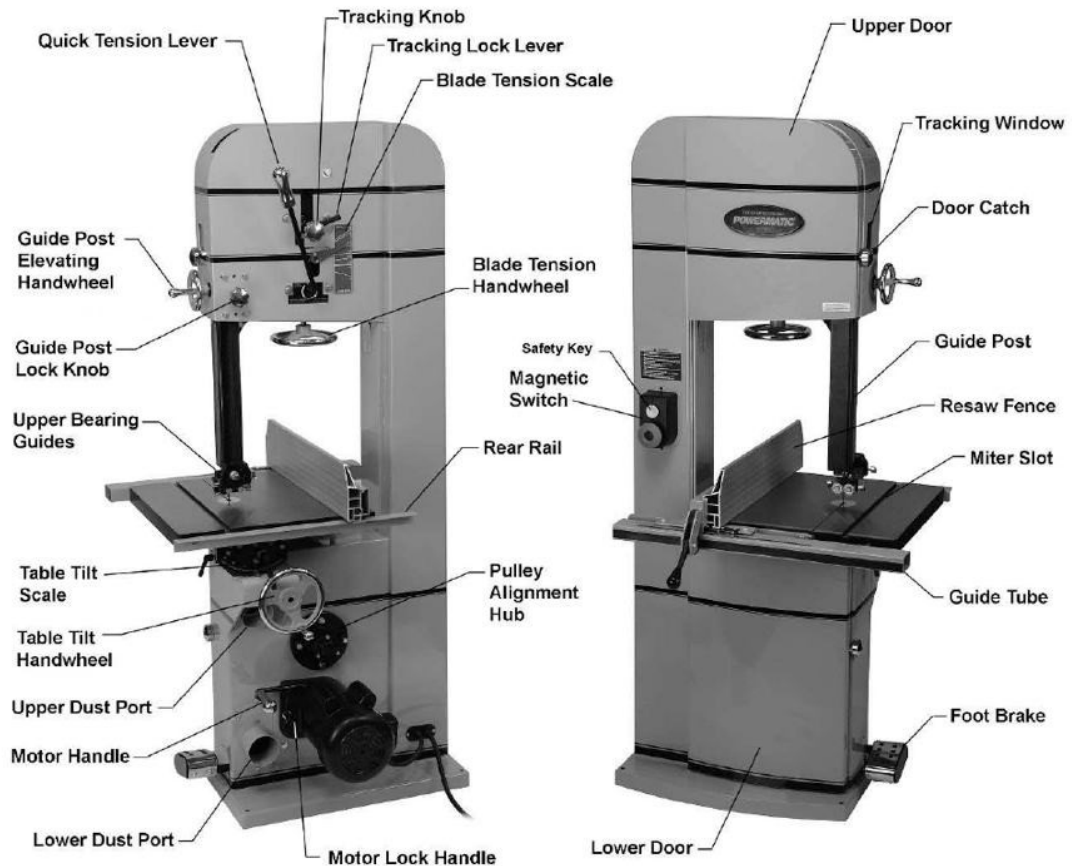


Figure 4.3. Band Saw

4.2.3.2. Requirements and Safeguards

All band saws must be secured to the floor or bench and have blade tension control devices with indicators. As with other machinery, all moving parts and the point of operation must be guarded. The entire saw blade must be enclosed or guarded, except for the working portion of the blade between the bottom of the guide rolls and the table. Adjust the blade guard as close as possible to the table without interfering with movement of the stock. An adjustable secondary debris guard must also be in place. Push sticks or push shoes are recommended to keep fingers and hands away from moving blades.

4.2.3.3. Training and PPE

You must receive specific training and PPE before working with a band saw. Training must include instruction from an experienced user on how to operate a band saw, review of the SOP, and the proper use of guards and PPE. Operators must wear safety glasses. If the material being sawed ships severely, use a face shield in addition to safety glasses. Non-slip

footwear is also essential. As with any power saw, do not wear gloves, ties, dangling jewelry, long sleeves, or loose fitting clothing.



Visor Guard



Push Sticks



Safety Glasses



No Gloves

4.2.3.4. Safety Tips

1. Clear tools, debris, and unnecessary materials off table.
2. Verify location of on/off switch and emergency power disconnect.
3. Check blade for tightness.
4. Adjust the blade guard as close as possible to the table without interfering with movement of the stock.
5. Adjust the travel guard down so that the blade will travel within the angle or channel.
6. Operate at manufacturer's recommended speed.
7. Cut only those materials recommended for use with the machine.
8. Do not force material into the blade.
9. Unplug power cord before changing blade or servicing.
10. Lock power disconnect in "off" position when changing the blade or servicing the saw.
11. Test the saw after disconnecting power and before beginning service.

4.2.4 Bench or Pedestal Grinder

4.2.4.1. What is a Bench or Pedestal Grinder?

A grinder uses an abrasive wheel to grind objects that need to be shaped or repaired. It is often used to remove metal from a work piece, sharpen tools, and clean parts. It consists of a power driven grinding wheel and a tool rest used to guide and feed work pieces onto the wheel (see Figure 4.4).

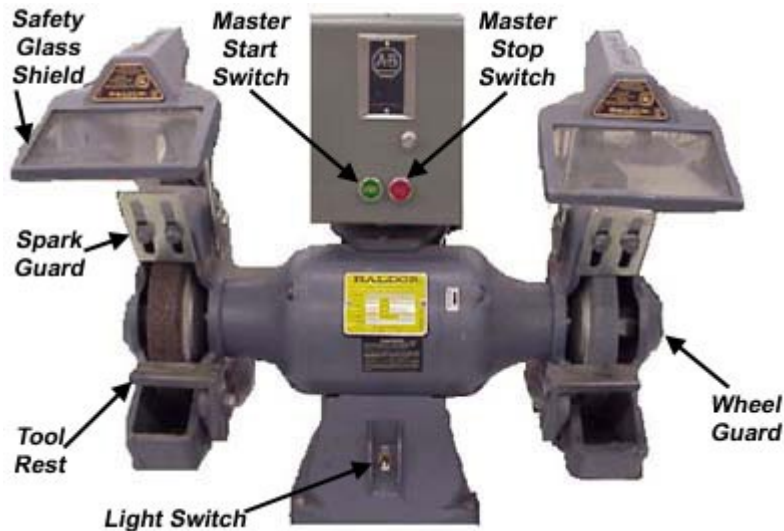


Figure 4.4. Bench Grinder

4.2.4.2. Requirements and Safeguards

All grinders must be mounted to floors or benches. The tool rest must be adjusted within 1/8 inch of the grinding wheel. Adjustable tongue guards should be within 1/8 inch from the wheel. Side guards must cover the spindle, nut and flange, and at least 75% of the wheel. Safety glass shields must be clear to allow the user to see the wheel.

As with other machinery, guards are required for all moving parts and at the point of operation. Side guards must cover the spindle, nut, flange, and 75% of the wheel. In addition, each stone or wire brush must have an adjustable, clear debris shield (also known as an eye shield).

4.2.4.3. Training and PPE

You must receive specific training and PPE before working with a bench or pedestal grinder. Training must include instruction from an experienced user on how to operate a grinder, review of the SOP, and the proper use of guards and PPE. Operators must wear full face protection, ear protection, leather gloves, and a leather apron.



Shield Guards Face Shield Ear Protection Leather Apron Leather Gloves

4.2.4.4. Safety Tips

1. Stand to the side of the grinder when starting the electric motor.
2. Use the correct wheel for the material you are grinding, polishing, or buffing.
3. Adjust the tool rest as close as possible to the grinding wheel without touching it. It must have a gap of 1/8 inch on the top and bottom.
4. Keep the face of the abrasive wheel square. Use a dressing tool to remove some of the abrasive compound to square the wheel.
5. Never grind on the side of the wheel. This can cause the wheel to shatter.
6. Avoid overheating metal when grinding. If the metal becomes too hot and is allowed to cool too slowly, it may become soft. If it is cooled too quickly (quenched), it may become brittle.
7. Dip the metal into the water pot attached to the bottom of the grinder as you shape it to keep it from getting too hot.
8. If your grinder does not have a water pot, place a container of water near the grinding to cool the piece you are grinding.

4.2.5 Milling Machine

4.2.5.1. What is a Milling Machine?

Milling machines shape metal and other solid materials. A cutter rotates about the spindle axis and table to which the work piece is affixed. In contrast to drilling, where the drill is moved exclusively along its axis, milling involves movement of the rotating cutter sideways as well as “in and out.” The cutter and work piece move relative to each other, generating a tool path along which material is removed. Milling machines may be manually operated, mechanically automated, or digitally automated via computer numerical control. (See Figure 4.5).

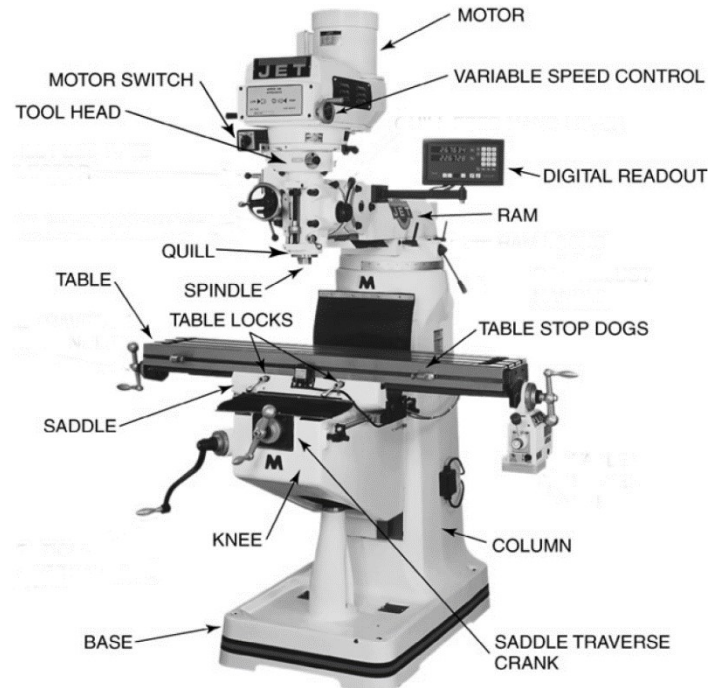


Figure 4.5. Vertical CNC Milling Machine

4.2.5.2. Requirements and Safeguards

Milling machines must be in good condition and properly lubricated with all moving chains and gears guarded at all times. As with all other machinery, guards are required for all moving parts and the point of operation. An adjustable chip shield must be in place whenever cutting is taking place.

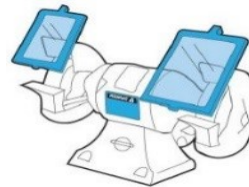
4.2.5.3. Training and PPE

You must receive specific training and PPE before working with a milling machine. Training must include instruction by an experienced user on how to operate a milling machine. Training must include a review of the SOP, and the proper use of guards and PPE.

Operators must always wear safety glasses and slip-resistant shoes. Never wear loose clothing or other articles that dangle and could catch on the cutter.



Guards



Safety Glasses



No Gloves

Chip

4.2.5.4. Safety Tips

1. Keep area around milling machine clear of debris; wipe up any oil on the floor.
2. Clean and dry the table before setting up.
3. Secure any holding devices (e.g., vise, angle plate, dividing head, or tail stock).
4. Select the right kind of cutter for the job.
5. Check to make sure that the machine is turned off before inserting the cutter.
6. Make sure that the arbor, cutter, and collars are clean before mounting them in the spindle.
7. Handle sharp cutters with a rag.
8. Securely set the work piece ion the vise with a rubber hammer or mallet.
9. Be certain that the holding device clears the arbor and the over-arm supports.
10. Select the proper cutting speed, rpm, and rate of feed for the job.
11. Disengage the control handles when using automatic feeds.
12. Keep hands away from the revolving cutter at all times.
13. Never touch the metal chips with your fingers. Clear chips away from the cutter with a brush. After cutting is finished, vacuum or sweep debris rather than blowing with an air hose.

14. Release any automatic feeds after the job is complete.

15. Clean and wipe the machine when finished.

4.3 Hand & Power Tool Guidelines

Shop workers often take hand & power tools for granted since they are used so frequently. This can make it easy to forget the potential danger they may pose. Nevertheless, many tool-related accidents occur due to improper maintenance or misuse of hand and power tools. Pay close attention to the condition of your tools and know how to use them properly.

4.3.1 Basic Safety Guidelines

1. Keep all tools in good condition with regular maintenance.
2. Use the right tool for the job.
3. Examine each tool for damage before use.
4. Operate tools according to the manufacturer's instructions.
5. Use the appropriate PPE for any existing hazards such as dust, fumes, mists, vapors, or gases.

4.3.2 Hand Tools

Hand tools are manually powered tools such as pliers, screwdrivers, hammers, hand saws, and wrenches. While not powered by an external source, hand tools can be dangerous if improperly handled or used to perform the wrong task.

Never use a tool for something other than for what it was intended. Common examples of misuse include using a wrench for a hammer or using a screwdriver as a crowbar. Don't use extender or "cheater" bars to increase leverage or force on wrenches.

Keep hand tools in good working condition and always inspect them before use.

4.3.2.1. Safety Tips

1. Keep knife and saw blades sharpened.
2. Direct blades away from other workers in the work area.
3. Replace wrenches when jaws are worn and begin to slip.
4. Replace tools with splintered handles, cracked blades, or any other defect.
5. Use tools for their intended use only.



4.3.3 Power Tools

Power tools are classified by their power source and include electrical, pneumatic, liquid hydraulic, and power actuated tools. Potential hazards include electric shock and injury from moving parts.

Most power tools are designed with safety in mind. Manufacturers must follow Occupational Safety and Health Administration (OSHA) guidelines that require all power tools have guards, switches and controls, electrical grounding, and maintenance guidelines. These features are important for your safety. Do not operate any tools that have broken or missing guards, switches, or grounding conductors. Never remove safety guards.



4.3.3.1. Power Tools that Require Guards

1. Tools with non-flush projections on revolving or reciprocating edges.
2. Tools with wheels.
3. Tools with blades.
4. Tools with sanding and grinding carts.

4.3.4 Electrical Tools

Examples of electrical power tools include power drills, power saws, and power grinders. Electrical tools introduce the risk of shock, which can potentially lead to heart attacks or serious burns. To help avoid electrical shock, it is required that all exposed non-current carrying metal parts of tools that may become energized be grounded.



4.3.4.1. Safety Guidelines

1. Inspect cords for defects such as cracks, frays, and other signs of wear or faults in the cord insulation.
2. Use properly grounded tools with three-prong plugs and double insulation.
3. Inspect the plug for cracks and for missing, loose, or faulty prongs.
4. Use manufacturer recommended guards and shields.
5. Switch off tools before connecting them to a power supply.
6. Disconnect the power supply before making adjustments or changing accessories.
7. During use, keep power cords clear of tools and away from the path that the tool will take.
8. Use approved extension cords that have the proper wire size (gauge) for the length of cord and power requirements of the electric tool that you are using.

9. Use appropriate PPE for the work you are doing. This may include items such as safety glasses or goggles, hearing protection, dust mask, gloves, safety boots or shoes, or rubber boots.

4.3.5 Pneumatic Tools

Pneumatic tools are powered by compressed air. Common types of these air-powered hand tools include nail guns, stapling guns, grinders, drills, riveting guns, and jackhammers. These tools can cause injuries due to flying parts or loose attachments. Before you begin a job, make sure that pneumatic tools are fastened securely to their air hoses to prevent them from becoming disconnected while in use.



4.3.5.1. Safety Guidelines

1. Review the manufacturer's instructions before using a tool.
2. Wear safety glasses or a face shield and, where necessary, safety shoes or boots and hearing protection.
3. Make sure air hoses do not present a tripping hazard.
4. Never point a compressed air gun at another person.
5. Use the recommended air pressure for the task.
6. Post warning signs where pneumatic tools are used. Set up screens or shields in areas where nearby workers may be exposed to flying fragments, chips, dust, and excessive noise.
7. Ensure that the compressed air supplied to the tool is clean and dry. Dust, moisture, and corrosive fumes can damage a tool. An in-line regulator filter and lubricator increases tool life.
8. Keep tools clean and lubricated, and maintain them according to the manufacturer's instructions.
9. Do not attempt to catch falling machinery or power tools.
10. Support heavy tools with a counter-balance when possible.

4.3.6 Liquid Fuel Tools

Liquid fuel-powered tools are usually powered by gasoline. Examples of liquid fuel tools include chainsaws, lawn mowers, concrete saws, and pressure washers. When used properly and according to the manufacturer's instructions, these types of tools are very dependable and safe. Like any other kind of tool, there can be some serious hazards involved if they are used improperly. The most serious hazards presented by these tools are dangerous



exhaust fumes and vapors that can burn or explode. Proper ventilation, careful handling of fuel, and attention to fire safety can help reduce these hazards.

4.3.6.1. Safety Guidelines

1. Shut and cool down the engine before refilling a fuel tank.
2. Provide ventilation and/or proper respirators when using a liquid fuel tool in an enclosed area to avoid breathing carbon monoxide.
3. Always transport fuel in approved flammable liquid containers.
4. Have fire extinguishers available when working.
5. Always wear foot, eye, face, head, and ear protection when required.

4.3.7 Hydraulic Tools

Hydraulic tools are powered by a hydraulic pump which can be hand, foot, or engine powered, or even built into the tool itself. Hydraulic tools are used for the generation, control, and transmission of power by the use of pressurized liquids. Hydraulic power tools present various hazards, including trip hazards or slipping hazards from oil leaks.



4.3.7.1. Safety Guidelines

1. Never exceed the load limit marked on the tool.
2. Always uses a hydraulic jack on a firm and level surface.
3. Inspect all hydraulic tools at least once every six months.
4. Inspect all jacks used outside the shop before they go out and when they return.
5. Immediately inspect any hydraulic tool when subjected to an abnormal load, pressure, or shock.
6. Always use leather gloves, safety shoes, and face, eye and ear protection.
7. Consider using impact-resistant gloves.

4.3.8 Powder-Actuated Tools

A powder-actuated tool (often called a “Hilti gun” or a “Ramset gun” after their manufacturing companies), is a nail gun used in construction to join materials to hard substrates such as steel and concrete. This technology relies on a controlled explosion created by a small chemical propellant similar to the process that discharges a firearm. An example of a powder-actuated tool is a concrete fastener.

Powder-actuated tools come in both low and high velocity types. Either design can be dangerous to operate. Low velocity tools introduce a piston into the chamber. The propellant acts on the piston, which then drives the fastener into the substrate. In high velocity tools, the propellant acts directly on the fastener, similar to a firearm.



4.3.8.1. Safety Guidelines

1. Never point a powder-actuated tool at another person.
2. Use an alignment guide when shooting a fastener into an existing hole.
3. Do not fire fasteners into materials that would allow passage through the other side.
4. Stay at least 3 inches away from the edges or corners of materials like brick or concrete.
5. Stay at least ½ inch away from a steel corner or edge. In steel, the fastener must not come any closer than ½ inch from a corner or an edge.
6. Do not drive fasteners into hard or brittle materials that might chip or splatter, or make the fastener ricochet.
7. Always wear hand, eye, ear, and face protection.

5.0 MACHINE MAINTENANCE, REPAIRS AND INSPECTION

5.1 Who can repair machinery?

Only authorized individuals, such as the shop supervisor, manager, or a designee can repair machinery. User manuals or SOPs must be consulted and followed when maintaining or repairing equipment. Any piece of machinery that undergoes repair, whether it is repaired in-house or sent out, must have documentation which clearly outlines the extent of the repairs. Records of machinery repair must be maintained in the shop.

5.2 What type of machinery must have routine inspections?

All heavy machinery that is continuously in use must have routine safety or maintenance inspections. Inspections must be documented using machine-specific checklists or general maintenance logs that demonstrate routine review and inspection of machine parts and performance.

5.3 How do I report a machine in need of maintenance or repairs?

You must immediately notify a supervisor, manager, their designee of needed maintenance or repairs. Lockout/Tagout (LOTO) procedures must be implemented if any machine guard is removed or before any maintenance repairs are conducted. Refer to UC Merced's Energy Isolation-Lockout Tagout program manual for more information on LOTO procedures.

EH&S Phone: 209-228-4234 or <http://ehs.ucmerced.edu/>

6.0 ISSUED BY AND NEXT REVIEW DATE

Issued by: Mal Donohue, Campus Safety Officer

Approved by: Mal Donohue, EH&S Director

Issue Date: July 1, 2021

Review Date: Three years from Issue Date