

Tools, Equipment, and Machinery Reference Resource

Always read the manual of all tools, equipment, and machinery used in agricultural labs. Each tool or piece of equipment or machinery should only be used for the purpose for which it was intended; using the incorrect equipment for the job can lead to serious injury.

All manufacturer's guidelines should be followed. In addition, the following best practice guidelines should be observed.

Hand Tool Safety

The following safety guidelines apply to hand tools in the agricultural lab:

- Ensure hands and tools are free of oil or grease.
- Use tied-off containers to keep tools from falling off scaffolds and other elevated work platforms.
- Carry all sharp tools in a sheath or holster; transport hand tools only in tool boxes or tool belts rather than in clothing.
- Secure work with clamps or a vise. This enables the worker to use both hands to operate the tool.
- Point the sharp point or cutting edge away when handing a tool to another person; never throw a hand tool.
- When using knives, shears or other cutting tools, cut in a direction away from the body; when working with a hand axe, do not chop at heights above the head; maintain blades on cutting tools.
- Do not use cheaters on load binders or boomers.
- Tag worn, damaged, or defective tools out of service and do not use them; do not perform makeshift repairs on tools.
- When finished with a tool, clean and store it so it cannot fall; vise handles should hang free when not in use.
- Do not continue to work if your safety glasses become fogged. Stop work and clean the glasses until the lenses are clear and defogged.
- Use tied off containers to keep tools from falling off of scaffolds and other elevated work platforms.
- Carry all sharp tools in a sheath or holster.
- Tag worn, damaged or defective tools "Out of Service" and do not use them.
- Do not use a tool if its handle has splinters, burrs, cracks, splits, or if the head of the tool is loose.
- Do not use impact tools, such as hammers, chisels, punches or steel stakes, that have mushroomed heads.
- When handing a tool to another person, direct sharp points and cutting edges away from yourself and the other person.
- When using knives, shears or other cutting tools, cut in a direction away from your body.
- Do not chop at heights above your head when you are working with a hand axe.
- Do not carry sharp or pointed hand tools (e.g., screwdrivers, scribes, aviation snips, scrapers, chisels or files) in your pocket unless the tool or your pocket is sheathed.
- Do not perform makeshift repairs to tools.
- Do not use "cheaters" on load binders or "boomers."
- Do not carry tools in your hand when you are climbing. Carry tools in tool belts or hoist the tools to the work area using a hand line.
- Do not throw tools from one location to another, from one employee to another, from scaffolds or other elevated platforms.
- Transport hand tools only in tool boxes or tool belts. Do not carry tools in your clothing.

Tool Storage

Regardless of the tool storage system selected, there must be an organized and official storage place for every tool, piece of equipment and supply item. A central tool room makes security and taking inventory much easier and also requires fewer keys. Wall panels or cabinets can be used to store tools. They can be placed in the tool room or placed in each instructional area. Creating a silhouette where each tool is supposed to be stored keeps the tools organized, and easy-to-find and misplaced or missing items can be detected easily.

Tool Boxes/Chests/Cabinets

- Use the handle when opening and closing a drawer or door of a tool box, chest, or cabinet.
- Tape over or file off sharp edges on tool boxes, chests, or cabinets.
- Do not stand on tool boxes, chests, or cabinets to gain extra height.
- Lock the wheels on large tool boxes, chests, or cabinets to prevent them from rolling.
- Push large chests, cabinets, and tool boxes; do not pull them.
- Do not open more than one drawer of a tool box at a time.
- Close and lock all drawers and doors before moving the tool chest to a new location.
- Do not use a tool box or chest as a workbench.
- Do not move a tool box, chest, or cabinet if it has loose tools or parts on the top.

Power Tool Safety

The following safety guidelines apply to power tools in the agricultural lab:

- Read all operators' manuals carefully. Learn each tool's applications, limitations, and the potential hazards associated with it. Keep tools sharp and clean for the best and safest performance. Follow instructions for lubricating and changing accessories.
- Do not use power tools in damp or wet locations. Keep the work area well-lighted.
- Ground all tools. If the tool is equipped with a three-prong plug, it must be plugged into a three-hole electrical receptacle; never remove the third prong. If an adapter is used to accommodate a two-prong receptacle, the adapter wire must be attached to a known ground. (Usually the screw secures the receptacle cover plate.) Guard against electric shock; prevent body contact with grounded surfaces such as pipes, radiators, ranges, and refrigerator enclosures.
- Check for frayed electrical cords and for chafed or worn air hoses. Do not abuse cords. Keep cords away from heat, oil, and sharp edges.
- Do not touch machines unless operating. Avoid accidental starting (e.g., do not carry a plugged-in tool with a finger on the switch).
- Keep clear of operators; a person feeling ill must never operate a machine. Do not stop or start a machine for another person, except in an emergency; only one person will operate a machine at a time.
- Keep guards in place and in working order; remove adjusting keys and wrenches before turning on machines.
- Allow the machine to power up and reach its proper operating speed (e.g., RPM) before use.
- Do not overreach. Keep proper footing and balance when operating machines.
- Keep handles dry, clean, and free of oil or gas. Inspect switches and cords periodically and have them repaired or replaced by an authorized service facility if damaged. Check moving parts for alignment and binding as well as for breakage and improper mounting.
- Store tools when they are not in use.
- Disconnect tools before servicing and when changing attachments (e.g., blades, bits, cutters).
- Allow revolving machinery to stop on its own. Never touch moving parts; stop/power down all machinery to oil, adjust, or clean.
- Wear proper clothing. Remove jewelry, eliminate loose clothing, and confine long hair.
- Goggles, glasses, or face shields are worn at all power machines.
- Long hair is controlled by a hairnet or an appropriate cap.
- Ensure that tool rests are secured properly.
- Tools and scraps are not left on the floor.
- Oily rags are placed in a metal safety can.
- Oil spots are wiped from the floor.
- No tools with mushroomed heads or loose or broken handles are used.
- All files have handles before students use them.
- All accidents are reported to the supervisor and taken care of properly.
- The tool room has no defective tools in the rack.
- No safety guards are removed from machinery.

- No operator walks away from his/her machine and leaves it running.
- All danger zones are marked.
- No one talks to or touches anyone operating a machine.
- Shirt tails are to be tucked in at *all* times.
- Coats or sweaters are not worn while students are working.

The following safety guidelines apply to power tool batteries in the agricultural lab:

- Replace batteries only with compatible batteries. See the manufacturer's recommendations.
- Do not store or use the tool and battery pack in locations where the temperature may reach or exceed 105°F (40°C), such as outside sheds or metal buildings in summer.
- Do not charge or use a battery in explosive atmospheres, such as in the presence of flammable liquids, gases, or dust. Inserting or removing the battery from the charger may ignite the dust or fumes.
- Charge battery packs only in chargers provided with the power tool; never force a battery pack into a charger. Never attempt to open the battery pack for any reason.
- Do not splash or immerse a battery in water or other liquids.
- Do not crush, drop, or damage the battery pack. Do not use a battery pack or charger that has been damaged in any way (e.g., pierced with a nail, hit with a hammer, stepped on). Damaged battery packs must be recycled.
- Do not store or carry a battery so that metal objects can contact exposed battery terminals. Transporting batteries can cause fires if the battery terminals inadvertently come in contact with conductive materials such as keys, coins, and hand tools.

The following safety guidelines apply specifically to lithium polymer and Li-ion batteries:

- Never incinerate a battery pack.
- If the contents of a battery come into contact with the skin, immediately wash the area with mild soap and water. If battery liquid gets into the eye, rinse water over the open eye for 15 minutes or until irritation ceases. Contents of opened battery cells may cause respiratory irritation. Provide fresh air. Seek medical attention if needed. See SDS for details.
- Battery liquid may be flammable if exposed to a spark or flame and presents a burn hazard.

The following safety guidelines apply to the disposal of batteries:

- Batteries that lose 20 percent of their capacity must be removed from service and disposed of properly:
 - Discharge the battery.
 - Wrap the contacts with electrical (nonconductive) tape.
 - Dispose of the battery at an authorized recycling center.

Power Tools

(*Safety Rules: Plumbing, Heating and Air Conditioning* [The State Auto Insurance Companies])

https://www.stateauto.com/uploadedfiles/Content/Insurance/Products/Businesses/Risk_Control_Services/Risk_Control_Services_PDFs/Plumbing%20HVAC%20Rules.pdf

- Do not use power equipment or tools on which you have not been trained.
- Keep power cords away from the path of drills, saws, and grinders.
- Do not use damaged cords.
- Do not carry plugged-in equipment or tools with your finger on the switch.
- Do not carry equipment or tools by the cord.
- Disconnect the tool from the outlet by pulling on the plug, not the cord.
- Turn the tool off before plugging or unplugging it.
- Do not leave tools that are "on" unattended.
- Do not handle or operate electrical tools when your hands are wet or when you are standing on wet floors.
- Do not operate spark-inducing tools such as drills, saws, or grinders near containers labeled "Flammable" or in an explosive atmosphere.
- Do not use extension cords or other three-pronged power cords that have a missing prong.
- Do not remove the ground prong from electrical cords.

- Do not use an adapter, such as a cheater plug, that eliminates the ground.
- Do not plug multiple electrical cords into a single outlet.
- Do not stand in water or on wet surfaces when operating power hand tools or portable electrical appliances.
- Do not use a power hand tool while wearing wet cotton gloves or wet leather gloves.
- Never operate electrical equipment while barefoot. Wear rubber-soled or insulated work boots.
- Do not operate a power hand tool or portable appliance that has a frayed, worn, cut, improperly spliced, or damaged power cord.
- Do not operate a power hand tool or portable appliance if a prong from the three-pronged power plug is missing or has been removed.
- Do not operate a power hand tool or portable appliance that has a two-pronged adapter or a two conductor extension cord.
- Do not operate a power hand tool or portable appliance while holding a part of the metal casing or while holding the extension cord in your hand. Hold all portable power tools by the plastic hand grips or other nonconductive areas designed for gripping purposes.

Power Saws

See *Safety Rules: Plumbing, Heating and Air Conditioning* (The State Auto Insurance Companies)

(https://www.stateauto.com/uploadedfiles/Content/Insurance/Products/Businesses/Risk_Control_Services/Risk_Control_Services_PDFs/Plumbing%20HVAC%20Rules.pdf).

- Wear the prescribed personal protective equipment such as goggles, gloves, dust masks, and hearing protection when operating the power saw.
- Turn the power switch of the saw to “off” before making measurements, adjustments, or repairs.
- Keep your hands away from the exposed blade.
- Operate the saw at full cutting speed, with a sharp blade, to prevent kickbacks.
- If the saw jams, turn the power switch of the saw to “off” before pulling out the incomplete cut.
- Do not alter the anti-kickback device or blade guard.

Small-engine Safety

- Ensure that the area in which the machine is being operated is free of spills, debris, and other obstructions or safety hazards, including other people who may be in the path of any debris from the machine.
- Ensure that the person operating the machine has had prior training and is not under the influence of alcohol or any drugs and is not smoking anywhere near the machine.
- Ensure that the person operating the machine is donning the correct PPE, including hand and foot protection and eye and ear protection.
- Guards/shields should be kept in place and not tampered with.
- Read the manufacturer’s manual for the following items:
 - Oil type, proper oil level, when oil needs to be added
 - Gasoline type
 - Ratio of oil to gasoline, if a combination is necessary
- Never fill the gas tank, touch the muffler, or put the machine in storage while the machine is hot.
- Clean up any spilled gasoline before starting the engine.
- Never start or run the engine in area without proper ventilation, in order to avoid carbon monoxide poisoning.
- Never perform maintenance, safety checks, or any other adjustments while the machine is plugged in. Always disconnect the machine before storing.

Pipe Threading Machine

Read and understand the operator’s manual.

Warning: Clothing/gloves can be caught in moving parts; fingers, hands, arms or other body parts can be crushed or broken.

- Use a footswitch.

- Do not wear gloves.
- Keep sleeves and jacket buttoned.
- Do not reach across the machine because clothing can be drawn into moving parts.
- Operate the machine from the switch side only.
- Do not disconnect or block footswitch.
- Keep the footswitch in working order.
- Make sure the switch is in the “off” position before plugging in the power cord.
- Make sure you can quickly remove your foot from the footswitch.
- The machine is made to thread and cut pipe or bolts. Other uses may increase the risk of injury.
- Secure the machine to a bench or stand to keep it from tipping over.
- Tighten the chuck hand wheel and engage the rear-centering device on the work before turning on the machine.
- Support long, heavy work from the floor with a pipe support to prevent tipping of machine.
- Use recommended accessories. Use of other accessories may increase the risk of injury.
- Check for broken or damaged parts before using a machine. Ensure that damaged guards or other machine parts are repaired or replaced by an authorized service center to ensure proper operation of the machine.
- Do not use the machine if any switches are broken.
- Keep covers in place. Do not operate the machine with covers removed.
- Use sharp cutting tools.
- Follow instructions for lubricating and changing accessories.
- Inspect the machine cord. Replace a damaged, frayed, broken or worn machine cord.
- Inspect extension cords. Repair or replace a damaged, frayed, broken or worn cor.
- Keep handles dry and clean. Keep free from oil and grease.
- When not being used, store the machine in a secured, locked area, out of reach of children and people unfamiliar with the threading machine.
- Lock footswitch when the machine is not in use, to avoid accidental starting.
- Wear snug-fitting clothes, safety shoes, hardhat, and safety glasses. Cover up or tie up long hair. Do not wear loose clothing, gloves, unbuttoned jackets, loose sleeve cuffs, neckties, rings, watches or other jewelry.
- Wear hearing protectors, earplugs or ear muffs if you use the machine daily or in a very noisy area.
- Operate the machine from the side with the REV/OFF/FOR switch.
- Keep good footing and balance. Do not overreach.
- Do not operate any machine when you are tired.
- Ground the machine. Use an approved three-conductor cord and three-prong grounding-type plug in a grounded receptacle. The green (or green and yellow) conductor in the cord is the grounding wire. Do not connect the green (or green and yellow) wire to a live terminal. If your unit is for use on less than 150 volts, it has a 120V plug. If it is for use on 150 to 250 volts, it has a 230V plug.
- Connect the machine to an AC power supply that matches the nameplate specifications. Do not use DC power.
- Use only three-wire extension cords, which have three-prong grounding plugs and three-pole receptacles, which accept the machine’s plug. Replace or repair damaged, frayed, broken or worn cords.
- When using an extension cord, be certain that the conductor size is large enough to prevent an excessive voltage drop, which will cause loss of power.
- When using an extension cord outdoors, use cords marked with the suffix "W-A II following the cord type designation. For example, SJTW-A II indicates that the cord is acceptable for outdoor use.
- Do not use a machine in damp or wet locations. Do not expose to rain.
- Unplug the power cord when adjusting, servicing or changing accessories.
- Keep children and visitors out of the work area. If visitors must be in an area, keep them far away from the machine and extension cord.
- Keep work areas clean, uncluttered and well-lighted.
- Keep floors dry and free of slippery materials.
- Clear the machine and bench of all objects, such as wrenches or tools, before turning the machine on.

Floor Jacks (Hydraulic)

- Make sure the jack makes secure contact with the frame of equipment.
- Be sure the contact point is strong enough to not be damaged or unstable.
- Always use jack stands to support equipment while performing repairs.
- Put all equipment back in its proper location.
- Be sure to clean area of oil, grease and dirt.

Knives/Sharp Instruments

- When handling knife blades and other cutting tools, direct sharp points and edges away from you.
- Cut in the direction away from your body.
- Use a knife that has been sharpened; do not use knives that have dull blades.
- Use knives for the operations for which they are named.
- Do not use knives that have broken or loose handles.
- Do not use knives as screwdrivers, pry bars, can openers or ice picks.
- Do not leave knives in sinks full of water.
- Do not pick up knives by their blades.
- Carry knives with their tips pointed toward the floor.
- Do not carry knives, scissors, or other sharp tools in your pockets or an apron unless they are first placed in their sheath or holder.
- Do not attempt to catch a falling knife.
- Store knives in knife blocks or in sheaths after using them.
- Follow this procedure for picking up any bags that have sharp objects protruding from them: Grab the top of the bag above the tie-off, using both hands, and hold the bag away from your body.
- Do not submerge hot glass in cold water or submerge cold glass in hot water.
- When opening cartons use the safety box cutters, do not cut with the blade extended beyond the guard.
- Do not use honing steels that do not have disc guards.

Files/Rasps

- Do not use a file as a pry bar, hammer, screwdriver or chisel.
- When using a file or a rasp, grasp the handle in one hand and the toe of the file in the other.
- Do not hammer on a file.

Chisels

- Use the chisel that has been sharpened; do not use a chisel that has a dull cutting edge.
- Do not use chisels that have “mushroomed” striking heads.
- Hold a chisel by using a tool holder, if possible.
- Clamp small workpieces in the vise and chip toward the stationary jaw when you are working with a chisel.

Hammers

- Use a claw hammer for pulling nails.
- Do not strike nails or other objects with the “cheek” of the hammer.
- Do not strike a hardened steel surface, such as a cold chisel, with a claw hammer.
- Do not strike one hammer against another hammer.
- Do not use a hammer if your hands are oily, greasy or wet.
- Do not use a hammer as a wedge or a pry bar, or for pulling large spikes.
- Use only the sledge type hammer on a striking face wrench.

Saws

- Keep control of saws by releasing downward pressure at the end of the stroke.
- Do not use an adjustable blade saw such as a hacksaw, coping saw, keyhole saw, or bow saw, if the blade is not taut.
- Do not use a saw that has dull saw blades.
- Oil saw blades after each use of the saw.
- Keep your hands and fingers away from the saw blade while you are using the saw.
- Do not carry a saw by the blade.
- When using the hand saw, hold the workpiece firmly against the work table.
- Use the circular saw, guard when using the circular saw.

Screwdrivers

- Always match the size and type of screwdriver blade to fit the head of the screw.
- Do not hold the workpiece against your body while using a screwdriver.
- Do not put your fingers near the blade of the screwdriver when tightening a screw.
- Use a drill, nail, or an awl to make a starting hole for screws.
- Do not force a screwdriver by using a hammer or pliers on it.
- Do not use a screwdriver as a punch, chisel, pry bar, or nail puller.
- When you are performing electrical work, use the screwdriver that has the blue handle; this screwdriver is insulated.
- Do not carry a screwdriver in your pocket.
- Do not use a screwdriver if your hands are wet, oily, or greasy.
- Do not use a screwdriver to test the charge of a battery.
- When using the spiral ratchet screwdriver, push down firmly and slowly.

Wrenches

- Do not use wrenches that are bent, cracked, or badly chipped or that have loose or broken handles.
- Do not slip a pipe over a single-head wrench handle for increased leverage.
- Do not use a shim to make a wrench fit.
- Use a split box wrench on flare nuts.
- Do not use a wrench that has broken or battered points.
- Use a hammer on striking-face wrenches.
- Discard any wrench that has spread, nicked, or battered jaws or if the handle is bent.
- Use box or socket wrenches on hexagon nuts and bolts as a first choice, and open-end wrenches as a second choice.

Pliers

- Do not use pliers as a wrench or a hammer.
- Do not attempt to force pliers by using a hammer on them.
- Do not slip a pipe over the handles of pliers to increase leverage.
- When you are performing electrical work, use the pliers that have the blue rubber sleeves covering the handle; these pliers are insulated.
- Do not use pliers that are cracked, broken or sprung.
- When using the diagonal cutting pliers, shield the loose pieces of cut material from flying into the air by using a cloth or your gloved hand.

Vises and Clamps

- When clamping a long workpiece in a vise, support the far end of the workpiece by using an adjustable pipe stand, saw horse, or box.
- Position the workpiece in the vise so that the entire face of the jaw supports the workpiece.
- Do not use a vise that has worn or broken jaw inserts, or has cracks or fractures in the body of the vise.
- Do not slip a pipe over the handle of a vise to gain extra leverage.
- Do not use the C-clamp for hoisting materials.
- Do not use the C-clamp as a permanent fastening device.

Metal Snips

- Wear your safety glasses or safety goggles when using snips to cut materials.
- Wear your work gloves when cutting materials with snips.
- Do not use straight cut snips to cut curves.
- Keep the blade aligned by tightening the nut and bolt on the snips.
- Do not use snips as a hammer, screwdriver, or pry bar.
- Use the locking clip on the snips after you have finished using them.

Bench Grinder

- Operate only after you have received instruction.
- Wear proper clothing.
- Wear a face shield, safety glasses, or goggles and use the glass safety guard on the grinder.
- Ensure that the guard is in place.
- Set tool rest one-sixteenth inch to one-eighth inch from the wheel.
- Dress the wheel when necessary.
- Make sure that no one but you is inside the operator's area.
- Adjust the grinder for your job before turning the power on.
- Stand to one side of wheel when turning the power on. The wheel may be cracked, causing it to break up.
- Turn on the power after permission is given.
- Keep your hands away from the wheel while it is in motion.
- Hold work with your hands. Ask permission to grind small pieces.
- Use the face of the wheel only.
- Press materials against the wheel with correct amount of pressure.

Horizontal Band Saw

- Operate only after you have received instruction.
- Remove jewelry, eliminate loose clothing, and confine long hair.
- Make sure all guards are in place and operating correctly.
- Always use proper eye protection.
- All adjustments to the chip-removal brushes, blade tension, guides, vise, or drive system should be done with the power off.
- Be sure blade guides are properly adjusted to both the blade and the work size or vise before starting cut.
- Adjust the feed rate so the blade does not bounce or plunge into the work when starting the cut.
- Be sure the work is tightly clamped in the vise and properly positioned for an efficient, safe cut.
- Keep your hands away from the cutting area and brush away chips only when the machine is turned off.
- If the material requires coolant, be sure that the system is working and that the correct coolant is used.

Portable Air Impact Wrench

- Operate only after you have received instruction.
- Remove jewelry, eliminate loose clothing, and confine long hair.
- Always use proper eye protection.
- Be sure throttle is in the “off” position before connecting the wrench to an air supply.
- Always use impact-type sockets designed for use with power equipment.
- Make sure work is secure or held with clamps or tightly in a vise.
- Set the torque control for the correct tightness before starting the job.
- Be sure both hands are free to properly operate an impact tool.
- Maintain balance and firm footing at all times.
- Always use the tool in short bursts of power.
- Quick-change coupling should be at end of hose whip, not at the tool.
- Always disconnect the tool when not in actual use.

Portable Disc Sander/Grinder

- Operate only after you have received instruction.
- Wear proper clothing. Remove jewelry, eliminate loose clothing, and confine long hair.
- Make sure all guards are in place and operating properly.
- Wear a face shield and safety glasses. Use hearing protection.
- Inspect the cord for damage. Repair or replace damaged cords before use.
- Do not abuse the cord. Never carry the tool by its cord or yank the cord to disconnect the tool from the receptacle. Keep the cord away from heat, oil and sharp edges.
- Before connecting the tool to a power source, be sure the tool’s switch is in the “off” position.
- Make sure the backup pad and disc are securely fastened to the tool. Unplug the sander when changing discs.
- Do not allow the edge of the disc to touch the edge of the stock.
- Stand clear of the spark line or spark area. Sparks are hot.
- Sand or finish with a stroking motion; do not pause in one spot.
- Allow the tool to stop before sitting down the tool. Set the sander on its back or on a rubber stand when not in use and disconnect from power source.

Portable Electric Drill

- Operate only after you have received instruction.
- Wear proper clothing. Remove jewelry, eliminate loose clothing, and confine long hair.
- Always use proper eye protection.
- Inspect the cord for damage. Repair or replace damaged cords before use.
- Do not abuse the cord. Never carry the tool by its cord or yank the cord to disconnect the tool from the receptacle. Keep the cord away from heat, oil and sharp edges.
- Unplug the drill when changing bits.
- Make sure the switch is off and the chuck key is removed before connecting to a power source.
- Mark the hole location with a center punch (metal) or awl (wood) before drilling.
- Be sure work is tightly clamped or otherwise secure before drilling.
- Drill with straight, even, steady pressure.

Oxygen-Acetylene Welder

- Operate only after you have received instruction.
- Wear proper clothing and protective equipment. Remove jewelry, eliminate loose clothing, and confine long hair.
- Be sure that you wear welding goggles. All assistants and observers must also wear welding goggles.
- Close the cylinder valve and replace the protective cover before moving the cylinder.

- Fasten cylinders with a chain or other suitable device as a protection against falling or rolling.
- Keep welding equipment free of oil and grease. Use only clean rags for wiping off welding equipment.
- Inspect the hose before using.
- Make sure that the hose is connected and that all connections are tight.
- Report any leaking of cylinders or connections to an instructor/supervisor immediately.
- Make sure you have ample ventilation.
- Keep all flammable material away from the working area.
- Release the regulator pressure screw. Open the cylinder valves gradually.
- Open the acetylene cylinder valve one turn or less. Keep the wrench in place so that the valve may be shut off quickly, if necessary.
- Keep acetylene pressure in the hose below 15 pounds per square inch.
- Use a flint lighter to ignite the torch.
- Close the acetylene valve first if the torch backfires.
- Make certain a lighted torch always points away from you and other students.
- Keep sparks and flame away from cylinders.
- Close the cylinder valve when you have finished your welding job.
- Quench the section of metal that has been welded or mark with chalk or soapstone the word “hot” on the metal if it is necessary for you to leave your work.

Electric Welder

- Operate only after you have received instruction.
- Wear proper clothing to protect from arc burns. Remove jewelry, eliminate loose clothing, and confine long hair.
- Wear a hood with a proper observation window, treated gauntlet gloves, and treated leather apron. All assistants and observers must also wear this equipment.
- Rubber-soled shoes, without tacks, should be worn when electric welding.
- The electric welder operator is to allow no one to look at the arc without the dark shield (No. 10-12 lens).
- Make sure electric welding is done only in a correctly constructed booth or room, or behind proper screens.
- Make sure there is ample ventilation.
- Keep all flammable material away from the working area.
- See that the floor area is clear of all obstructions.
- Report to the instructor/supervisor at once if the electrode holder, holder cable connection, cable, or cable terminals at the welding machine, ground clamps, lugs, or cable get hot.
- While removing scale from the work, wear ordinary safety glasses or goggles.
- Have a dry-chemical fire extinguisher available when electric welding.
- Hang up the electrode holder and turn off the welder when work is being changed or when work has been completed.

GMAW (MIG) and GTAW (TIG) Welder

- Operate only after you have received instruction.
- Wear proper clothing to protect from arc burns. Remove jewelry, eliminate loose clothing, and confine long hair.
- Make sure all guards are in place and operating correctly.
- Always use proper eye protection.
- Always buff using the lower half of the buffing wheel.
- Additional protective welding clothing, including a helmet, long-sleeve jacket, and gloves, must be worn to prevent burns from ultraviolet and infrared rays emitted while arc welding.
- The helmet used for GTAW should be equipped with a minimum No. 12-density shade.
- Be certain that a welder equipped with a high-frequency stabilizing unit is installed, maintained, and used according to the recommendations of the manufacturer and Federal Communication Commission.
- Never touch the tungsten electrode or wire electrode while the welder is turned on. It is electrically “hot” and can cause a serious shock.
- Never use the high frequency when performing shield metal arc (stick electrode) welding.

Spot Welder

- Always wear a protective face shield in addition to proper eye protection.
- Do not weld with wet hands or in a damp area.
- Do not touch the tips, tongs, or welded material after welding, because as they become very hot.
- Never leave the spot welder unattended with the electrical cord plugged in.
- The metal being spot-welded must be clean and dry.
- When spot welding galvanized material, remove the galvanize from the area being welded. Avoid the fumes.
- Check and adjust the timer for the correct duration before starting the welder.

Plasma Cutter

Read and understand the operator's manual.

- To activate the plasma arc cutter, make sure the air pressure is around 70 psi for most plasma arc cutter units and the ground clamp is attached to the work piece.
- Turn the plasma arc cutter on and adjust the amperage the manufacturer's specifications for the thickness of metal to be cut.
- Position the shielding cup over the metal, press the igniter button, and allow the arc to become established. Next, move the arc over the cut line and make the cut.
- The thicker the metal, the slower the travel speed must be to get a good cut, and vice versa. The quality of the cut usually decreases as the metal thickness increases and the travel speed decreases.
- A guide bar may be used to help achieve good, straight cuts.
- The shielding cup and constricting nozzle should be held approximately one-eighth inch to one-quarter inch above the metal being cut. The operator should avoid dragging the constricting nozzle and shielding cup on the metal when making the cut unless they are specifically designed to touch the base metal while cutting.
- Always make cuts on the waste side of the cut line.
- Avoid cutting with the plasma arc cutter in damp or wet locations. The hazards of electrical shock greatly increased.
- If plasma arc cutting over an open barrel with a grate, be aware that the fume plume will be directed back toward the operator. Avoid this condition if at all possible, otherwise limit the exposure to fumes to short duration's.
- Cuts with the plasma arc cutter may be made by moving forward, backward, or sideways. Determine which direction is easiest for you and use that procedure as often as possible.
- Always move the plasma arc cutter (PAC) as fast as possible when making a cut. This increases time efficiency, improves the cut quality, and reduces the buildup of dross.
- Compressed air used in plasma arc cutter should be dry or the cutter will not yield a quality cut or it not cut at all. An auxiliary air filter may be place in the compressed air line to condition the air for a plasma arc cutter.
- Always turn the plasma arc cutter off before laying the torch down and leaving the work area.
- If the quality of the cut deteriorates to an unacceptable level the constricting nozzle, the electrode, or both may need to be changed. The electrode on most plasma arc cutters will have a life of about twice the life of the constriction nozzle. Keep a supply of constricting nozzles and electrodes on hand, because they deteriorate quickly during continuous use. Turn the plasma arc cutter off to put on replacement parts.
- Keep the plasma arc cutter torch leads and ground lead stored so they will not be cut or damaged when not in use.

Plasma Arc Cutter

- Wear protective clothing when using the plasma arc cutter. Clothing should be wool or cotton, long sleeves, leather shoes (high top), gauntlet gloves, and leather apron.
- Never wear synthetic clothing when using the plasma arc cutter. Many synthetics are highly flammable.
- Always wear industrial-quality eye protection. A No. 5 shaded lens is the minimum for the plasma arc cutter process. The shaded lens needed to adequately protect the eyes varies by the thickness of the

metal being cut and the intensity of the arc required to make the cut. Follow the manufacturer's recommendation for selecting an appropriate shaded lens for given plasma arc cut.

- Make sure that work area is well ventilated when using the plasma arc cutter. The plasma arc cutter process generates lots of fumes and therefore must be well ventilated.
- The operator should position himself/herself so there will be minimum exposure to fumes during the cutting process.
- Fumes from the following metals can be toxic:
 - Antimony
 - Arsenic
 - Barium
 - Beryllium
 - Cadmium
 - Chromium
 - Cobalt
 - Copper
 - Lead
 - Manganese
 - Mercury
 - Nickel
 - Selenium
 - Silver
 - Vanadium
- Use a cutting table which has a downdraft to capture fumes. A cutting table with water filtration is also recommended for plasma arc cutting.
- Never use the plasma arc cutter in areas where combustible or explosive gases or materials are located.
- Chlorinated solvents and cleaner vapors in the presence of plasma arc cutter generates toxic phosgene gas. Avoid plasma arc cutting use in areas which house chlorinated solvents and cleaners.
- Never touch any parts on the plasma arc cutter that are electrically connected. The plasma arc cutter uses high amperage and produces high voltage which can cause severe or fatal electrical shock.
- Disconnect the electrical power before performing any service or repair on the plasma arc cutter.
- Do not use the plasma arc cutter to cut on containers that have held combustible materials.
- Hydrogen gas may be formed and trapped when cutting aluminum in the presence of water. Trapped hydrogen gas in the presence of an arc will ignite and explode; make sure fumes are well-ventilated when cutting aluminum.
- Hearing protection should be worn when operating the plasma arc cutter.
- Make sure that others in the work area are protected from the plasma arc cutter arc rays and fumes.
- Use pliers or tongs to handle hot metals cut by the plasma arc cutter. Cool and store hot metal before leaving the work area.

Metal Cutoff Saw

- Operate only after you have received instruction.
- Wear proper clothing. Remove jewelry, eliminate loose clothing, and confine long hair.
- Make sure the stock is tightly clamped in place before starting your cut. If it isn't, the blade will grab it and roll it around.
- Keep your hands clear of the path of the blade at all times. Some of these saws cut automatically; on others, you control the cut. In either case, keep your hands clear and out of danger.
- Do not force the cut. There is often a temptation to speed things up by pushing on the saw, but this could overload the machine or damage the blade.
- Although these saws cut automatically, you should always watch the cut as it proceeds. The blade could twist or jam, the stock could twist free, or the saw could fail to stop when it should. Be there.
- Take care in handling fresh-cut pieces of metal; they could be sharp and hot. Cool and deburr them right away.

- If metal chips or filings build up in the saw, turn it off and clean it with a brush. Never use your hand. Metal splinters that penetrate the skin can be painful.
- Wear eye and hearing protection.
- Wear appropriate gloves when handling the stock.

Table Saw

- Operate only after you have received instruction.
- Wear proper clothing. Remove jewelry, eliminate loose clothing, and confine long hair.
- Wear safety goggles or glasses.
- Make sure saw guards are in place and operative. Guards must be kept down over the saw while machine is being operated.
- The saw must not be raised above the table *more* than absolutely necessary to make the cut, approximately one-eighth inch.
- A push stick must be used when ripping narrow pieces of lumber.
- The clearance block must be fastened to fence when cutting off short pieces of stock.
- The fence must not be adjusted until the saw is at a dead stop.
- Sawdust underfoot is slippery; keep the floor around saw area clean.
- Use a brush to keep the table clear of scraps; never use the hands.
- Fingers must be kept clear of track of saw, and hands must never be allowed to cross the saw line in advance of the end of the board while machine is in operation.
- Reaching over the saw blade or passing wood over the saw blade is prohibited.
- All special setups and dado heads must be inspected by the instructor/supervisor before the power is turned on.
- The dado head must be taken off the saw arbor after use.
- When helping to tail off the saw, students must never pull on a board being ripped. They should hold board up and allow operator to push stock through saw.
- Re-sawing must not be done on a circular saw without special permission of the instructor/supervisor.
- Cylindrical stock must not be cut on a circular saw.
- Never lower pieces of stock down over the saw. This operation is sometimes performed when cutting holes in rails for drawer fronts. Special permission should be obtained from the instructor/supervisor for doing this type of work.
- Ripping stock without using the ripping fence or cross-cutting stock without using the sliding cross-cutting fence is extremely dangerous and is absolutely forbidden. This rule applies to dado head work.
- See that no fence or setup will be in line of saw before starting work or turning on power.
- Be sure that the saw or tilting arbor saw will clear on both sides when sawing angles before the power is turned on.
- Never stand directly behind the blade; stay to the left.
- Only the operator turns the machine on and off.
- Only the operator should be in the safety area of the saw.

Band Saw

- Operate only after you have received instruction.
- Wear proper clothing. Remove jewelry, eliminate loose clothing, and confine long hair.
- Wear safety goggles or glasses.
- Always keep guards in place. Both upper and lower wheels, as well as most of the blade itself, must be guarded.
- Adjust the guard to about one-quarter inch above the thickness of the stock.
- The upper and lower guides must be properly adjusted when the machine is stopped, so that there will be a minimum of blade breakage.
- A clicking or cracked blade should be stopped immediately.
- The saw must be allowed to stop itself naturally in order that the blade may not be damaged.
- Plan your cuts carefully; lay out and make release cuts before cutting long curves.

- If the stock binds or pinches the blade, do not attempt to back out until power has been shut off and the machine is at a dead stop.
- The proper blade width for the diameter of work being cut must be used. Avoid cutting a radius too small for the blade width and pinching the blade.

Blade width (inches)	1/8	3/16	1/4	3/8	1/2	3/4	1
Cut radius (inches)	3/16	5/16	5/8	1 1/2	2 1/2	5 1/2	7

- The right side of the machine is generally the most dangerous place to stand in case of blade breakage.
- Proper blade tension must be maintained.
- The blade must be sharp and properly set at all times.
- Remove scrap material from the saw table with a stick or brush.
- If the blade breaks, shut off the power and stand clear until machine is at a dead stop.
- Make cuts always under power, never while the machine is coasting.
- Leave the machine only after the power is turned off and the blade has stopped moving. This is especially important with a band saw.

Jig/Scroll Saw

- Operate only after you have received instruction.
- Wear proper clothing. Remove jewelry, eliminate loose clothing, and confine long hair.
- Wear face shield, safety glasses, or goggles.
- Cut only stock with a flat surface on bottom.
- Make adjustments only when the machine is at a dead stop.
- Install saw blades to cut on the downstroke.
- Tighten the blade securely in the lower vise, then in the upper vise. Check the blade for the correct tension.
- Make sure the saw blade is the proper size for the job.
- Adjust the hold-down so it will be as close as possible to the work.
- Turn the machine by hand to make sure all parts are clear.
- Make sure that no one but you is inside the operator's line.
- Select the correct machine speed for the material and blade type.
- Lower the hold-down foot to press lightly on the surface of the wood.
- Turn on the power after permission is given.
- Hold material firmly.
- Feed the material into the machine at a moderate rate of speed.
- Keep fingers away from saw and hands out of the path of saw.
- Report mechanical defects or a broken blade to the instructor/supervisor.
- Turn off power after using the scroll saw and stand by until the machine has stopped.
- Clear away scraps of wood on the table only after saw stops running.

Radial Arm Saw

- Operate only after you have received instruction.
- Wear proper clothing while operating the machine. Remove jewelry, eliminate loose clothing, and confine long hair.
- Wear safety goggles or glasses.
- Always keep guards in place.
- Before starting the machine, all clamping devices should be tight.
- The saw must be kept well sharpened.
- Be sure the saw swings clear and free.
- Place the stock snugly against the backstop and flat on the table.
- Operate the saw with your left hand; never reach across your body to operate the saw.
- Set the anti-kickback device one-eighth inch above the material to be cut.
- While ripping, the rip lock should be tight.
- Two people are necessary while ripping.

- While ripping, be sure to feed the material from the infeed end of the saw guard, never from the kickback end. Make no exception to this rule.
- Before making any special adjustment, the saw must be fully stopped.
- Before starting the motor, make sure everything is clear of the cutter.
- Remove scraps from the path of the radial-saw blade with a piece of wood while the saw is at a dead stop.
- Stand to one side and keep your hands away from the direction of travel of the radial-saw blade.
- A radial arm saw is used primarily for crosscutting stock. Use a table saw for ripping, when possible.

Drill Press

- Eye protection must be worn at all times.
- Restrain loose clothing and hair. Remove hand jewelry.
- Select an appropriate speed for the bit and material (see chart below), fast for small holes, slow for large ones. Too slow is better than too fast. Be sure to replace guards if removed for a speed change.
- Tighten the bit and remove the chuck key.
- Clamp the material to the table, when possible. All small work must be secured. Be cautious when drilling thin stock like sheet metal.
- Use cutting oil when drilling metal.
- If the material becomes caught by the bit, step back and turn off the machine. Do not reach for the stock if the stock is spinning with the drill.

Materials	SFM* Range		Drill Diameter			
			1/4"	1/2"	1"	1½"
Aluminum and its Alloys	200	300	3,820	1,910	955	637
Brass and Bronze (Ordinary)	150	300	2,292	1,146	573	382
Bronze (High Tensile)	70	150	1,070	535	267	178
Die Castings (Zinc Base)	300	400	4,584	2,292	1,146	764
Iron-Cast (Soft)	100	150	1,528	764	382	255
Cast (Medium hard)	70	100	1,070	535	267	178
Hard Chilled	30	40	458	229	115	76
Malleable	80	90	1,222	611	306	204
Magnesium and its Alloys	250	400	3,820	1,910	955	637
Monel Metal or High-Nickel Steel	30	50	458	229	115	76
Plastics or Similar Materials (Bakelite)	100	300	1,528	764	382	255
Steel - Mild (.2 carbon to .3 carbon)	80	110	1,222	611	306	204
Steel (.4 carbon to .5 carbon)	70	80	1,070	535	267	178
Tool (1.2 carbon)	50	60	764	382	191	127
Forgings	40	50	611	306	153	102
Alloy - 300 to 400 Brinell	20	30	306	153	76	51
High Tensile (Heat Treated)						
35 to 40 Rockwell C	30	40	458	229	115	76
40 to 45 Rockwell C	25	35	382	191	96	64
45 to 50 Rockwell C	15	25	229	115	57	38

Materials	SFM* Range		Drill Diameter			
			1/4"	1/2"	1"	1½"
50 to 55 Rockwell C	7	15	107	53	27	18
Stainless Steel						
Free Machining Grades	30	80	458	229	115	76
Work Hardening Grades	15	50	229	115	57	38
Wood (soft)	300	400	4,584	2,292	1,146	764

*SFM = surface feet per minute

**Based on RPM = SFM*3.82/diameter

Planer/Surfacer

- Operate only after you have received instruction.
- Wear proper clothing while operating the machine. Remove jewelry, eliminate loose clothing, and confine long hair.
- Wear safety glasses or goggles.
- Make sure guards are in place and operative.
- Do not plane two or more pieces of stock with various thicknesses. The stock could be kicked out. Plane only one thickness at a time. (Note: Some planers have sectional feed rollers, which could allow planing various thicknesses. Instructors/supervisors, make the appropriate decision.)
- Keep your fingers from under the stock as it is fed through the planer.
- Stock must be at least 15 inches long or greater than the distance between the centers of infeed and outfeed rollers. True one face of the stock on the jointer before planing.
- Always make sure the machine is turned off before leaving.
- Make sure no one is behind the machine while it is operating.
- Always stand erect and to one side of work being planed.
- Do not look into the planer as the board passes through.
- Plane no thickness less than three-eighths inch.
- Stock that is 8 inches in width or less should not be planed more than one-sixteenth inch per cut.
- Stop the planer and run all pieces through, reducing all to the same thickness.
- With a rule, measure the thickness of the stock at the thickest point.
- Place the stock on the bed of the planer with the working face down and the grain turned so that the knives will cut with the grain. Hold the board flat on the feed-in table when starting the cut. The knives on a single-surface planer cut on the upper side and revolve in a direction opposite to the direction of feed.
- Never attempt to plane cross-grain.

Jointer

- Operate only after you have received instruction.
- Wear proper clothing while operating the machine. Remove jewelry, eliminate loose clothing, and confine long hair.
- Wear safety glasses or goggles.
- Make sure the guard is in place and operating freely.
- Always check the depth of cut before starting the machine.
- Joint no thickness greater than one-quarter inch.
- Keep your fingers well away from the cutter head and never placed on the stock above the cutter head.
- Stock must be at least 18 inches long.
- Always use a push stick to push the end of the stock across the cutter head.
- Always make sure the machine is turned off before leaving.
- Make sure everyone is from behind machine while it is operating.

- Always stand erect and to one side of work being jointed.
- Never attempt to joint cross-grain.

Wood Lathe

- Operate only with the instructor's/supervisor's permission and after you have received instruction.
- Remove jewelry, eliminate loose clothing, and confine long hair.
- Make sure all guards are in place and operating correctly.
- Always use proper eye protection.
- The tool rest must be close to the work when cutting tools are being used.
- The cutting tools must be kept sharp.
- Do not feel for smoothness of work while machine is running.
- Work must be centered, balanced, and secured.
- The tool rest must be removed while sanding.
- Examine set up and turn work by hand before turning on the power.
- Shut off the power while cleaning the machine.

Power Miter Saw

- Operate only after you have received instruction.
- Wear proper clothing while operating the machine. Remove jewelry, eliminate loose clothing, and confine long hair.
- Wear a face shield, goggles, or safety glasses.
- Make sure all guards are in place and are operating properly.
- Be sure the power is disconnected before making angle adjustments or changing blades.
- Always hold the work firmly against the fence and table.
- Never reach across your body to operate the saw.
- Allow the motor to reach full speed before starting to cut.
- Apply smooth, steady pressure to the motor when cutting.
- Lock the slide (if equipped) when not in use. When using the slide, start your cut at the front of the work and push the saw into the work.
- Use the brake to stop the blade before removing scraps or chips from the work area.

Portable Jig Saw

- Operate only after you have received instruction.
- Wear proper clothing while operating the machine. Remove jewelry, eliminate loose clothing, and confine long hair.
- Always use proper eye protection.
- Inspect the cord for damage. Repair or replace damaged cords before use.
- Do not abuse the cord. Never carry the tool by its cord or yank the cord to disconnect the tool from the receptacle. Keep the cord away from heat, oil, and sharp edges.
- Make sure all guards are in place and are operating correctly.
- Make sure the blade is the correct type for the material and that it is tightly clamped in the chuck.
- Be sure the switch is off before connecting to the power source.
- Use vises or clamps to securely hold the material to be cut.
- Keep cutting pressure constant; do not force the blade into the work.
- Always keep the base tightly against the materials being cut.
- Do not set the saw down on the bench until it has stopped.
- If the blade is in the tool, be sure to lay the tool on its side.

Circular Saw

- Operate only after you have received instruction.
- Wear proper clothing. Remove jewelry, eliminate loose clothing, and confine long hair.
- Make sure all guards are in place and operating properly.
- Wear a face shield, goggles, or safety glasses.
- Inspect the cord for damage. Repair or replace damaged cords before use.
- Do not abuse the cord. Never carry the tool by its cord or yank the cord to disconnect the tool from the receptacle. Keep the cord away from heat, oil and sharp edges.
- Make sure the telescoping guard returns automatically to cover the blade after each cut. Test before operation.
- Check the base setting for the proper depth of cut.
- Make sure the power cord is clear of the blade.
- Make sure your hands are away from the blade before starting. Do not support material with your leg or foot.
- Be sure the material you are cutting is adequately supported.
- Start the saw away from the work. Do not start the cut until the blade has reached full speed.
- Advance the saw slowly, straight through the work. Do not twist or turn.
- If the saw blade binds or smokes, stop cutting immediately.
- The blade should be extended below the work until the blade gullets clear the material.
- Do not set the saw down until the blade stops.

Woodworker's Vise

- Keep the vise tight on the bench. A loose vise is inefficient.
- Keep your work clean. Never oil or grease a woodworker's vise.
- Do not overtighten.
- Normal handle leverage holds jaws securely. Do not hammer the handle. Never pound to tighten or loosen. Do not use a handle extension.
- Avoid using a woodworker's vise to clamp glue joints. Dried glue on a vise screw, etc., makes vise operation difficult.
- Do not use the vice to hold metal objects.

Router

Read and understand the operator's manual.

- Wear safety glasses or goggles, or a face shield (with safety glasses or goggles), and appropriate hearing protection.
- Disconnect the power supply before making any adjustments or changing bits. Inspect bits carefully before installing
- Inspect the cord for damage. Repair or replace damaged cords before use.
- Do not abuse the cord. Never carry the tool by its cord or yank the cord to disconnect the tool from the receptacle. Keep the cord away from heat, oil and sharp edges.
- Ensure that the bit is securely mounted in the chuck and the base is tight.
- Put the base of the router on the work, template or guide. Make sure that the bit can rotate freely before switching on the motor.
- Secure the stock you are working on. Never rely on yourself or a second person to support or hold the material. Sudden torque or kickback from the router can cause damage and injury.
- Before using a router, check the stock thoroughly for staples, nails, screws, or other foreign objects.
- Keep all cords clear of the cutting area.
- Keep both hands on the router handles always, until the motor has stopped. Do not set the router down until the exposed router bit has stopped turning.
- Do not overreach. Keep proper footing and balance.
- When inside routing, start the motor with the bit above the stock. When the router reaches full power, lower the bit to the required depth.

- When routing outside edges, guide the router counter-clockwise around the work.
- When routing bevels, moldings and other edge work, make sure the router bit is in contact with the stock to the left of a starting point and is pointed in the correct cutting direction.
- Feed the router bit into the material at a firm, controlled speed.
- With softwood, you can sometimes move the router as fast as it can go.
- With hardwood, knotty and twisted wood, or with larger bits, cutting may be slow.
- The sound of the motor can indicate safe cutting speeds. When the router is fed into the material too slowly, the motor makes a high-pitched whine. When the router is pushed too hard, the motor makes a low growling noise.
- When the type of wood or size of the bit requires going slow, make two or more passes to prevent the router from burning out or kicking back.
- To decide the depth of cut and how many passes to make, test the router on scrap lumber similar to the work.

Palm Sander

- Do not sand paints that contain lead.
- Use safety glasses and a dust mask to avoid breathing any dust.
- Wear proper clothing while operating the machine. Remove jewelry, eliminate loose clothing, and confine long hair.
- Disconnect the plug from the power source before making any adjustments, changing accessories, or storing the sander
- *Do not* wet sand with the sander. Liquids may enter the motor housing and cause electric shock.
- *Do not use* torn sandpaper. Damage to the rubber backing pad may occur.

Belt Sander

- Do not sand paints that contain lead.
- Use safety glasses and a dust mask to avoid breathing any dust.
- Wear proper clothing while operating the machine. Remove jewelry, eliminate loose clothing, and confine long hair.
- Inspect the cord for damage. Repair or replace damaged cords before use.
- Do not abuse the cord. Never carry the tool by its cord or yank the cord to disconnect the tool from the receptacle. Keep the cord away from heat, oil and sharp edges.
- Disconnect the plug from the power source before making any adjustments, changing accessories, or storing the sander
- Be sure that the sander is turned off before starting. Start the sander only when over the work.
- Hold securely when starting the sander, because it will pull away from the operator.
- Keep the cord clear of the sander.
- When operating the sander, check that the belt remains centered and tracking smoothly on the rollers. Adjust as necessary.
- Always keep the sander moving back and forth over the work.
- Be sure the sander is at a complete stop before setting on the workbench.

Pneumatic Nail Gun

Read and understand the operator's manual.

- Always wear safety glasses.
- Do not touch the trigger unless firing the tool against a work piece.
- Use extreme caution when using an air tool around other students.
- Never point the tool at anyone. Treat the tool like a firearm and assume it is loaded.
- Never load the gun while it is connected to a compressor.
- Disconnect the air hose before clearing a jam or making adjustments.
- Use manufacturer's specified pressures for the tool.

- Keep your free hand safely out of the way of the tool.
- Always know what type of trigger mode the nail gun is equipped with.
- Secure the hose when working on scaffolding to prevent the weight of the hose from dragging the tool off the scaffold if you set the tool down.

Ricochet accidents can occur if you nail into another nail, the surface is too hard, or the tool is at an angle. Work with a nail gun only from a sturdy and stable surface. Do not press your finger on the trigger unless you are ready to fire, especially when climbing ladders.

Sequential mode and bump mode are the two basic trigger mechanisms used in pneumatic nailers and staplers. It is important to understand the differences between the two triggers in order to prevent injuries.

In the sequential mode, also known as a restrictive trigger or operating in the trigger fire mode, you must first press the nail gun firmly against the workpiece and then press the trigger. One nail is fired and you must release the trigger before you can begin the next nailing cycle.

In the bump mode trigger, also known as dual action, bottom fire, or contact trip, you must press the trigger before you bring the nail gun into contact with the workpiece. Each time you press the nailer against the workpiece, a nail is fired and a nailing cycle begins. You must keep the trigger pulled while moving the tool along the work surface with a bouncing motion, depressing the safety element where you want to drive a nail or staple. By repeatedly “bumping” the nail gun against the workpiece, you can rapidly fire any number of nails.

To find out whether your nail gun is a sequential trigger or bump trigger model:

- Fire a nail as usual and keep the trigger depressed.
- Lift the nail gun and carefully press its nose against the work surface again. If the gun fires a second nail, you have a bump trigger model.
- If the gun does not fire, you have the sequential trigger model.

Gas-powered Concrete Mixer

- Transport and handle fuel only when it is contained in an approved safety container.
- Do not smoke when refueling or during any other fuel-handling operation.
- Do not refuel while the engine is running or while it is still hot.
- If fuel is spilled during refueling, wipe it off of the engine immediately and discard the rag in a safe place.
- Do not operate the equipment if fuel or oil leaks exist—repair immediately.
- Never operate this equipment in an explosive atmosphere.
- Avoid contact with hot exhaust systems and engines.
- Allow all components in the engine compartment to cool before performing any service work.
- Never leave the mixer unattended while it is running.
- Mix only concrete.
- Never perform any work on the mixer while it is running.
- Before working on the mixer, stop the engine and disconnect the spark plug wire(s) to prevent accidental starting. On electric models, disconnect the electric cord at the mixer.
- Keep the cowl closed and latched during operation; close and latch the cowl immediately after starting.
- Keep hands, clothing and jewelry away from all moving parts.
- Keep all guards in place, including drum guards.
- Never place your hands or any solid object into the drum while the mixer is operating.
- Starting fluid (ether) is highly flammable; do not use or an explosion or fire may result.
- Never operate a unit in a poorly ventilated or enclosed area.
- Avoid prolonged breathing of exhaust gases.
- Engine exhaust fumes can cause sickness or death.
- Wear close-fitting clothing and safety equipment appropriate to the job.
- Prolonged exposure to loud noise can cause impairment or loss of hearing.

- Wear a suitable hearing protective device, such as earmuffs or earplugs, to protect against objectionable or uncomfortable loud noises.
- Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.
- Keep a first aid kit and fire extinguisher handy.
- Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.
- Always wear splash goggles when operating a mixer.
- Warning: Do not tow the mixer with the drum in the dump position. The mixer may become unstable and tip over when hitting a curb, pothole, or other obstruction.
- Warning: Always properly attach safety chains before the mixer is towed. The maximum towing speed is 55 mph (90 kmh). Reduce speed according to highway conditions.
- Use safety chains and hitch pins with a safety pin.
- Understand the service procedure before doing work. Keep your work area clean and dry.
- Never lubricate, service, or adjust the machine while it is moving. Keep hands, feet, and clothing from power-driven parts. Disengage all power and operate controls to relieve pressure. Lower equipment to the ground. Stop the engine. Remove the key. Allow the machine to cool.
- Securely support any machine elements that must be raised for service work.
- Keep all parts in good condition and properly installed. Repair damage immediately. Replace worn or broken parts. Remove any buildup of grease, oil, or debris.
- Disconnect battery ground cable (negative) before making adjustments on electrical systems or welding on machine.

Foot (Squaring) Shear

- Obtain permission from your teacher before using the shear.
- See that guards are in place.
- Follow manufacturer's specifications as to the gauge of sheet metal that can be safely cut.
- Cut narrow strips of metal crosswise only.
- Make sure that no one but you is inside the operator's zone.
- Stand directly in front of the machine.
- Feed pieces of metal into shear from the front (operator's position).
- Keep your fingers away from the clamp and blade.
- Hold the stock securely against the guide.
- Make sure the foot that is not being used to operate the treadle is clear before pushing down on the treadle.
- Regulate pressure on the treadle according to gauge and type of stock. Keep your foot on the treadle to ease its return to the normal position.
- Allow small pieces of metal being cut to drop to the floor or into a container.
- Use care when picking up trimmings.

Hydraulic Shear (Ironworker)

- **Shearing**
 - Pre-operation
 - Read and understand the operational manual before using the machine.
 - Wear safety glasses.
 - Shear only mild steel. The machine is designed to handle SAE-1020 steel. This is a grade of steel, not a thickness.
 - Keep the punch section clear.
 - Stay within rated shearing capacities. The ironworker is designed to shear mild steel.
 - Operation
 - Turn on the motor switch.
 - Place the material to be cut between the shear blades.
 - Check that the area below the foot pedal is clear.

- Always keep the guard in place and adjusted for minimum clearance.
- Move hands away from shear blade. Make the shear stroke by depressing the foot pedal.
- At the conclusion of the stroke, remove the foot from the pedal and the machine will return and stop in readiness for the next stroke.
- **Punching**
 - Pre-operation
 - Read and understand the instruction manual before operating the ironworker.
 - Wear safety glasses.
 - Keep the shear section clear.
 - Check the punch-securing nut, die, stripper and die at the start of each shift and periodically throughout the day for tightness.
 - Check the punch and die for alignment before punching the first hole and intermittently during the day.
 - Do not punch anything thicker than one punch diameter. Remember that the higher the grade of steel, the more punch power is required.
 - Punch full and complete holes; do not punch partial holes. The side thrust encountered in punching a partial hole can force the punch against the die and result in punch or die breakage.
 - Before operating the ironworker, remove all tools or other objects from under the beam and punch ram. Failure to do so could result in danger to other personnel and to tools.
 - Stay within rated punching capacities. The ironworker is designed to punch mild steel.
 - Operation
 - Turn on the motor switch.
 - Place the material to be punched beneath the punch.
 - Check that the area below the foot pedal is clear.
 - Move hands away from the punch area. There is no need to hold the material being punched.
 - Depress the foot pedal.
 - At the conclusion of the stroke, the foot should be removed from the pedal and the machine will return and stop in readiness for the next stroke.

Cornice Brake

There are many types of brakes available to use when working with sheet metal. The cornice brake is the most commonly used. Safety is important when it is time to use the brake.

- Do not place your hand in the cornice brake when someone else is operating the handle.
- Make sure when going to use the brake that no one else is near the counterbalance balls so they will not be hit by them.
- If you are standing in front of the brake, stand back so that you will not be struck by the handles that project from the leaf when it is swung up.
- Never bend rod or wire on any sheet metal brake. This will damage the blade and the bending leaf.
- Never pound on a brake with any type of steel hammer. Always use a wooden mallet.