

MONTANA STATE UNIVERSITY SCHOOL OF ARCHITECTURE

METAL SHOP SAFETY MANUAL



• Craft Shop Manager Bill Clinton • wclinton@montana.edu • 994-4402 •

Policies and Procedures

1. Eye Protection

- Eye protection must be worn at all times in the shop facilities.
- Failure to wear eye protection may result in loss of shop privileges.

2. Shop Orientation and Safety Requirements

- Shop orientation and Successful completion of the safety course precludes any shop use.
- Demonstration of proficiency of select pieces of shop equipment also precludes shop use.
- Shop users must sign and date a copy of the Shop Users Safety Agreement form.
- Individuals must receive additional instruction for machines not included in the standard orientation.

3. Injury-Causing Accidents

In the event of an injury-causing accident, the following procedures must be followed:

- Notify the shop supervisor immediately! Shop personnel will follow established procedures.
- All personal injury accidents require a meeting between the injured person and the shop manager before shop privileges will resume. The purpose is to determine the cause of the accident for the prevention of future accidents.

4. Non-injury Accidents

In the event of accidents resulting in machine damage, material "kick-backs," jamming, or other unsafe events, the following procedure must be followed:

- A meeting is required between the person involved in the accident and the shop manager before shop privileges resume.

5. Shop Occupancy Requirements

In order to maintain a safe shop environment strict user limits are enforced.

- No more than 12 students can be in the metal shop any given time. It is your responsibility to make sure that you don't exceed that number.

- You must sign in and sign out every time you use the shop. There is a signup sheet by the front door of the wood shop.

6. Cleaning of Shop Facilities

- Each student is personally responsible for clean up and tool return.
- Each machine and work area should be cleaned immediately after use.
- The last person to use a machine is responsible for cleaning the machine and surrounding work area.
- Each student is required to assist in a general clean up of the shop at the end of the day, or when deemed necessary by shop supervisory personnel.
- Students failing in their clean-up responsibilities:
 1. First offense: Warning.
 2. Second offense: Loss of shop privilege for 48 hours.
 3. Third offense: Loss of shop privilege until meeting with shop manager.

8. General Shop Hours

- Shop hours will be posted by the main wood shop entrance.

General Shop Safety Rules

1. Shop is open during posted hours. Check for schedule changes during finals period and holidays.
2. **Do not enter the shop while under the influence of mind-altering drugs or alcohol.**
3. Every person is required to wear eye protection in the shop as required by OSHA.
4. Tie back long hair when operating machinery.
5. Remove all rings, wristwatches and necklaces before operating machinery.
6. Do not wear sandals or open toe shoes while working in the shop.
7. Loose clothing should be restrained - tuck in shirttails, etc.
8. All accidents, even if very small, must be reported to your instructor/shop manager or the staff person on duty.
9. A safe attitude will protect you and others. Think, practice, and develop safe working habits.
10. Respect the rights and property of other students. Be thoughtful and helpful towards others in the shop.
11. Horseplay, running, yelling and/or fighting is absolutely forbidden in the shop.
12. Make sure machines are in the **“off”** position and motion has stopped, **before leaving them.**
13. All safety guards must be kept in place while operating equipment. If a guard or safety device is an impediment to safe operation of a machine, seek help.
14. Use equipment for its intended use. If in doubt, ask for help.
15. No one should use equipment until he or she has received proper and safe instruction and feels comfortable with its operation.
16. **Never make an adjustment to knobs or handles marked with red tape.**
17. If you have made an adjustment on a piece of equipment, return it to its normal position after you are done.
18. Do not use broken or damaged equipment; report immediately to manager.
19. Do not attempt repairs to any equipment that is broken. Notify shop manager or student assistants for help.
20. Make sure machine's work surface is unobstructed and clean before use.
21. Always keep your eyes on your fingers, listen to the sound of the machine and nose keen to the smell of smoke.
22. Never talk to someone operating a machine.
23. Operator should never talk to someone while operating a machine.
24. **Clean up your mess!** Wipe up all spilled liquids. Pick up your materials. Put away tools. Sweep up any loose debris.
25. Dispose of solvents, finishes, chemicals, oily/wet rags, and other hazardous materials of any kind in the red fireproof cans.
26. Return all tools to their proper storage place after using.
27. Ask for Shop Managers approval before storing materials or projects in shop.
28. **Absolutely no tools out of the shop!**
29. Do not use plaster or any cement-based material on any power machines.
30. Headphones are prohibited in the shop.
35. These rules are meant to protect you and others from injury; please obey them.
36. The mission of the shop is to provide a safe and reliable facility for the pursuit of higher understanding as it applies to the nature of materials and the possibilities and limitations of the tools and techniques used to shape them.

Handheld Portable Power Tools

Hand Drills

Jigsaw

4 ¼ inch Grinders

Set up for grinding/polishing

Set up for cutting

Contents

No table of contents entries found.

General Safety for Handheld power tools

- ***Eye protection is required when using these tools.***
- ***Hearing protection (ear plugs) is required for hand grinders.***
- ***Do not talk with observers while operating these tools.***
- Keep work area clear of other tools and materials.
- Use the right tool for the job.
- Do not abuse the electric cords.
- Keep hands clear of tool's cutting path.
- Secure work to bench when using electric hand tools.
- Do not over reach with electric hand tools.
- Make all adjustments on the tool with the power cord unplugged.
- Remove wrenches and chuck keys after adjusting.
- Do not carry plugged in tools with finger on power switch.
- Use only grounded extension cords.
- Keep guards in place and working properly.
- Keep hands away from the cutting portions of tools.
- Seek help if you are unsure of tool operating procedures.
- Unplug, clean and put away tools when finished working.
- Let the tool's bits and the blades do the work. Do not force tools into the material.



4 ½ Inch Grinders

4 ½ Inch Grinders are used for beveling edges, cleaning off slag after welding, light shaping of curves, and texturing metal plate.

Safety and Use

- ***Eye protection and ear protection are required when using these tools.***
- ***The guard must be adjusted to prevent the sparks from hitting the operator.***
- ***Be sure switch is “OFF” before plugging in.***
- ***Make sure the sparks are not directed toward another person or an unsafe area.***
- Do not talk with observers while operating these tools.
- Use appropriate grinding disc for that grinder and for the work to be performed. Ask attendant for assistance if needed.
- Make sure the metal is secured before grinding.
- Start grinder BEFORE contacting the metal. Hold grinder firmly.
- When pausing or stopping your grinding operation, lift grinder off material and hold away from any surfaces until disc coasts to a complete stop.
- Lightly make initial contact with the grinder onto the metal.
- Hold the grinder at about a 30 degree angle to the metal and move the grinder in a slow to moderate motion.
- Do not use the entire flat side of the grinding wheel against the metal.

- Unplug the tool before changing the grinding wheel or cutting wheel.
- **Be careful when touching the metal after grinding; it will be very hot and possibly quite sharp.**



4 ½ Inch Grinder with Abrasive Cut-Off Disk

The 4 ½ Inch Grinder with an abrasive cut-off disk allows the operator to make a straight line cut in steel. The cut-off disk results in a very thin kerf.

Safety and use

- ***Eye protection and ear protection are required when using these tools.***
- ***The guard must be adjusted to prevent the sparks from hitting the operator.***
- ***Be sure switch is “OFF” before plugging in.***
- ***Make sure the sparks are not directed toward another person or an unsafe area.***
- Make sure the metal is secured before cutting.
- Do not talk with observers while operating these tools.
- Start grinder BEFORE contacting the metal. Hold grinder firmly.
- When pausing or stopping your grinding operation, lift grinder off material and hold away from any surfaces until disc coasts to a complete stop.
- Lightly make initial contact with the cutting wheel onto the metal.
- Hold the grinder at a 90 degree angle to the metal and move the grinder in a slow to moderate motion.

- Do not use the flat side of the cutting wheel against the metal; only use the edge.
- Unplug the tool before changing the cutting wheel.
- **Be careful when touching the metal after cutting; it will be very hot and probably quite sharp.**



Drills

Drills have a variety of uses; drilling holes, driving screws and fasteners, sanding with abrasive accessories, etc. They are very versatile because of the large number of accessories available.

Safety and Use

- **Eye protection is required when using these tools.**
- **Do not talk with observers while operating these tools.**
- **Use only metal cutting drill bits, never wood cutting bits.**
- When drilling holes secure the metal in a vice.
- Use extreme caution when drilling into sheet metal, especially smaller pieces. **Check with a shop supervisor first.**
- Use appropriate drill bit or accessory for work to be performed. Ask attendant for assistance if you are not sure which bit or accessory to use.
- Check forward/reverse switch before drilling or driving screws. Switch should be in forward position for drilling or driving screws and reverse for removing screws.
- Adjust clutch to appropriate setting for work being performed. Ask for assistance if you are not sure which setting to use.
- Always keep finger or exposed flesh away from drill bit or accessory.
- Avoid dropping or bumping drill off tables and ledges. Be mindful and keep drill away from the edge of work benches or elevated surfaces.
- When using an AC drill, use only grounded extension cords.
- Be sure the chuck key is removed before using the drill.
- When using a check key, tighten the chuck **using all three positions.**

- Use a few drops of oil when drilling metal. This keeps the drill bit sharp and actually reduces the drilling time.



Jigsaw

This tool is generally used for pattern cutting into thinner metals using a metal cutting blade.

Safety and Use

- ***Eye and ear protection is required at all times when using this tool.***
- ***Do not talk with observers while operating this tool.***
- Restrain loose clothing, tie back long hair, remove or restrain loose jewelry.
- Keep fingers away from line of cut
- Always securely clamp or hold material in position.
- Use appropriate blade for type of metal and thickness of metal to be cut. Ask for help from shop staff.
- When cutting material on bench-tops be aware of where bench surface is. Avoid cutting bench-top.
- Area underneath line of cut should be free of any obstructions.
- Line up front edge of blade with line of cut.
- Never start the Jigsaw with front edge of blade pressed up against the metal.
- Keep jigsaw base flat on material when in use.
- Never use a bent blade.
- When selecting a blade, the thinner the metal, the more “teeth per inch” needed.

Stationary Metalworking Machines

Drill Press

Vertical Band Saw

Belt/Disc Sander

Grinder

Horizontal Band Saw

Metal Cut-off Saw

MIG Welder

Plasma Cutter

Acetylene Welder

CNC Plasma Cutter

Di-Arco Metal Bender



Drill Press

The Drill press can cut holes in wood, metal and plastics depending on the type of drill bit installed. The shop has a variety of basic drill bits and a small collection of specialty bits. Please follow the operating directions carefully for this machine.

Safety

- ***Protective eyewear should always be worn when operating this machine.***
- ***Do not talk with observers while operating this machine.***
- ***Always clamp down metal.***
- General Rule: The Larger the bit the slower the speed. Holes over ½ inch and in harder materials should be bored with slower speeds. Ask shop attendant for help changing speed.
- Always remove chuck key before starting drill press.
- Make adjustments with power off.
- Unlock table before adjusting height.
- Position the table and adjust the feed stroke so there is no possibility of the bit striking the table.
- Small or irregularly shaped pieces must be clamped to the table or held firmly by some means.
- Feed the bit slowly into the work.
- When the hole is deep, withdraw the bit frequently to clear the shavings and cool the bit.
- Securely lock bits into chuck by tightening all three holes.
- Avoid drilling into drill press table top.
- Drill only wood, plastics, mild steel, aluminum, brass with the drill press.
- Use a center punch mark before drilling.
- For drilling larger holes, it is faster if you drill a smaller hole first.
- Do not drill length of hole in one plunge. Take several small plunges.
- Shut off power, remove bit and clean drill press and surrounding area when done.



Floor Grinder

The FLOOR GRINDER is the fastest and safest tool for grinding edges of metal, shaping metal, and sharpening tools. Rule of thumb for grinding is to use a hard wheel for soft materials and a soft wheel for hard materials. Most of the steel used in our shop is low carbon steel so use the coarsest grinding wheel.

Safety

- **Protective eyewear and ear plugs should always be worn when operating this machine.**
- **Do not talk with observers while operating this machine.**
- **Always check that the tool rest is no more than 1/8 inch from the wheel.**
- **Inspect the grinding wheel before using the grinder. Never use a cracked wheel!**
- **Stand to the side when starting up the grinder.**
- **Never grind sheet metal.**
- Do not grind soft metals like aluminum or brass.
- Avoid grinding small pieces. Use vice grips when necessary.
- Grinding will quickly heat up the metal. Be careful when handling the metal. Cool the metal with water as needed.
- Grinding often produces sharp edges on the metal. Wear gloves when handling the metal.
- Use moderate pressure when grinding. Pushing too hard stresses the wheel and builds up excessive heat.
- Work should be moved back and forth across the wheel to prevent forming a groove in the wheel.
- If the wheel is grooved or loaded up with a soft metal, ask a supervisor to “dress” the wheel to a new surface.



The Vertical Band Saw can be used to cut all kinds of metals. The metal-cutting band saw is similar to a wood-cutting band saw, but the material is fed at a much slower pace. Also, hand protection needs to be used (either vice grips or gloves).

Safety

- **Eye protection is required when using this machine.**
- **Do not talk with observers while operating the band saw.**
- **Always maintain a 3" margin of safety** (Keep hands and body parts away from line of cut).
- **Never attempt to cut hardened steel, high speed steel, or tool grade steel.**
- **Do not expose more than 1/2" of blade between material and bottom of upper guide.**
- Make all adjustments with the power off.
- Allow saw to reach full speed before beginning cut.
- Hold stock flat on table top.
- Do not cut stock that does not have a flat surface. (I.e. do not attempt to cut spherical objects.
- Feed stock only as fast as teeth will remove material.
- Avoid backing out of cuts when possible.
- Plan relief cuts in advance – think first.
- Do not make turns too tight – listen for blade twisting.
- If “clicking” noise is heard, **SHUT OFF POWER – BLADE MAY BE DAMAGED.**
- Stop machine and blade before removing scrap pieces.
- Operate the machine from front side (side with doors). Avoid standing to side of machine.
- Ask for help when cutting long or wide or difficult to handle pieces.
- Saw is for use in cutting soft metals and mild steel only (ask shop attendant).
- Keep hands and body parts away from line of cut.

Procedure for using Band Saw

1. Inspect material. It should be flat and free of debris (dirt, nails, screws, etc.)
2. Check blade pitch. Use proper blade for various cuts (ask shop attendant).
3. **Adjust upper guide to within 1/4" above surface of material.**

4. For straight cuts set up fence (see attendant for assistance).
5. Turn on saw. Machine should run smoothly with a consistent buzz, report strange noises to shop attendant.
6. Feed material while standing directly in front of blade. Avoid standing to side of blade.
7. Keep hands and body parts away from line of cut.
8. Begin feeding material into blade. Use enough pressure to feed material through blade at a slow consistent speed. If material gets hot, report it to shop attendant.
9. If you need to pull material out of blade do so with caution. If blade gets stuck in saw kerf and pulls out of guides, turn off machine and seek help from shop attendant.
10. For angled cuts check with shop attendant for help.



Metal Cut-Off Saw

The Metal Cut-Off Saw can cut between 90 degree and 45 degree angles. It cuts soft metals, up to low carbon steel. For larger or thicker stock, use the horizontal band saw.

Safety

- **Protective eyewear should always be worn when operating this machine.**
- **Do not talk with observers while operating this machine.**
- **Metal will be hot and sharp after cutting. Use gloves or vice grips.**
- **Material should be securely clamped before turning on the machine.**
- Do not attempt to hold pieces with your hands; always use the vise.
- Cut only softer metals and low to mild carbon steel with this saw.

Procedure for cutting

1. Make sure the stock is tightly clamped in place before starting your cut. If it is not secure, the blade will grab it and possibly cause damage to the blade and the operator.
2. Initiate the cut by **slowly** lowering the blade onto the metal.
3. Do not force the cut.
4. If metal chips or slag build up on the saw, remove them when the saw is not running and using brush or scraper.
5. Make sure the saw is at full running speed before contacting the metal.



Horizontal Band Saw

The Horizontal Band Saw is used to cut metal tube, rod, bar and other shapes. It can cut stock between 90 degree and 45 degree angles. This is the most commonly used power tool for cutting longer or larger pieces of metal stock.

Safety

- **Protective eyewear should always be worn when operating this machine.**
- **Do not talk with observers while operating these machines.**
- **Do not move the blade tensioning hand wheel (upper hand wheel)!**
- **Do not attempt to remove any jammed metal pieces while the blade is moving!**
- **Use a moderate amount of coolant/lubricant: see the attendant for assistance.**
- Cut metal will be sharp and hot. Use gloves or vice grips to handle the metal.
- Material **must always** be clamped with the vice. Do not attempt to hold it with your hand.
- Use roller or stock supports for long pieces of metal.

Procedure for Cutting Metal

1. Turn the *Feed Knob* clockwise until it stops (towards slow).
2. Raise the band saw Arm.
3. Clamp metal into the Band Saw's vice using the **lower** hand wheel.
4. You may choose to use the length stop gauge if needed.
5. Start the machine (Stop knob may need to be rotated first).
6. Turn on the coolant. Use a very small amount. Ask attendant for help.
7. **Slowly** turn the Feed Knob counterclockwise to lower the cutting arm.
8. Have the blade engage the metal softly.
9. Once the cut begins, you may increase the feed rate by turning the feed knob further counterclockwise.
10. Handle the cut metal carefully; it will be hot and sharp.
11. Clean up the machine and the floor.



Belt/Disc Sander

The belt/disc sander can be used to remove very small amounts of metal from a project. Use a floor grinder or hand-held grinder for larger amounts of metal removal. Do **not** use thin metal or sheet metal on the belt/disc sander.

Safety

- **Protective eyewear should always be worn when operating this machine**
- **Do not talk with observers while operating this machine.**
- **Never attempt to sand/grind sheet metal on this machine!**
- **Use vise grips to hold smaller pieces.**
- **Belt Sander: Stand so the belt is moving away from you.**
- **Disc Sander: Use the left side of the disc with the disc moving “down.”**
- Long hair should be tied back and restrained.
- Loose clothing should be restrained or removed. Roll up sleeves.
- Metal will become hot and sharp; use caution when handling.
- Do not force material into disc.
- Material to be sanded should be flat on at least one face.
- Belt/disc sander is for use with metal only.
- If disc appears to be clogged or dirty ask shop attendant for assistance.
- Do not place sharp edges against the belt; it can easily cut the belt.

Procedures for Disc Sanding:

- Use vise grips for smaller pieces; use gloves for larger pieces.
- Turn on Sander.
- Place flattened surface of material on table to the **left** of center of disc.
- Hold material firmly and gently move it into spinning disc.
- Move material steadily back and forth across **left** half of disc.
- Turn off machine when finished and allow disc to coast to a stop.

Procedures for Belt Sanding:

- Use vise grips for smaller pieces; use gloves for larger pieces.
- Turn on Sander.
- Stand so the belt is moving **away** from you.
- Hold material firmly and gently lower it onto the belt.
- Turn off machine when finished and allow belt to coast to a stop.

Welding Safety:

All welding and cutting (plasma, gas, electrical) can be very dangerous. Be careful for the following:

- Danger of fire. Keep combustibles away. Never cut/weld into a closed container such as a barrel.
- Danger of electric shock. Welders/cutters use high voltages and amperages. Do not open the housing while the machine is plugged in. Use caution when plugging into an outlet.
- Danger of burns. Welding and cutting always produces very hot metal. Use gloves, long sleeve shirts, welding jacket, welding cap, leather shoes, and long pants.
- Danger of cuts. Welding “slag” can be very sharp. Cut metal edges are also very sharp.
- Danger to your eyes. Welding and cutting creates very bright light; proper eye shading is always required.
- Danger of fumes. All welding and cutting produces dangerous fumes; use proper ventilation.
- Danger of gas explosion. Oxygen tanks are under extremely high pressure and acetylene gas should never exceed 15 pounds per square inch (PSI).
- Danger of excessively loud sounds. Some welding operations can be fairly noisy so use appropriate hearing protection when applicable.



Plasma Cutter

The plasma cutter can cut metal of any thickness up to 1/2 inch. It can also pierce a hole into metal and can also cut a “U” shaped groove (gouge).

Safety

- **Protective eyewear should always be worn when operating this machine.**
- **Wear the proper welding mask.**
- **Wear a welding jacket, welding gloves, long sleeve shirt, long pants and leather shoes.**
- **You may want to wear head protection as sparks can burn your hair.**

- ***Always wear the proper shoes; never sandals, as many sparks will drop to the floor when cutting.***
- ***Do not talk with observers while operating this machine.***
- ***Ventilation is critical; use the overhead exhaust fans when using the machine.***
- ***Do not use the plasma cutter near anything combustible.***

Procedures for Plasma Cutting:

- Properly secure the metal to be cut using clamps, vise grips, etc.*
- Turn on both overhead ventilators.
- Secure ground clamp to either the metal table or the metal project.
- Mark the area you plan to cut.
- Set the plasma cutter to the appropriate amperage and air pressure (See attendant).
- Put on all the proper safety apparel.
- Turn on the machine and begin cutting.
- After cutting is finished, use caution when handling the hot material.
- Turn the machine off and clean up the area.
- Turn off the ventilators.

* You may use a non-metallic template to guide your cut (see attendant).



CNC Plasma Cutter

The CNC plasma cutter can cut metal of any thickness up to 1/2 inch. The machine uses Plasma Cam software but can read Rhino drawings IF they are saved as DXF files (2004 Polylines). The CNC Plasma Cutter will only cut in two dimensions (X and Y), although it can move on a Z axis to accommodate any metal warpage or corrugations.

Safety

- ***Protective eyewear should always be worn when operating this machine.***
- ***Wear the proper welding mask or stand behind the welding screens.***
- ***Do not talk with observers while operating this machine.***
- ***Ventilation is critical; use the overhead exhaust fans when using the machine.***
- ***Do not use the CNC plasma cutter near anything combustible.***

Procedures for CNC Plasma Cutting:

- Properly secure the metal to be cut.
- Turn on both overhead ventilators.
- Secure ground clamp to either the metal table.
- Set the plasma cutter to the appropriate amperage and air pressure (See attendant and the CNC Procedure Sheet).
- Turn on the computer, the CNC Control Panel, and the Plasma Cutter.
- Make sure you have the correct size tip installed (see attendant).
- “Input” your file.
- Set all the appropriate Machine settings on the computer (see attendant).
- Set the appropriate cut paths, their order, and whether they are internal or external cuts (see attendant).
- Check for unwanted “intersections” (see attendant).
- Check the cut paths using the computer.
- Have the CNC machine run a “dry run” but be sure to raise the Z setting first!
- Run the actual cutting operation.
- After cutting is finished, use caution when handling the hot material.
- Turn the machines off and clean up the area.
- Turn off the ventilators.



Oxy-Acetylene Welding

The Oxy-Acetylene welding unit can be used to weld steel, heat metal to very high temperatures (for bending, annealing, etc), and to cut steel. There are several sizes of welding tips for welding or for heating up metal. There is also a cutting torch that can be installed for cutting steel. It is not really feasible to weld aluminum with the Oxy-Acetylene welding unit.

Safety

- ***Protective eyewear should always be worn when operating this equipment.***
- ***Wear the proper welding mask or goggles.***
- ***Wear a welding jacket, welding gloves, long sleeve shirt, long pants and leather shoes.***
- ***You may want to wear head protection as sparks can burn your hair.***
- ***Always wear the proper shoes; never sandals, as many sparks will drop to the floor when cutting.***
- ***Do not talk with observers while operating this equipment.***
- ***Ventilation is critical; use the overhead exhaust fans when using the welding equipment.***
- ***Never use the Oxy-Acetylene equipment near anything combustible.***
- ***Use extreme caution when handling the two tanks, turning them off or on, and setting the regulators.***
- ***Use caution when lighting the torch. Follow the procedures exactly!***
- ***Never allow an oxygen cylinder to fall over!***
- ***Always keep the acetylene cylinder in a vertical position: never lay it on its side!***
- ***Never allow the acetylene pressure to exceed 15 psi.***

Procedures for Handling the Oxygen tank and regulator:

- A full Oxygen tank holds over 2,000 psi of pressure! Should it fall over and the valve break open, the tank will literally become a high velocity missile!
- Always make sure the tank is properly secured to the stand with a chain.
- Always install a protective cap over the valve whenever the regulator is not attached: even on an empty tank.
- Never stand in front of the regulator when turning on a tank of Oxygen. The sudden surge of high pressure could rupture the gauge and cause serious injury. Always stand to one side when opening the tank!
- Turn the Oxygen tank valve to the full on position when using the oxygen.
- After use, always close the oxygen tank valve fully and bleed the gas out of **both** the regulator and the tank gauge (see Oxy-Acetylene Procedures).

Procedures for Handling the Acetylene tank and regulator:

- Acetylene gas is highly unstable above 15 psi. Therefore, the gas is stored in the tank as a dissolved liquid in a special material.
- Always make sure the tank is properly secured to the stand with a chain.
- Always install a protective cap over the valve whenever the regulator is not attached: even on an empty tank.
- Never allow the Acetylene tank to be in any position except completely vertical.
- Turn the Acetylene tank valve $\frac{1}{4}$ turn open when in use.
- After use, always close the acetylene tank valve fully and bleed the gas out of **both** the regulator and the tank gauge (see Oxy-Acetylene Procedures).

Procedures for Oxy-Acetylene Welding:

- Where all appropriate welding apparel and safety equipment.
- Turn the ventilators on.
- Secure your metal/project using appropriate clamps, magnets, etc.
- Select the appropriate welding tip size.
 - To turn on the torch:
 1. Turn the Acetylene regulator valve counterclockwise (closed) in the chance that the last person who used it mistakenly left it in the open position.
 2. Slowly turn the Acetylene tank valve $\frac{1}{4}$ turn counterclockwise.
 3. Open the Acetylene torch valve slightly ($\frac{1}{4}$ turn).
 4. Turn the Acetylene regulator clockwise (in) until the gauge shows about 7 psi: you will hear the Acetylene gas flowing out. This will give you a “flowing” pressure which is more accurate than a static pressure. Do this fairly quickly so you don’t waste much gas and for safety.
 5. Turn the Acetylene torch valve closed (clockwise).
 6. Now turn the Oxygen regulator valve counterclockwise (closed) in the chance that the last person who used it mistakenly left it in the open position.
 7. Stand to one side of the Oxygen regulator and turn the Oxygen tank valve slowly until it is fully open.
 8. Open the Oxygen torch valve $\frac{1}{4}$ - $\frac{1}{2}$ turn.
 9. Turn the Oxygen regulator clockwise (in) until the gauge shows about 15 psi: you will hear the Oxygen gas flowing out. This will give you a “flowing”

pressure which is more accurate than a static pressure. Do this fairly quickly so you don't waste much gas and for safety.

10. Turn the Oxygen torch valve closed (clockwise).

- To light the torch:

1. Turn on the ventilators.
2. Open the Acetylene torch valve 1/8 turn.
3. Light the torch with the flint sparker: never use a match or butane lighter.
4. Adjust the flame until the black smoke clears up. If the flame jumps away from the tip, reduce the acetylene until the flame is back on the tip.
5. Open the oxygen torch valve slowly.
6. As you slowly add more oxygen, you will see a cone shaped flame form. Add more oxygen until the cone just disappears. If you add too much oxygen the torch will make a hissing sound. If it does, reduce the amount of oxygen.
7. You should now have a "neutral" flame and are ready to weld.

- To turn the torch off:

1. Turn off the oxygen at the torch valve.
2. Turn off the acetylene at the torch valve.
3. Close the oxygen tank valve (clockwise).
4. Close the acetylene tank valve (clockwise).
5. Now open the oxygen torch valve (counterclockwise). You will hear the gas purging from both the regulator and the tank gauge. Once both gauges read zero, close the oxygen torch valve.
6. Now turn the Oxygen regulator valve counterclockwise (closed) so it will not receive high pressure when the next person turns on the oxygen tank.
7. Now open the acetylene torch valve (counterclockwise). You will hear the gas purging from both the regulator and the tank gauge. Once both gauges read zero, close the acetylene torch valve.
8. Turn the Acetylene regulator valve counterclockwise (closed) so it will not receive high pressure when the next person turns on the acetylene tank.
9. Wrap the torch hoses neatly around the cart and carefully place the torch in the cart storage compartment.

- To operate the Oxy-Acetylene cutting torch:

The cutting torch is similar to the welding torch except for the additional oxygen torch valve and the thumb-operated oxygen valve.

1. Attach the oxy-acetylene cutting torch to the base handle.
2. Open the oxygen torch valve (nearest the hoses) to full open – (counterclockwise). Leave this open for the remainder of the use.
3. Make sure the other oxygen torch valve (nearest the tip) is closed.
4. Now follow the directions for the regular welding setup, but use the oxygen torch valve nearest the tip for all the adjustments: leave the oxygen torch valve nearest the hoses in its fully opened position.
5. When attempting to cut steel, wait until the torch has just started a liquid steel puddle before pushing the Oxygen thumb valve.
6. The pressure settings will vary according to the thickness of the steel, but a good starting point is 8 psi acetylene and 25 psi oxygen.



MIG (Metal Inert Gas) Welding

The MIG welding unit will weld steel up to ½ inch thick. It can also weld aluminum, but the special spool gun (right hand picture) must be installed and the Argon/CO₂ tank must be replaced with a pure Argon tank. See an attendant for assistance with welding aluminum. MIG welding of steel is probably the easiest type of welding to learn.

Safety

- **Wear the proper welding mask or goggles.**
- **Wear a welding jacket, welding gloves, long sleeve shirt, long pants and leather shoes.**
- **You may want to wear head protection as sparks can burn your hair.**
- **Always wear the proper shoes; never sandals, as many sparks will drop to the floor when cutting.**
- **Do not talk with observers while operating this equipment.**
- **Ventilation is critical; use the overhead exhaust fans when using the welding equipment.**
- **Never use the MIG welder near anything combustible.**
- **Use caution when handling welded metal as it will remain hot for a fairly long time.**

Procedures for MIG Welding:

- Where all appropriate welding apparel and safety equipment.
- Turn the ventilators on.
- Secure your metal/project using appropriate clamps, magnets, etc.
- Secure the ground clamp to the metal welding table or to your project.
 - To turn on the welder:
 1. Turn the regulator valve counterclockwise (closed) in the chance that the last person who used it mistakenly left it in the open position.
 2. Slowly turn the Argon/CO₂ tank valve to the fully open position (counterclockwise).
 3. Turn the MIG welder on using the switch on the back of the unit.
 4. Set the mode switch to “Spool gun.” This will allow you to use the gas switch without the torch handle feeding the wire.
 5. Turn the gas regulator clockwise (in) until the gauge shows about 20 psi while holding the trigger closed. You will hear the Argon/CO₂ gas flowing out. This will give you a “flowing” pressure which is more accurate than a static pressure. Do this fairly quickly so you don’t waste much gas.

6. Set the Amperage needed (see attendant)
 7. Make sure the Wire Feed Knob is set to .035. This will automatically provide the optimum feed rate for the .035 wire in the machine.
 8. Set the Mode switch to MIG wire feed.
 9. With the tip of the MIG torch 1/8 inch from the metal, pull the trigger and weld, using the optimum welding motion (see attendant).
- To turn off the welder:
 1. Switch the Mode to Spool Gun.
 2. Turn the Argon/CO₂ tank valve to the fully closed position (clockwise).
 3. Hold the trigger down to allow the gas to clear the tank gauge and the regulator.
 4. Turn the gas regulator counterclockwise to close the regulator.
 5. Turn the MIG welder off.
 6. Wrap the cables around the handle.
 7. Clean up the area.
 8. Turn off the ventilators.