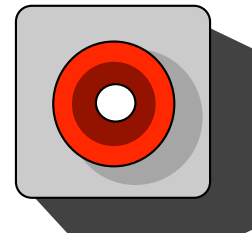


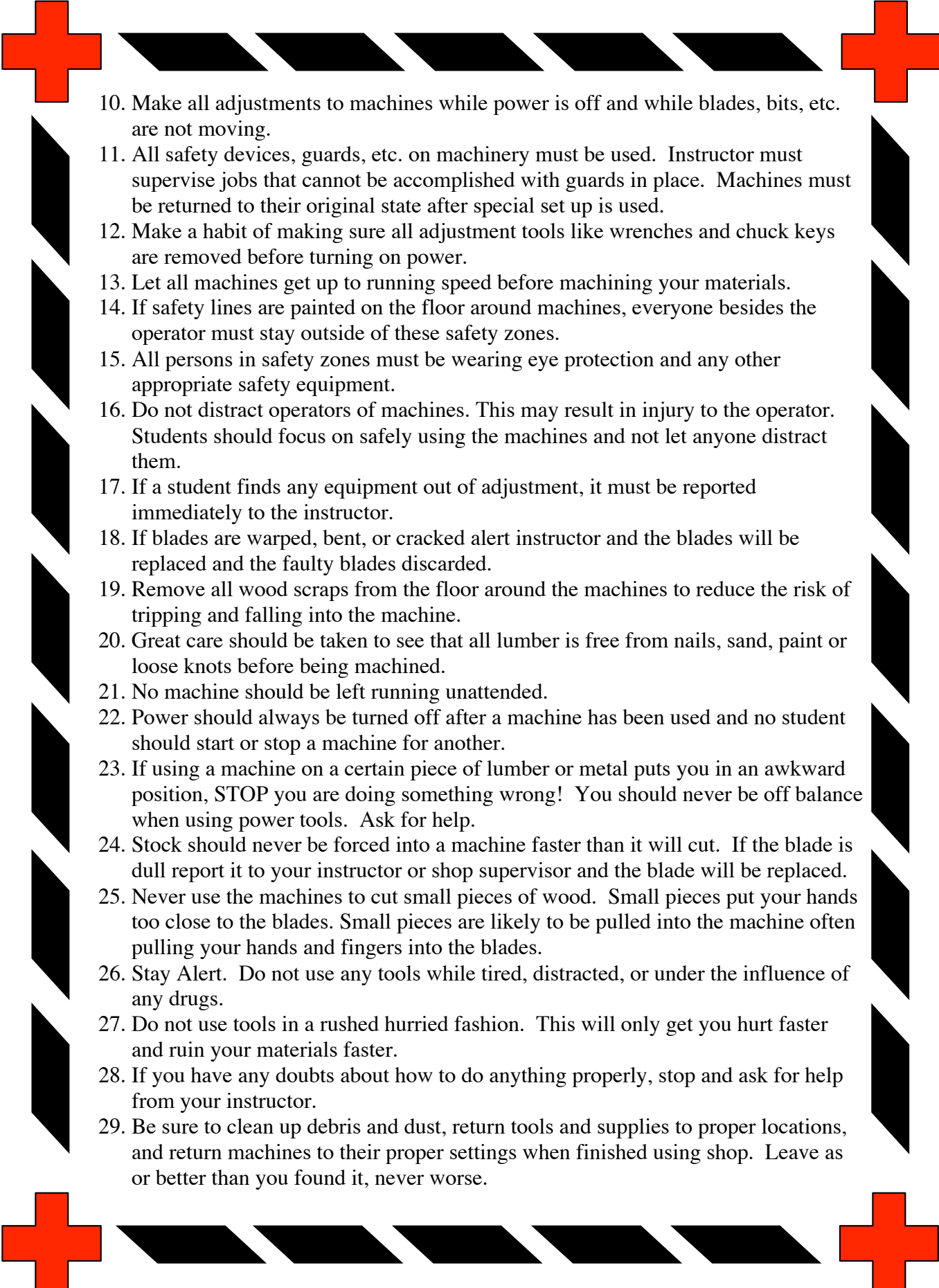
Safety First, Think Before You Start.

General Safety Rules

Before using any equipment, be sure you know how to use the equipment properly and are wearing proper protection. When using any saw, drill, sander, hammer, chisels, etc., you need to do the following.

1. **Wear eye protection.** Face shields are available, but you should buy safety glasses.
2. **Wear dust masks and turn on vent to the equipment you are using.** All dust is harmful to your health.
3. **Wear proper protective clothing.** Do not wear short pants that will not protect your body or loose clothing that could get caught in the equipment. You should also remove any hanging jewelry, ties, bracelets, and rings from hands.
4. **Wear protective shoes such as work boots.**
5. **Tie long hair back.**
6. **Wear ear protection such as earplugs or muffs.**
7. **Generally it is best not to wear gloves when using power tools. Gloves extend the length of your fingers and hands, and will actually pull you into machinery if they get caught.** You should wear gloves for only certain tasks. For Example: Wear welding gloves for welding. Wear rubber gloves if mixing materials such as cement by hand. Wear work gloves if handling sharp or splintery materials.
8. In case of accident with machinery, push the **EMERGENCY SHUT OFF**. This button turns off power to all power tools. This red button is located at the end of the wall dividing the metals area from the rest of the sculpture studio.
9. In case of Emergency when dialing from campus phone, dial **911 for CMU POLICE** or **9-911 for AMBULANCE, POLICE, or FIREFIGHTERS.**



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10. Make all adjustments to machines while power is off and while blades, bits, etc. are not moving.
 11. All safety devices, guards, etc. on machinery must be used. Instructor must supervise jobs that cannot be accomplished with guards in place. Machines must be returned to their original state after special set up is used.
 12. Make a habit of making sure all adjustment tools like wrenches and chuck keys are removed before turning on power.
 13. Let all machines get up to running speed before machining your materials.
 14. If safety lines are painted on the floor around machines, everyone besides the operator must stay outside of these safety zones.
 15. All persons in safety zones must be wearing eye protection and any other appropriate safety equipment.
 16. Do not distract operators of machines. This may result in injury to the operator. Students should focus on safely using the machines and not let anyone distract them.
 17. If a student finds any equipment out of adjustment, it must be reported immediately to the instructor.
 18. If blades are warped, bent, or cracked alert instructor and the blades will be replaced and the faulty blades discarded.
 19. Remove all wood scraps from the floor around the machines to reduce the risk of tripping and falling into the machine.
 20. Great care should be taken to see that all lumber is free from nails, sand, paint or loose knots before being machined.
 21. No machine should be left running unattended.
 22. Power should always be turned off after a machine has been used and no student should start or stop a machine for another.
 23. If using a machine on a certain piece of lumber or metal puts you in an awkward position, STOP you are doing something wrong! You should never be off balance when using power tools. Ask for help.
 24. Stock should never be forced into a machine faster than it will cut. If the blade is dull report it to your instructor or shop supervisor and the blade will be replaced.
 25. Never use the machines to cut small pieces of wood. Small pieces put your hands too close to the blades. Small pieces are likely to be pulled into the machine often pulling your hands and fingers into the blades.
 26. Stay Alert. Do not use any tools while tired, distracted, or under the influence of any drugs.
 27. Do not use tools in a rushed hurried fashion. This will only get you hurt faster and ruin your materials faster.
 28. If you have any doubts about how to do anything properly, stop and ask for help from your instructor.
 29. Be sure to clean up debris and dust, return tools and supplies to proper locations, and return machines to their proper settings when finished using shop. Leave as or better than you found it, never worse.

Band Saw

1. Use right tool. This saw is capable of making curvilinear cuts and rough straight cuts. If right clean angle or straight cuts are desired use table saw or miter saw.
2. Adjust guides and safety shield to aprox. 1/4" to 1/2" above the material you are cutting to reduce risk of injury.
3. Keep hands away from blade. AT LEAST 4"!
4. Turn off power and wait till blade stops before making adjustments or changing blade.
5. Make sure fence and table is in proper position and alignment. If you tilt the table the table must be set back to level.
6. Do not cut steel with the wood blade! Make sure you are using the right saw to cut wood or steel.

Wood blade



Steel blade



7. Make sure teeth on blade are pointing down.
8. If blade breaks or machine jams turn off machine and inform instructor.
9. Stock being cut must have at least one flat side to place against the table.
10. Plan cuts to avoid backing out of long kerf.
11. Avoid pinching blade by turning to sharply.
12. Allow blade to get to full speed before cutting.
13. Do not cut small pieces of wood that put your hands to close the blade.
14. Do not force tool. Let the saw cut at its own rate. If tool is dull tell instructor, and new blade will be installed.

Miter Saw

1. Use right tool. This tool is for cross cutting long boards under 5" wide. Use table saw or panel saw for larger wood.
2. Make sure fence is in proper position and alignment. If you tilt the saw the fence must be set at the proper position.
3. Hold board firmly against fence. Clamp work down if necessary.
4. Keep hands away from blade.
5. Pull trigger and when the blade is rotating at full speed gently push saw down until the blade cuts through the board.
6. Turn off power and wait till blade stops before making adjustments or changing blade.
7. Do not force tool. Let the saw cut at its own rate. If tool is dull tell instructor, and new blade will be installed.

Radial Arm Saw

1. Use right tool. This tool is for cross cutting boards less than 14" wide. Use table saw or panel saw for larger wood or the miter saw for wood less than 5". Some special setups may require using the radial arm saw.
2. Cut only across the width of a board.
3. Move the cutting head fully back against the column so the blade does not touch and feed itself into your stock.
4. You should not cross cut a board that is less than 6" long.
5. Pull the cutting head forward slowly and steadily. The blade will want to pull itself into your stock and if pulled too quickly the blade will climb onto your jamming the machine.
6. Keep hands out of path of blade.
7. Keep stock firmly against fence to prevent kickback.
8. Each turn of the elevating handle lifts or lowers the blade 1/8". Do not cut more than a 1/4" into the deck.
9. Raise the blade 3" above the table before setting the angle of the blade to make bevel cuts. This angle can be changed by pulling up on the tension lever on the front of the cutting head.

If groove for desired setting is not already cut in the deck ask for help. Instructor or shop supervisor must approve any special operation or set up.

10. To change the direction of the arm, raise blade above the deck and fence. Loosen lever on right side of column and press down flat lever on top of arm to bypass 45-degree stops. Tighten lever when desired angle achieved and lower saw into groove. If groove is not already cut see instructor or shop supervisor for help.
11. Do not cut round stock with this machine.
12. Do not remove safety guards.

Panel Saw

1. Use right tool. This tool is for cross cutting and ripping 4 by 8' panels under an inch thick. Boards smaller than the saw carriage should not be cut on the panel saw. Use the table saw. This machine makes only 90 degree perpendicular cuts.
2. Make sure thin panel such as formica sheets are supported by another thicker panel.
3. Make sure panel is supported and square on the rollers to prevent kick backs.
4. Hold board down against back support. Clamp work down if necessary.
5. Keep hands away from blade. You should never have to reach under the saw carriage
6. Keep saw carriage up at top of saw when not in use in locked position.
7. Cross-cutting must always be done from the top down. Pull trigger and when the blade is rotating at full speed gently push saw down until the blade cuts through the board.
8. Do not stop mid cut. If this occurs pull the saw (cross-cut) or board (rip-cut) back and start saw again.
9. Ripping (horizontal cutting) must always be done with the direction of the arrow.
10. To rip loosen the carriage lock and slide carriage down to the desired position and tighten carriage lock. Pull up on the indexing pin and rotate the saw to the desired direction. Remember to always feed the board against the rotation of the blade.
11. Turn off power and wait till blade stops before making adjustments or changing blade.
12. Do not force tool. Let the saw cut at its own rate. If tool is dull tell instructor, and a new blade will be installed.

Table Saw

1. Make sure you are using the correct blade. There is a blade for thin panel and a blade for thicker stock. Make sure the blade is installed securely with the teeth pointing to the front of the machine, the side with the power switch.
2. Operate the saw from the front, but do stand directly in front of blade. You will be feeding the wood against the rotation of the blade. If kickback occurs it will come to the front of the machine.
3. Do not lean over machine. Do not reach over blade to remove scraps.
4. Adjust blade 1/2" above the material you are cutting to reduce risk of injury. Put safety shield over the blade.
5. Use push stick, if needed. Avoid cutting small pieces of wood. If you need a small piece cut off a large piece. Keep hands away from blade.
6. Make sure splitter, fence, and miter are aligned with blade if not tell your instructor.
7. Always use the splitter to prevent kick backs.
8. Keep wood clear of blade until blade is turning at full speed.
9. Make sure no one walking behind you. A board could strike them due to kick back.
10. Use the miter when cross-cutting and the fence when ripping. Do not use the fence and miter in the same operation unless a facing board is used on the fence so as to allow the cut-off material to come free when the cut is made. Never cut free hand.
11. Avoid cutting warped wood that does not lay flat.
12. Use the out-feed rollers if cutting large stock. Also it is wise to ask for help handling larger lumber.
13. Clear special setups with instructor or shop supervisor.

14. Consult the Powermatic Table Saw Operating Instructions for further information.

Router Lift

1. The router is set up to used with the table saw. Do not use table saw and router at the same time.
2. Avoid routing small pieces of wood. Small pieces put your hands too close to the blades and when the wood is kicked away your hands will go into the blades. Keep hands away from blades.
3. Make all adjustments and blade changes with the router unplugged.
4. If the blade is small enough use the reducing collar.
5. Remove adjustment arm and wrenches after making adjustments. Keep all accessories together in router box.
6. Start router before feeding wood into blade.
7. If you need to use the router without the lift consult with your instructor or shop supervisor.

Drill Press

1. Select the right bit for the right job. If you do not know ask.
2. Select the correct speed for the material and for the bit you are using.
3. Be sure to tighten the drill bits securely in the chuck and be sure to remove the chuck key before starting drill press.
4. Start drill then lower into the material you are drilling.
5. Center punch the material to be drilled to prevent the bit from wandering.
6. Back thin material with wooden block.
7. After positioning material clamp it securely to the drill press table.
8. Make sure bit is in line with the hole in the table. If there is no hole you must leave a block under your material and set the depth gauge to stop the drill before it reaches the platform.
9. If drilling steel use progressively larger bits to drill large holes and use coolant (oil) to prevent overheating the bits.
10. Apply gentle pressure to lever to force bit into material and ease up when the bit is about to penetrate your material.
11. If the bit hangs up or the material being drilled comes loose, turn off drill press if safe to do so. If not calmly walk over and hit the emergency stop and get help.
12. Stop the drill before making any adjustments or cleaning off any wood or metal chips.

Combination Sanders Belt & Disc

1. Be sure you are using the right sander. One is for metal and one is for wood. There is a sign on each machine stating this.
2. Make sure the belt and disc are not loose, torn, or off track. If so do not use ask your instructor or the shop supervisor for help.
3. If the belt becomes off center turn off machine. Again ask for help.
4. If you apply excessive pressure to one spot the sand paper will become gummed up and the belt will wander to one side. It is also possible to rip the sanding belt. Keep wood and steel moving.
5. Sand only on the down side on the disc sander.
6. Keep hands as far as possible from the sanding surfaces.
7. Do not sand small pieces.
8. Keep work firmly against the table surfaces and do not tip up objects that could be caught in-between the sandpaper and the tables. This will jam the machine and possibly rip the sandpaper causing severe injury. No free hand sanding.
9. Let sander get up to speed before sanding.
10. If you need to remove guards and tables for a certain task ask for permission.

Jointer/Planer

1. Check wood to make sure it is free of nails, grit, loose knots, or anything else that will damage the blades.
2. Make sure guard is functioning properly.
3. Adjust only the in-feed table. Limit cuts to less than a 1/8". Normally you should not cut more than a 1/16".
4. Joint with the grain. Never the end grain.
5. Use push blocks on flat stock and push sticks on stock less than 2". Keep hands away from blades.
6. Do not plane wood under 1" square.
7. Do not plane boards less than 1/2" thick.
8. Do not plane wood less than 12" long.
9. Let the jointer get up to speed before feeding in wood.
10. Expose only the needed amount of the cutting head.
11. Pass wood far enough so the guard will close after making a pass.
12. Feed wood slowly while holding it firmly against fence and table.
13. Return all settings to normal when done.

Over-head Planer

1. Check wood to make sure it is free of nails, grit, loose knots, or anything else that will damage the blades.
2. Feed wood in from the adjustment wheel side.
3. Do not stick hands inside planer.
4. Boards must be at least 3 feet long to plane.
5. Leave 1/2" clearance on each side of the board. Your board must be 1" smaller than the planer's table.
6. Do not plane boards on edge. Use the table saw or jointer for this.
7. Limit cuts to less than a 1/8". Normally you should not cut more than a 1/16".
8. Plane with the grain.
9. Let the planer get up to speed before feeding in wood.

Hand Power Tools

1. The hand power tools can be just as dangerous as any other equipment. Use the same General Safety Rules outlined for the stationary equipment: wear eye protection, dust masks, protective clothing, remove jewelry, remove loose clothing, wear protective boots, etc.
2. Always secure work. Leaving both hands free to operate the power tool. When using saws and drills make sure you are not drilling or cutting into table. Saw horses are available.
3. Saws, drills, and grinders may catch. Make sure to stand in a balanced position where the tool will not be kicked back at you. Do not lock switches unless absolutely necessary.
4. Make sure power cords are out of the way of the blades.

Mig Welder

1. A Mig Welder is basically an Arc welder with shielding gas and instead of using a welding rod a spool of wire is fed into the weld.
2. Never open the CO2 shield gas cylinder valve more than one complete turn. Stand to the side of adjustment knob when turning on gas.
3. Cylinders must always be kept in vertical up right position and secured from falling with chains.
4. Do not strike, drop, or apply heat to cylinder.
5. Valve protection caps should be in place whenever cylinders are moved or stored (full or empty).
6. Mark all cylinders "empty" or "MT" with chalk.
7. Valves on empty cylinders should be closed completely.

8. Keep empty cylinders in specified storage areas.
9. Always open cylinder valves slowly and carefully.
10. Turn on vent and move snorkel near where you are welding venting away from you. Welding gives off toxic fumes.
11. Never look at the arc. Wear a welding mask with a minimum of shield 10 protection. Warn others about the arc.
12. Do not wear contacts when welding.
13. Welded metal becomes hot and will burn you. Let recently welded metal cool before handling. Dunking the metal in water can cool it quickly, but may produce hot burning steam. Warn others about potential burn hazards.
14. Make sure all electrical connections are good and tight before power is turned on.
15. Do not touch live electrical parts.
16. Wear dry, hole-free insulating gloves and body protection. Green flame retardant jackets are provided and stored in locker at end of welding area wall. Also wear long pants and foot protection like leather boots. Do not wear materials like nylon or polyester. Blue jeans with no wholes work well.
17. If work area is wet or damp do not weld.
18. Insulate yourself from the ground the metal table and the objects you are welding.
19. Do not touch electrode if you are in contact with the work. Ground, or another electrode from a different machine.
20. Keep panel closed when in use.
21. Clamp ground with good metal to metal contact to the work as close as possible to the weld.
22. Do not weld coated metals, such as galvanized, lead, or cadmium plated steel. These coatings give off toxic fumes.
23. Do not weld on closed tanks such as sealed pipes, paint cans or drums or on combustible materials.
24. Keep all flammable materials out of welding area.
25. Wire from nozzle can penetrate skin and even gloves and clothing do not aim gun at any body parts. Never point nozzle at face. Wire could free itself or if trigger is pulled, the wire could cause injury.
26. If wire fuses to nozzle. Ask for help.
27. Turn off power and return ground and electrode back to their proper locations over the machines. Turn off valve to shield gas. Clean welding splatter from welding tables.
28. Consult Mig Welder Manual. Read all precautions in manual.

Tig Welder

1. The Tig Welder very similar to Mig Welder. One difference is that the Tig does not have a trigger or a spool of wire. Current flows when the pedal is pressed. A filler rod may or may not be used in conjunction with the electrode.
2. Never open the argon shield gas cylinder valve more than one complete turn. Stand to the side of adjustment knob when turning on gas.
3. Cylinders must always be kept in vertical up right position and secured from falling with chains.
4. Do not strike, drop, or apply heat to cylinder.
5. Valve protection caps should be in place whenever cylinders are moved or stored (full or empty).
6. Mark all cylinders "empty" or "MT" with chalk.
7. Valves on empty cylinders should be closed completely.
8. Keep empty cylinders in specified storage areas.
9. Always open cylinder valves slowly and carefully.
10. Turn on vent and move snorkel near where you are welding venting away from you. Welding gives off toxic fumes.

11. Never look at the arc. Wear a welding mask with a minimum of shield 10 protection. Warn others about the arc.
12. Do not wear contacts when welding.
13. Welded metal becomes hot and will burn you. Let recently welded metal cool before handling. Dunking the metal in water can cool it quickly, but may produce hot burning steam. Warn others about potential burn hazards.
14. Make sure all electrical connections are good and tight before power is turned on.
15. Do not touch live electrical parts.
16. Wear dry, hole-free insulating gloves and body protection. Green flame retardant jackets are provided and stored in locker at end of welding area wall. Also wear long pants and foot protection like leather boots. Do not wear materials like nylon or polyester. Blue jeans with no wholes work well.
17. If work area is wet or damp do not weld.
18. Insulate yourself from the ground the metal table and the objects you are welding.
19. Do not touch electrode if you are in contact with the work. Ground, or another electrode from a different machine.
20. Clamp ground with good metal-to-metal contact to the work as close as possible to the weld.
21. Do not weld coated metals, such as galvanized, lead, or cadmium plated steel. These coatings give off toxic fumes.
22. Do not weld on closed tanks such as sealed pipes, paint cans or drums or on combustible materials.
23. Keep all flammable materials out of welding area.
24. Turn off power and return ground and electrode back to their proper locations over the machines. Turn off valve to shield gas.

Arc Welder

1. The Arc welder welds by completing a circuit through a welding rod. The rod and the metal it meets melt and form a weld on contact.
2. Turn on vent and move snorkel near where you are welding venting away from you. Welding gives off toxic fumes.
3. Never look at the arc. Wear a welding mask with a minimum of shield 10 protection. Warn others about the arc.
4. Do not wear contacts when welding.
5. Welded metal becomes hot and will burn you. Let recently welded metal cool before handling. Dunking the metal in water can cool it quickly, but may produce hot burning steam. Warn others about potential burn hazards.
6. Make sure all electrical connections are good and tight before power is turned on.
7. Do not touch live electrical parts.
8. Wear dry, hole-free insulating gloves and body protection. Green flame retardant jackets are provided and stored in locker at end of welding area wall. Also wear long pants and foot protection like leather boots. Do not wear materials like nylon or polyester. Blue jeans with no wholes work well.
9. If work area is wet or damp do not weld.
10. Insulate yourself from the ground the metal table and the objects you are welding.
11. Do not touch electrode if you are in contact with the work. Ground, or another electrode from a different machine.
12. Clamp ground with good metal to metal contact to the work as close as possible to the weld.
13. Do not weld coated metals, such as galvanized, lead, or cadmium plated steel. These coatings give off toxic fumes.
14. Do not weld on closed tanks such as sealed pipes, paint cans or drums or on combustible materials.
15. Keep all flammable materials out of welding area.

16. Turn off power and return ground and electrode back to their proper locations over the machines.

Oxy-Acetylene Torch

1. Never use grease on or around any oxy-fuel apparatus. Even a trace of oil or grease can ignite and burn violently in the presence of oxygen.
2. Keep flames and sparks away from cylinders and hoses. If hoses are damaged do not use, notify your instructor or shop supervisor.
3. Keep combustibles away from welding area.
4. Use oxy-fuel equipment only with gas for which it is intended.
5. Never open the acetylene cylinder valve more than one complete turn. Stand to the side of adjustment knob when turning on gas.
6. Always check for leaks. Acetylene has an odor and you may hear a hissing noise. Never test for gas leak with a flame. If you suspect a leak, notify your instructor or shop supervisor.
7. Never lubricate the adjusting screw with oil or grease. If oil or grease is detected, notify your instructor or shop supervisor.
8. Cylinders must always be kept in vertical up right position and secured from falling with chains.
9. Do not strike, drop, or apply heat to cylinder.
10. Valve protection caps should be in place whenever cylinders are moved or stored (full or empty).
11. Mark all cylinders "empty" or "MT" with chalk.
12. Valves on empty cylinders should be closed completely.
13. Keep empty cylinders in specified storage areas.
14. Always open cylinder valves slowly and carefully.

Oxy-Acetylene Welding (Procedure)

Oxy-Acetylene (OA) welding is extremely versatile, and with enough skill and practice you can use this type of welding for virtually any metal. In fact, the oxy-acetylene flame burns at 6000°F, and is the only gas flame that is hot enough to melt all commercial metals. Oxy-acetylene welding is simple in concept - two pieces of metal are brought together, and the touching edges are melted by the flame with or without the addition of filler rod. This document will help you get started welding using the oxy-acetylene set-up. Read the steps below to get a feel for what is going on, and then get a shop supervisor to walk you through the process the first time.

Advantages of Oxy-Acetylene Welding:

- It's easy to learn.
- The equipment is cheaper than most other types of welding rigs (e.g. TIG welding)
- The equipment is more portable than most other types of welding rigs (e.g. TIG welding)
- OA equipment can also be used to "flame-cut" large pieces of material.

Disadvantages of Oxy-Acetylene Welding:

- OA weld lines are much rougher in appearance than other kinds of welds, and require more finishing if neatness is required.
- OA welds have large heat affected zones (areas around the weld line that have had their mechanical properties adversely affected by the welding process)

Materials Suitable for OA Welding in the Student Shops:

Most steels

Brass

Preparation:

1. Assemble all of the materials needed to make the weld. This includes parts, OA equipment, fixturing, tools, safety mask, gloves, and filler rod.
2. Clean the parts to be welded to remove any oil, rust, or other contaminants. Use a wire brush if needed to remove any rust.
3. Assemble and fixture the parts in place - the parts need to be stable for a good weld line. Ceramic bricks, vise grip clamps, pliers, and C-clamps are available in the welding room for fixturing.
4. Select the nozzle you plan to use for welding. Nozzles come in a variety of sizes, from 000 (for a very small flame - typically used for thin materials) to 3 (for a large flame - needed for thick materials). Larger nozzles produce larger flames and, in general, are more appropriate for thicker material. Choosing the right size nozzle becomes easier with more experience. Ask your instructor, shop supervisor or make some test welds to determine if you are using the right size nozzle.
5. Clean the nozzle. Carbon deposits can build up on the nozzles, which interfere with flame quality and cause backfiring. The cleaning tool has a wide flat blade (with a file-like surface), which is used to clean carbon deposits on the exterior of the nozzle. Use it to scrape any deposits from the flat face of the tip. Use the wire-like files to clean the interior of the nozzle. Pick the largest wire, which will fit inside the nozzle, and the scrape the edges of the hole to remove any carbon buildup.
6. Attach the nozzle to the gas feed line handle with 2 knobs. Don't over torque - the nozzle and hose fitting are both made of brass, which doesn't stand up well to abuse. A snug, finger tight fit is sufficient.
7. Check the pressure levels in the oxygen and acetylene tanks. There should be at least 50 psi in the acetylene tank. The oxygen tank can be used until it is completely empty. If empty ask your instructor or shop supervisor for help changing the bottles. Note: The oxygen used in OA welding is NOT for human consumption. It contains contaminants that could be unhealthy if taken in large quantities.

Lighting the flame

1. Open the main valve on the acetylene tank ~1/2 turn. This charges the pressure regulator at the top of the tank.
2. Open the pressure regulator valve on the acetylene tank and adjust the pressure in the acetylene line to 5 psi. DO NOT pressurize the acetylene over 15 psi - it will explode.
3. Open the acetylene pin valve on the handle of the welding tool, letting acetylene escape. Tweak the pressure regulator valve until the regulator pressure is constant at 5 psi. Close the acetylene pin valve.
4. Open the main valve on the oxygen tank. Turn the valve until it is fully open (until it stops turning).
5. Open the pressure regulator valve on the oxygen tank and adjust the pressure in the oxygen line to 10 psi.
6. Open the oxygen pin valve on the handle of the welding tool, letting oxygen escape. Tweak the pressure regulator valve until the regulator pressure is constant at 10 psi. Close the oxygen pin valve.
7. Slightly open the acetylene valve (~1/8), until you can just barely hear acetylene escaping.
8. Make sure there is no person or anything flammable in the path of the nozzle. Use the striker to ignite the acetylene. The flame should be yellow and will give off a lot of soot.

Adjusting the flame

1. Open the acetylene valve further and watch the flame near the nozzle tip. Add more acetylene until the flame is just about to separate from the tip. (The flame will separate from the tip of the nozzle if you add too much acetylene.) If so, reduce the flow until the flame reattaches to the tip, and then open the valve again to the near-separation point.

2. Slightly open the oxygen pin valve. If the flame goes out, turn off the gases and try again. DO NOT try and ignite the flame with both oxygen and acetylene pin valves open. As the oxygen is added the flame will turn bluish in color.
3. The blue flame will be divided into 3 different color regions - a long yellowish tip, a blue middle section, and a whitish-blue intense inner section. There are three types of flames as described below:
4. Neutral - This type of flame is the one you will use most often in the shop. It is called "neutral" because it has no chemical effect upon the metal during welding. It is achieved by equal parts oxygen and acetylene and is witnessed in the flame by adjusting the oxygen flow until the middle blue section and inner whitish-blue parts merge into a single region.
5. Reducing flame - If there is excess acetylene, the whitish-blue flame will be larger than the blue flame. This flame contains white hot carbon particles, which may be dissolved during welding. This "reducing" flame will remove oxygen from iron oxides in steel.
6. Oxidizing flame - If there is excess oxygen, the whitish-blue flame will be smaller than the blue flame. This flame burns hotter. A slightly oxidizing flame is used in brazing, and a more strongly oxidizing flame is used in welding certain brasses and bronzes.

Welding

1. Apply the flame to the parts to begin heating. Use the region of the flame near the tip of the bluish inner region.
2. The metal will begin to glow. Continue heating both parts being welded until a small pool of welded metal appears near the edge of each of the parts. You must get molten pools on BOTH parts simultaneously to create the weld. This may require adding more heat to one side than the other, and takes some practice.
3. After the molten pools have formed on both sides of the weld, use the flame to gently stir the two pools together to form the weld. This also takes a little practice.
4. After the two pools have joined, slowly move the flame along the weld line, lengthening the pool using metal from both parts. A gentle, circular, swirling motion will help mix the molten metal from both sides as the puddle is lengthened. This process is highly dependent on the materials and part geometries being welded. Practice, practice, practice to get better control. Welding sample parts is a good idea.
5. Continue this process until the entire weld line is complete.
6. Once you're done, turn off the flame. Close the oxygen pin valve first on the brass handle, and then the acetylene valve. Note: Welded parts can remain hot for a LONG time.

Backfiring

Improper operation of the torch may cause the flame to go out with a loud snap or pop. This is called backfire. It is caused by one of a few things. The first thing to do is turn the gas in the torch off, check all the connections and try relighting the torch. Backfiring can be caused by touching the tip against your work piece, overheating of the tip, operating the torch at other than recommended gas pressures, by a loose tip or head or by dirt on the seat.

Shutting Down and Cleaning Up

1. When you're completely finished welding and are ready to quit for the day, you need to clean up.
2. With the flame extinguished and the pin valves closed on the torch handle, close the main valve on the oxygen tank. It should be firmly seated at the bottom.
3. Open the oxygen pin valve to bleed off all of the oxygen in the regulator and feed line. Close the pin valve once the feed line pressure has gone to zero.
4. Fully open the oxygen regulator valve so there is no pressure in the line. DO NOT close the valve, as this will pressurize the line once the tank is open again. In the case of the acetylene, if it is pressurized over 15 psi, it may explode! If you are not sure about doing this properly, ask for help.
5. Repeat steps 1 through 3 for the acetylene line.

6. Return all of the tools to their proper storage places and coil the feed lines around the handle on the gas cylinder cart. Note: Do not remove the nozzle from the feed line. The feed lines should always have a nozzle attached to prevent accidental damage to the threads used to attach the nozzle.

Plasma Cutter

1. Turn on vents. Poisonous fumes may be produced.
2. Wear safety shields for eye protection with at least shield 8 protection when cutting with plasma cutter.
3. Avoid direct contact with arc. Severe burns and/or electrical shock may result.
4. Avoid using cutter in damp wet areas. Electrocution may occur.
5. Keep combustible materials out of welding area.
6. Do not cut containers that contained combustible materials. Explosions may occur.
7. Button shirt pockets, and do not wear pants with cuffs.
8. Wear protective clothing such as welding Jackets, welding gloves, and leather boots.
9. Earplugs are recommended.
10. Do not wear oily or greasy clothes that could catch fire.
11. Make sure equipment is properly grounded.
12. Make sure equipment is properly set up. If you need help with this ask for help.

Metal Chop Saw

1. Wear eye and ear protection.
2. Set up machine on stable work surface where the object you are cutting is supported to reduce risk of the machine falling or being thrown off balance once the cut is made. It is sometimes best to place the machine on a long table or the floor.
3. Do not attempt to cut small pieces of steel.
4. Clamp metal down securely with clamp. Do not attempt to cut metal that is an awkward shape. If the metal comes loose the blade could shatter throwing dangerous shards.
5. Aim sparks away from combustibles and bystanders.
6. Avoid touching metal near cuts. The steel will become very hot and will burn you. It will also be very sharp and could cut you.
7. If you change the angle of the fence, return it to its original position and secure it.
8. Clean and return to cart and the storage room.

Sand-blast Booth

1. Only operate booth with doors closed and window in place.
2. Make sure hands are clean before putting them in the gloves.
3. If window is fogged over, ask instructor or shop monitor to help you change the acetate over the window.
4. Do not aim gun at window or the light.
5. Turn air pressure up to 80 psi.
6. Before opening booth make sure dust is vented out.
7. Avoid getting debris in booth this will clog the line.
8. Do not overload sand hopper. The extra pressure will clog the line.
9. Keep floor clean. Sand is very slippery and you may slip and fall. Clean up sand mess on floor when done.

Spray Room

1. Do all spray painting outside or in the Spray Room with the vent on. Spray painting in the studio will not be permitted.
2. You will notice there are no outlets in the Spray Room. Do not run electrical devices, smoke, or create spark or flame of any kind while painting or while in the Spray Room. An explosion may occur.

3. Wear appropriate respirator to protect against paint fumes.
4. You may leave work in Spray Room to dry, but you must move it as soon as possible.
5. Clean up mess and return all paints to the yellow flame safety cabinet.

Stationary Grinder

11. Do not apply excessive pressure to one spot. This will wear a groove in the grinding-stone and cause your steel to overheat. Keep steel moving.
12. Keep hands as far as possible from the grinding surfaces. Do not grind small pieces.
13. Keep work firmly against the table surfaces and do not tip up objects that could be caught in-between the stones and the tables. This will jam the machine and possibly pull your hands into the grinder. No free hand grinding.
14. Let grinder get up to speed before grinding.