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**SAFETY TEST SHEET: BASIC SAFETY INFORMATION**

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All students will have to complete the required safety test and achieve a score of 90%. You may only miss 6 questions when taking the Safety Test.

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**What this test is:**

You must demonstrate understanding of basic safety regulations related to the Swanson Center for Product Innovation (SCPI) machine shop. Generally speaking, operating in this environment takes care and practice, and you need to understand that a large investment of your time will be necessary to be trained properly.

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**What this test is NOT:**

This test is NOT sufficient training for equipment. The right to use individual machine tools is secured by being trained on those specific machines at a later date.

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**SAFE PRACTICES IN MACHINE SHOP**

Adhering to safety precautions can prevent serious and sometimes fatal accidents. You are responsible for the prevention of accidents in the machine shop, so you are required to know the following safety information, in addition to the information on Material data sheets, and safety rules demonstrated and explained by your instructor.

## FIRE SAFETY

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1. Keep areas in front of fire extinguishing equipment, exits, power off valves and panels free of obstacles
2. Learn location of all shop fire extinguishers.
3. Do not overload electrical circuits.
4. Do not use frayed or defective electrical cords.
5. **In case of fire**, utilize the appropriate fire extinguisher. If the fire cannot be extinguished quickly, **SET OFF FIRE ALARM** and **EVACUATE THE BUILDING**.
6. Report all fires to Instructor immediately.
7. **DO NOT SMOKE** in the Machine Shop at any time.

## Controlling Fires








To produce fire, three elements must be present at the same time.

1. **FUEL:** Any combustible material
2. **HEAT:** Enough to raise the fuel to its ignition temperature.
3. **OXYGEN:** Needed to sustain combustion.

If any one of the three components of a fire is missing, a fire cannot be started, or with the removal of any one, the fire will be extinguished.

## Fire Classifications and Fire Extinguishers

The following are the main classifications of fires and the extinguishers used for each. Generally, in SCPI: red fire extinguishers (A/B/C) are good for most applications and yellow fire extinguishers (D) are for burning/reactive metal fires.

Fire Class	Geometric Symbol	Pictogram	Intended Use	Mnemonic
A			Ordinary solid combustibles	A for "Ash"
B			Flammable liquids and gases	B for "Barrel"
C			Energized electrical equipment	C for "Current"
D		(none)	Combustible metals	D for "Dynamite"



Typical class 'A/B/C', common in SCPI



Class D, for metal fires only

## **GENERAL MACHINE SHOP SAFETY**

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1. **REPORT ALL ILLNESS and INJURY IMMEDIATELY TO INSTRUCTOR.**
2. Always be aware of and adhere to safety precautions in the shop.
3. **REPORT** all conditions, tools, equipment and persons violating ANY safety rules immediately to instructor/supervisor.
4. **DO NOT** play around in shop. Injuries can occur and equipment can be damaged.
5. Place waste materials and rags with toxic or flammable substance such as cleaning solvent, grease and oil, in designated lidded metal containers.
6. **WEAR SAFETY GLASSES IN SHOP AREA AT ALL TIMES.**
7. Adhere to following personal safety precautions when on the shop floor:
  - Wear closed toe and heel shoes to protect feet. No slippers or sandals are allowed. **SAFETY SHOES PROVIDE THE MOST FOOT PROTECTION.**
  - Wear long pants, a shop apron and any other safety equipment required for operation of machine and/or completion of project.
  - Wear short sleeved clothing or roll up sleeves.
  - Secure long hair behind head with hat, hairnet, tie, or other holding device.
  - Remove **ALL** jewelry from wrists, fingers and neck.
  - **DO NOT** wear gloves when operating a machine tool with moving parts.
  - Wear face shield and protective gloves when working with hot items such as heat treating and welding equipment.
8. **DO NOT USE COMPRESSED AIR** to clean your body, clothing or to point at another person, as it may cause damage or injury. Compressed air is used only to operate air driven equipment in the shop.

9. Ensure area is properly ventilated when working with materials that produce fumes.

10. Keep floors and aisles in shop free of materials and tools to prevent trips and falls.

KEEP MATERIALS and TOOLS IN THEIR SPECIFIED LOCATION.

11. Clean up spills immediately to prevent slips and falls. “Floor Dry” powder is available and can be brushed onto spills, swept up, and thrown away.

12. DO NOT BRING GUNS, FIREWORKS OR ANY OTHER WEAPONS INTO THE SHOP.

13. DO NOT MAKE OR GRIND KNIVES IN SHOP.

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### **GENERAL MACHINE AND TOOL SAFETY**

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1. Obtain instructions and approval from the Instructor/supervisor before operating new or unfamiliar machinery.

2. Review safety rules of machine when switching to another machine.

3. Obtain Instructor’s approval of work piece set up before starting machine operation.

4. Ensure instructor or staff member is present before using any machine tool.

5. Ensure required guards are in place and no oil or grease is on floor before turning on machine tool.

6. Ensure guards are kept in place while tool is in use.

7. Only one person operates the switches and controls of a machine, when more than one person is working at the machine.

8. Do not start or stop a machine for another person. Unless you have been specifically asked to do so, or in the case of an **EMERGENCY STOP**

9. Do not touch, talk to, or make loud noises around someone operating a machine tool, as they may get distracted and injure themselves.
10. TURN OFF machine spindle before walking away and when machine is not in use.
11. DO NOT USE machines with "**OUT of ORDER**" tags.
12. Report broken or faulty machines, equipment, or tools to Instructor immediately. DO NOT try to repair or use.
13. DO NOT USE tools having loose handles or other defects. Inform Instructor when any of these conditions are found.
14. Remove chips, dust, burrs and cutting fluid from a machine or part using a brush, towel, file or other removing device. **NEVER** use your fingers or hands.
15. STAND AWAY from moving parts when turning on a machine.
16. Allow machine parts to stop by themselves after turning them off. **NEVER** try to stop with your hand or an object.
17. Secure work piece and parts of a machine properly before starting a machine.
18. Allow moving parts of machine to stop completely before:
  - making adjustments or measurements
  - attaching or removing a tool
  - securing or releasing work piece
  - lubricating machine or changing belts
19. Position splash guards when using coolant/cutting fluid.
20. Carry scribes, dividers, and other sharply pointed or bladed tools with point or blade pointing down. **NEVER CARRY IN POCKETS.**
21. Use files with handles, as tang can severely injure your hand or wrist.

22. Do not attempt to break hardened steel objects without first notching on grinder and wrapping with a rag. When hit, unwrapped pieces of hardened steel can fly across shop and injure someone.

23. Do not use bars or pipes on the handle of a vice to provide additional leverage for tightening vice.

24. Never strike pieces of hardened steel together, such as the faces of two hammers, as sharp chips could fly off.

25. Avoid the following, when using a hand hacksaw, as the blade may break and cause arm or hand injury.

- Loose blade
- Excessive pressure on blade
- Binding or twisting blade while in use

26. Ease up on cutting pressure of hand hacksaw when cut nears completion of cut.

27. Adhere to the following when using a vice.

- use only soft hammers to bend stock in vice
- clamp work piece against the solid vice jaw

28. Adhere to the following when using screwdrivers and punches:

- Never use as a chisel or pry bar
- avoid using screwdrivers that are worn badly or incorrectly ground as they may jump out of slot and cause injury

29. Do not use files to pound or pry. The material of these tools is brittle and may break causing particles to fly at high speeds resulting in serious injury.

30. Adhere to the following regarding use of wrenches to avoid injury.

- Use wrench of correct size to avoid wrench slipping when pressure is applied

- Turn wrench by pulling towards you instead of pushing wrench away
- Never use wrenches while machinery is moving
- Do not hammer on wrench or extend the handle for additional leverage. Use a longer wrench.

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## **GENERAL MATERIAL HANDLING SAFETY**

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1. Lift objects in the shop using following guidelines:
  - lift no more than 50 pounds without assistance
  - Request assistance to lift any object under 50 pounds that you feel is too heavy or awkward to carry
  - Do not engage in weight lifting contests with heavy objects in shop
  - Lift items sitting below waist level by squatting down with knees bent to pick up object, and then standing up with back straight which allows leg muscles to do the lifting
2. Prevent serious cuts when disposing of metal chips by brushing into a carrying container (dust pan) then dumping into designated container or vacuuming up.
3. Prevent serious cuts by removing burrs and sharp edges on material before making layouts, before and after machining or cutting.
4. Move material that is long and/or over 40 pounds using two people.
5. Ensure long pieces of stock that extend into aisles are flagged on end.
6. Do not place round objects on machines, benches, racks or shelves in a way that they can roll or fall off.



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## **BAND SAW SAFETY**

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1. Handle band saw blades with gloves, when installing, to prevent cuts. **DO NOT** WEAR gloves when operating band saws.
2. Ensure your workpiece, hands, rags and any work holding devices are clear of the blade.
3. Ensure all guards are in place before starting the saw.
4. If necessary, secure round or oddly shaped work pieces in a vice prior to cutting.
5. Set top guide on band saw 1/4" above the thickest part of the work piece.
6. Apply pressure to the part using a wooden push stick, **NOT YOUR FINGERS**. Usually, only light pressure is required when using the band saw.
7. Use appropriate SPEEDS and FEEDS relative to material being cut

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## **GRINDER AND BAND SANDER SAFETY**

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## Conventional pedestal grinder

## Band Sander

Generally, at SCPI: the band sander can be used for 99% of grinding and shaping tasks in the shop, whereas the pedestal grinder is reserved for grinding custom tools and sharpening dull tools, both of which are advanced user activities.

### 1. Ensure the following before grinding:

- Wheel guards are in place before turning on machine. Wheel safety guards must cover at least half of the grinding wheel, spark guards on pedestal grinders are adjusted to 1/16" from wheel.

- Wheel is correct for material being ground.

Gray is for HS steel – Aluminum Oxide

Green is for Carbide - Carborundum

**Do not use the grinder for Aluminum.**

### 2. Stand to one side of wheel when grinding.

### 3. DO NOT FORCE work piece into grinder or band sander.

4. Avoid standing in line of grinding wheel, when grinding, whether it is guarded or not. Make sure no one else is standing in line with grinding wheel also.

5. TURN OFF machine when not using it, when taking any measurements, or when walking away from it.

6. DO NOT STOP grinding wheel or band sander with your hand or other objects. Let it come to a complete stop by itself.

### 7. NEVER WEAR GLOVES when operating the grinder or band sander.

### 8. Adhere to the following regarding grinding wheel condition:

- Ensure grinding wheels are rated at proper speed for grinder.

- DO NOT use a cracked grinding wheel as wheel could break apart and fly off causing severe injury.

- DO NOT use wheels that have been dropped as they could be damaged.

9. Adhere to the following when operating pedestal grinders, in addition to the other grinder safety rules:

- DO NOT ADJUST the gap between the grinding wheel and the tool rest. If it looks to be different than **1/16"-1/8"** , inform an Instructor.
- FREQUENTLY cool work piece during grinding to prevent serious burn from overheated work pieces.
- **GRIND ONLY ON FACE OF WHEEL.** Grinding can be done on side only if wheel is designed to do so.
- Hold work piece by hand unless it is very short in which case it should be held with vise grips.

10. Only use the section of the **band sander** that is SUPPORTED by the METAL PLATE; using the unsupported section can cause the band to fray and snap.

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### **DRILL PRESS SAFETY**

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1. Turn off spindle before cleaning, removing chips, oiling, or adjusting drill press.
2. Allow spindle to stop by itself. DO NOT grab chuck to stop it.
3. Place tools on an adjacent table and not on drill press table.
4. Wipe cutting tools clean after use with a shop towel. DO NOT clean with unprotected hands as cuts may occur.
5. Remember that the drill press work table (that can be raised and lowered) must be locked in place prior to drilling
6. Remove metal chips from drill press with a brush and not your hand or compressed air.
7. ALWAYS TURN OFF drill press when walking away from machine or when work is interrupted.

8. **ALWAYS REMOVE CHUCK KEY** immediately after using it, as a key can be thrown off when press is operating.

9. Check the following before starting drill:

- Speed and feed is proper for operation.
- Drill bit or other cutting tool is sharp and in good shape.
- Drill bits or other cutting tools and tool holders are secured properly in spindle.

11. Secure parts for drilling as follows:

- Always secure work piece in a work holding device. **DO NOT HOLD WORK PIECE BY HAND** as it may spin and cause injury.

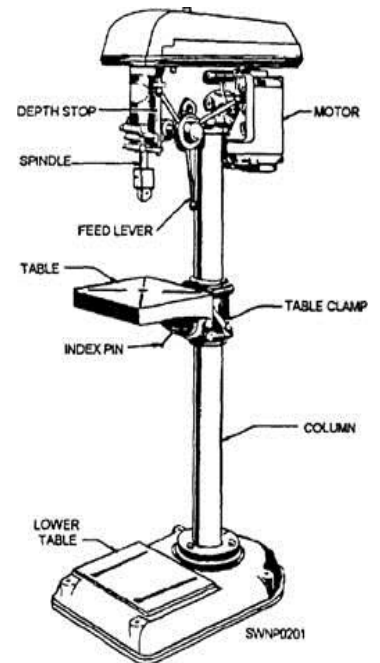
- Clamp large or heavy parts to drill press table when drilling holes 1/2" in diameter.
- **CLAMP THIN SHEET METAL** to table placing a wood block under metal.

12. Use coolant when drilling holes.

13. Slow spindle speed to prevent chattering when countersinking or counter boring.

14. Generally, large drill bits need to be run at low rpm and small drill bits needs to run at high rpm. This is important to make sure the drill behaves properly.

15. If the drill grabs or catches and causes the work piece and vice to start spinning, **TURN OFF THE MACHINE** if it is safe to do so. Do NOT attempt to grab the workpiece to stop it spinning. If the spinning work piece means you can't safely get to the on/off switch, stand FAR back and wait: usually the piece will fall off by itself.



16. DO NOT USE excess force; you may have a dull or improperly sharpened drill bits and need to switch for a better one. Also, breaking through the far side of a part with too much force applied may cause the drill to grab/seize.

17. Adhere to the following when drill starts breaking through bottom of drilled hole:

- Apply less feed pressures
- Use a cutting tool with a zero degree rake angle to prevent drill from grabbing when breaking through brass, bronze, copper, or some plastics.

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## LATHE SAFETY

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1. **BEFORE TURNING SPINDLE ON:** Spin the spindle by hand to make sure the workpiece and/or chuck are not going to collide with anything.

2. STOP machine spindle before:

- Making part measurements, changing tool bits, adjusting tool bits, or changing drive belt positions.
- Mounting chuck or changing collets.
- Reaching over chuck with hand to support file.
- Oiling or replacing cutting fluid.



Pictured: Chuck with chuck key

3. **REMOVE CHUCK KEY FROM SPINDLE BEFORE STARTING LATHE, ALWAYS REMOVE CHUCK KEY immediately after using it, as a key can be thrown off when lathe is turned on.**

4. Use hands to mount lathe chuck; using a tool will overtighten it.
5. Ensure lathe chuck or face plate is secured before machining work piece.
6. It is important to remember that overly long round stock can bend outward when spun with catastrophic results. Make sure your workpiece doesn't extend too far from the front of the collet or chuck, and NEVER allow bar stock to extend out the back of the machine.
7. DO NOT run spindle at high speed, when machining large, heavy work pieces in a lathe chuck.
8. When starting the machine, avoid being "in plane" with the spinning part: standing to the side will ensure that if something goes wrong, you should be safe.
9. Be mindful of where the tool carriage will have to move while machining your part; check that it does not run into the chuck BEFORE you start machining.
10. DO NOT allow sand paper to encircle the work piece when polishing, it can grab and injure you. DON'T WRAP PAPER AROUND WORK PIECE.
11. DO NOT part or cut off stock in lathe when work piece is mounted between centers or using a tail-stock.
12. DO NOT INSERT a hand file inside a rotating tube or pipe as it may get caught and cause an injury.
13. Allow lathe spindle to stop by itself, after machine is shut off. DO NOT TRY to stop lathe by hand or by switching on reverse
14. Remove lathe tools when changing jobs or chucks/collets.
15. To avoid cutting yourself, move the carriage (toolholder) and tailstock (if in use) away from your workpiece before making adjustments or measurements.
16. Learn to file with left hand on lathe work pieces to keep left arm away from revolving lathe chuck. Break sharp edges on work piece before removing from lathe.
17. REMOVE chips from lathe by first stopping machine spindle and then remove chips with a brush, or long chips with pliers or a chip hook. DON'T USE HANDS.

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## MILLING MACHINE SAFETY

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1. When changing between the High and Low RPM gear ratio it is VERY important to:
  - Turn off the spindle and wait for it to come to a complete stop.
  - After the gear ratio is changed, and while the motor is OFF, turn the spindle by hand to make sure the gears are engaged properly.
  - Remember that the motor direction will now be reversed when you turn the spindle on.
2. When changing the RPMs using the rotary dial handle, it is VERY important to:
  - Only do this when the spindle is turning
  - Don't turn the wheel to fast
3. Use care to protect your hands from cuts when handling milling tools and sharp edged work pieces.
4. ENSURE spindle has stopped rotating before securing cutters, accessories, or work pieces, making adjustments and taking measurements.
5. Place tools you are not using on an adjacent table.
6. **ENSURE** work piece, cutter and machine details are secured **TIGHTLY** before starting a milling operation.
7. Loosen locking devices on the machine axis and disengage hand wheels or hand cranks before operating rapid traverse control.
8. Bring work piece to the cutter first using rapid traverse control to bring it to within 6" of cutter, and then move it to cutter with hand wheels or hand cranks. ONLY USE RAPID TRAVERSE WHEN CUTTER IS 2" OR MORE FROM WORK PIECE.

9. Check that spindle rotation is correct and that the cutter is sharp and is the correct size for the job before starting the spindle.

10. Adhere to following when mounting machine accessories or work pieces to machine table:

- Remove any chips and burrs from table with a brush or towel before mounting.
- Ask for help when mounting a heavy object on the milling table, such as a large vise or rotary table.
- Use slot keys to align and prevent vise from moving during heavy milling operations.
- Prevent hand cuts by moving table as far as possible from cutter before mounting work piece.
- Check that cutter and machine parts clear work piece before starting machine.

11. **DO NOT REACH** over cutter, or remove chips from work piece until spindle comes to a complete stop. Use brush to remove cuttings. **DO NOT USE A TOWEL OR HANDS.**

12. Lock whichever axes are **NOT** in use during a given cut. For example: lock the y axis when milling a slot in the x axis direction.

13. When feeling excess vibration or noise, stop machine and check set up. This is an indication of a loose tool, dull tool, loose work holding or improper position of the cutter.

14. Remove vice handle from vice before machining.

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### **LASER SAFETY**

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1. **RESPECT THE SIGN!** If the “LASER IN USE” light is on above the door, do **NOT** enter without proper safety glasses or without knocking first.



2. Make sure you have the CORRECT SAFETY GLASSES! Standard shop safety glasses are NOT laser safe. Our laser safety glasses have fine print written on the side that state they are OD 5+ for 10,000-11,000 nm wavelength radiation.

3. Be aware of your material: many materials are unsafe to cut for fume or fire hazard reasons or will cause damage to the machine if cutting is attempted.

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## **WELDING SAFETY**

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Read and understand the following safety highlights. For additional safety information it is strongly recommended that you purchase a copy of "Safety in Welding & Cutting - ANSI Standard Z49.1 from the American Welding Society. A Free copy of "Arc Welding Safety", booklet E205 is available from the Lincoln Electric Company.

**BE SURE THAT ALL INSTALLATION, OPERATION, MAINTENANCE, AND REPAIR PROCEDURES ARE PERFORMED ONLY BY QUALIFIED INDIVIDUALS.**

### **ELECTRIC SHOCK can kill**

1.a. The electrode and work (or ground) circuits are electrically "hot" when the welder is on. Do not touch these "hot" parts with your bare skin or wet clothing. Wear dry, hole-free gloves to insulate hands.

1.b. Insulate yourself from work and ground using dry insulation. Make certain the insulation is large enough to cover your full area of physical contact with work and ground.

1.c. In semiautomatic or automatic wire welding, the electrode, electrode reel, welding head, nozzle or semiautomatic welding gun are also electrically "hot".

1.d. Always be sure the work cable makes a good electrical connection with the metal being welded. The connection should be as close as possible to the area being welded.

1.e. Ground the work or metal to be welded to a good electrical ground.

1.f. Maintain the electrode holder, work clamp, welding cable and welding machine in good, safe operating condition. Replace damaged insulation.

1.g. Never dip the electrode in water for cooling.

1.h. Never simultaneously touch electrically "hot" parts of electrode holders connected to two welders because voltage between the two can be the total of the open circuit voltage of both welders.

### **ARC RAYS can burn**

2.a. Use a shield with the proper filter and cover plates to protect your eyes from sparks and the rays of the arc when welding or observing open arc welding. Head shield and filter lens should conform to ANSI Z87.1 standards.

2.b. Use suitable clothing made from durable flame-resistant material to protect your skin and that of your helpers from the arc rays.

2.c. Protect other nearby personnel with suitable non-flammable screening and/or warn them not to watch the arc nor expose themselves to the arc rays or to hot spatter or metal.

### **CYLINDER may explode if damaged**

3.a. Use only compressed gas cylinders containing the correct shielding gas for the process used and properly operating regulators designed for the gas and pressure used. All hoses, fittings, etc. should be suitable for the application and maintained in good condition.

3.b. Always keep cylinders in an upright position securely chained to an undercarriage or fixed support.

3.c. Cylinders should be located away from areas where they may be struck or subjected to physical damage and a safe distance from arc welding or cutting operations and any other source of heat, sparks, or flame.

3.d. Never allow the electrode, electrode holder or any other electrically "hot" parts to touch a cylinder.

3.e. Keep your head and face away from the cylinder valve outlet when opening the cylinder valve.

3.f. Valve protection caps should always be in place and hand tight except when the cylinder is in use or connected for use.

**FOR ELECTRICALLY powered equipment**

4.a. Turn off input power using the disconnect switch at the fuse box before working on the equipment.

4.b. Install equipment in accordance with the U.S. National Electrical Code, all local codes and the manufacturer's recommendations.

4.c. Ground the equipment in accordance with the U.S. National Electrical Code and the manufacturer's recommendations.

**FOR ENGINE powered equipment**

5.a. Turn the engine off before troubleshooting and maintenance work unless the maintenance work requires it to be running.

5.b. Operate engine in open, well-ventilated areas or vent the engines exhaust fumes outdoors.

5.c. Do not add the fuel near an open flame, welding arc or when the engine is running. Stop the engine and allow it to cool before refueling to prevent spilled fuel from vaporizing on contact with hot engine parts and igniting. Do not spill fuel when filling tank. If fuel is spilled, wipe it up and do not start engine until fumes have been eliminated.

5.d. Keep all equipment safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing equipment

5.e. In some cases it may be necessary to remove safety guards to perform required maintenance. Remove guards only when necessary and replace them when the maintenance requiring their removal is complete. Always use the greatest care when working near moving parts.

5.f. Do not put your hands near the engine fan. Do not attempt to override the governor or idler by pushing on the throttle control rods while the engine is running.

5.g. To prevent accidentally starting gasoline engines while turning the engine or welding generator during maintenance work, disconnect the spark plug wires, distributor cap or magneto wire as appropriate.

5.h. To avoid scalding, do not remove the radiator pressure cap when the engine is hot.

**FUMES AND GASES can be dangerous**

6.a. Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gasses. When welding, keep your head out of the fume. Use enough ventilation and/or exhaust at the arc to keep fumes and gases away from the breathing zone. When welding with electrodes which require special ventilation such as stainless or hard facing (see instructions on container or MSDS) or on lead or cadmium plated steel and other metals or coatings which produce highly toxic fumes, keep exposure as low as possible and below Threshold Limit Values (TLV) using local exhaust or mechanical ventilation. In confined spaces or in some circumstances, outdoors, a respirator may be required. Additional precautions are also required when welding on galvanized steel.

6.b. Do not weld in locations near chlorinated hydrocarbon vapors coming from degreasing, cleaning or spraying operations. The heat and rays of the arc can react with solvent vapors to form phosgene, a highly toxic gas, and other irritating products.

6.c. Shielding gases used for arc welding can displace air and cause injury or death. Always use enough ventilation, especially in confined areas, to insure breathing air is safe.

6.d. Read and understand the manufacturer's instructions for this equipment and the consumables to be used, including the material safety data sheet (MSDS) and follow your employer's safety practices. MSDS forms are available from your welding distributor or from the manufacturer.

**ELECTRIC AND MAGNETIC FIELDS may be dangerous**

7.a. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding current creates EMF fields around welding cables and welding machines.

7.b. EMF fields may interfere with some pacemakers, and welders having a pacemaker should consult their physician before welding.

7.c. Exposure to EMF fields in welding may have other health effects which are now not known.

7.d. All welders should use the following procedures in order to minimize exposure to EMF fields from the welding circuit:

7.d.1. Route the electrode and work cables together- Secure them with tape when possible.

7.d.2. Never coil the electrode lead around your body.

7.d.3. Do not place your body between the electrode and work cables. If the electrode cable is on your right side, the work cable should also be on your right side.

7.d.4. Connect the work cable to the work piece as close as possible to the area being welded.

7.d.5 Do not work next to welding power source.