

3. SHOP SAFETY

Introduction

The following sections provide general guidelines and requirements for shop safety. This chapter covers the following topics:

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3.1 General Shop Safety

The hazards associated with shop work require special safety considerations. Whether you work in a metal shop, wood shop, automotive shop, glass shop, or electrical shop, the potential hazards for personal injury are numerous. This chapter highlights essential safety information for working in a Texas State University - San Marcos shop. Refer to other chapters in this manual, including General Safety, Electrical Safety, and Fire/Life Safety, for more information on handling many shop situations.

The following table highlights common shop hazards

Potential Hazards	Hazard Sources
Physical: - Compressed air/gases - Flying debris - Noise - Pinching, cutting, amputation - Slipping, tripping - UV radiation	- Oxygen, acetylene, air - Grinders, saws, welders - Any power tool - Vises, power tools, hand tools - Wood/metal chips, electrical cords, oil, etc - Welding
Electrical: - Overload - Fire - Shock	- Too many cords per outlet - Frayed, damaged cords - Ungrounded tools, equipment
Fire: - Flammable chemicals - Sparks - Static sparks - Uncontrolled fire	- Gasoline, degreasers, paint thinners, etc. - Welders, grinders - Ungrounded tools or solvent containers - Lack of appropriate fire extinguishers
Chemical: - Toxic liquids - Toxic fumes, gases, dusts	- Cleaning solvents, degreasers, etc. - Welding, motor exhaust, etc.

It is not possible to detail all the risks involved with shop work. However, it is possible to foresee many hazards by carefully planning each job. To prevent accidents, utilize your knowledge, training, and common sense. Evaluate potential sources of injury, and attempt to eliminate any hazards.

A. Personal Protection

There are several measures you must take to protect yourself from shop hazards. For example, do not wear the following when working around machinery:

- Loose fitting clothing
- Neckties
- Jewelry

If you must wear a long sleeved shirt, be sure the sleeves are rolled down and buttoned. Snug fitting clothes and safety shoes are essential safety equipment in the shop.

Always wear safety glasses with side shields when working with shop equipment. Additional protection using goggles or face shields may be necessary for the following types of work:

- Grinding, Chipping, Sandblasting
- Welding
- Glassworking

Wear approved hard hats whenever there is a chance of objects falling from above. In addition, wear suitable gloves, preferably leather, when working with the following:

- Scrap metal or wood
- Sharp-edged stock
- Unfinished lumber

Refer to the Personal Protective Equipment chapter in this manual for more information.

B. Job Safety

Before beginning work in a shop, be sure you are authorized to perform the work to be done and inspect your tools and equipment. If a procedure is potentially hazardous to others in the area, warn fellow workers accordingly. Use warning signs or barriers, as necessary.

Notify your supervisor if you notice any unsafe conditions such as the following:

- Defective tools or equipment
- Improperly guarded machines
- Oil, gas, or other leaks

Inform other employees if you see an unsafe work practice; however, be careful not to distract a person who is working with power tools.

C. Safety Guidelines

Follow these guidelines for general shop safety:

- Know the hazards associated with your work. Be sure you are fully educated on the proper use and operation of any tool before beginning a job.
- Always wear appropriate safety gear and protective clothing.
- Wear nitrile gloves when cleaning with degreasers or ferric chloride.
- Ensure that there is adequate ventilation to prevent exposure from vapors of glues, lacquers, paints and from dust and fumes.
- Maintain good housekeeping standards.
 - Keep the work area free from slipping/tripping hazards (oil, cords, debris, etc.).
 - Clean all spills immediately.
 - Remove sawdust, wood chips, and metal chips regularly.
 - It is recommended that electrical cords pull down from an overhead pulley rather than lying on the floor.
- Leave tool and equipment guards in place.
- Know where fire extinguishers are located and how to use them.
- Make sure all tools and equipment are properly grounded and that cords are in good condition.
 - Double-insulated tools or those with three-wire cords are essential for safety.
 - Use extension cords that are large enough for the load and distance.
- Secure all compressed gas cylinders. Never use compressed gas to clean clothing or skin.
- Always use flashback arrestors on cutting/welding torches.
- Take precautions against heat stroke and heat exhaustion.
- Wear infrared safety goggles when appropriate.

Refer any questions regarding shop safety to the Facilities Department and/or RMSO.

3.2 Hand Tools

Hand tools are non-powered tools. They include axes, wrenches, hammers, chisels, screw drivers, and other hand-operated mechanisms. Even though hand tool injuries tend to be less severe than power tool injuries, hand tool injuries are more common. Because people take everyday hand tools for granted, they forget to follow simple precautions for safety.

The most common hand tool accidents are caused by the following:

- Failure to use the right tool
- Failure to use a tool correctly
- Failure to keep edged tools sharp
- Failure to replace or repair a defective tool
- Failure to store tools safely

IMPORTANT!

Use the right tool to complete a job safely, quickly, and efficiently.

Follow these guidelines for general hand tool safety:

- Wear safety glasses whenever you hammer or cut, especially when working with surfaces that chip or splinter.
- Do not use a screwdriver as a chisel. The tool can slip and cause a deep puncture wound.
- Do not use a chisel as a screwdriver. The tip of the chisel may break and cause an injury.
- Do not use a knife as a screwdriver. The blade can snap and injure an eye.
- Never carry a screwdriver or chisel in your pocket. If you fall, the tool could cause a serious injury. Instead, use a tool belt holder.
- Replace loose, splintered, or cracked handles. Loose hammer, axe, or maul heads can fly off defective handles.
- Use the proper wrench to tighten or loosen nuts. Pliers can chew the corners off a nut.
- When using a chisel, always chip or cut away from yourself. Use a soft-headed hammer or mallet to strike a wooden chisel handle. A metal hammer or mallet may cause the handle to split.
- Do not use a wrench if the jaws are sprung.
- Do not use impact tools, such as chisels, wedges, or drift pins, if their heads are mushroom shaped. The heads may shatter upon impact.
- Direct saw blades, knives, and other tools away from aisle areas and other employees.
- Keep knives and scissors sharp. Dull tools are more dangerous than sharp tools.
- Iron or steel hand tools may cause sparks and be hazardous around flammable substances. Use spark-resistant tools made from brass, plastic, aluminum, or wood when working around flammable hazards.

Improper tool storage is responsible for many shop accidents. Follow these guidelines to ensure proper tool storage:

- Have a specific place for each tool.
- Do not place unguarded cutting tools in a drawer. Many hand injuries are caused by rummaging through drawers that contain a jumbled assortment of sharp-edged tools.
- Store knives or chisels in their scabbards.
- Hang saws with the blades away from someone's reach.
- Provide sturdy hooks to hang most tools on.
- Rack heavy tools, such as axes and sledges, with the heavy end down

3.3 Insulation

Asbestos, man-made mineral fibers, PVC, and urethane foam can be extreme respiratory hazards. To protect yourself from these and other respiratory hazards, minimize your exposure to particulate matter from insulation, fumes, dusts, and aerosols. Refer to the General Safety chapter for more information on asbestos and respiratory hazards.

3.4 Ladders

Ladders can make many tasks easier, but they are also a continual safety hazard. Even the best ladder is not safe unless you are trained and proficient in using ladders. Each year, many people suffer serious injuries from accidents involving ladders. Before you use a ladder, take a moment to think about doing it safely.

A secure, well made ladder is necessary for safe ladder use. Ladders come in different styles, including step, straight, and extension. They also vary in construction and may consist of wood, aluminum, or fiberglass. Choose the correct type and size ladder for the job. All ladders sold within the U.S. are rated as follows:

- Type IA:
Heavy-duty industrial ladder rated to hold up to 250 pounds.
- Type II:
Medium-duty commercial ladder rated to hold up to 225 pounds.
- Type III:
Light-duty household ladder rated to hold up to 200 pounds.

Follow these guidelines for safe ladder usage:

- Always inspect a ladder before you climb it. Make sure the steps are sturdy and the locking mechanisms are in good working order.
- Carry ladders horizontally with the front end slightly higher than the back end.
- To open a stepladder, make sure the spreader is locked and the pail shelf is in position. To open an extension ladder, brace the bottom end and push the rungs or rails out.
- Place ladders on a solid, level surface to ensure safety:
 - Watch for overhead obstructions and powerlines.
 - To prevent ladders from sinking into soft ground, use a large board under the feet of the ladder.
 - Position a straight or extension ladder so that the base of the ladder is one foot away from the vertical support for every four feet of working ladder height (e.g., if you are working with eight feet of ladder, place the base of the ladder two feet from the wall).
 - Do not place the top of a ladder against a window or an uneven surface.
 - When possible, tie the top of a straight or extension ladder to supports. Stake and tie the feet of the ladder.
 - An extension ladder used for access to a roof must extend at least 3 feet beyond the support point.

- Use a wooden or plastic ladder if you must work near electrical sources.
- Do not place a ladder in front of a door unless you lock and barricade the door and post a warning sign on the opposite side of the door.
- Use common sense when climbing or working on ladders:
 - Wear shoes with slip-resistant soles and make sure they are dry before climbing.
 - Never allow more than one person on a ladder.
 - To climb or descend a ladder, face the ladder and firmly grip the rails, not the rungs, with both hands.
 - Keep your body between the rails at all times. Do not shift your weight to one side.
 - Have someone steady the ladder if it cannot be secured otherwise.
 - Do not stand on the top four rungs of an extension ladder or the top two rungs of a step ladder.
 - When working on a ladder, keep two feet and one hand on the ladder at all times.
 - Do not stand on the bucket shelf of a ladder.
- When working on a ladder, carry small tools on a tool belt. Use a rope to raise and lower heavy tools.
- Never leave a raised or open ladder unattended.
- Store ladders away from heat and moisture. Destroy damaged or unsafe ladders.

3.5 Power Tools

Power tools can be extremely dangerous if they are used improperly. Each year, thousands of people are injured or killed by power tool accidents. Common accidents associated with power tools include abrasions, cuts, lacerations, amputations, burns, electrocution, and broken bones. These accidents are often caused by the following:

- Touching the cutting, drilling, or grinding components
- Getting caught in moving parts
- Suffering electrical shock due to improper grounding, equipment defects, or operator misuse
- Being struck by particles that normally eject during operation
- Touching hot tools or workpieces
- Falling in the work area
- Being struck by falling tools

When working around power tools, you must wear personal protective equipment and avoid wearing loose clothing or jewelry that could catch in moving machinery. In addition to general shop guidelines, follow these guidelines for working with power tools:

- Use the correct tool for the job. Do not use a tool or attachment for something it was not designed to do.
- Select the correct bit, blade, cutter, or grinder wheel for the material at hand. This precaution will reduce the chance for an accident and improve the quality of your work.
- Keep all guards in place. Cover exposed belts, pulleys, gears, and shafts that could cause injury.
- Always operate tools at the correct speed for the job at hand. Working too slowly can cause an accident just as easily as working too fast.
- Watch your work when operating power tools. Stop working if something distracts you.
- Do not rely on strength to perform an operation. The correct tool, blade, and method should not require excessive strength. If undue force is necessary, you may be using the wrong tool or have a dull blade.
- Before clearing jams or blockages on power tools, disconnect from power source. Do not use your hand to clear jams or blockages, use an appropriate tool.
- Never reach over equipment while it is running.
- Never disable or tamper with safety releases or other automatic switches.
- When the chance for operator injury is great, use a push stick to move material through a machine.
- Disconnect power tools before performing maintenance or changing components.
- Keep a firm grip on portable power tools. These tools tend to “get away” from operators and can be difficult to control.
- Remove chuck keys or adjusting tools prior to operation.
- Keep bystanders away from moving machinery.
- Do not operate power tools when you are sick, fatigued, or taking strong medication.
- When possible, secure work pieces with a clamp or vise to free the hands and minimize the chance of injury. Use a jig for pieces that are unstable or do not lie flat.

A. Machine Guards

Moving machine parts must be safeguarded to protect operators from serious injury. Belts, gears, shafts, pulleys, fly wheels, chains, and other moving parts must be guarded if there is a chance they could contact an employee.

As mentioned before, the hazards associated with moving machinery can be deadly. Hazardous areas that must be guarded include the following:

- Point of operation:
Area where the machine either cuts, bends, molds, or forms, the material.
- Pinch/nip point:
Area where moving machine parts can trap, pinch, or crush body parts (e.g., roller feeds, intermeshing gears, etc.).
- Sharp edges
- Stored potential energy

There are three types of barrier guards that protect people from moving machinery. They consist of the following:

- Fixed guards
- Interlocked guards
- Adjustable guards

A fixed guard is a permanent machine part that completely encases potential hazards. Fixed guards provide maximum operator protection.

Interlock guards are connected to a machine's power source. If the guard is opened or removed, the machine automatically disengages. Interlocking guards are often preferable because they provide adequate protection to the operator, but they also allow easy machine maintenance. This is ideal for problems such as jams.

Self-adjusting guards change their position to allow materials to pass through the moving components of a power tool. These guards accommodate various types of materials, but they provide less protection to the operator.

IMPORTANT!

Guards must be in place. If a guard is removed to perform maintenance or repairs, follow lockout/tagout procedures.

Replace the guard after repairs are completed. Do not disable or move machine guards for any reason. If you notice that a guard is missing or damaged, contact your supervisor and have the guard replaced or repaired before beginning work.

NOTE:

Hand-held power tools typically have less guarding in place than stationary power tools. Use extreme caution when working with hand-held power tools and always wear a face shield.

B. Safety Guidelines

In addition to the safety suggestions for general power tool usage, there are specific safety requirements for each type of tool. The following sections cover safety guidelines for these types of tools:

- Drill press
- Grinder
- Jointer and shaper
- Lathe
- Nail/air gun
- Planer
- Forging machines
- Sander
- Saw:
 - Band
 - Circular
 - Radial arm
 - Table

1. Drill Press Safety

Follow these safety guidelines when using drill presses:

- Securely fasten work materials to prevent spinning. Never use your hands to secure work materials.
- Use a center punch to score the material before drilling.
- Run the drill at the correct speed. Forcing or feeding too fast can break drill bits.
- Never attempt to loosen the chuck unless the power is off.
- Lower the spindle before removing a chuck.
- Never use a regular auger bit in a drill press.
- Frequently back the drill out of deep cuts to clean and cool the bit.

2. Grinder Safety

Follow these safety guidelines when working with grinders:

- Ensure that no combustible or flammable materials are nearby that could be ignited by sparks from the grinder wheel.
- Ensure that a guard covers at least 270 degrees of the grinding wheel on bench-mounted machines.
- Place the grinder tool rest 1/8 inch from the wheel and slightly above the center line. Adjust the upper tongue guard to 1/4 inch from the wheel.
- Allow the grinder to reach full speed before stepping into the grinding position. Faulty wheels usually break at the start of an operation.
- Unless otherwise designed, grind on the face of the wheel.
- Use a vise-grip plier or clamp to hold small pieces.
- Slowly move workpieces across the face of wheel in a uniform manner. This will keep the wheel sound.
- Do not grind non-ferrous materials.
- Periodically check grinder wheels for soundness. Suspend the wheel on a string and tap it. If the wheel rings, it is probably sound.
- Replace wheels that are badly worn or cracked.
- Never use a wheel that has been dropped or received a heavy blow, even if there is no apparent damage.
- Before using a new wheel, let it run a few seconds at full speed to make sure it is balanced.

3. Jointer and Shaper Safety

Follow these safety guidelines when using jointers and shapers:

- Ensure that jointers are equipped with cylindrical cutting heads.
- Use a push stick, as necessary.
- Do not use single cutter knives in shaper heads.
- Ensure that knives are balanced and correctly mounted.
- Adjust cut depth before turning the machine on.
- Do not use the jointer for strips that are less than 1 inch wide.

4. Lathe Safety

Follow these safety guidelines when working with wood lathes:

- Examine wood for knots and other defects before placing it in the lathe.
- Ensure that glued materials are set before placing them in the lathe.
- Before turning the lathe on, slowly turn rough materials a few times to ensure they will clear the tool rest.
- Keep hands off the chuck rim when the lathe is moving.
- Hold all wood cutting tools firmly with two hands.
- Start all jobs at the lowest speed. Ensure that materials are in a cylindrical form before advancing to higher speeds. Never turn large diameter materials at a high speed.
- Firmly screw faceplate work to the faceplate. Take care to avoid cutting too deep and hitting the screws.
- Do not cut too deep or scrape too long.
- Remove the "T" rest when sanding or polishing.

Follow these safety guidelines when working with metal lathes:

- Make sure that all gear and belt guards are in place.
- Never leave a chuck wrench in a chuck.
- Keep your hands off chuck rims when a lathe is in operation.
- Do not attempt to screw the chuck onto the lathe spindle with the power on, as it may get cross-threaded and cause injury. Stop the machine, place a board under the chuck, and then screw on by hand.
- Steady rests should be properly adjusted to conform with the material being worked on.
- When filing work in a lathe, always face the head stock and chuck.
- See that tailstock, toolholder, and work are properly clamped before turning on power.
- Never attempt to adjust a tool while the lathe is running.
- Never apply a wrench to revolving work or parts.
- Always use a brush to remove chips; never your hands.
- When possible, use pipe sleeves to cover work protruding from the end of the lathe.
- Before removing your work from the lathe, remove the tool bit.

5. Nail/Air Gun Safety (Pneumatic Fastening Tools)

Nail guns and air guns are powered by compressed air. The main danger associated with pneumatic fastening tools is injury from one of the tool's attachments or fasteners.

Follow these safety guidelines for working with pneumatic tools:

- Ensure that pneumatic tools which shoot nails, rivets, or staples are equipped with a device that keeps fasteners from ejecting unless the muzzle is pressed against a firm surface.
- Never point a tool at items you do not want to fasten.
- Keep your finger off the trigger until you are ready to begin work. Most pneumatic tools have a hair-trigger that requires little pressure to activate the gun.
- Treat air hoses with the same care as an electrical cord.
- Do not drive fasteners into hard, brittle surfaces or areas where the fastener may pass through the material and protrude on the other side.

6. Planer Safety

Follow these safety guidelines for working with planers:

- Examine wood for knots and other defects before placing it in the planer.
- Do not plane against the grain of the wood.
- Let go of the materials as the feeder rolls catch. Do not follow the work with your hands.
- Do not run boards that are more than 2 inches shorter than the distance between the infeed and outfeed rolls.
- Use a push stick if a board stops with its end on the infeed table.
- If a board sticks under the cutter head, turn off the machine to keep from burning the cutter knives.

7. Forging Machines

Once punchers, shears, and benders are activated, it is impossible to stop them until the end of a cycle. Use extreme care when working with these tools.

- Inspection and maintenance:
All forge shop equipment must be maintained in a condition which will insure continued safe operation.
- Hammers and presses:
All hammers must be positioned or installed in such a manner that they remain on or are anchored to foundations sufficient to support them according to applicable engineering standards.

- **Hammers:**
Die keys and shims must be made from a grade of material that will not unduly crack or splinter.
- **Presses:**
All manually operated valves and switches must be clearly identified and readily accessible.
- **Power-driven hammers:**
Every steam or air hammer must have a safety cylinder head to act as a cushion if the rod should break or pull out of the ram.
- **Gravity Hammers:**
Air-lift hammers must have a safety cylinder head.
- **Forging and trimming presses:**
When dies are being changed or maintenance is being performed on the press, insure the following:
 - The power to the pressure is locked out
 - The flywheel is at rest.
 - The ram is blocked with a material of the appropriate strength.
- **Upsetters:**
All upsetters must be installed so that they remain on their supporting foundations.

8. Sander Safety

Follow these safety guidelines for working with circular and belt sanders:

- Ensure that sanding belts are not too tight or too loose. Never operate a sanding disk if the paper is too loose.
- Use the correct grade of abrasive material.
- Ensure that the distance between a circular sander and the edge of the table is not greater than ¼ inch.
- Do not push materials against sanders with excessive force.
- Sand only on the downstroke side of a disk sander.
- Do not hold small pieces by hand. Use a jig for pieces that are difficult to hold securely.

9. Saw Safety

There are numerous types of power saws, such as band saws, circular saws, radial arm saws, saber saws, and table saws. Regardless of the type of saw you use, never reach over the sawline to position or guide materials.

Follow these safety guidelines for working with band saws:

- Set the blade evenly with the proper amount of tension.
- Keep your hands on either side of the cut line. Never reach across the cut line for any reason.
- Do not stand to the right of the band saw.
- Be sure the radius of your cutting area is not too small for the saw blade.
- If you hear a rhythmic click, check the saw blade for cracks.

Follow these safety guidelines for working with circular saws:

- Do not raise the saw any higher than absolutely necessary.
- Fasten a clearance block to the fence when cutting off short pieces.
- Never attempt to clear away scraps with your fingers.
- Do not cut thin tubular materials with a circular saw.
- Ensure that the fence is not in the cut line of the saw.
- Take care when working with warped or twisted lumber.

Follow these guidelines when working with a radial arm saw:

- Push the saw blade against the stop before turning on the power.
- Never place one piece of wood on top of another when using this saw. The top piece may kick over.
- This saw pulls itself into wooden materials. It may be necessary to hold the saw back to prevent it from choking.
- Never leave the saw hanging over the end of the arm.

Follow these guidelines when working with table saws:

- Circular table saws must have a hood over the portion of the saw above the table. The hood must automatically adjust to the thickness of, and remain in contact with, the material being cut
- Circular table saws must have a spreader aligned with the blade. The spreader must be spaced no more than ½ inch behind the largest blade mounted in the saw. Providing a spreader while grooving, dadoing, or rabbeting is not required.
- Circular table saws used for ripping must have non-kickback fingers or dogs.
- Feed rolls and blades of self-feed circular saws must be protected by a hood or guard to prevent the operator's hand from coming in contact with the in-running rolls.

3.6 Spray Paint Booths

When working with paint or painting equipment, it is important to have adequate ventilation and to avoid flames or other sources of ignition. Because most paints, varnishes, and thinners are flammable, spray paint jobs should be conducted in a well-ventilated enclosure such as a spray paint booth. Spray paint booths minimize toxic vapors and flammable fumes while providing adequate ventilation. Always wear personal protective equipment when working with paint. In addition, clean the booths and ventilation ducts frequently to avoid heavy accumulations of paint, dust, and pigment.

3.7 Welding and Cutting (Hot Work Permit)

Welding and cutting are two forms of hot work that require special safety considerations. Unless they are done in a designated shop area, welding and cutting are strictly prohibited without proper authorization, Hot Work Permit.

Before conducting welding or cutting operations, inspect your equipment for the following:

- Welding leads must be completely insulated and in good condition.
- Cutting tools must be leak-free and equipped with proper fittings, gauges, regulators, and flashback devices.
- Oxygen and acetylene tanks must be secured in a safe place.

In addition, follow these guidelines for most welding and cutting procedures:

- Conduct welding and cutting operations in a designated area free from flammable materials. When welding or cutting is necessary in an undesignated or hazardous area, have someone nearby act as a fire attendant.
- Periodically check welding and cutting areas for combustible atmospheres.
- Take care to prevent sparks from starting a fire.
- Remove unused gas cylinders from the welding and cutting area.
- Keep hoses out of doorways and away from other people. A flattened hose can cause a flashback.
- Mark hot metal with a sign or other warning when welding or cutting operations are complete.

The following table provides an overview of welding and cutting hazards:

Potential Hazard	Hazard Source
Electrocution	<ul style="list-style-type: none"> - Damp working conditions - Improper grounding - Improper insulation - Indirect work connection
Hazardous Atmospheres	<ul style="list-style-type: none"> - Confined space - Inadequate ventilation - Electrode (manganese, chromium, etc.) - Base metal coating
Sparks, Fire, Explosion	<ul style="list-style-type: none"> - Flammable materials - Containers that have held combustibles
UV Radiation Burns	<ul style="list-style-type: none"> - Gas arc - Reflective enclosures - Inadequate visor lens - Welding curtain not it use
Confined Space	<ul style="list-style-type: none"> - Atmosphere not monitored - No safety attendant present
Gas Cylinders	<ul style="list-style-type: none"> - Touching cylinder with electrode - Storing cylinders on their side - Unsecured cylinders

A. Welding Guidelines

Proper selection of personal protective equipment is very important when welding; make sure your welding helmet visor is dark enough to provide adequate protection. Wear fireproof apron and gloves. In addition, take care to protect other people from the hazards of welding. For example, use a welding curtain to protect other employees from UV radiation.

There are three types of welders:

■ AC welders:

These welders are used for standard welding procedures. AC welders are powered by an electrical cord.

■ DC welders:

These are portable welders that are commonly used in manholes. DC welders have their own power supply.

■ Wire-feed welders:

These welders use inert gas for light metal work (e.g., stainless steel, aluminum, etc.).

Common hazards associated with welding include the following:

- Electrocutation
- Burns
- UV radiation exposure
- Oxygen depletion
- Sparking

In addition to the general guidelines for welding and cutting, follow these specific guidelines for safe welding operations:

- Make sure the welding area has a nonreflective, noncombustible surface.
- Ensure that adequate ventilation and exhaust are available.
- Be aware of electrocution hazards, particularly in damp conditions. Be sure that electrical cords are properly grounded. It is advisable for cords to pull down from an overhead pulley.

B. Cutting Guidelines

Gas welding and cutting tools are often powered by oxygen or acetylene gas cylinders. These tanks require special safety precautions to prevent explosions and serious injuries. Follow the safety guidelines below, and refer to the Laboratory Safety chapter in this manual for more information on gas cylinder safety:

- Ensure that acetylene/oxygen systems are equipped with flame or flashback arrestors.
- Store acetylene bottles upright and secured. Oxygen cylinders must be shored 20 feet from flammable gases or separated by a fire foot wall.
- Keep cylinder fittings and hoses free from oil and grease.
- Repair or replace defective hoses by splicing. Do not use tape.
- Do not tamper or attempt to repair cylinders, valves, or regulators.
- Do not interchange regulators or pressure gauges with other gas cylinders.
- Carefully purge hoses and torches before connecting a cylinder.
- Set acetylene pressure at or below 15 psig. Always use the minimum acceptable flowrate.
- Never use a match to light a torch. Use an approved lighter.