



Prototyping Lab Safety

*Bush Combat Development Complex
Research Integration Center*

Purpose



Conducting safe operations is our number one priority. This training is intended to introduce BCDC personnel, customers, and visitors to basic safety requirements and procedures in the Prototyping Lab, High Bay, and Motor Pool.

At the conclusion of this training there will be a link to a Safety Test that you will need to complete.

The Prototyping Lab Manager must ensure you are properly trained and authorize you to use each piece of equipment. This training does not grant such authorization.

Rules and Regulations



- Personnel are not allowed to use the equipment in the Prototyping Lab without:
 - Reviewing this presentation and passing the safety test
 - Going through safety training on each of the machines to be used
 - Receiving authorization for each piece of equipment from the Prototyping Lab Manager

- ANSI Z87.1+ safety glasses must be worn at all times in the prototyping area.
- Prescription glasses with safety lenses must be worn with side shields.
- Full length pants which sufficiently cover the shoe opening must be worn at all times.
- Sleeved shirts must be worn at all times. Long sleeves must be rolled up or cuffed or buttoned at the wrist. No loose or dangling sleeves are permitted.
- Watches, rings, lanyards, and dangling jewelry must be removed.
- Long beards must be tucked into the collar of the shirt.
- Hair below the shoulders must be tied up. Ponytails must be tucked into the shirt collar.
- **Only operate equipment that you are properly trained and authorized to use by the Prototyping Shop Manager.**

General Shop Safety – Part 2



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Yes



Hair is tied up and secured in collar.



No



Hair is left hanging.

- All safety features of the machinery shall be properly utilized.
- Extreme care must be exercised when using compressed air to blow chips off machines.
- **DO NOT use compressed air to blow off clothing or skin.**
- No electronic media players, cell phones, or headphones are permitted while operating a machine.
- Cameras may be used to document work progress, as long as they are not being held while operating a machine.
- Ensure no slip/trip hazards are present in workspaces and walkways.
- No one is allowed to use machinery alone. If Prototyping Shop personnel are not in the Shop, you are required to work in pairs. **This is particularly important when using the machines after normal working hours.**

General Shop Safety – Part 4



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First Aid – Part 1



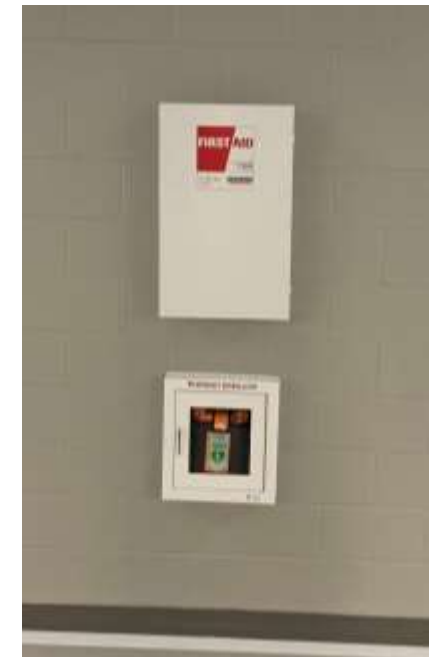
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First Aid kits are located in the Prototyping Lab in the following areas:

- On the East Wall in the Prototyping Lab
- Just through the High Bay doors, above the AED

If you are injured, notify the Prototyping Lab staff as soon as possible.

[Watch First Aid video](#)



Emergency Eyewash stations and showers are located:

- On the North and South Walls in the Prototyping Lab
- In the High Bay opposite the entrance from the Prototyping Lab, by the sink (eyewash only, no shower)
- In the Fume Hood room by the door
- In the Electronics Lab to the right of the main doors
- In the Clean Room
- In the Laser Lab

Fire Extinguishers



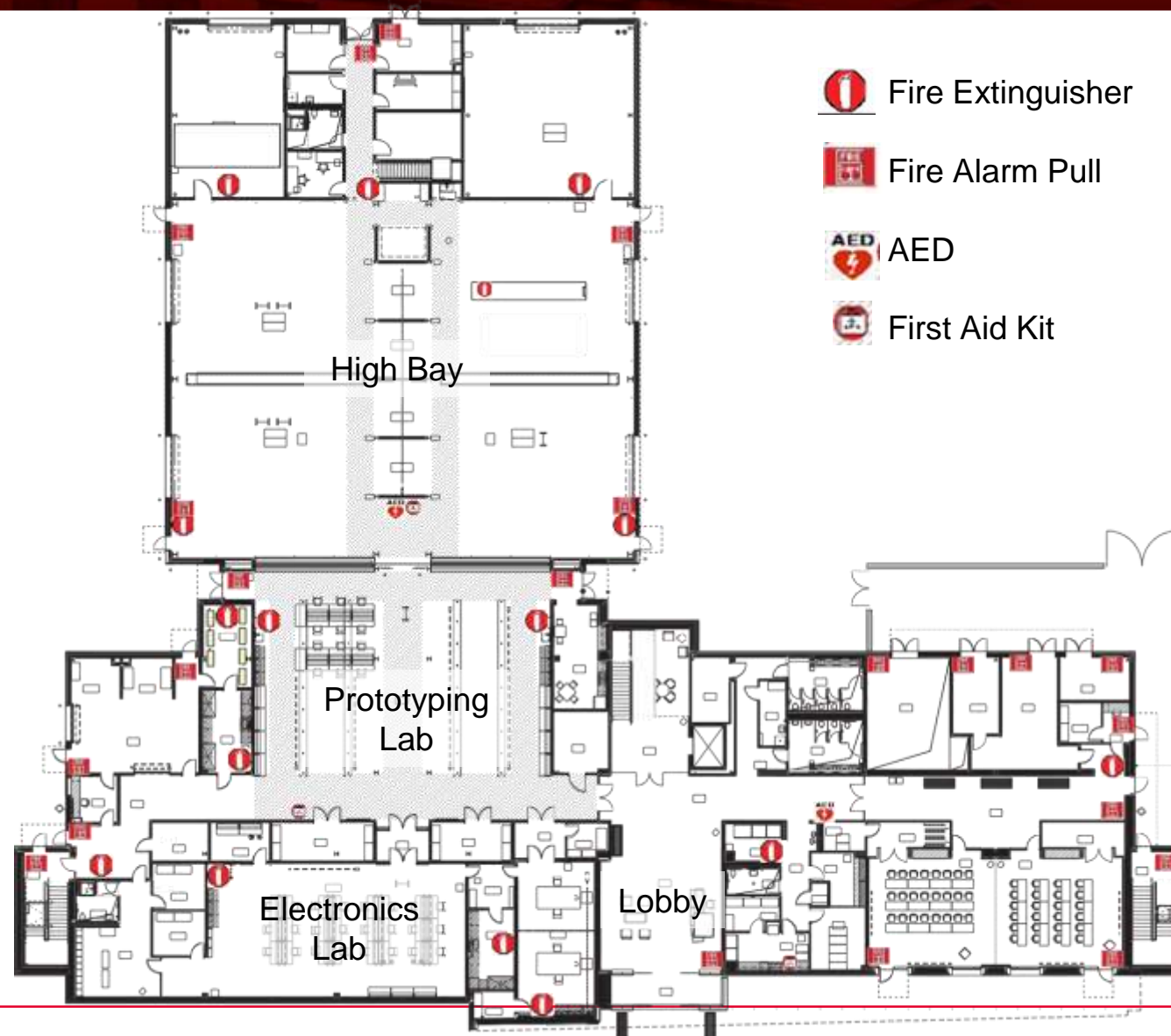
- There are 13 ABC fire extinguishers located in the Prototyping Lab, High Bay, and Lobby.
- Fire Extinguishers are inside a small cabinet, as shown in the pictures.
- Please take this [Fire Extinguisher Training](#).*



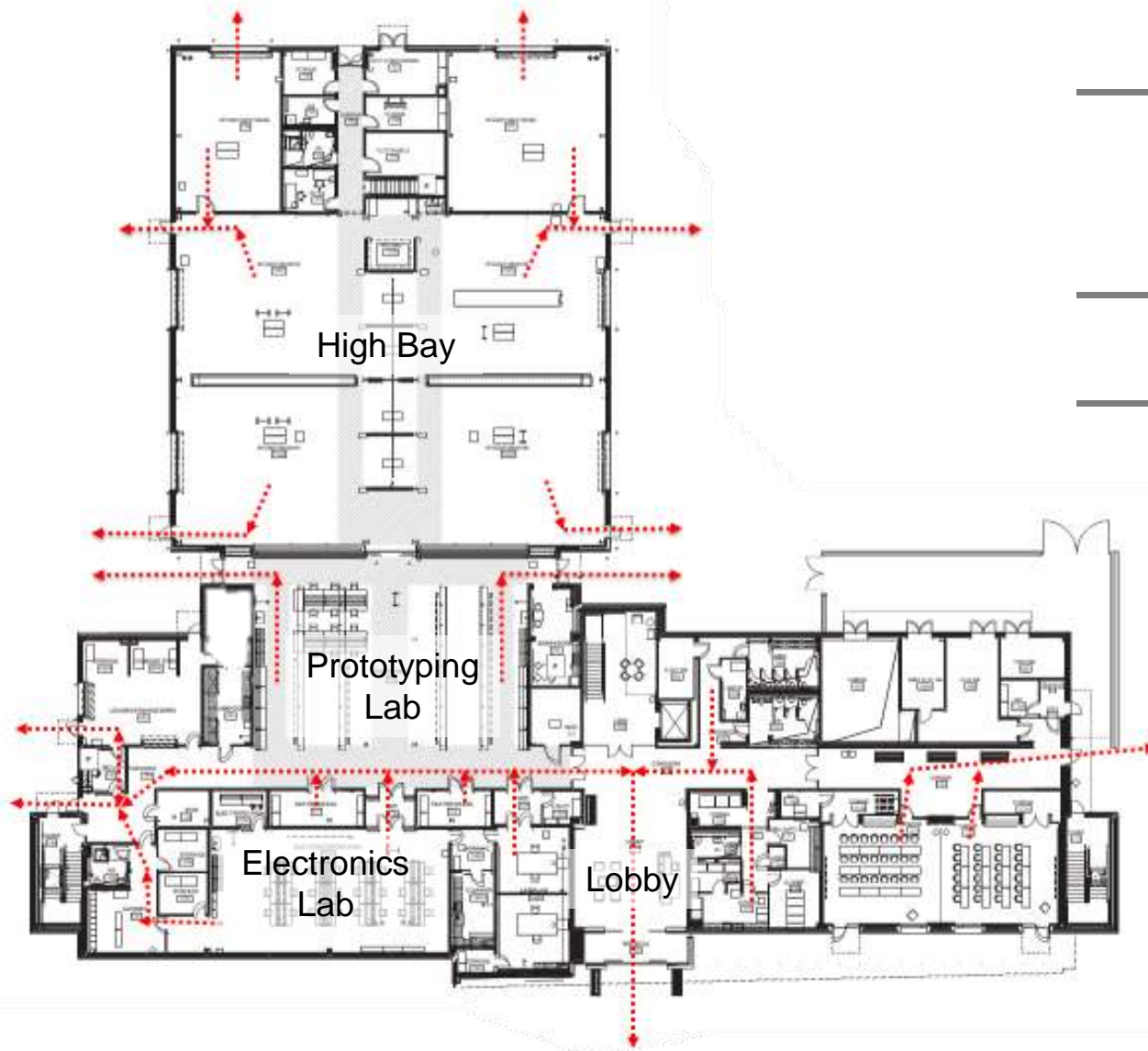
Emergency Equipment Locations



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Emergency Exits – Part 1



- Exit through the nearest Exit Door.
- Meet in front of the RIC.
- Be prepared to account for your team.

Buddy System



- You should always have another person help you lift something heavy, approximately 50 pounds or more.
- Always use proper form when lifting objects; do not lift with your back.

Yes



A buddy was used.

No



He is lifting alone.

Work Cleanup – Part 1



The user of a machine shall be responsible for cleaning each machine after use.

- Clear machine of all chips; may use compressed air.
- Wipe up coolant, tap fluid, or any other residue with shop cloths or paper towels.
- Sweep the floor and dispose of all chips created during work in the appropriate receptacle.
- Leave it cleaner than it was before.
- The customer is responsible for returning all tools to their appropriate locations.
- The Prototyping Lab is not a depository for junk. Any project or other material left in the Prototyping Lab will be discarded, unless special permission is obtained from the Lab Manager.

Work Cleanup – Part 2



Metal Chips/Shavings Disposal



Non-hazardous Trash



Metal Solids and Chips/Shavings
Disposal

Prototyping Shop Tooling



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The Prototyping Shop provides all standard tooling:

- Drills
- Taps
- Endmills
- Hand tools
- Portable drills and hand saws
- Turning and boring tools
- Welding equipment

In the event that a request requires special tooling, the customer will be billed for the special tooling (e.g., a project requires a 6-inch tap, the customer will be billed for the tap).

Prototyping Lab Dress Code



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DRESS CODE MUST BE FOLLOWED.

- ANSI Z87.1+ safety glasses must be worn at all times in the prototyping area.
- Prescription glasses with safety lenses must be worn with side shields.
- Full length pants which sufficiently cover the shoe opening must be worn at all times.
- Sleeved shirts must be worn at all times. Long sleeves must be rolled up or cuffed or buttoned at the wrist. No loose or dangling sleeves are permitted.
- Watches, rings, lanyards, and dangling jewelry must be removed.
- Long beards must be tucked into the collar of the shirt.
- Hair below the shoulders must be tied up. Ponytails must be tucked into the shirt collar.

Manual Mill Safety – Part 1



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- Keep tools and other loose items away from the spindle while it is in motion.
- Never reach over, near, or around a revolving spindle; keep hands at least 12 inches from the revolving spindle.
- Turn off the mill before clearing chips with a brush or soft air blasts.
- Stop the spindle before mounting, measuring, or adjusting the work.
- Never attempt to stop the tool with your hand; allow it to slow to a stop or use the brake.



Manual Mill Safety – Part 2



- When mounting or removing a milling tool from the spindle, always hold it with a cloth to avoid the sharp edges.
- Be sure that both the work and tool are mounted securely before taking a cut.
- Be sure that the tool and machine parts will clear the work before making any cut.
- Do not use an excessively heavy cut or feed. This can cause the tool to break, and the resulting flying pieces may cause injury.
- Keep the floor around the machine free of excess debris.

Manual Mill Safety – Part 3



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Yes



Use the open end of a wrench.

No



Do not use the closed end.

Manual Mill Safety – Part 4



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Yes



Drill bit is held with a drill chuck.



End mill is held with a collet.

No



An end mill should not be held with a drill chuck.



The chuck key should never be left in the drill chuck.

Manual Lathe Safety – Part 1



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Chuck
Wrench



Chip Brushes

ALWAYS REMOVE THE CHUCK WRENCH IMMEDIATELY AFTER USE.

- Keep all tools and other loose items away from the lathe while it is in motion.
- Turn off the lathe before clearing chips with a brush or soft air blasts.
- Stop the lathe before mounting, measuring, or adjusting the work.
- Do not grasp or touch chips or turnings with your fingers.
- Always ensure that chuck or collet will clear the tool post before you start.
- Make sure that the part is securely tightened in the chuck or collet.
- Keep the floor around the machine free of excess debris.

Manual Lathe Safety – Part 3



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Yes



The chuck is clear of tools.

No



The chuck wrench should never be left in chuck.

CNC Mill and Lathe Safety – Part 1



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- Use the buddy system when moving heavy attachments.
- Ensure all tools, chuck wrenches/keys, vise handles, hammers, and other loose items are removed from the machine enclosure.
- Check for damaged parts and tools before operating the machine. Any part or tool that is damaged should be properly repaired or replaced by properly trained and authorized personnel. Do NOT operate the machine if any component does not appear to be functioning correctly.
- **Do NOT operate with the doors open.**
- **This machine can cause severe bodily injury.**
- **This machine is automatically controlled and may start at any time, be aware where you are relative to it.**

- The Emergency Stop button is the large, circular red switch located on the Control Panel. Pressing the Emergency Stop button will instantly stop all motion of the machine, the servo motors, the tool changer, and the coolant pump.
- **Use the Emergency Stop button only in emergencies to avoid crashing the machine.**
- The electrical panel should be closed and the key and latches on the control cabinet should be secured at all times except during installation and service.



Shop Bot CNC Router – Part 1



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Shop Bot CNC Router – Part 2



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- Stop the router before mounting, measuring, or adjusting the work.
- Never attempt to stop the router with your hand.
- Keep shields in place.
- Use the buddy system when moving heavy attachments.
- Keep all tools and other loose items away from the machine while it is in motion.
- Be sure that both the work and tool are mounted securely. Verify clearance of tool path before cutting.
- Do NOT locate metal fasteners in or near the cutting area.

- Check for damaged parts and tools before operating the machine. Any part or tool that is damaged should be properly repaired or replaced by properly trained and authorized personnel. Do NOT operate the machine if any component does not appear to be functioning correctly.
- Keep the floor around the machine free of excess debris.
- Use bits that are clean, sharp and in good condition.
- Use bit manufacturer's recommendation for speed and depth of cut.
- Dust collector must be turned on when router is in operation.

Shop Bot CNC Router – Part 4



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- The machine must be supervised while in operation.
- **This machine can cause severe bodily injury.**
- **This machine is automatically controlled and may start at any time, be aware where you are relative to it.**
- The Emergency Stop button is the red button located on the table, on the tool organizer.
- **Use the Emergency Stop button only in emergencies to avoid crashing the machine.**



Drill Press



ALWAYS REMOVE THE CHUCK KEY FROM CHUCK IMMEDIATELY AFTER USING.

- Keep all tools and other loose items away from the drill press while it is in motion.
- Stop the drill press before mounting, measuring, or adjusting the work.
- Do NOT hold the workpiece, use a clamp to secure it.
- Do NOT force the drill, allow it to work at its own rate.
- Never attempt to stop the drill chuck and spindle with your hand.
- Do NOT remove safeguards and shields.
- Do NOT use if the equipment is not in proper condition.



Press



- Do NOT hold the workpiece, use a clamp to secure it.
- Keep the space under the press clear of all objects that are not being pressed, including fingers.
- Do NOT use if the equipment is not in proper condition.



Chop Saw Safety – Part 1



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- Turn the saw off and wait for the blade to come to a complete stop before clearing scrap.
- **Do not walk away from the Chop saw while it is running.**
- **DO NOT CUT METAL WITH THE CHOP SAW.**
- **Do not cut stock shorter than 6 inches unless you have received special permission from the Prototyping Lab Manager.**
- Only cut stock against the grain of the wood. Never cut stock with the grain of the wood.



Chop Saw Safety – Part 2



- Hold the stock solidly against the fence when making a cut.
- Keep hands and fingers away from the path of the blade when cutting.
- Do not pull or force the saw through the wood faster than the blade is able to cut.
- Hold the saw firmly when cutting. The blade may try to force its way through the cut faster than you want it to. This is called “riding up on the board.”
- **Crosscut only one piece of wood at a time.**
- At the finish of each cut, return the saw to the normal starting position and beware of a bounce back tendency.

Chop Saw Safety – Part 3



- Stop the saw before mounting, measuring, or adjusting the work.
- Never attempt to stop the saw with your hand.
- Be aware of people who are around you before making your cut. Someone could bump your stock while you are cutting and cause an accident.
- Do not remove any guards. Keep them in their proper position.
- Do all measuring and marking of stock to be cut before turning the machine on.
- Keep the floor around the saw free of excess debris.

Band Saw Safety – Part 1



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Vertical
band saws



Horizontal
band saws

Band Saw Safety – Part 2



- Keep all tools and other loose items away from the saw while it is in motion.
- Turn off the saw before clearing away debris.
- Stop the saw before mounting, measuring, or adjusting the work.
- Never attempt to stop the tool with your hand.
- Use coolant when running the horizontal saw unless you are cutting wood or other porous material.

Band Saw Safety – Part 3



- When sawing steel and thin materials (under 1/8”), use a fine-toothed blade.
- When sawing aluminum or thick material (over 1/8”), use a course-toothed blade.
- When sawing round material on the vertical saw, use a vise to hold the work piece.
- When sawing thin material, use a piece of scrap wood under the piece being cut.
- Use a push stick on work pieces that are small.
- **NEVER PUT YOUR FINGERS CLOSE TO THE BLADE WHILE THE MACHINE IS RUNNING.**

Band Saw Safety – Part 4



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Yes

No



A push stick is being used to keep fingers clear of the blade.



No push stick is being used and the fingers are too close to the blade.

Circular Saw Safety – Part 1



- Whenever possible, objects being cut should be laid flat and stabilized by clamps.
- Hold the saw with two hands while cutting.
- Never attempt to hold a piece of wood in the air while cutting with the other hand.
- Adjust the depth of the cut $\frac{1}{8}$ " greater than material thickness.



- Ensure the correct blade is being used (based on the material being cut) and the blade tightness has been checked.
- Always begin operating blade before making contact with the material to be cut.
- Inspect for and remove all nails from lumber before cutting.
- Never cut with a dull blade.
- Unplug the saw when setting depth of cut and changing the blade.

Arc Welding Safety – Part 1



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- ANSI Z87.1+ safety glasses must be worn at all times in the prototyping area.
- Prescription glasses with safety lenses must be worn with side shields.
- Welding hood, leather welding gloves, leather welding coat or heavy-duty denim shirt, denim jeans, and leather boots are required.
- Lanyards and dangling jewelry must be removed.
- Long beards must be tucked into the collar of the shirt.
- Hair below the shoulders must be tied up. Ponytails must be tucked into the shirt collar.
- **APPROVAL FROM PROTOTYPING LAB MANAGER IS REQUIRED EACH TIME ARC WELDING OPERATIONS ARE CONDUCTED.**



Arc Welding Safety – Part 2



- To prevent injury to personnel, extreme caution should be exercised when using any types of welding equipment. Injury can result from fire, explosions, electric shock, or harmful agents. Both the general and specific safety precautions listed must be strictly observed by persons who weld or cut metals.
- Ensure proper ventilation is achieved and use fan to circulate air if necessary.
- Remove all flammable material, such as cotton, oil, gasoline, etc., from the vicinity of welding.
- When welding is done near other personnel, screens should be used to protect their eyes from the arc or reflected glare.

Arc Welding Safety – Part 3



- Before welding or cutting, warn those in close proximity who are not protected to wear proper clothing or goggles by saying, “Arcing!” in a loud voice.
- Remove any assembled parts from the component being welded that may become warped or otherwise damaged by the welding process.
- Do not leave hot rejected electrode stubs, steel scrap, or tools on the floor or around the welding equipment. Accidents and/or fires may occur.
- Keep a suitable fire extinguisher nearby at all times. Ensure the fire extinguisher is in operable condition.
- Mark all hot metal after welding operations are completed. Soapstone is commonly used for this purpose.

Arc Welding Safety – Part 4



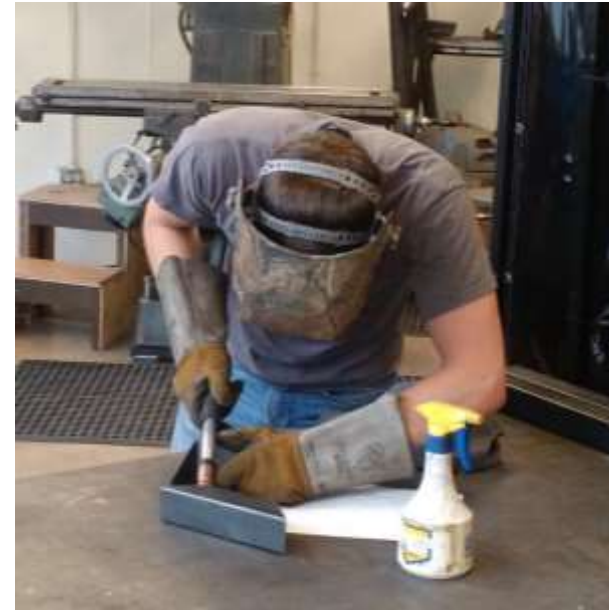
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Yes



Proper PPE is being worn (welding hood, welding jacket, leather welding gloves) and work area is clear.

No



No welding jacket, no sleeves, flammables in the welding area.

Plasma Cutter Safety – Part 1



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- ANSI Z87.1+ safety glasses must be worn at all times in the prototyping area.
- Prescription glasses with safety lenses must be worn with side shields.
- Welding hood, leather welding gloves, leather welding coat or heavy-duty denim shirt, denim jeans, and leather boots are required.
- Lanyards and dangling jewelry must be removed.
- Long beards must be tucked into the collar of the shirt.
- Hair below the shoulders must be tied up. Ponytails must be tucked into the shirt collar.
- **APPROVAL FROM PROTOTYPING LAB MANAGER IS REQUIRED TO EACH TIME PLASMA CUTTING OPERATIONS ARE CONDUCTED.**



- Before welding or cutting, warn those in close proximity who are not protected to wear proper clothing or goggles by saying, “Arcing!” in a loud voice.
- Ensure other people are protected from flashes by closing curtain to welding bay or erecting screens.
- **Ensure material to be cut poses no hazard.** Where possible consult the manufacturers' Material Safety Data Sheets (MSDS) for specific technical data and precautionary measures concerning any materials or coatings on materials cut with this equipment.
- Do not weld or cut containers that have held combustible liquids or gases.
- Ensure no slip/trip hazards are present in workspaces and walkways.

- Ensure the work area is clean and clear of grease, oil, and any flammable materials.
- Keep the equipment, work area and gloves dry to avoid electric shocks.
- Ensure the gloves, handpiece and work leads are in good condition.
- Ensure machine is used in a well-ventilated area, use fan to circulate air if needed.
- Ensure the work leads and hoses do not create a tripping hazard.
- Faulty equipment must not be used. Immediately report suspect equipment.
- Ensure machine is correctly set up for current and airflow.

- Ensure machine is correctly set up for current and airflow.
- Ensure work return cables make firm contact to provide a good electrical connection.
- Metals coated with or containing materials that emit toxic fumes should not be heated or cut unless coating is removed from the work surface.
- Do not leave the plasma cutter running unattended.
- When finished, switch off the machine and fume extraction (where used).
- When finished, turn off air supply and hang up handpiece, hose, and welding cables.
- Leave the work area in a safe, clean, and tidy state.

Grinder/Belt Sander Safety – Part 1



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Belt Sander



Pedestal
Grinder

- A face shield must be worn in addition to the safety glasses.
- **Do not grind aluminum, brass, wood or plastic on the pedestal grinder. Grind only steel or iron on the pedestal grinder.**
- Aluminum, brass, wood, plastic, and steel may be sanded on the belt sander.
- **Do not use gloves or rags to hold parts while grinding or sanding.**
- Quench parts that may become hot in water.
- The tool rest on the pedestal grinder should never be more than 1/8” away from the wheel.
- Inspect grinding wheel before using for debris, chips, or cracks. Report any defects to the Fabrication Shop Manager.

Grinder/Belt Sander Safety – Part 3



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Yes



A face shield and safety glasses are being worn.

No



Safety glasses with no face shield are being worn.

Hand Tool Safety – Part 1



- ANSI Z87.1+ safety glasses must be worn at all times in the prototyping area.
- Prescription glasses with safety lenses must be worn with side shields.
- Long beards must be tucked into the collar of the shirt.
- Hair below the shoulders must be tied up. Ponytails must be tucked into the shirt collar.
- Use tools that are the right size and type for the job.
- Do not work with oily or greasy hands. Sinks are located in the Prototyping Lab.
- Handle sharp edged and pointed tools with care.
- Always carry pointed tools by your side and with the points and heavy ends down.
- Never carry tools in your pocket.
- Never use tools which have loose or cracked handles.

Hand Tool Safety – Part 2



- Keep punches and chisels in good condition. Mushroomed heads can chip and cause injuries.
- Do not use a file without a handle.
- Do not pry or hammer with a file as it may shatter.
- Do not try to increase your leverage with a cheater bar.
- After using a tool, clean and return it to its proper storage location.
- If anything breaks or malfunctions, report it to the Prototyping Shop Manager and mark it as broken.
- Cut away from yourself when you use chisels and other sharp tools.
- Always pull a wrench; you have more control over the tool and there is less chance of injury.
- The wrench should fit snugly around the bolt.

Hand Tool Safety – Part 3



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Yes



Using a pry bar as a pry bar.

No



Using a screwdriver as a pry bar.

Hand Tool Safety – Part 4



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Yes



Using a claw hammer to drive a nail.

No



Using a brass hammer to drive a nail.

Portable Drill Safety – Part 1



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- Drilling boards with nails, paint, gravel, staples, or other foreign materials can dull the drill bit.
- Do not drill into unfixed work pieces.
- Hold the portable electric drill firmly with both hands at all times when drilling.
- Make sure the chuck key has been removed before turning the power on.
- Feed the drill into the material at a constant rate.



Portable Drill Safety – Part 2



- Never make adjustments or while the drill is connected to power or running.
- A drill should be in the off position (between forward and reverse) or be disconnected from power when changing bits or when it is not in use.
- Keep others away from the machine and out of the safety zone.
- Wearing gloves while using the drill is unsafe.
- Drilling into a container that may have once contained or does contain flammable materials could cause a fire or explosion.
- Use a "V" block to hold round or cylindrical stock.

Crane Safety – Part 1



- Before beginning crane operations, ensure the area is clear of any unnecessary personnel.
- A spotter will be used to help keep the path clear and monitor the load.
- Before beginning crane operations perform a thorough inspection of the crane and all attachments.
- Before beginning crane operations, announce, “Crane moving!” in a loud voice.
- Before moving a load, ensure that the path is clear.
- Do NOT overload the crane.

Crane Safety – Part 2



- Do NOT suddenly stop or move loads.
- Do NOT swing loads.
- When crane operations are occurring, obey all instructions from the crane operator and spotter (verbal or gesture).
- Do not walk under a lifted load.
- When in doubt of a safe path, ask or wait for operations to complete.
- When crane operations are complete, safely stow all equipment.

- Autonomous vehicles must be run with a human in the loop (i.e. non-autonomously) in the High Bay and Motor Pool.
- Before conducting vehicle operations, ensure a clear path exists (i.e. no people or objects are in the path).
- Before moving the vehicle, ensure that safety systems are functioning.
- Ensure vehicle is properly maintained.
- Before beginning operations, perform a thorough inspection of the vehicle.
- Limit personnel in the vicinity of the moving vehicle to the minimum necessary for operations.
- Only properly trained and authorized personnel may operate the vehicle.
- Open doors to ensure proper ventilation is established before creating any exhaust in the High Bay.
- Operator will maintain awareness of the area around the vehicle and the intended path.

- Vehicles will not exceed 5 mph in the High Bay and Motor Pool.
- Do NOT stand in front of or behind the powered vehicle.
- NEVER cross the path of the vehicle.
- After operations are complete, replace all necessary safeties on the vehicle.
- Obey all commands from the vehicle operator and the team.
- When in doubt of a safe path, ask or wait until after operations are complete.
- Verify your operations plan with other High Bay users to ensure that your operations will not conflict (including any frequencies used).
- Before operating an autonomous vehicle in the High Bay, announce, “Vehicle moving!” in a loud voice.

- Before conducting vehicle operations, ensure a clear path exists (i.e. no people or objects are in the path).
- 1 ground guide is required when moving vehicles weighing 2 tons or more, vehicles with limited visibility, or military style vehicles (tracked or wheeled) within the Motor Pool (fenced in) area and High Bays.
- 2 ground guides (one front and one rear) are required when backing vehicles weighing 2 tons or more, vehicles with limited visibility, or military style vehicles (tracked or wheeled) within the Motor Pool (fenced in) area and High Bays.
- Ensure vehicle is properly maintained.
- Before beginning operations, perform an inspection of the vehicle.
- Limit personnel in the vicinity of the moving vehicle to a minimum.
- NEVER cross the path of the vehicle.

Manned Vehicle Safety – Part 2



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Yes



Ground Guides placed slightly to the side, both in front and behind the vehicle.

No



Ground Guide placed directly in front of the vehicle.



Ground Guide placed directly behind the vehicle.

Manned Vehicle Safety – Part 3



- Vehicles will not exceed 5 mph in the High Bay and Motor Pool.
- Persons in the vehicle will wear a seatbelt during ALL operations.
- Only properly trained and authorized personnel may operate the vehicle or act as ground guides.
- Do NOT stand directly in front of or behind the powered vehicle.
- Follow all directions from the driver and ground guides.
- The driver will stay vigilant for potential impediments to the vehicle's motion (including people and objects).
- Open High Bay doors to ensure proper ventilation is established before creating any exhaust.
- Before operating a vehicle in the High Bay, announce, "Vehicle moving!" in a loud voice.

Conclusion



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There is a Safety test at the link below. You must get at least an 80% on this test.

[Safety Test](#)

The Prototyping Lab Manager must ensure you are properly trained and authorize you to use each piece of equipment. This training does not grant such authorization.



Thank you.