

Robot Group Project: B3

Shop Safety Manual

Adapted from the University of Florida

FORWARD

The safety of team members, Robot Group personnel, and visitors is a principal consideration in every activity.

The goal of the Project B3 Safety Program is to develop positive attitudes regarding safety among all members of the Robot Group community. It is essential that all B3 members take an active part in initiating preventive measures to control hazards associated with activities under their direction. Safety is an integral part of all programs in which there is a risk of injury or health.

The success of this safety program depends upon the cooperation and support of everyone.

PREFACE

The environmental health and safety standards included in the following sections are furnished for the guidance of all B3 project team members. Compliance with these standards may not, by itself, prevent injuries or diseases, but will substantially aid in providing a safe and healthful environment which is a fundamental prerequisite in controlling accidents and injuries. It is, therefore, of vital importance that everyone become familiar with those sections and standards in this Manual that pertain to the operation(s) under their control.

It should be understood that these are minimum standards that apply to all B3 operations. Most are drawn from existing standards promulgated by either state or federal occupational safety and health regulation. The remainder are derived from various consensus standards published by nationally recognized private organizations such as: National Fire Protection Association, American National Standards Institute, American Conference of Governmental Industrial Hygienists, National Safety Council, and others.

General Safety Rules

General

1. Team members or project visitors shall not turn on, use, repair, or operate any machine, tool, vehicle, crane, electricity, gas, steam, air, acid, caustic or other dangerous material or equipment in the B3 project area unless authorized by the group.
2. Safety guards and devices associated with machinery shall be used. Removal or non-use will not be authorized.
3. Approved personal protective equipment shall be worn when the exposure indicates the need for it, i.e., head and ear protection, face and eye protection, respiratory equipment, safety belts, protective footwear, etc. (See Section "Personal Protective Equipment" for more details).
4. Only tools, equipment, and machinery that is properly maintained and adjusted may be used on the project.
5. Other people's tools may not be modified unless authorized by that person.
6. Floors must be kept free of debris or substance that might constitute a tripping or slipping hazard. Members responsible for any such spill shall clean it up immediately.
7. Horseplay, running and practical jokes are prohibited in buildings because of potential slipping, tripping and collision hazards.

Clothing & Safe Dress

1. Members will wear clothing appropriate to their work assignments. Clothing will be in reasonably good condition and clean.
2. Team Members are responsible for ensuring that their guests are informed as to the requirements for wearing apparel that is suitable for the type of work to be performed and the hazards involved.
3. For those working with machinery or in other hazardous operations, clothing should be well fitted, with no loose or flowing appendages. Sleeves, if full length, should be buttoned at the wrist. The practice of working without a shirt is not approved.
4. Unless working conditions dictate otherwise, Members must wear shoes while at work. Shoes should be well-fitted with good soles and heels and of a style that completely covers the foot. Open-toe shoes, or light-weight shoes of the canvas "sneaker" type may not be safe. Safety shoes or safety toe caps are recommended in foot-hazardous work. Because of sanitation and liability, persons with bare feet should not be allowed within Robot Group buildings.

5. **Members with long hair who work around moving machinery must wear adequate hair covering to preclude the possibility of entanglement.**
6. **Jewelry such as rings, pendants, necklaces, earrings, watches shall not be worn when they constitute a hazard, i.e. working around moving machinery, electrical or electronics equipment, etc.**

Electrical Safety

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Reference 29CFR1910.301-308

General:

The cause of electrical accidents, like most other accidents, is often rooted in human behavior. Ignorance, neglect or carelessness in the use of electrical equipment and appliances are the chief causes of electrical accidents.

Appliances:

- A. Appliances should bear the label of Underwriters Laboratory (UL) or Factory Mutual (FM) or other recognized national testing agencies, indicating that they have been tested and approved for safe operation. All electrical units that are to be used in laboratories or other areas with hazardous concentrations of flammable gases or vapors shall be approved for Class I, Division I locations.
- B. All electrical equipment and cords should be inspected periodically by team members to insure proper use and safe condition. Be sure that all electrical equipment is properly grounded (3-prong plugs).
- C. Never use electrical equipment and appliances where flammable vapors, gases, or dust are present unless devices are known to be explosive proof.
- D. Heating appliances such as coffee pots, microwave ovens, etc, should always be placed on a non-combustible surface and away from combustible materials. All electrical units should be disconnected when not in use.

Panels and Wiring:

Circuit breaker panels and electrical wiring shall not be modified in any way without prior approval by the other team members. All circuit breakers shall be identified by label according to service area to facilitate power shut-off in case of emergency.

Extension Cords:

A. Never overload an extension cord with too many appliances. This practice can cause fires.

A rule of thumb to remember in preventing this type of hazard is to add up the number of " amps" or "watts" required by the appliances you intend to use with a single extension cord, then compare that total with the "amp" or "watt" rating imprinted on the extension cord label. Remember that the capacity of the extension cord should always be equal or exceed the number of amps drawn by the appliances it serves.

B. Extension cords should not be used on a permanent basis to supplement existing outlets to provide electricity for appliances and equipment in regular use.

Where there is a permanent need for an electrical outlet, one should be installed.

C. Do not attempt to obscure an extension cord from view by tacking, nailing or stapling to walls, ceilings or similar structures. Nails, tacks, and staples penetrate the protective insulation of the cord and possibly expose bare wiring creating hazards of electrical shock, as well as fire.

D. Do not hide extension cords under rugs, behind furniture or run them through doorways.

All of these practices result in damage to the cord and will cause electrical shock or fire.

E. When removing a plug from a receptacle, do not pull the cord. The plug should, be held firmly and pulled. When plugs are removed by pulling the cord, the connection between the plug and the cord is weakened and the blades on the plug become distorted. When this connection is weakened to the point that live wires are exposed, or poor electrical contact results from distorted blades, the hazards of electric shock and fire appear once again.

F. When using an adapter to facilitate the use of a cord with a three prong plug on a two hole receptacle, be sure to observe the following:

- 1. Insert adapter into receptacle.**
- 2. Provide grounding by fastening the green grounding "ear" attached to the adapter to the screw securing the receptacle face plate.**
- 3. Be sure that the receptacle itself is grounded.**
- 4. If in doubt, consult an electrician.**

Guidelines on Electrical Extension Cords:

- A. No extension cords used for permanent appliances and equipment shall exceed ten (10) feet in length as measured from the wall receptacle to the equipment plug. Extension cords for portable tools or emergency power may be greater than ten (10) feet in length provided the gauge of the wire used is sufficient for the power required and length involved.
- B. Only three-wire type extension cords that are Underwriters Laboratories (UL) or other recognized agency approved shall be used; they will provide the capability of grounding related electrical equipment.
- C. Extension cord wire shall be a minimum of No. 16 gauge for all portable appliances and equipment.
- D. Extension cords shall be provided with attachment plugs or connectors of the same or greater rating as the equipment being used.
- E. Multiple plug-on attachments on extension cords shall not be used.
- F. Only surge protector/circuit breaker "bars" are permitted. Extension cords are not to run through walls, doorways passageways or work spaces. They should not be hung over nails, fastened by staples or used in any other way that may damage the cord insulation.
- G. All extension cords shall be Used in continuous lengths, without splices or breaks in insulation or any frayed or worn area. .

Selection and use of work practices.

- A. General. Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazard.
- B. Lockout/Tagout. Refer to policy for guidance.
- C. Vehicular and mechanical equipment. Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 ft. (305 cm) is maintained. If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10kV over that voltage. However, under any of the following conditions, the clearance may be reduced:
 - (1) If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 ft. (122 cm). If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10kV over that voltage.

(2) If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

(3) If the equipment is an aerial lift insulated for the voltage involved, and if the work is performed by a qualified person, the clearance (between the uninsulated portion of the aerial lift and the power line) may be reduced to the distance given in Table S-5.

Members standing on the ground may not contact the vehicle or mechanical equipment or any of its attachments, unless:

(1) The member is using protective equipment rated for the voltage; or

(2) The equipment is located so that no uninsulated part of its structure (that portion of the structure that provides a conductive path to members on the ground) can come closer to the line than permitted in paragraph (c)(30)(iii) of this section.

If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, members working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions such as the use of barricades or insulation, shall be taken to protect members from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounding point.

- D. Confined or enclosed work spaces. When a member works in a confined or enclosed space (such as a manhole or vault) that contains exposed energized parts, the member shall use protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swing into a member causing the member to contact exposed energized parts.
- E. Portable ladders. Portable ladders shall have nonconductive side rails if they are used where the member or the ladder could contact exposed energized parts.
- F. Conductive apparel. Conductive articles of jewelry and clothing (such as watch band, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread or metal headgear) may not be worn if they might contact exposed energized parts. However, such articles may be worn if they are rendered nonconductive by covering, wrapping, or other insulating means.
- G. Housekeeping Duties. Where live parts present an electrical contact hazard, members may not perform housekeeping duties at such close distances to the parts that there is a possibility of contact, unless adequate safeguards *(such as insulating equipment or barriers) are provided. Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized

parts unless procedures are followed which will prevent electrical contact.

Lockout & Tagout Procedures

General

A. This procedure establishes the minimum requirements for the Lockout or Tagout of energy isolating devices. It will be used to ensure that the machine or equipment is isolated from all potentially hazardous energy, and locked out and tagged out before members perform any servicing or maintenance activities where the unexpected start-up, or release of stored energy could cause injury.

B. Lockout/Tagout requirements **do not** apply to cord and plug connected equipment if the equipment is unplugged and the plug is in the **exclusive** control of the member who is performing the equipment servicing or maintenance.

Responsibility

A. Appropriate members will be instructed in the safety significance of the lockout and tagout procedure.

B. The Group will ensure that all members that are required to perform lockout/tagout Procedures have been properly trained and are using lockout/tagout procedures.

C. Each new member and other members whose work operations are or may be in the area will be instructed in the purpose and use of the lockout and tagout procedures.

D. The purpose and use of lockout/tagout procedures will be reviewed with members annually during Group safety meetings.

Procedure

A. General Lockout/Tagout Procedures.

1. Standardized lockout/tagout tags and fastening devices are available for purchase.
2. Persons applying these tags to switches, valves, etc. will clearly place their names and the date applied in the space provided.
3. A one-piece nylon cable tie will be used to attach the tagout tags.
4. The tags will be applied in a manner, which clearly indicates the movement of energy isolating devices from the "safe", or "off" position to "on" is prohibited. When the tag cannot be affixed directly to the energy isolating device, the tag will be located in a conspicuous position as close as safely possible to the device.

5. Lockout devices should be used in conjunction with tagout procedures.

B. Preparation for Lockout or Tagout

Before beginning to service or perform maintenance activities, members will make a survey to locate and identify all isolating devices to make certain which switch(es), valve(s), or other energy isolating devices apply to the equipment to be tagged or locked out. More than one energy source (electrical, mechanical, or others) may be involved.

C. Sequence of Lockout/Tagout System Procedure.

1. Notify all affected members that a lockout or tagout system is going to be used and the reason for its use.
2. If the machine or equipment is operating, shut it down by the normal stopping procedure (depress stop button, open toggle switch, etc.).
3. Operate the switch, valve, or other energy isolating devices. Stored energy (such as that in springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as repositioning, locking, bleeding down, etc.
4. Lockout and/or tagout the energy isolating devices with assigned tag(s) or locks.
5. After ensuring that no people are exposed, operate the push button or other normal operating controls to make certain the equipment will not operate.

CAUTION: Return operating control(s) to "neutral" or "off" after the test.

6. The equipment is now locked or tagged out.

D. Restoring machines or equipment to normal production operations.

1. After the servicing and/or maintenance is complete, reinstall all guards and remove all tools. When the equipment is ready for normal operation, check the area around the equipment to ensure that no one is exposed.
2. Ensure all members are in the clear.
3. Remove all lockout or tagout devices.
4. Operate the energy isolating devices to restore energy to the machine or equipment.

E. Procedure involving More Than One Person.

1. In the preceding steps, if more than one individual is required to lockout or tagout equipment, each person shall place his/her own personal device on the energy isolating devices.
2. When an energy isolating device cannot accept multiple locks or tags, a multiple lockout or tagout device (hasp) may be used.
3. If lockout is used, a single lock may be used to lockout the machine or equipment with the key being placed in a lockout box or cabinet which allows the use of multiple locks to secure it. Each member will then use his/her own lock to secure the lockout box or cabinet. As each person no longer needs to maintain his or her

lockout device, that person will remove his/her lock from the lockout box or cabinet.

F. Basic Rules for Using the Lockout or Tagout System Procedure.

1. All equipment will be locked or tagged out to protect against accidental or inadvertent operation when such operation could cause injury to personnel or damage to machinery.
2. Do not attempt to operate any switch, valve, or other energy when it is locked or tagged out.

Reference

This procedure was developed in compliance with instructions contained in 29 CFR Part 1910.147, Control of Hazardous Energy Source (Lockout/tagout); Final Rule, OSHA, Department of Labor, September 1, 1989. Consult that document for additional information and guidance.

Guarding of portable powered tools

29CFR1910.243

Portable powered tools

(1) Portable circular saws.

(i) All portable, power-driven circular saws having a blade diameter greater than 2 in. shall be equipped with guards above and below the base plate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to covering position.

(2) Switches and controls.

(i) All hand-held powered circular saws having a blade diameter greater than 2 inches, electric, hydraulic or pneumatic chain saws, and percussion tools without positive accessory holding means shall be equipped with a constant pressure switch or control that will shut off the power when the pressure is released. All hand-held gasoline powered chain saws shall be equipped with a constant pressure throttle control that will shut off the power to the saw chain when the pressure is released.

(ii) All hand-held powered drills, tappers, fastener drivers, horizontal, vertical, and angle grinders with wheels greater than 2 inches in diameter, disc sanders with discs greater than 2 inches in diameter, belt sanders, reciprocating saws, saber, scroll, and jig saws with blade shanks greater than a nominal one-fourth inch, and other similarly operating powered tools shall be equipped with a constant pressure switch or control, and may have a lock-on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

(iii)

{a} All other hand-held powered tools, such as, but not limited to, platen sanders, grinders with wheels 2 inches in diameter or less, disc sanders with discs 2 inches in diameter or less, routers, planers, laminate trimmers, nibblers, shears, saber, scroll, and jig saws with blade shanks a nominal one-fourth of an inch wide or less, may be equipped with either a positive "on-off" control, or other controls as described by paragraph (a)(2)(i) and (ii) of this section.

{b} Saber, scroll, and jig saws with nonstandard blade holders may use blades with shanks which are nonuniform in width, provided the narrowest portion of the blade shank is an integral part in mounting the blade.

{c} Blade shank width shall be measured at the narrowest portion of the blade shank when saber, scroll, and jig saws have nonstandard blade holders.

{d} "Nominal" in this subparagraph means + or - 0.05 inch.

(iv) The operating control on hand-held power tools shall be so located as to minimize the possibility of its accidental operation, if such accidental operation would constitute a hazard to employees.

(v) This subparagraph does not apply to concrete vibrators, concrete breakers, powered tampers, jack hammers, rock drills, garden appliances, household and kitchen appliances, personal care appliances, medical or dental equipment, or to fixed machinery.

(3) Portable belt sanding machines. Belt sanding machines shall be provided with guards at each nip point where the sanding belt runs onto a pulley. These guards shall effectively prevent the hands or fingers of the operator from coming in contact with the nip points. The unused run of the sanding belt shall be guarded against accidental contact.

(4) Cracked saws. All cracked saws shall be removed from service.

(5) Grounding. Portable electric powered tools shall meet the electrical requirements of subpart S of this part.

Pneumatic powered tools and hose

(1) Tool retainer. A tool retainer shall be installed on each piece of utilization equipment which, without such a retainer, may eject the tool.

(2) Airhose. Hose and hose connections used for conducting compressed air to utilization equipment shall be designed for the pressure and service to which they are subjected.

Portable abrasive wheels

(1) General requirements. Abrasive wheels shall be used only on machine provided with safety guards as defined in paragraph (c) (1) through (4) of this section.

(i) Exceptions. The requirements of this paragraph Acts shall not apply to the following classes of wheels and conditions.

{a} Wheels used for internal work while within the work being ground;

{b} Mounted wheels used in portable operations 2 inches and smaller in diameter.

(ii)

{a} A safety guard shall cover the spindle end, nut and flange projections. The safety guard shall be mounted so as to maintain proper alignment with the wheel, and the strength of the fastenings shall exceed the strength of the

guard.

{b} Exception. Safety guards on all operations where the work provides a suitable measure of protection to the operator may be so constructed that the spindle end, nut and outer flange are exposed. Where the nature of the work is such as to entirely cover the side of the wheel, the side covers of the guard may be omitted.

{c} Exception. The spindle end, nut, and outer flange may be exposed on portable machines designed for, and used with, type 6, 11, 27, and 28 abrasive wheels, cutting off wheels, and tuck pointing wheels.

(2) Cup wheels. (Types 6 and 11) shall be protected by:

(i) Safety guards as specified in paragraph Acts of this section; or,

(ii) Special "revolving cup guards" which mount behind the wheel and turn with it. They shall be made of steel or other material with adequate strength and shall enclose the wheel sides upward from the back for one-third of the wheel thickness. The mounting features shall conform with all regulations. (See paragraph (c)(5) of this section.) It is necessary to maintain clearance between the wheel side and the guard. The clearance shall not exceed one-sixteenth inch; or,

(iii) Some other form of guard that will insure as good protection as that which would be provided by the guards specified in paragraph Acts (i) or (ii) of this subparagraph.

(3) Vertical portable grinders. Safety guards used on machines known as right angle head or vertical portable grinders shall have a maximum exposure angle of 180 deg., and the guard shall be so located so as to be between the operator and the wheel during use. Adjustment of guard shall be such that pieces of an accidentally broken wheel will be deflected away from the operator.

(4) Other portable grinders. The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on other portable grinding machines shall not exceed 180 deg. and the top half of the wheel shall be enclosed at all times.

5) Mounting and inspection of abrasive wheels.

(i) Immediately before mounting, all wheels shall be closely inspected and sounded by the user to make sure they have not been damaged in transit, storage, or otherwise. The spindle speed of the machine shall be checked before mounting of the wheel to be certain that it does not exceed the maximum operating speed marked on the wheel.

(ii) Grinding wheels shall fit freely on the spindle and remain free under all grinding conditions. A controlled clearance between the wheel hole and the machine spindle (or wheel sleeves or adaptor(s) is essential to avoid excessive pressure from mounting and spindle expansion. To accomplish this, the machine spindle shall be made to nominal (standard) size plus zero minus .002 inch, and the

wheel hole shall be made suitably oversize to assure safety clearance under the conditions of operating heat and pressure.

(iii) All contact surfaces of wheels, blotters, and flangers shall be flat and free of foreign matter.

(iv) When a bushing is used in the wheel hole it shall not exceed the width of the wheel and shall not contact the flanges.

(6) Excluded machinery. Natural sandstone wheels and metal, wooden, cloth, or paper discs, having a layer of abrasive on the surface are not covered by this paragraph.

Explosive actuated fastening tools

(1) General requirements.

(i) Explosive-actuated fastening tools which are actuated by explosives or any similar means and propel a stud, pin, fastener, or other object for the purpose of affixing it by penetration to any other object shall meet the design requirements in "American National Standard Safety Requirements for Explosive-Actuated Fastening Tools," ANSI A10.3-1970. This requirement does not apply to devices designed for attaching objects to soft construction materials, such as wood, plaster, tar, dry wallboard, and the like, or to stud welding equipment.

(ii) Operators and assistants using tools shall be safeguarded by means of eye protection. Head and face protection shall be used, as required by working conditions, as set forth in Subpart I.

(2) Inspection, maintenance, and tool handling -

(i) High-velocity tools. Tools of this type shall have the characteristics outlined in (a) through (h) of this section.

{a} The muzzle end of the tool shall have a protective shield or guard at least 3 ½ inches in diameter, mounted perpendicular to and concentric with the barrel, and designed to confine any flying fragments or particles that might otherwise create a hazard at the time of firing.

{b} Where a standard shield or guard cannot be used, or where it does not cover all apparent avenues through which flying particles might escape, a special shield, guard, fixture, or jig designed and built by the manufacturer of the tool being used, which provides this degree of protection, shall be used as a substitute

{c} The tool shall be so designed that it cannot be fired unless it is equipped with a standard protective shield or guard, or a special shield, guard, fixture, or jig.

{d}

{1} The firing mechanism shall be so designed that the tool cannot fire during loading or preparation to fire, or if the tool should be dropped while loaded.

{2} Firing of the tool shall be dependent upon at least two separate and distinct operations of the operator, with the final firing movement being separate from the operation of bringing the tool into the firing position.

{e} The tool shall be so designed as not to be operable other than against a work surface, and unless the operator is holding the tool against the work surface with a force at least 5 pounds greater than the total weight of the tool.

{f} The tool shall be so designed that it will not operate when equipped with the standard guard indexed to the center position if any bearing surface of the guard is tilted more than 8 deg. from contact with the work surface.

{g} The tool shall be so designed that positive means of varying the power are available or can be made available to the operator as part of the tool, or as an auxiliary, in order to make it possible for the operator to select a power level adequate to perform the desired work without excessive force.

{h} The tool shall be so designed that all breaching parts will be reasonably visible to allow a check for any foreign matter that may be present.

(ii) Tools of the low-velocity-piston type shall have the characteristics outlined in paragraphs (d)(2)(ii) (a) through (e) of this section and any additional safety features he may wish to incorporate.

{a} The muzzle end of the tool shall be designed so that suitable protective shields, guards, jigs, or fixtures, designed and built by the manufacturer of the tool being used, can be mounted perpendicular to the barrel. A standard spell shield shall be supplied with each tool.

{b}

{1} The tool shall be designed so that it shall not in ordinary usage propel or discharge a stud, pin, or fastener while loading or during preparation to fire, or if the tool should be dropped while loaded.

{2} Firing of the tool shall be dependent upon at least two separate and distinct operations of the operator, with the final firing movement being separate from the operation of bringing the tool into the firing position.

{c} The tool shall be so designed as not to be operable other than against a work surface, and unless the operator is holding the tool against the work surface with a force at least 5 pounds greater than the total weight of the tool.

{d} The tool shall be so designed that positive means of varying the power are available or can be made available to the operator as part of the tool, or as an auxiliary, in order to make it possible for the operator to select a power level

adequate to perform the desired work without excessive force.

{e} The tool shall be so designed that all breaching parts will be reasonably visible to allow a check for any foreign matter that may be present.

(iii) Tools of the hammer-operated piston tools - low-velocity type shall have the characteristics outlined in paragraphs (d)(2)(iii) (a) through (e) of this section.

{a} The muzzle end of the tool shall be so designed that suitable protective shields, guards, jigs, or fixtures, designed and built by the manufacturer of the tool being used, can be mounted perpendicular to the barrel. A standard spell shield shall be supplied with each tool.

{b} The tool shall be so designed that it shall not in ordinary usage propel or discharge a stud, pin, or fastener while loading, or during preparation to fire, or if the tool should be dropped while loaded.

{c} Firing of the tool shall be dependent upon at least two separate and distinct operations of the operator, with the final firing movement being separate from the operation of bringing the tool into the firing position.

{d} The tool shall be so designed that positive means of varying the power are available or can be made available to the operator as part of the tool, or as an auxiliary, in order to make it possible for the operator to select a power level adequate to perform the desired work without excessive force.

{e} The tool shall be so designed that all breaching parts will be reasonably visible to allow a check for any foreign matter that may be present.

(3) Requirements for loads and fasteners.

(i) There shall be a standard means of identifying the power levels of loads used in tools.

(ii) No load (cased or caseless) shall be used if it will accurately chamber in any existing approved commercially available low-velocity piston tool or hammer operated piston tool - low-velocity type and will cause a fastener to have a mean velocity in excess of 300 feet per second when measured 6.5 feet from the muzzle end of the barrel. No individual test firing of a series shall exceed 300 feet per second by more than 8 percent.

(iii) Fasteners used in tools shall be only those specifically manufactured for use in such tools.

(4) Operating requirements.

(i) Before using a tool, the operator shall inspect it to determine to his satisfaction that it is clean, that all moving parts operate freely, and that the barrel is free from obstructions.

(ii) When a tool develops a defect during use, the operator shall immediately cease

to use it, until it is properly repaired.

(iii) Tools shall not be loaded until just prior to the intended firing time. Neither loaded nor empty tools are to be pointed at any workmen.

(iv) No tools shall be loaded unless being prepared for immediate use, nor shall an unattended tool be left loaded.

(v) In case of a misfire, the operator shall hold the tool in the operating position for at least 30 seconds. He shall then try to operate the tool a second time. He shall wait another 30 seconds, holding the tool in the operating position; then he shall proceed to remove the explosive load in strict accordance with the manufacturer's instructions.

(vi) A tool shall never be left unattended in a place where it would be available to unauthorized persons.

(vii) Fasteners shall not be driven into very hard or brittle materials including, but not limited to, cast iron, glazed tile, surface-hardened steel, glass block, live rock, face brick, or hollow tile.

(viii) Driving into materials easily penetrated shall be avoided unless such materials are backed by a substance that will prevent the pin or fastener from passing completely through and creating a flying-missile hazard on the other side.

(ix)

{a} Fasteners shall not be driven directly into materials such as brick or concrete closer than 3 inches from the unsupported edge or corner, or into steel surfaces closer than one-half inch from the unsupported edge or corner, unless a special guard, fixture, or jig is used. (Exception: Low-velocity tools may drive no closer than 2 inches from an edge in concrete or one-fourth inch in steel.)

{b} When fastening other materials, such as a 2 by 4-inch wood section to a concrete surface, it is permissible to drive a fastener of no greater than 7/32-inch shank diameter not closer than 2 inches from the unsupported edge or corner of the work surface.

(x) Fasteners shall not be driven through existing holes unless a positive guide is used to secure accurate alignment.

(xi) No fastener shall be driven into a spalled area caused by an unsatisfactory fastening.

(xii) Tools shall not be used in an explosive or flammable atmosphere.

(xiii) All tools shall be used with the correct shield, guard, or attachment recommended by the manufacturer.

(xiv) Any tool found not in proper working order shall be immediately removed

from service. The tool shall be inspected at regular intervals and shall be repaired in accordance with the manufacturer's specifications.

Power lawnmowers

(1) General requirements.

(i) Power lawnmowers of the walk-behind, riding-rotary, and reel power lawnmowers designed for sale to the general public shall meet the design specifications in "American National Standard Safety Specifications for Power Lawnmowers" ANSI B71.1-X1968. These specifications do not apply to a walk-behind mower which has been converted to a riding mower by the addition of a sulky. Also, these specifications do not apply to flail mowers, sicklebar mowers, or mowers designed for commercial use.

(ii) All power-driven chains, belts, and gears shall be so positioned or otherwise guarded to prevent the operator's accidental contact therewith, during normal starting, mounting, and operation of the machine.

(iii) A shutoff device shall be provided to stop operation of the motor or engine. This device shall require manual and intentional reactivation to restart the motor or engine.

(iv) All positions of the operating controls shall be clearly identified.

(v) The words, "Caution. Be sure the operating controls is in neutral before starting the engine," or similar wording shall be clearly visible at an engine starting control point on self-propelled mowers.

(2) Walk-behind and riding rotary mowers.

(i) The mower blade shall be enclosed except on the bottom and the enclosure shall extend to or below the lowest cutting point of the blade in the lowest blade position.

(ii) Guards which must be removed to install a catcher assembly shall comply with the following:

{a} Warning instructions shall be affixed to the mower near the opening stating that the mower shall not be used without either the catcher assembly or the guard in place.

{b} The catcher assembly or the guard shall be shipped and sold as part of the mower.

{c} The instruction manual shall state that the mower shall not be used without either the catcher assembly or the guard in place.

{d} The catcher assembly, when properly and completely installed, shall not create a condition which violates the units given for the guarded opening.

(iii) Openings in the blade enclosure, intended for the discharge of grass, shall be limited to a maximum vertical angle of the opening of 30 deg. Measurements shall be taken from the lowest blade position.

(iv) The total effective opening area of the grass discharge openings shall not exceed 1,000 square degrees on units having a width of cut less than 27 ½ inches, or 2,000 square degrees on units having a width of cut 27 ½ inches or over.

(v) The word "Caution." or stronger wording, shall be placed on the mower at or near each discharge opening.

(vi) Blades shall stop rotating from the manufacturer's specified maximum speed within 15 seconds after declutching, or shutting off power.

(vii) In a multipiece blade, the means of fastening the cutting members to the body of the blade or disc shall be so designed that they will not become worn to a hazardous condition before the cutting members themselves are worn beyond use.

(viii) The maximum tip speed of any blade shall be 19,000 feet per minute.

(3) Walk-behind rotary mowers.

(i) The horizontal angle of the openings in the blade enclosure, intended for the discharge of grass, shall not contact the operator area.

(ii) There shall be one of the following at all openings in the blade enclosure intended for the discharge of grass:

{a} A minimum unobstructed horizontal distance of 3 inches from the end of the discharge chute to the blade tip circle.

{b} A rigid bar fastened across the discharge opening, secured to prevent removal without the use of tools. The bottom of the bar shall be no higher than the bottom edge of the blade enclosure.

(iii) The highest pointers) of the front of the blade enclosure, except discharge openings, shall be such that any line extending a maximum of 15 deg. downward from the horizontal toward the blade shaft axis (axes) shall not intersect the horizontal plane within the blade tip circle. The highest pointers) on the blade enclosure front, except discharge-openings, shall not exceed 1 ¼ inches above the lowest cutting point of the blade in the lowest blade position. Mowers with a swingover handle are to be considered as having no front in the blade enclosure and therefore shall comply with paragraph (e)(2)(i) of this section.

(iv) The mower handle shall be fastened to the mower so as to prevent loss of control by unintentional uncoupling while in operation.

(v) A positive upstop or latch shall be provided for the mower handle in the normal operating position(s). The upstop shall not be subject to unintentional disengagement during normal operation of the mower. The upstop or latch shall

not allow the center or the handle grips to come closer than 17 inches horizontally behind the closest path of the mower blade(s) unless manually disengaged.

(vi) A swing-over handle, which complies with the above requirements, will be permitted.

(vii) Wheel drive disengaging controls, except deadman controls, shall move opposite to the direction of the vehicle motion in order to disengage the drive. Deadman controls shall automatically interrupt power to a drive when the operator's actuating force is removed, and may operate in any direction to disengage the drive.

(4) Riding rotary mowers.

(i) The highest pointers) of all openings in the blade enclosure, front shall be limited by a vertical angle of opening of 15 deg. and a maximum distance of 1 1/4 inches above the lowest cutting point of the blade in the lowest blade position.

(ii) Openings shall be placed so that grass or debris will not discharge directly toward any part of an operator seated in a normal operator position.

(iii) There shall be one of the following at all openings in the blade enclosure intended for the discharge of grass:

{a} A minimum unobstructed horizontal distance of 6 inches from the end of the discharge chute to the blade tip circle.

{b} A rigid bar fastened across the discharge opening, secured to prevent removal without the use of tools. The bottom of the bar shall be no higher than the bottom edge of the blade enclosure.

(iv) Mowers shall be provided with stops to prevent jackknifing or locking of the steering mechanism.

(v) Vehicle stopping means shall be provided.

(vi) Hand-operated wheel drive disengaging controls shall move opposite to the direction of vehicle motion in order to disengage the drive. Foot-operated wheel drive disengaging controls shall be depressed to disengage the drive. Deadman controls, both hand and foot operated, shall automatically interrupt power to a drive when the operator's actuating force is removed, and may operate in any direction to disengage the drive.

Compressed Gas Cylinders: Use and Storage

General

Compressed gas cylinders are found throughout the Robot Group. Their storage and use pose a serious potential hazard for all members who may be in the vicinity of or who may handle gas cylinders.

Member's Responsibility

It is the responsibility of Group and team members where gas cylinders are used to see that the following safety rules are observed. They are also responsible to see that all visitors under their supervision who use gas cylinders have been trained in the safe methods for storage, handling, and use of compressed gas cylinders.

Federal and State Codes and Regulations

The Federal and State Codes and regulations are practical and essential if compressed gases are to be used safely.

Handling and Use of Compressed Gas Cylinders

- A. All compressed gas cylinders (regardless of size) shall be secured to racks, walls, work benches, or hand trucks by a strong chain or strap, or secured by any other approved method capable of preventing the cylinder from falling or being knocked over.
- B. All questionable gas cylinders or equipment shall be reported immediately to the supplier for correction or replacement.
- C. All cylinders shall be clearly labeled to identify the contents.
- D. Only personnel trained in the proper transportation and safe use of gas cylinders should handle cylinders.
- E. Compressed gases shall be used only in areas with adequate ventilation for the gas being used.
- F. Cylinders shall not be intentionally dropped, struck, or permitted to violently strike each other and shall be reasonably protected from violent impact of any kind.

- G. All cylinders shall be kept far enough away or shielded while in the work area in order to prevent contact with sparks, flame, or radiant heat.
- H. Valve protection caps are required on all cylinders that are threaded to accommodate a cap unless the cylinder valve is actually connected for use to a regulator or manifold.
- I. All gas cylinders shall be equipped with a functioning gas regulator while in use.
- J. No one shall attempt to connect a regulator and/or accessory equipment by the use of improvised hookups or adapters.
- K. When personnel have finished using a compressed gas cylinder for the day, the cylinder valve shall be closed and the pressure in the regulator and associated equipment released.
- L. If a compressed gas is used to maintain a static pressure on a closed system, a clearly visible warning sign shall be posted indicating the approximate pressure the system is under and the gas involved.
- M. All empty cylinders shall have their valves closed.
- N. All empty cylinders shall be handled with the same care as full cylinder.
- O. Compressed gas or compressed air shall not be used for cleaning purposes (to blow dust and debris away) without appropriate reduction valves (30 p.s.i. maximum).
- P. Under no conditions shall a person direct high pressure gas at another person.
- Q. While in use, all cylinders of flammable gases shall be protected by a flashback protection device approved by the EH&S Division.
- R. Cylinders of flammable gas shall not be opened more than 1-1/2 turns of the cylinder valve to allow for quick closing. If a special wrench is required, the wrench shall be left in position on the stem of the valve while the cylinder is in use. This allows the gas flow to be shut off quickly in case of an emergency.
- S. All oxygen or nitrous oxide cylinders and manifolds shall be at least 20 feet away from or separated by a one-hour rated fire resistant partition from all flammable gases and materials (such as oil, grease, and all petroleum products in general) in the area of use.
- T. All manifold enclosures for oxygen and nitrous oxide in excess of 2000 cubic feet of manifold capacity shall be vented to the outside and the cylinder or manifold shall be protected with check valves or alarms.
- U. Due to the possibility of an explosion, all regulators and other equipment used for oxygen shall be identified as being "OXYGEN ONLY" and the equipment used for other gases shall not be used for oxygen.
- V. Due to the possibility of an explosion, all oxygen regulators, tubing, etc. shall be kept clean and free of all organic materials such as oil and lint.
- W. In the event a particularly hazardous gas (e.g., phosgene, hydrogen chloride, hydrogen cyanide) is used, a procedure shall be established for evacuating, sealing, and isolating the area of use. The EH&S Division shall be notified prior to procuring such hazardous gases.

- X. Only personnel properly instructed in the chemical and biological hazards of a corrosive and/or toxic gas are to release or use the gas or operate any equipment using the particular gas.
- Y. All team members are to have available the necessary emergency treatment and first aid supplies and be able to administer or have administered the necessary first aid that may be required as a result of any hazardous gas being used.

Transportation of Compressed Gas Cylinders

- A. Only personnel of sufficient physical stature and strength are physically to move gas cylinders so as to minimize any potential hazard resulting from the size and weight of the cylinders.
- B. When cylinders are moved, they shall be disconnected from any regulators or manifolds, and where threaded to accept protective valve caps, the valve caps shall be secured in place before the cylinders are released from their securing device.
- C. Cylinders shall be moved only on a hand truck or other cart designed for handling gas cylinders.
- D. No more than one cylinder shall be handled at a time except on carts designed to transport more than one cylinder.

Storage of Compressed Gas Cylinders

- A. Compressed gas cylinder storage areas must be in a fire resistant enclosure located away from emergency exits and must be kept well-drained, well-ventilated, cool, and protected from the weather. Regardless of size, all cylinders shall be provided with supports (straps, chains, or other similar devices) capable of preventing the cylinders from falling.
- B. Under no Condition shall the temperature of gas cylinders exceed 50°(125°F). When Type E gas cylinders are being not exceed 34°C (93°F) since the relief valves of Type E cylinders are set to release above 35°C.
- C. Excessive storage time shall be prevented by the use of the smallest practical size cylinder for a particular gas application.
- D. Corrosive gases shall not be stored for more than six (6) months. Usually after this period of time, there is a deterioration of the gas purity which increases the possibility of cylinder valve malfunction.
- E. Oxygen or nitrous oxide shall not be stored in the same area with flammable gases unless separated by at least 20 feet or by a one-hour rated fire resistant partition. Cylinders stored in an area outside a building must be a minimum distance of 20 feet from flammable gases or combustible material.
- F. All storage rooms that contain in excess of 2000 cubic feet of oxygen and/or nitrous

oxide shall be vented to the outside.

Personal Protective Equipment

General

This section addresses eye, face, head, hand and foot protection. Separate programs exist for respiratory and hearing protection.

Members will supply personal protective equipment (PPE) for themselves and will use them whenever doing so will reduce the likelihood of an injury and/or illness. PPE is not a substitute for engineering or administrative controls, or good work practices, but should be used in conjunction with these controls.

Responsibilities

Since we have no formal Supervisory members, each member will share the responsibility for implementation of the PPE Program in their work area. This includes:

- Conducting a hazard assessment in their work area.
- Determining what type of PPE is required.
- Ordering the necessary equipment.
- Ensuring they are trained on the proper use, care and cleaning of PPE.
- Ensuring their team-mates are wearing the PPE.
- Seeking assistance to evaluate hazards as needed.
- Maintaining records on hazard assessments.
- Replacing their defective or damaged equipment immediately.

Members have the primary responsibility for wearing and cleaning the assigned PPE in accordance with the training received.

The B3 Team as a whole has the primary responsibility for the development, implementation and administration of the PPE Program. This includes:

- Assisting in conducting hazard assessments.
- Providing training and technical assistance to members on the proper use, care, and cleaning of approved PPE.
- Providing guidance to members for the selection and purchase of approved PPE.

Hazard Assessment and PPE Selection

The Team will conduct a walk-through survey of each work area to identify potential hazards. Each survey will be documented. A guideline for filling out the assessment follows the actual form. The hazard assessment should be dated and signed as the written certification and filed with the Team records.

Protective Devices

All PPE will be appropriate for the work to be performed and maintained in a clean condition. Equipment must meet American National Standards Institute (ANSI) standards. Gloves must be selected based on style, size and performance characteristics of the glove in relation to the hazards encountered. (Note: currently there is no ANSI standard for hand protection).

Training

Members who wear PPE need to be knowledgeable in the following:

- Which PPE is necessary

- When PPE is necessary
- How to properly adjust and wear their PPE
- The limitations of the PPE
- The proper care, decontamination and maintenance of PPE
- The proper disposal of the PPE

Eye and Face Protection

Members must use appropriate eye or face protection when exposed to hazards from flying particles, liquid chemicals, acids or caustics, chemical gases or vapors, or injurious light radiation. Eyewear shall comply with ANSI Z87.1 as indicated by labels on the PPE. When there is a hazard from flying objects, side protectors meeting ANSI standards must be used. Examples where this protection is needed includes:

- carpenters
- electricians
- machinists
- mechanics
- pipe fitters
- sheet metal workers
- sanders
- grinders
- welders
- laboratory workers
- groundskeepers
- tractor operators
- pesticide sprayers

Those members wearing prescription glasses need to wear approved safety glasses that incorporate the prescription into the glasses or wear goggles over the prescription glasses.

Visitors or others passing through an identified eye hazard area need to wear appropriate eyewear also. An ample supply of visitor safety glasses should be available for use.

Occupational Foot Protection

Members working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole shall wear protective footwear. All safety footwear shall comply with ANSI Z41-1991. Examples at UF where this protection is needed includes:

- Hazardous Waste Management
- Solid Waste Management
- Demolition or Construction Work
- Landscaping
- Steamfitters
- Furniture Moving Crews

Head Protection

All members must wear a hard hat when there is a danger from impact and/or penetration from falling objects in any work location. Where there is a possibility of hitting the head on protruding objects or pipes, a bump hat may be worn. Examples where this protection is needed includes:

- Construction sites
- Heat plant employees
- Workers in multi-level mechanical rooms

Hand Protection

Members must use appropriate hand protection when exposed to hazards from skin absorption of harmful substances, severe cuts or lacerations, abrasions, punctures, chemical burns, or temperature extremes. A careful evaluation of the hazard must be made due to the enormous variety of gloves on the market. Glove selection will be based on performance characteristics of the gloves, conditions, duration of use, and hazards present. One type of glove will not work in all situations.

In selecting gloves for use against chemicals, the exact chemicals encountered need to be determined. Labels and MSDSs can provide this information. Recommended glove types are often listed in the section for PPE on the MSDS. All glove materials are eventually permeated by chemicals. They can be used safely for a limited time. A manufacturer's glove selection guide is the best reference when selecting gloves. EH&S can assist in determining the specific type of glove material that should be worn for particular chemicals.

Latex gloves should be avoided due to the possibility of latex allergies. Studies have revealed that 8 to 12 percent of health-care workers regularly exposed to latex are sensitized. The National Institute for Occupational Safety and Health (NIOSH) recommends the selection of products that reduce the risk of allergic reactions. For general laboratory use, disposable nitrile gloves are an excellent latex substitute. In addition to reducing the risk of sensitization, nitrile gloves offer superior chemical resistance over latex to many chemical substances.

Additional PPE

Guidelines for the selection and use of respirators and hearing protectors are available from those specific UF policies. Cool vests and cooling scarves may be indicated for those jobs in hot environments. This includes outdoor jobs in the summer such as grounds and agricultural positions.

Cleaning and Maintenance

It is the member's responsibility to ensure their PPE is clean and properly maintained. Cleaning is particularly important for eye and face protection where dirty or fogged lenses could impair vision. PPE should be inspected, cleaned and maintained at regular intervals.

It is also important to ensure that contaminated PPE, which cannot be decontaminated, is disposed of in a manner that protects members from exposure to hazards.

General requirements for all machines

Machinery and Machine Guarding

Machine guarding

29CFR1910.212

(a) General

(1) Types of guarding. One or more methods of machine guarding shall be provided to protect the operator and other members in the machine area from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips and sparks. Examples of guarding methods are-barrier guards, two-hand tripping devices, electronic safety devices, etc.

(2) General requirements for machine guards. Guards shall be affixed to the machine where possible and secured elsewhere if for any reason attachment to the machine is not possible. The guard shall be such that it does not offer an accident hazard in itself

(3) Point of operation guarding.

(i) Point of operation is the area on a machine where work is actually performed upon the material being processed.

(ii) The point of operation of machines whose operation exposes a member to injury, shall be guarded. The guarding device shall be in conformity with any appropriate standards, or, in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle.

(iii) Special handtools for placing and removing material shall be such as to permit easy handling of material without the operator placing a hand in the danger zone. Such tools shall not be in lieu of other guarding required by this section, but can only be used to supplement protection provided.

- i. The following are some of the machines which usually require point of operation guarding:
Guillotine cutters, Shears, Alligator shears, Power presses, Milling machines, Power saws, Jointers, Portable power tools

(4) Barrels, containers, and drums. Revolving drums, barrels, and containers shall be guarded by an enclosure which is interlocked with the drive mechanism, so that the barrel, drum and container cannot revolve unless the guard enclosure is in place.

(5) **Exposure of blades.** When the periphery of the blades of a fan is less than seven (7) feet above the floor or working level, the blades shall be guarded. The guard shall have openings no larger than ½ inch.

(b) **Anchoring fixed machinery.** Machines designed for a fixed location shall be securely anchored to prevent walking or moving.

Guarding Material

Metal is usually the best material for guards. Guard framework is usually made from structural shapes, pipe, bar, or rod stock. Filler material generally is expanded or perforated or solid sheet metal or wire mesh. It may be feasible to use plastic or safety glass where visibility is required.

Guards made of wood generally are not recommended because of their flammability and lack of durability and strength. However, in areas where corrosive materials are present, wooden guards may be the better choice.

Requirements for Safeguards

Safeguards must meet the following minimum requirements:

1. **Prevent Contact:** The safeguard must prevent hands, arms, and any other part of the worker's body from making contact with dangerous moving parts.
2. **Secure:** Workers should not be able to easily remove or tamper with the safeguard. Guards and safety devices should be made of durable material that will withstand the conditions of normal use. They must be firmly secured to the machine.
3. **Protect from Falling Objects:** The safeguard should ensure that no objects can fall into moving parts.
4. **Create no New Hazards:** A safeguard defeats its own purpose if it creates a hazard of its own such as a shear point, a jagged edge, or an unfinished surface which can cause a laceration. The edges of guards, for instance, should be rolled or bolted in such a way that they eliminate sharp edges.
5. **Create no Interference:** Any safeguard, which impedes a worker from performing the job quickly and comfortably, might soon be overridden or disregarded. Proper safeguarding can actually enhance efficiency since it can relieve the worker's apprehensions about injury.
6. **Allow Safe Lubrication:** If possible, one should be able to lubricate the machine without removing the safeguards. Locating oil reservoirs outside the guard, with a line leading to the lubrication point, will reduce the need for the operator or maintenance worker to enter the hazardous area.

Taken from Concepts and Techniques of Machine Guarding, U.S. DOL/OSHA, OSHA 3067, 1992

For more information refer to ANSI/ASAE S493, July 93, Guarding for Agricultural Equipment.

Woodworking Machinery Requirements

Machinery and Machine Guarding

Machine construction general.

29CFR1910.213 Only typical woodworking equipment included here, for specialized equipment refer to the standard listed above.

General

- (1) Each machine shall be so constructed as to be free from sensible vibration when the largest size tool is mounted and run idle at full speed.
- (2) Arbors and mandrels shall be constructed so as to have firm and secure bearing and be free from play.
- (3) A dust collection system is required for each woodworking machine.
- (4) Any automatic cutoff saw that strokes continuously without the operator being able to control each stroke shall not be used.
- (5) Saw frames or tables shall be constructed with lugs cast on the frame or with an equivalent means to limit the size of the saw blade that can be mounted, so as to avoid overspeed caused by mounting a saw larger than intended.
- (6) Circular saw fences shall be so constructed that they can be firmly secured to the table or table assembly without changing their alignment with the saw. For saws with tilting tables or tilting arbors the fence shall be so constructed that it will remain in a line parallel with the saw, regardless of the angle of the saw with the table.
- (7) Circular saw gages shall be so constructed as to slide in grooves or tracks that are accurately machined, to insure exact alignment with the saw for all positions of the guide.
- (8) Hinged saw tables shall be so constructed that the table can be firmly secured in any position and in true alignment with the saw.
- (9) All belts, pulleys, gears, shafts, and moving parts shall be guarded in accordance with the specific requirements of 1910.219.
- (10) It is recommended that each power-driven woodworking machine be provided with a disconnect switch that can be locked in the off position.
- (11) The frames and all exposed, noncurrent-carrying metal parts of portable electric woodworking machinery operated at more than 90 volts to ground shall be grounded and other portable motors driving electric tools which are held in the

hand while being operated shall be grounded if they operate at more than 90 volts to ground. The ground shall be provided through use of a separate ground wire and polarized plug and receptacle.

(12) For all circular saws where conditions are such that there is a possibility of contact with the portion of the saw either beneath or behind the table, that portion of the saw shall be covered with an exhaust hood, or, if no exhaust system is required, with a guard that shall be so arranged as to prevent accidental contact with the saw.

(13) Revolving double arbor saws shall be fully guarded in accordance with all the requirements for circular crosscut saws or with all the requirements for circular rip saws, according to the kind of saws mounted on the arbors.

(14) No saw, cutter head, or tool collar shall be placed or mounted on a machine arbor unless the tool has been accurately machined to size and shape to fit the arbor.

(15) Combs (featherboards) or suitable jigs shall be provided at the workplace for use when a standard guard cannot be used, as in dadoing, grooving, jointing, moulding, and rabbeting.

Machine controls and equipment.

(1) A mechanical or electrical power control shall be provided on each machine to make it possible for the operator to cut off the power from each machine without leaving his position at the point of operation.

(2) On machines driven by belts and shafting, a locking-type belt shifter or an equivalent positive device shall be used.

(3) On applications where injury to the operator might result if motors were to restart after power failures, provision shall be made to prevent machines from automatically restarting upon restoration of power.

(4) Power controls and operating controls should be located within easy reach of the operator while he is at his regular work location, making it unnecessary for him to reach over the cutter to make adjustments. This does not apply to constant pressure controls used only for setup purposes.

(5) On each machine operated by electric motors, positive means shall be provided for rendering such controls or devices inoperative while repairs or adjustments are being made to the machines they control.

(6) Each operating treadle shall be protected against unexpected or accidental tripping.

(7) Feeder attachments shall have the feed rolls or other moving parts so covered or guarded as to protect the operator from hazardous points.

Hand-fed ripaws.

(1) Each circular hand-fed ripaw shall be guarded by a hood which shall completely enclose that portion of the saw above the table and that portion of the saw above the material being cut. The hood and mounting shall be arranged so that the hood will automatically adjust itself to the thickness of and remain in contact with the material being cut but it shall not offer any considerable resistance to insertion of material to saw or to passage of the material being sawed. The hood shall be made of adequate strength to resist blows and strains incidental to reasonable operation, adjusting, and handling, and shall be so designed as to protect the operator from flying splinters and broken saw teeth. It shall be made of material that is soft enough so that it will be unlikely to cause tooth breakage. The hood shall be so mounted as to insure that its operation will be positive, reliable, and in true alignment with the saw; and the mounting shall be adequate in strength to resist any reasonable side thrust or other force tending to throw it out of line.

(2) Each hand-fed circular ripaw shall be furnished with a spreader to prevent material from squeezing the saw or being thrown back on the operator. The spreader shall be made of hard tempered steel, or its equivalent, and shall be thinner than the saw kerf. It shall be of sufficient width to provide adequate stiffness or rigidity to resist any reasonable side thrust or blow tending to bend or throw it out of position. The spreader shall be attached so that it will remain in true alignment with the saw even when either the saw or table is tilted. The provision of a spreader in connection with grooving, dadoing, or rabbeting is not required. On the completion of such operations, the spreader shall be immediately replaced.

(3) Each hand-fed circular ripaw shall be provided with nonkickback fingers or dogs so located as to oppose the thrust or tendency of the saw to pick up the material or to throw it back toward the operator. They shall be designed to provide adequate holding power for all the thicknesses of materials being cut.

Hand-fed crosscut table saws.

(1) Each circular crosscut table saw shall be guarded by a hood which shall meet all the requirements of paragraph (c)(1) of this section for hoods for circular ripaws.

Circular resaws.

(1) Each circular resaw shall be guarded by a hood or shield of metal above the saw. This hood or shield shall be so designed as to guard against danger from flying splinters or broken saw teeth.

(2) Each circular resaw (other than self-feed saws with a roller or wheel at back of the saw) shall be provided with a spreader fastened securely behind the saw. The spreader shall be slightly thinner than the saw kerf and slightly thicker than the saw disk.

Self-feed circular saws.

(1) Feed rolls and saws shall be protected by a hood or guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be constructed of heavy material, preferably metal, and the bottom of the guard shall come down to within three-eighths inch of the plane formed by the bottom or working surfaces of the feed rolls. This distance (three-eighths inch) may be increased to three-fourths inch, provided the lead edge of the hood is extended to be not less than 5 ½ inches in front of the nip point between the front roll and the work.

(2) Each self-feed circular rip saw shall be provided with sectional non-kickback fingers for the full width of the feed rolls. They shall be located in front of the saw and so arranged as to be in continual contact with the wood being fed.

Swing cutoff saws.

The requirements of this paragraph are also applicable to sliding cutoff saws mounted above the table.

(1) Each swing cutoff saw shall be provided with a hood that will completely enclose the upper half of the saw, the arbor end, and the point of operation at all positions of the saw. The hood shall be constructed in such a manner and of such material that it will protect the operator from flying splinters and broken saw teeth. Its hood shall be so designed that it will automatically cover the lower portion of the blade, so that when the saw is returned to the back of the table the hood will rise on top of the fence, and when the saw is moved forward the hood will drop on top of and remain in contact with the table or material being cut.

(2) Each swing cutoff saw shall be provided with an effective device to return the saw automatically to the back of the table when released at any point of its travel. Such a device shall not depend for its proper functioning upon any rope, cord, or spring. If there is a counterweight, the bolts supporting the bar and counterweight shall be provided with cotter pins; and the counterweight shall be prevented from dropping by either a bolt passing through both the bar and counterweight, or a bolt put through the extreme end of the bar, or, where the counterweight does not encircle the bar, a safety chain attached to it.

(3) Limit chains or other equally effective devices shall be provided to prevent the saw from swinging beyond the front or back edges of the table, or beyond a forward position where the gullets of the lowest saw teeth will rise above the table top.

(4) Inverted swing cutoff saws shall be provided with a hood that will cover the part of the saw that protrudes above the top of the table or above the material being cut. It shall automatically adjust itself to the thickness of and remain in contact with the material being cut.

Radial saws.

- (1) The upper hood shall completely enclose the upper portion of the blade down to a point that will include the end of the saw arbor. The upper hood shall be constructed in such a manner and of such material that it will protect the operator from flying splinters, broken saw teeth, etc., and will deflect sawdust away from the operator. The sides of the lower exposed portion of the blade shall be guarded to the full diameter of the blade by a device that will automatically adjust itself to the thickness of the stock and remain in contact with stock being cut to give maximum protection possible for the operation being performed.
- (2) Each radial saw used for ripping shall be provided with nonkickback fingers or dogs located on both sides of the saw so as to oppose the thrust or tendency of the saw to pick up the material or to throw it back toward the operator. They shall be designed to provide adequate holding power for all the thicknesses of material being cut.
- (3) An adjustable stop shall be provided to prevent the forward travel of the blade beyond the position necessary to complete the cut in repetitive operations.
- (4) Installation shall be in such a manner that the front end of the unit will be slightly higher than the rear, so as to cause the cutting head to return gently to the starting position when released by the operator.
- (5) Ripping and ploughing shall be against the direction in which the saw turns. The direction of the saw rotation shall be conspicuously marked on the hood. In addition, a permanent label not less than 1 ½ inches by ¾ inch shall be affixed to the rear of the guard at approximately the level of the arbor, reading as follows: "Danger: Do Not Rip or Plough From This End".

Bandsaws and band resaws.

- (1) All portions of the saw blade shall be enclosed or guarded, except for the working portion of the blade between the bottom of the guide rolls and the table. Bandsaw wheels shall be fully encased. The outside periphery of the enclosure shall be solid. The front and back of the band wheels shall be either enclosed by solid material or by wire mesh or perforated metal. Such mesh or perforated metal shall be not less than 0.037 inch (U.S. Gage No. 20), and the openings shall be not greater than three-eighths inch. Solid material used for this purpose shall be of an equivalent strength and firmness. The guard for the portion of the blade between the sliding guide and the upper-saw-wheel guard shall protect the saw blade at the front and outer side. This portion of the guard shall be self-adjusting to raise and lower with the guide. The upper-wheel guard shall be made to conform to the travel of the saw on the wheel.
- (2) Each bandsaw machine shall be provided with a tension control device to indicate a proper tension for the standard saws used on the machine, In order to assist in the elimination of saw breakage due to improper tension.

(3) Feed rolls of band resaws shall be protected with a suitable guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be constructed of heavy material, preferably metal, and the edge of the guard shall come to within three-eighths inch of the plane formed by the inside face of the feed roll in contact with the stock being cut.

Jointers.

(1) Each hand-fed planer and jointer with horizontal head shall be equipped with a cylindrical cutting head, the knife projection of which shall not exceed one-eighth inch beyond the cylindrical body of the head.

(2) The opening in the table shall be kept as small as possible. The clearance between the edge of the rear table and the cutter head shall be not more than one-eighth inch. The table throat opening shall be not more than 2 ½ inches when tables are set or aligned with each other for zero cut.

(3) Each hand-fed jointer with a horizontal cutting head shall have an automatic guard which will cover all the section of the head on the working side of the fence or gage. The guard shall effectively keep the operator's hand from coming in contact with the revolving knives. The guard shall automatically adjust itself to cover the unused portion of the head and shall remain in contact with the material at all times.

(4) Each hand-fed jointer with horizontal cutting head shall have a guard which will cover the section of the head back of the gage or fence.

(5) Each wood jointer with vertical head shall have either an exhaust hood or other guard so arranged as to enclose completely the revolving head, except for a slot of such width as may be necessary and convenient for the application of the material to be jointed.

Wood shapers and similar equipment.

(1) The cutting heads of each wood shaper, hand-fed panel raiser, or other similar machine not automatically fed, shall be enclosed with a cage or adjustable guard so designed as to keep the operator's hand away from the cutting edge. The diameter of circular shaper guards shall be not less than the greatest diameter of the cutter. In no case shall a warning device of leather or other material attached to the spindle be acceptable.

(2) All double-spindle shapers shall be provided with a spindle starting and stopping device for each spindle.

Planing, molding, sticking, and matching machines.

(1) Each planing, molding, sticking, and matching machine shall have all cutting heads, and saws if used, covered by a metal guard. If such guard is constructed of

sheet metal, the material used shall be not less than 1/16 inch in thickness, and if cast iron is used, it shall be not less than three-sixteenths inch in thickness.

(2) Where an exhaust system is used, the guards shall form part or all of the exhaust hood and shall be constructed of metal of a thickness not less than that specified in paragraph (h)(1) of this section.

(3) Feed rolls shall be guarded by a hood or suitable guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be fastened to the frame carrying the rolls so as to remain in adjustment for any thickness of stock.

(4) Surfacers or planers used in thickening multiple pieces of material simultaneously shall be provided with sectional infeed rolls having sufficient yield in the construction of the sections to provide feeding contact pressure on the stock, over the permissible range of variation in stock thickness specified or for which the machine is designed. In lieu of such yielding sectional rolls, suitable section kickback finger devices shall be provided at the infeed end.

Sanding machines.

(1) Feed rolls of self-feed sanding machines shall be protected with a semicylindrical guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be constructed of heavy material, preferably metal, and firmly secured to the frame carrying the rolls so as to remain in adjustment for any thickness of stock. The bottom of the guard should come down to within three-eighths inch of a plane formed by the bottom or contact face of the feed roll where it touches the stock.

(2) Each drum sanding machine shall have an exhaust hood, or other guard if no exhaust system is required, so arranged as to enclose the revolving drum, except for that portion of the drum above the table, if a table is used, which may be necessary and convenient for the application of the material to be finished.

(3) Each disk sanding machine shall have the exhaust hood, or other guard if no exhaust system is required, so arranged as to enclose the revolving disk, except for that portion of the disk above the table, if a table is used, which may be necessary for the application of the material to be finished.

(4) Belt sanding machines shall be provided with guards at each nip point where the sanding belt runs on to a pulley. These guards shall effectively prevent the hands or fingers of the operator from coming in contact with the nip points. The unused run of the sanding belt shall be guarded against accidental contact

Miscellaneous woodworking machines.

(1) The feed rolls of roll type glue spreaders shall be guarded by a semicylindrical guard. The bottom of the guard shall come to within three-eighths inch of a plane

formed by bottom or contact face of the feed roll where it touches the stock.

(2) Drag saws shall be so located as to give at least a 4-foot clearance for passage when the saw is at the extreme end of the stroke; or if such clearance is not obtainable, the saw and its driving mechanism shall be provided with a standard enclosure.

(3) For combination or universal woodworking machines each point of operation of any tool shall be guarded as required for such a tool in a separate machine.

(4) The mention of specific machines in paragraphs (a) thru (q) and this paragraph (r) of this section, inclusive, is not intended to exclude other woodworking machines from the requirement that suitable guards and exhaust hoods be provided to reduce to a minimum the hazard due to the point of operation of such machines.

Inspection and maintenance of woodworking machinery.

(1) Dull, badly set, improperly filed, or improperly tensioned saws shall be immediately removed from service, before they begin to cause the material to stick, jam, or kick back when it is fed to the saw at normal speed. Saws to which gum has adhered on the sides shall be immediately cleaned.

(2) All knives and cutting heads of woodworking machines shall be kept sharp, properly adjusted, and firmly secured. Where two or more knives are used in one head, they shall be properly balanced.

(3) Bearings shall be kept free from lost motion and shall be well lubricated.

(4) Arbors of all circular saws shall be free from play.

(5) Sharpening or tensioning of saw blades or cutters shall be done only by persons of demonstrated skill in this kind of work.

(6) Emphasis is placed upon the importance of maintaining cleanliness around woodworking machinery, particularly as regards the effective functioning of guards and the prevention of fire hazards in switch enclosures, bearings, and motors.

(7) All cracked saws shall be removed from service.

(8) The practice of inserting wedges between the saw disk and the collar to form what is commonly known as a "wobble saw" shall not be permitted.

(9) Push sticks or push blocks shall be provided at the work place in the several sizes and types suitable for the work to be done.

(10) The knife blade of jointers shall be so installed and adjusted that it does not protrude more than one-eighth inch beyond the cylindrical body of the head. Push sticks or push blocks shall be provided at the work place in the several sizes and

types suitable for the work to be done.

(11) Whenever veneer slicers or rotary veneer-cutting machines have been shutdown for the purpose of inserting logs or to make adjustments, operators shall make sure that machine is clear and other workmen are not in a hazardous position before starting the machine.

(12) Operators shall not ride the carriage of a veneer slicer.

Welding, Cutting, Brazing & Soldering

Objective:

To establish requirements to ensure safe performance of all tasks involving welding, cutting, brazing and soldering. Also, to provide specific guidance for fire safety.

Minimum Requirements:

All welders must be knowledgeable of the criteria contained in 29CFR, Part 1910, Subpart Q, and NFPA 51B.

- Fire hazards: If the object to be welded, cut, brazed or soldered cannot be readily moved, all movable fire hazards in the vicinity shall be taken to a safe place.
- Guards: If the object cannot be moved and all fire hazards cannot be removed, then guards shall be used to confine the heat, sparks, and slag and protect the immovable fire hazards.
- Combustible material: Whenever there are floor openings or cracks in the floor that cannot be closed, precautions shall be taken so that no readily combustible materials on the floor below will be exposed to sparks and slag which may drop through the floor. The same precautions will be taken with regard to cracks or holes in walls, open doorways and open or broken windows.
- Fire extinguishers: Suitable fire extinguishing equipment shall be maintained in a state of readiness for instant use.
- Fire watch: Fire watchers shall be required whenever tasks are performed in locations where appreciable combustible material are closer than 35 feet to the point of operation.
- Prohibited areas: Welding, cutting, brazing and soldering shall not be permitted in the following situations:
 1. In sprinkler buildings while such protection is impaired.
 2. In the presence of explosive atmospheres (mixtures of flammable gases, vapors, liquids, or dust in the air).
 3. Where adequate ventilation cannot be provided.
 4. On pipes or ducts that may permit sparks or fumes to be transferred to other areas of the facility.
- Soldering: Soldering of metals affixed to combustible materials shall be performed using an electric iron rather than gas flame.
- Ventilation: Local exhaust or general ventilation systems shall be provided and arranged to keep the amount of toxic fumes, gases, or dusts below the maximum allowable concentration as specified in 29CFR Part 1910.1000.
- Personal Protective equipment: The individual performing the task shall wear the

appropriate protective devices. All observers and/or individuals assisting in the performance of the job shall also wear appropriate protective devices.

- **Authorization:** Before cutting, welding, brazing or soldering is permitted, the area shall be inspected by the individual responsible for authorizing the operation. He/she shall designate the precautions to be followed in granting authorization to proceed. He shall also ensure that the person performing the operation is properly trained and qualified.
- **Special Exemption:** When a task cannot be conducted under the restrictions of this policy, Environmental Health and Safety must be contacted to assist in the development of and approval of alternative conditions.

Portable wood ladders

29CFR1910.25

Application of requirements.

This section is intended to prescribe rules and establish minimum requirements for the construction, care, and use of the common types of portable wood ladders, in order to insure safety under normal conditions of usage. Other types of special ladders, fruit-picker's ladders, combination step and extension ladders, stockroom step ladders, aisle-way step ladders, shelf ladders, and library ladders are not specifically covered by this section.

Materials

(1) Requirements applicable to all wood parts.

(i) All wood parts shall be free from sharp edges and splinters; sound and free from accepted visual inspection from shake, wane, compression failures, decay, or other irregularities. Low density wood shall not be used.

Construction requirements.

(1) Portable stepladders. Stepladders longer than 20 feet shall not be supplied. Stepladders as hereinafter specified shall be of three types:

Type I - Industrial stepladder, 3 to 20 feet for heavy duty, such as utilities, contractors, and industrial use.

Type II - Commercial stepladder, 3 to 12 feet for medium duty, such as painters, offices, and light industrial use.

Type III - Household stepladder, 3 to 6 feet for light duty, such as light household use.

(i) General requirements.

{a} A uniform step spacing shall be employed which shall be not more than 12 inches. Steps shall be parallel and level when the ladder is in position for use.

{b} The minimum width between side rails at the top, inside to inside, shall be not less than 11 ½ inches. From top to bottom, the side rails shall spread at least 1 inch for each foot of length of stepladder.

{c} A metal spreader or locking device of sufficient size and strength to securely hold the front and back sections in open positions shall be a component of each stepladder. The spreader shall have all sharp points covered or removed to protect the user.

(3) Portable rung ladders

(i) Single ladder.

{a} Single ladders longer than 30 feet shall not be supplied.

(ii) Two-section ladder.

{a} Two-section extension ladders longer than 60 feet shall not be supplied. All ladders of this type shall consist of two sections, one to fit within the side rails of the other, and arranged in such a manner that the upper section can be raised and lowered.

(4) Special-purpose ladders.

(i) Painter's stepladder.

{a} Painter's stepladders longer than 12 feet shall not be supplied.

(ii) Mason's ladder. A mason's ladder is a special type of single ladder intended for use in heavy construction work.

{a} Mason's ladders longer than 40 feet shall not be supplied.

Care and use of ladders

(1) Care. To insure safety and serviceability the following precautions on the care of ladders shall be observed:

(i) Ladders shall be maintained in good condition at all times, the joint between the steps and side rails shall be tight, all hardware and fittings securely attached, and the movable parts shall operate freely without binding or undue play.

(ii) Metal bearings of locks, wheels, pulleys, etc., shall be frequently lubricated.

(iii) Frayed or badly worn rope shall be replaced.

(iv) Safety feet and other auxiliary equipment shall be kept in good condition to insure proper performance.

(v) Ladders shall be inspected frequently and those which have developed defects shall be withdrawn from service for repair or destruction and tagged or marked as "Dangerous, Do Not Use."

(vi) Rungs should be kept free of grease and oil.

(2) Use. The following safety precautions shall be observed in connection with the use of ladders:

(i) Portable rung and cleat ladders shall, where possible, be used at such a pitch that the horizontal distance from the top support to the foot of the ladder is one quarter of the working length of the ladder (the length along the ladder between the foot and the top support). The ladder shall be so placed as to prevent slipping, or it shall be lashed, or held in position. Ladders shall not be used in a horizontal position as platforms, runways, or scaffolds.

(ii) Ladders for which dimensions are specified should not be used by more than one man at a time nor with ladder jacks and scaffold planks where use by more than one man is anticipated. In such cases, specially designed ladders with larger dimensions of the parts should be procured.

(iii) Portable ladders shall be so placed that the side rails have a secure footing. The top rest for portable rung and cleat shall have ample strength to support the applied load.

(iv) Ladders shall not be placed in front of doors opening toward the ladder unless the door is blocked upon, locked, or guarded.

(v) Ladders shall not be placed on boxes, barrels, or other unstable bases to obtain additional height.

(vi) Ladders with broken or missing steps, rungs, or cleats, broken side rails, or other faulty equipment shall not be used; improvised repairs shall not be made.

(vii) Short ladders shall not be spliced together to provide long sections.

(viii) Ladders made by fastening cleats across a single rail shall not be used.

(ix) Ladders shall not be used as guys, braces, or skids, or for other than their intended purposes.

(x) Tops of the ordinary types of stepladders shall not be used as steps.

(xi) On two-section extension ladders the minimum overlap for the two sections in use shall be as follows:

<u>Size of ladder (feet)</u>	<u>Overlap (feet)</u>
Up to and including 36	3
Over 36 and up to and including 48	4
Over 48 and up to and including 60	5

(xii) Portable rung ladders with reinforced rails (see paragraphs (c)(3) (ii)(c) and (iii)(d) this section) shall be used only with the metal reinforcement on the under side.

(xiii) No ladder should be used to gain access to a roof unless the top of the ladder shall extend at least 3 feet above the point of support, at eave, gutter, or roofline.

(xiv) Middle and top sections of sectional or window cleaner's ladders should not be used for bottom section unless the user equips them with safety shoes.

(xv) The user should equip all portable rung ladders with nonslip bases when there is a hazard of slipping. Nonslip bases are not intended as a substitute for care in safely placing, lashing, or holding a ladder that is being used upon oily, metal, concrete, or slippery surfaces;

(xvi) The bracing on the back legs of step ladders is designed solely for increasing stability and not for climbing.

Portable metal ladders

29CFR1910.26

Requirements

(1) General. Specific design and construction requirements are not part of this section because of the wide variety of metals and design possibilities. However, the design shall be such as to produce a ladder without structural defects or accident hazards such as sharp edges, burrs, etc. The metal selected shall be of sufficient strength to meet the test requirements, and shall be protected against corrosion unless inherently corrosion resistant.

(i) The spacing of rungs or steps shall be on 12 inch centers.

(ii) Rungs and steps shall be corrugated, coated with skid resistant material, or otherwise treated to minimize the possibility of slipping.

(2) General specifications - straight and extension ladders.

(i) The minimum width between side rails of a straight ladder or any section of an extension ladder shall be 12 inches.

(ii) The length of single ladders or individual sections of ladders shall not exceed 30 feet. Two-section ladders shall not exceed 48 feet in length and over two-section ladders shall not exceed 60 feet in length.

(iii) Based on the nominal length of the ladder, each section of a multi-section ladder shall overlap the adjacent section by at least the number of feet stated in the following:

Normal length of ladder (feet)	Overlap (feet)
Up to and including 36	3
Over 36 and up to and including 48	4
Over 48 and up to and including 60	5

(iv) Extension ladders shall be equipped with positive stops which will insure the overlap specified in the table above.

(3) General specifications - step ladders.

(i) The length of a stepladder is measured by the length of the front rail. To be classified as a standard length ladder, the measured length shall be within plus or minus $\frac{1}{2}$ inch of the specified length. Stepladders shall not exceed 20 feet in length.

(ii) The bottoms of the four rails are to be supplied with insulating non-slip material for the safety of the user.

(iii) A metal spreader or locking device of sufficient size and strength to securely hold the front and back sections in the open position shall be a component of each stepladder. The spreader shall have all sharp points or edges covered or removed to protect the user.

Care and maintenance of ladders

(1) General. To get maximum serviceability, safety, and to eliminate unnecessary damage of equipment, good safe practices in the use and care of ladder equipment must be employed by the users. The following rules and regulations are essential to the life of the equipment and the safety of the user.

(2) Care of ladders.

(i) Ladders must be maintained in good usable condition at all times.

(ii) If a ladder is involved in any of the following, immediate inspection is necessary:

{a} If ladders tip over, inspect ladder for side rail dents or bends, or excessively dented rungs; check all rung-to-side-rail connections; check hardware connections; check rivets for shear.

{b} If ladders are exposed to oil and grease, equipment should be cleaned of oil, grease, or slippery materials. This can easily be done with a solvent or steam cleaning.

(ii) Ladders having defects are to be marked and taken out of service until repaired by either maintenance department or the manufacturer.

(3) Use of ladders.

(i) A simple rule for setting up a ladder at the proper angle is to place the base a distance from the vertical wall equal to one-fourth the working length of the ladder.

(ii) Portable ladders are designed as a one-man working ladder based on a 200 pound load.

(iii) The ladder base section must be placed with a secure footing.

(iv) The top of the ladder must be placed with the two rails supported, unless equipped with a single support attachment.

(v) When ascending or descending, the climber must face the ladder.

(vi) Ladders must not be tied or fastened together to provide longer sections. They must be equipped with the hardware fittings necessary if the manufacturer endorses extended uses.

(vii) Ladders should not be used as a brace, skid, gangway, or for other uses than that for which they were intended, unless specifically recommended for use by the manufacturer.

(viii) Metal ladders are not to be used when work is performed on or near electric circuits.

Materials Handling

Occupational injuries resulting from material handling are among the most frequent and severe injuries causing lost time from work. The back is the most injured part of the body. The following information is submitted to aid in injury prevention.

Back Fact

For many years experts have estimated that 8 out of 10 Americans will have a back injury sometimes during their life. Yet preventing back injuries can be as simple as learning proper lifting and material handling techniques, eliminating excess body weight, strengthening neglected back muscles, and adopting good posture habits

The personal pain, inconvenience and loss of social activity cannot be measured. But workers compensation insurance claims and individual out of pocket expense is estimated at 13 billion dollars a year nationally. Reduced production, increased turnover, medical bills and pain means bad backs are bad business.

Anatomy of the Back

Supporting the back is the spinal column, made up of 24 vertebrae stacked one upon another. Separating the vertebrae are soft discs made of cartilage, which act as shock absorbers and allow the vertebrae to move. Most people don't realize that it's the abdominal muscles along with the muscles and ligaments along the spinal column that give the back its support. A healthy back is properly aligned with three natural curves called the cervical, thoracic and lumbar curves.

Because we stand upright, most of our body weight falls squarely on the vertebrae (L1 through L5) of the lower back, or the lumbar region, making it prone to injury. Abdominal and back muscles weakened from underuse or poor posture can rob the spinal column of the support it needs. A sudden twist or a careless lift can cause injury to the lower back. The best way to ensure a healthy back is to keep all your body's muscles strong, watch your posture and learn proper lifting and material handling techniques.

Prevention

Back safety is a shared responsibility. The Group is committed to reducing back injuries at work by teaching proper lifting and material handling techniques. Most back injuries result from improper lifting. According to the principles of biomechanics, the worst lifting situation occurs when the body is extended over the load. The lower back becomes a fulcrum, supporting the weight of the body plus the load. Twisting in this position can

cause injury. Keep your back upright to shift weight onto the more powerful leg muscles and reduce the lever effect. Maintain the three natural curves of the back in their normal position.

Prior to lifting an object, first lift the load mentally. Plan every step before you do it physically. Size up the load; how much does it weigh? Give it the heft test to see if you can lift it. If the load is too heavy or bulky to lift alone, get help. Check the route of travel and look for obstacles and surface conditions, which may be unsafe. Arrange for mechanical devices like a pushcart, handtruck or other appropriate means to help with transporting the load. Remember to use proper lifting techniques when loading mechanical devices. Whenever possible, push rather than pull.

There are six steps to safe lifting which will eliminate most back injuries:

- Get a firm footing. Keep your feet apart (shoulder width) for a stable base. Point toes out.
- Bend your knees. Don't bend at the waist. Keep the principles of leverage in mind. Don't do more work than you have to. Maintain your three natural back curves.
- Tighten your stomach muscles. Abdominal muscles support your spine when you lift, offsetting the force of the load. Train muscle groups to work together.
- Lift with your legs. Let your powerful leg muscles do the work of lifting, not your weaker back muscles. Maintain your three natural curves.
- Keep the load close. Don't hold the load away from your body. The closer it is to your spine, the less force it exerts on your back.
- Keep your back upright. Whether you are lifting or putting down the load, don't add the weight of your body to the load. Avoid twisting; it can cause injury.

Other conditions to consider are:

- Store items within easy reach, rather than high or low.
- Break up loads.
- Make shelves less deep.
- Arrange the space so workers do not have to lift and twist. Twisting while under a load increases the potential for injury four fold.
- Provide stools or footrests for stationary standing jobs or rotate task so that periods of standing alternate with movement or sitting.

Compressed Air Safety

General safety requirements for compressed air

The following precautions pertain to the use of compressed air in machine shops:

1. All pipes, hoses, and fittings must have a rating of the maximum pressure of the compressor. Compressed air pipelines should be identified (psi) as to maximum working pressure.
2. Air supply shutoff valves should be located (as near as possible) at the point-of-operation.
3. Air hoses should be kept free of grease and oil to reduce the possibility of deterioration.
4. Hoses should not be strung across floors or aisles where they are liable to cause personnel to trip and fall. When possible, air supply hoses should be suspended overhead, or otherwise located to afford efficient access and protection against damage.
5. Hose ends must be secured to prevent whipping if an accidental cut or break occurs.
6. Pneumatic impact tools, such as riveting guns, should never be pointed at a person.
7. Before a pneumatic tool is disconnected (unless it has quick disconnect plugs), the air supply must be turned off at the control valve and the tool bled.
8. Compressed air must not be used under any circumstances to clean dirt and dust from clothing or off a person's skin. Shop air used for cleaning should be regulated to 15 psi unless equipped with diffuser nozzles to provide lessor pressure.
9. Goggles, face shields or other eye protection must be worn by personnel using compressed air for cleaning equipment.
10. . Static electricity can be generated through the use of pneumatic tools. This type of equipment must be grounded or bonded if it is used where fuel, flammable vapors or explosive atmospheres are present.

Safety Requirements for Operating & Maintaining Compressed Air Machinery:

All components of compressed air systems should be inspected regularly by qualified and members. Operators need to be aware of the following:

Air receivers:

The maximum allowable working pressures of air receivers should never be exceeded

except when being tested. Only hydrostatically tested and approved tanks shall be used as air receivers.

1. Air tanks and receivers should be equipped with inspection openings, and tanks over 36 inches in diameter should have a manhole. Pipelug openings should be provided on tanks with volumes of less than five cubic feet.
2. The intake and exhaust pipes of small tanks, similar to those used in garages, should be made removable for interior inspections.
3. No tank or receiver should be altered or modified by unauthorized persons.
4. Air receivers should be fitted with a drain cock that is located at the bottom Of the receiver.
5. Receivers should be drained frequently to prevent accumulation of liquid inside the unit. Receivers having automatic drain systems are exempt from this Requirement.
6. Air tanks should be located so that the entire outside surfaces can be easily inspected. Air tanks should not be buried or placed where they cannot be seen for frequent inspection.
7. Each air receiver shall be equipped with at least one pressure gauge and an ASME safety valve of the proper design.
8. A safety (spring loaded) release valve shall be installed to prevent the receiver from exceeding the maximum allowable working pressure.
9. Only qualified personnel should be permitted to repair air tanks, and all work must be done according to established safety standards.

Air Distribution Lines:

1. Air lines should be made of high quality materials, fitted with secure connections.
2. Only standard fittings should be used on air lines.
3. Operators should avoid bending or kinking air hoses.
4. Air hoses should not be placed where they will create tripping hazards.
5. Hoses should be checked to make sure they are properly connected to pipe outlets before use.
6. Air lines should be inspected frequently for defects, and any defective equipment repaired or replaced immediately.
7. Compressed air lines should be identified as to maximum working pressures (psi), by tagging or marking pipeline outlets.

Pressure regulation Devices:

1. Only qualified personnel should be allowed to repair or adjust pressure regulating equipment.

2. Valves, gauges and other regulating devices should be installed on compressor equipment in such a way that cannot be made inoperative.
3. Air tank safety valves should be set no less than 15 psi or 10 percent (whichever is greater) above the operating pressure of the compressor but never higher than the maximum allowable working pressure of the air receiver.
4. Air lines between the compressor and receiver should usually not be equipped with stop valves. Where stop valves are necessary and authorized, ASME safety valves should be installed between the stop valves and the compressor.
5. The Safety valves should be set to blow at pressures slightly above those necessary to pop the receiver safety valves.
6. Blowoff valves should be located on the equipment and shielded so sudden blowoffs will not cause personnel injuries or equipment damage.
7. Case iron seat or disk safety valves should be ASME approved and stamped for intended service application.
8. If the design of a safety or a relief valve is such that liquid can collect on the discharge side of the disk, the valve should be equipped with a drain at the lowest point where liquid can collect.
9. Safety valves exposed to freezing temperatures should be located so water cannot collect in the valves. Frozen valves must be thawed and drained before operating the compressor.

Air Compressor Operation:

1. Air compressor equipment should be operated only by authorized and trained personnel.
2. The air intake should be from a clean, outside, fresh air source. Screens or filters can be used to clean the air.
3. Air compressors should Never be operated at speeds faster than the manufacturers recommendation.
4. Equipment should not become overheated.
5. Moving parts, such as compressor flywheels, pulleys, and belts that could be hazardous should be effectively guarded.

Compressed Air Equipment Maintenance:

1. Only authorized and trained personnel should service and maintain air compressor equipment.
2. Exposed, non current-carrying, metal parts of compressor should be effectively grounded.
3. High flash point lubricants should not be used on compressors because of its high

operating temperatures that could cause a fire or explosion.

4. Equipment should not be over lubricated.
5. Gasoline or diesel fuel powered compressors shall not be used indoors.
6. Equipment placed outside but near buildings should have the exhausts directed away from doors, windows and fresh air intakes.
7. Soapy water or lye solutions can be used to clean compressor parts of carbon deposits, but kerosene or other flammable substances should not be used. Frequent cleaning is necessary to keep compressors in good working condition.
8. The air systems should be completely purged after each cleaning.
9. During maintenance work, the switches of electrically operated compressors should be locked open and tagged to prevent accidental starting.
10. . Portable electric compressors should be disconnected from the power supply before performing maintenance.

B3 Robot Operation Safety

B3 is, by design and inherent nature, a very dangerous machine. Team members will be working in close proximity to this robot. In order to minimize the dangers and avoid personal injury, these robot-specific guidelines should be followed at all times.

Proposed Safety Features

As B3 is designed and constructed, the safety of the operator, crew, and spectators will be kept in mind at all times. Each energy system within B3 will be designed with safeguards to prevent accidental actuation. Such systems may include:

1. Power plant.

The gasoline engines in B3 will be designed for remote electrical starting. There will be a safety switch that enables the remote start capability. When this switch is in the active position, a red safety beacon will also become activated.

2. Hydraulic pump system.

The hydraulic pumps are by default unloaded, so any pump operation will not build up pressure in the system. The valve that serves to load the pumps is remotely activated. There will be a safety switch that enables the pump loading valve. When this switch is in the active position, a yellow safety beacon will also become activated.

The remote unloader valve will be placed downstream of all pressure reservoirs, so when it is released, all pressure systems vent to low-pressure.

3. Drive motors.

With a pressurized system, the drive motors can be activated remotely and the robot will move in unpredictable ways, under the operator control or out of control.

Prior to any planned movement of the robot, the operator will give an audible warning to all team members. The operator must receive positive feedback from all members and visitors in the area that they are aware of the pending actuation before he is to actually drive the robot.

4. Hydraulic weapons.

The primary weapon systems in B3 are hydraulically actuated. These systems may still be dangerous even if the motors and pump are deactivated, due to pressure reservoirs and line pressure.

The operator must remotely bleed the pressure from these systems before anyone may approach the robot. The valve systems will be designed so that, once the main pumps are offline, the operator will be able to bleed all pressure lines between the valve and actuator remotely.

5. Other weapons.

Any additional weapons will have remote deactivation features in keeping with the B3 total safety policy.

6. Dead man's switch.

A wire-attached dead-man's switch will be fitted to B3's electrical supply. This is a normally open switch that cuts off all power to all hydraulic valves in B3. It will be a spring-loaded switch, so it requires conscious activation at all times.

When the switch goes open, the minimum events it will force are:

- i. Motor valves to go to center, freezing the motors.
- ii. The pump becomes unloaded, halting pressure buildup and releasing all reservoir pressure.

At this time, the only pressure in the system will be in lines between valves and their actuator.

Operational Guidelines

1. At no time will an operator disable any safety feature of the robot.
2. Prior to any robot motion, the operator will alert all team members. This includes motor activity, weapon activity, or any other activity that may cause a team member to come to harm.
3. All actions will be announced, play by play, prior to implementation.
4. Team members need to remain within voice range of the operator at all times.
5. The running sequence shall be this:
 - i. Dead-man's switch activated and announced.
 - ii. Hydraulic safety switch set and announced.
 - iii. Engine safety switch set and announced.
 - iv. Operator calls all-clear and waits for response.
 - v. Engines started
 - vi. Hydraulic pumps loaded and announced.

- vii. Testing.
 - viii. Pumps unloaded.
 - ix. Pressure in lines released.
 - x. Engines stopped remotely.
 - xi. Dead man's switch released.
 - xii. B3 is now safe to approach.
6. If at any time the dead man's switch is released, be aware that there is still pressure in the system. If the hydraulic valves can be re-activated, remotely release all pressure before approaching B3. If, through system failure, the operator is unable to release pressure in one or more systems, extreme caution must be exercised in approaching B3 and manually releasing all pressurized systems.