

Machinery, Robotics & Power Tool Safety Program



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1. Purpose

It is the policy of the University of Pennsylvania in coordination with the Office of Environmental Health and Radiation Safety to provide the Penn community with a safe and healthful environment. The Machinery, Robotics and Power Tool Safety Program is presented to raise awareness of some of the key hazards associated with machines, robots, power tools, and other dangerous moving parts. Guidance is provided to aid in mitigating the hazards.

2. Application

This procedure applies to University of Pennsylvania employees and students.

3. Responsibilities**3.1. Environmental Health & Radiation Safety (EHRS)**

- 3.1.1. Develop and periodically review and update the Machinery, Robotics and Power Tool Safety Program.
- 3.1.2. Perform or assist with coordinating initial and periodic hazard assessments of shops, maker spaces, robotics laboratories and other locations where hazardous machinery, robots and tools are used. Provide guidance on mitigating identified hazards.
- 3.1.3. Complete or coordinate completion of equipment-specific control of hazardous energy (lockout/tagout – LOTO) procedures as required.
- 3.1.4. Review proposed machinery and robots and the layout of new or renovated shops, maker spaces and robotics laboratories.
- 3.1.5. Develop, provide or coordinate safety training.
- 3.1.6. Assist with selection of proper personal protective equipment.

3.2. Management/Supervisors/Faculty

- 3.2.1. Ensure that users of machinery, robots and tools receive proper safety training and supervision.
- 3.2.2. Provide required personal protective equipment and enforce proper usage.
- 3.2.3. Ensure that machinery, robots and tools are properly maintained.
- 3.2.4. Notify EHRS of the installation of new machines and robots to facilitate completion of equipment-specific risk assessments and control of hazardous energy (lockout/tagout LOTO) procedures if required.
- 3.2.5. Notify EHRS of new or planned renovations of shops, maker spaces and robotics laboratories.
- 3.2.6. Coordinate completion and documentation of machine safeguarding and risk assessments for robots.

- 3.2.7. Conduct periodic inspections to ensure that guards and safety equipment originally installed on machines robots and tools remain in place, have not been tampered with and are properly adjusted.
- 3.2.8. Remove from service and restrict use of machines, robots or tools that have been reported with safety deficiencies. Coordinate repairs or replacement.

3.3. **Machinery/Tool/Robot Operators**

- 3.3.1. Receive training on the safe use of machinery, robots and tools prior to use.
- 3.3.2. Ensure someone is available within earshot to render assistance if an accident occurs.
- 3.3.3. Review posted equipment-specific risk assessments and control of hazardous energy (lockout/tagout LOTO) procedures.
- 3.3.4. Ensure all required guards and safety devices/systems are in place and functional prior to using machines, robots and tools.
- 3.3.5. Report machines, robots and tools that are damaged or those that are missing guards or have other safety deficiencies to supervisor or management.
- 3.3.6. Secure hair and wear the appropriate clothing and assigned personal protective equipment.

4. Glossary of Selected Terms

- 4.1. **Administrative Lockout** - A lock applied to a machine, robot system, power tool or tool storage cabinet to prevent unauthorized use. This lock shall not be the same type and color as those used under Penn's Control of Hazardous Energy (lockout/tagout) program. Orange or red colored locks may not be used as administrative locks.
- 4.2. **Block** - A short block of wood, provided with a handle similar to that of a plane and a shoulder at the rear end, which is used for pushing short stock over revolving cutters.
- 4.3. **Collaborative operation (robotics)** – State in which purposely designed robots work in direct cooperation with a human within a defined workspace.
- 4.4. **Guard** - A barrier that prevents entry of the operator's hands or fingers at the point of operation.
- 4.5. **Nip-point belt and pulley guard** – A device which encloses the pulley and is provided with rounded or rolled edge slots through which the belt passes.
- 4.6. **Pinch point** - Any point other than the point of operation at which it is possible for a part of the body to be caught between the moving parts of a press or auxiliary equipment, or between moving and stationary parts of a press or auxiliary equipment or between the material and moving part or parts of the press or auxiliary equipment.

- 4.7. **Point of operation** - That point at which cutting, shaping, or forming is accomplished upon the stock and shall include such other points as may offer a hazard to the operator in inserting or manipulating the stock in the operation of the machine.
- 4.8. **Power take off (PTO)** - A drive shaft or belt used to transfer power from one machine to another. A common application is a drive shaft between a tractor and an implement.
- 4.9. **Push stick** - A narrow strip of wood or other soft material with a notch cut into one end and which is used to push short pieces of material through saws.

5. General Procedures

This section outlines some of the requirements for commonly encountered machinery and tools in use at Penn facilities. *This listing is not meant to be all-inclusive and the listed requirements are a summary of some of the most commonly encountered machines, tools & equipment.* Contact EHRS or refer to the OSHA [Machine Guarding e-Tool](#) for a more comprehensive listing of tools, machinery and equipment and the full machine guarding requirements.

- 5.1. **Proper attire for operators of machinery, robots and power tools:**
Many of the serious injuries and fatalities that occur to operators are caused by loose clothing, long hair, jewelry, gloves and other dangling objects that become entangled in moving parts and suddenly pull the operator into contact with the machine or the work. The following recommendations will minimize the potential for entanglement:
 - 5.1.1. Tie back and tuck loose hair completely inside the collar when operating machinery with rotating parts. Hair nets or hats that fully contain the hair are other options.
 - 5.1.2. Short sleeves are generally recommended for operators of machinery and equipment with rotating parts. If long sleeves are worn, cuffs must fit snugly around the wrists.
 - 5.1.3. Neck ties, scarves, etc. may not be worn while in close proximity to machines or tools with rotating parts.
 - 5.1.4. Drawstrings associated with jacket or sweatshirt hoods must be secured.
 - 5.1.5. Wearing gloves is not recommended while operating machinery or equipment with rotating parts.
 - 5.1.6. Jewelry including rings, necklaces, bracelets, wristwatches and identification badges hanging from chains or lanyards should not be worn while operating machinery and power tools.
- 5.2. **General requirements for all machines, robots and power tools:**

- 5.2.1. Hazardous machines, robots and power tools may not be operated without another person present to render aid in case of an accident.
- 5.2.2. Hazardous machines, robots and power tools must be locked out of service (administrative lockout) or be accessible after-hours only to properly qualified individuals. This can be controlled by locking them out individually or by access control to the lab, shop or maker space.
- 5.2.3. Students may not have access to or operate hazardous machinery, robots or power tools without supervision.
- 5.2.4. One or more methods of machine guarding shall be provided to protect the operator and others in the machine area from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips and sparks.
- 5.2.5. 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 not present an accident hazard in itself.
- 5.2.6. The point of operation is the area on a machine where work is actually performed upon the material being processed. The point of operation of machines whose operation exposes an operator 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 the body in the danger zone during the operating cycle.
- 5.2.7. Machines designed for a fixed location shall be securely anchored to prevent walking or moving.

6. Woodworking Machinery

6.1. General requirements for all woodworking machinery:

- 6.1.1. 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.
- 6.1.2. 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/her position at the point of operation.
- 6.1.3. Power and operation controls shall be located within easy reach of the operator while at his/her regular work location. The controls must be positioned in a manner that allows safe use without exposing the operator to hazards presented by the machine.
- 6.1.4. 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. Refer to [Penn's Control of Hazardous Energy-Lockout/Tagout Program](#) for additional procedures and information.
- 6.1.5. Provide combs (featherboards) or suitable jigs at the workplace for use when a standard guard cannot be used, as in dadoing, grooving, jointing, moulding and rabbeting.

- 6.1.6. All knives and cutting heads of woodworking machines shall be kept sharp, properly adjusted, and firmly secured. When two or more knives are used in one head, they shall be properly balanced.
- 6.1.7. Bearings shall be kept free from lost motion and shall be well lubricated.
- 6.1.8. Arbors of all circular saws shall be free from play.
- 6.1.9. Sharpening or tensioning of saw blades or cutters shall be done only by persons of demonstrated skill in this kind of work.
- 6.1.10. Maintain cleanliness around woodworking machinery. Dust and debris must not be permitted to accumulate on machinery to ensure that guards function properly and to reduce the risk of fire.

6.2. **Table Saws:**

- 6.2.1. Each circular hand-fed rip saw 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 ensure 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.
- 6.2.2. Each hand-fed circular rip saw 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
- 6.2.3. Each hand-fed circular rip saw shall be provided with non-kickback 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.
- 6.2.4. Provide push sticks for small pieces of wood and for pushing stock past the blade.

6.2.5. When it is time to replace or purchase a new table saw we strongly recommend that [SawStop](#) brand saws be considered. [SawStop](#) table saws have built-in safety technology that prevents blade-related severe cuts and amputations.

6.3. **Bandsaws:**

6.3.1. 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 3/8-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. Use a self-adjusting guard for the portion of the blade between the sliding guide and the upper saw so that it raises and lowers with the guide.

6.3.2. Each bandsaw 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.

6.3.3. Do not retrieve material until the blade has stopped. Preferably, the saw should incorporate a brake that minimizes coasting after the saw has been shut off.

6.4. **Radial Arm Saws:**

6.4.1. 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.

6.4.2. Each radial saw used for ripping shall be provided with non-kickback 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 thicknesses of material being cut.

6.4.3. 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.

- 6.4.4. 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.
- 6.4.5. 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 1-1/2 inches by 3/4-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".

6.5. **Jointers:**

- 6.5.1. Each hand-fed jointer with horizontal head shall be equipped with a cylindrical cutting head, the knife projection of which shall not exceed 1/8-inch beyond the cylindrical body of the head.
- 6.5.2. 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 1/8-inch. The table throat opening shall be not more than 2-1/2-inches when tables are set or aligned with each other for zero cut.
- 6.5.3. 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. Adjust the cylindrical cutter head so that the knife projects no more than 1/8-inch beyond the cylindrical body of the head.
- 6.5.4. Each hand-fed jointer with horizontal cutting head shall have a guard which will cover the section of the head in back of the gage or fence.
- 6.5.5. 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.
- 6.5.6. Provide and use hold-down push blocks when jointing wood narrower than 3-inches.

6.6. **Drill Presses:**

- 6.6.1. Ensure all pulleys and drive belts are fully enclosed.
- 6.6.2. The rotating chuck and drill bit should be guarded to prevent entanglement of hair and clothing with rotating parts and to protect against shattered bit parts or chips. Many drill presses do not come equipped with guards. Installation of an aftermarket guard is recommended. [STRONGHOLD SAFETY](http://www.stronghold-safety.com) is a source for guards designed to fit most drill presses.
- 6.6.3. Ensure chuck key is not left in the chuck. Consider using spring-loaded self-ejecting chuck keys.

6.7. Sanders:

- 6.7.1. Guard feed rolls with a semi-cylindrical guard to prevent the operator's hands from coming in contact with the in-running rolls on automatic sanders. The guard design must allow for adjustment to any thickness of stock.
- 6.7.2. Guard the unused run of the sanding belt against accidental contact. These guards must prevent the operator's hands or fingers from coming in contact with nip points.
- 6.7.3. Enclose drum and disc sanders with guards, except for the portion of the sander's drum above the table. The guard can consist of a protective cover at the rear side of the wheel and a hinged cover around the wheel periphery.
- 6.7.4. Replace torn, frayed, or excessively worn belts or drums. A worn-out belt, disk, or drum can cause massive heat build-up which can cause the belt, disk, or drum to tear or break and pelt the surrounding area with projected bits.
- 6.7.5. Enclose power transmission pulleys and drive belts with a fixed guard.

6.8. Planers/Moulders:

- 6.8.1. All cutting heads shall be guarded with a metal guard or cage so designed as to keep the operator's hand away from the cutting edge.
- 6.8.2. Provide barriers at the loading and unloading ends to keep hands out of point of operation.
- 6.8.3. 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.

6.9. Woodworking Lathes:

- 6.9.1. Ensure all pulleys and drive belts are fully enclosed.
- 6.9.2. Cutting heads on wood-turning lathes, whether rotating or not, shall be covered as completely as possible by hoods or shields.
- 6.9.3. Lathes used for turning long pieces of wood stock held only between the two centers shall be equipped with long curved guards extending over the tops of the lathes in order to prevent the work pieces from being thrown out of the machine if they should become loose.

7. Metalworking Machinery**7.1. Mechanical Power Shears:**

- 7.1.1. Foot pedal mechanisms shall be protected to prevent unintended operation from falling or moving objects or by accidental stepping onto the pedal. A pad with a nonslip

contact area shall be firmly attached to the pedal. The pedal return spring(s) shall be of the compression type, operating on a rod or guided within a hole or tube, or designed to prevent interleaving of spring coils in event of breakage.

- 7.1.2. A main power disconnect switch capable of being locked only in the off position shall be provided with every power shear control system.
- 7.1.3. The point of operation must be guarded to prevent entry of hands and fingers into the point of operation by reaching through, over, under or around the guard.
- 7.1.4. Mechanical power shears must be inspected quarterly to ensure that all parts and safeguards are in a safe operating condition and adjustment. The inspection must be documented and include the inspection date, serial number of the shear and the signature of the inspector.
- 7.1.5. Students are not permitted to operate mechanical power shears.

7.2. **Metalworking Lathes:**

- 7.2.1. Use spring-loaded chuck keys to ensure that keys cannot be left in the chuck.
- 7.2.2. Provide a guard around the chuck.
- 7.2.3. Where feasible, provide a shield between the operator and the point of operation. It is imperative that the shield be constructed of appropriate material to contain parts thrown by the lathe. Shields should be purchased from the lathe manufacturer or a company that specializes in manufacturing shields with adequate impact-resistance.
- 7.2.4. Provide a [lead screw cover](#) to prevent clothing and hair entanglement with the lead screw.

7.3. **Computer Numerical Control (CNC) Machines:**

- 7.3.1. Ensure CNC machine is fully enclosed and equipped with an interlocked door. The cutting tool should not start unless the door is closed and should stop when the door is opened.
- 7.3.2. Ensure that polycarbonate vision panels are strong enough to contain ejected parts. Over time, the polycarbonate panels can weaken from exposure to cutting fluids and lubricants.
- 7.3.3. Verify appropriate turning speed and closely inspect chuck, clamps and all components of the turning fixtures prior to each use.
- 7.3.4. A lockout/tagout procedure may need to be established in order to perform service on or to maintain CNC machines. The procedure must be developed in accordance with [Penn's Control of Hazardous Energy - Lockout/Tagout Program](#).

8. Abrasive Wheel Machinery (Grinders)

- 8.1. The spindle end, nut and flange projections must be covered by a guard. The guard shall be mounted to maintain proper alignment with the wheel and the strength of the fastenings shall exceed the strength of the guard.
- 8.2. On typical bench or floor stand mounted grinders, the angular exposure of the grinding wheel periphery and sides for safety guards used on machines should not exceed 90-degrees or one-fourth the periphery. This exposure shall begin at a point not more than 65-degrees above the horizontal plane of the wheel spindle.
- 8.3. Work rests must be maintained within at least 1/8-inch of the wheel.
- 8.4. The tongue (shatter) guard must be maintained within 1/4-inch of the wheel. The tongue guard is located on the top cover in front of the wheel. The tongue guard must be adjusted to maintain the 1/4-inch gap as the wheel wears.
- 8.5. Ensure wheel mounting flanges are of the proper type and size. Immediately before mounting, all wheels shall be closely inspected and sounded by the user (ring test) to make sure they have not been damaged in transit, storage or otherwise. Wheels should be tapped gently with a light non-metallic implement, such as the handle of a screwdriver for light wheels, or a wooden mallet for heavier wheels. If they sound cracked (dead), they shall not be used.
- 8.6. 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.

9. Pneumatically-Powered Tools & Equipment

- 9.1. **General:**
 - 9.1.1. Compressed air shall not be used for cleaning purposes except where reduced to less than 30 pounds per square inch and then only with effective chip guarding and personal protective equipment.
 - 9.1.2. Pneumatic tools must be checked to confirm that they are fastened securely to the air hose to prevent them from becoming disconnected. A short wire or positive locking device attaching the air hose to the tool also must be used and will serve as an added safeguard. If an air hose is more than 1/2-inch in diameter, a safety excess flow valve must be installed at the source of the air supply to reduce pressure in case of hose failure.

9.2. **Handheld Nail/Stapling Guns:**

- 9.2.1. Pneumatic tools that shoot nails, rivets, staples, or similar fasteners, and operate at pressures more than 100 pounds per square inch must be equipped with a special device to keep fasteners from being ejected, unless the muzzle is pressed against the work surface.

10. Robots

- 10.1. EHRS must be notified of all robot acquisitions and installations.
- 10.2. A robot machine safeguarding assessment and risk reduction assessment must be completed and documented by a properly qualified robotics safety risk assessor/integrator to identify required safeguards and prescribe safe work practices. This should be completed as part of the initial design process. Contact EHRS if help is required to identify resources for this.
- 10.3. Installation and use of robots shall comply with the appropriate [Robotics Industry Association \(RIA\)](#)/American National Standards Institute (ANSI) robotics R15 series safety standards.
- 10.4. Robots designed for collaborative operation must be selected for applications where there is a need for robot and humans to be in the same operating space.
- 10.5. Employees and students must adhere to all safety procedures prescribed by the robot operating manual and the machine safeguarding and risk reduction assessment.
- 10.6. Robot safety systems must be verified periodically in accordance with the robot operator manual and the safeguarding and risk reduction assessment.
- 10.7. An equipment-specific control of hazardous energy (lockout/tagout-LOTO) procedure must be developed and used to place the robot system in a safe energy state for service, maintenance or when direct interaction with the robot is required.

11. Mechanical Power Transmission Equipment

- 11.1. All belts, pulleys, gears, shafts and moving parts located so that any part is seven (7) feet or less above floor or platform shall be guarded.

12. Compactors and Baling Equipment

- 12.1. Ensure access covers and point of operation guards are interlocked in such a manner that the compactor cannot be operated if the guard or loading door is removed or opened.
- 12.2. Follow Control of Hazardous Energy (Lockout/Tagout) procedure to isolate electrical power and release stored energy prior to clearing jams, adjusting, cleaning, repairing, or performing any other maintenance tasks. Refer to Penn's [Control of Hazardous Energy – Lockout/Tagout Program](#).
- 12.3. Ensure all operator instruction, caution and warning labels are legible. Contact compactor/baler service provider to replace labels when they are no longer easily legible.

13. Fans

- 13.1. 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 one-half (1/2) inch.

14. Lawn Mowers

- 14.1. All power-driven chains, belts and gears shall be so positioned or otherwise guarded to prevent the operator's accidental contact during normal starting, mounting and operation of the machine.
- 14.2. 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.
- 14.3. 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.
- 14.4. All caution/warning labels and instructions at controls, removable blade covers and at discharge must be legible. Labels must be replaced when they become worn or otherwise damaged.
- 14.5. Mower must not be used without either the catcher assembly or the guard in place.
- 14.6. The blade(s) shall stop rotating from the manufacturer's specified maximum speed within 15-seconds after declutching, or shutting off power.

- 14.7. Deadman controls, both hand and foot operated, shall automatically interrupt power to a drive when the operator's actuating force is removed.

15. Farm and Landscaping Machinery

- 15.1. Complete routine hazard analyses of each piece of farm/landscaping machinery. Some of the key inspection points are as follows:
- 15.1.1. Roll over protection systems are in good condition and properly positioned.
 - 15.1.2. Seatbelts in working condition.
 - 15.1.3. Operator platforms and tool storage.
 - 15.1.4. Power takeoff (PTO) master shields - Master shields shall cover the drive shaft connection points at the power source and at the implement.
 - 15.1.5. PTO drivelines – rotating parts of exposed drivelines shall be covered.
 - 15.1.6. PTO warning decals – Replace when they become illegible or otherwise damaged.
 - 15.1.7. Hydraulic couplers and hoses are in good condition.
 - 15.1.8. Hydraulic safety support bars are installed and used on equipment that have parts raised by hydraulic cylinders. The support bars are installed whenever the area under the raised equipment parts must be accessed. The support bars prevent the raised parts from lowering in the event of a hydraulic failure or unexpected operation of the equipment's controls. Commonly found on backhoes, front end loaders and skid steer loader arms.
 - 15.1.9. Lights, turn signals, brake lamps and flashers are functional.
 - 15.1.10. Slow moving vehicle emblems shall be installed and clearly visible.
 - 15.1.11. Fixed and flexible guards on agricultural machinery. Ensure all guards that were originally supplied with the machinery are in place and functioning as designed.
 - 15.1.12. Jack stands are in good condition and lock properly.
 - 15.1.13. Tires are in good condition.
 - 15.1.14. Belts, chains and gear drives – ensure guards are in place.

16. Ice Conditioning Equipment

- 16.1. Ensure that seat dead man's switch that shuts the unit off if the operator leaves the seat is working correctly.
- 16.2. Ensure that hydraulic cylinder safety support bars designed to prevent the snow bin from lowering in the event of a hydraulic failure or unexpected operation of the hydraulic controls are installed and used whenever the area under the bin is accessed with the snow bin raised.
- 16.3. Ensure ice edger blade guard is installed and in good condition.

17. Chain saws

- 17.1. Ensure chain brake functions properly. Start the saw with the brake engaged.
- 17.2. The use of chain saws requires specialized training and personal protective equipment. Contact EHRS to coordinate an on-site training session.

18. Shop, Robotics Lab & Maker Space Design Review and Safety Audits

- 18.1. EHRS shall review the design and layout of new shops, robotics labs and maker spaces.
- 18.2. EHRS shall perform periodic safety audits of shops, robotics labs and maker spaces.

19. Training

- 19.1. Employees who operate shop machinery and power tools must complete Penn's online Shop Safety Training Program available through [KnowledgeLink](#).
- 19.2. Students who work in shops, robotics labs and maker spaces or use power tools outside of the shops, must receive training through their respective program of study. Training must be documented.
- 19.3. EHRS coordinates specialized live training sessions as required, including Control of Hazardous Energy (Lockout/Tagout), Agricultural Safety, Chain Saw Safety, etc.. Contact EHRS to coordinate any safety training that is currently not addressed.

20. Recordkeeping

- 20.1. EHRS shall maintain training records of EHRS-coordinated training. School shops, robotics labs and maker spaces shall maintain records of equipment-specific training provided to students and employees.
- 20.2. Training record documentation must include curriculum and training dates. Training records shall be maintained for as long as students and employees use the shop, robotics lab or makerspace.

21. Related Safety Programs

The following safety-related programs may apply to operators of machinery, equipment and power tools.

- 21.1. [**Control of Hazardous Energy – Lockout/Tagout Program**](#) – Adjustment, maintenance or repairs that pose a risk to the individual performing the work in the event of the release of stored release or activation while the work is being performed require specialized training and procedures.
- 21.2. [**Hearing Conservation Program**](#) – Contact EHRS to assess noise exposure associated with machinery, equipment and tools.
- 21.3. [**Personal Protective Equipment Program**](#) – Contact EHRS to perform hazard analysis of tasks to assist in recommending specific personal protective equipment.

22. References/Resources

- 22.1. [**Occupational Safety and Health Administration \(OSHA\) 1910 Subpart O**](#) – Machinery and Machine Guarding.
- 22.2. OSHA [**Woodworking eTool**](#).
- 22.3. [**Machine Safeguarding at the Point of Operation**](#) – A guide for Finding Solutions to Machine Hazards. Oregon OSHA Standards and Technical Resources.
- 22.4. Farm/Agriculture/Rural Management Hazard Analysis Tool (FARM HAT). Dr. Dennis J. Murphy. The Pennsylvania State University. <https://extension.psu.edu/business-and-operations/farm-safety>
- 22.5. Robotics Industry Association (RIA) - [**Safety standards**](#).