MACHINE and POWER TOOL SAFETY PROGRAM – TABLE OF CONTENTS

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1. Purpose

The Machine and Power Tool Safety Program informs the Penn community of some of the key hazards associated with machines, 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 Machine and Power Tool Safety Program.

3.1.2 Perform initial and periodic hazard assessments of shops and other locations where hazardous machinery and tools are used. Provide guidance on mitigating identified hazards.

3.1.3 Develop, provide or coordinate safety training.

3.1.4 Assist with selection of personal protective equipment and provide training on its use.

3.2 *Management/Supervisors/Faculty*

3.2.1 Ensure that users of machinery and tools receive proper safety training.

3.2.2 Purchase required personal protective equipment and enforce proper usage.

3.2.3 Ensure that machinery and tools are properly maintained.

3.2.4 Conduct periodic inspections to ensure that guards and safety equipment originally installed on machines and tools remain in place, have not been tampered with and are properly adjusted.

3.3 *Machinery/Tool Operators*

3.3.1 Receive training on safe use of machinery and tools prior to use.

3.3.2 Ensure all required guards and safety equipment are in place prior to using machines and tools.

3.3.3 Report machinery and tools that are damaged or those that are missing guards or other safety devices to supervisor or management.

3.3.4 Wear assigned personal protective equipment.
4. Glossary of Selected Terms

4.1 **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.

4.2 **Guard** – a barrier that prevents entry of the operator’s hands or fingers in the point of operation.

4.3 **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.

4.4 **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.

4.5 **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.

4.6 **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.

4.7 **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. Procedures

This section outlines some requirements for common machinery and tools existing at the University of Pennsylvania. This listing is not meant to be all-inclusive and the listed requirements are a summary of some items found on commonly encountered machines and equipment. Contact EHRS or refer to the OSHA 1910 subpart O for a fully-comprehensive listing of equipment and the full machine guarding requirements.

5.1 **Proper attire for operators of machinery, tools and equipment:**

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 immediately 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 While stylish, neck ties, scarves, etc. may not be worn while in close proximity to machines or tools with rotating parts.

5.1.4 Wearing gloves is not recommended while operating machinery or equipment with rotating parts.

5.1.5 Jewelry including rings, necklaces, bracelets, wristwatches and identification badges hanging from chains or non-breakaway lanyards should not be worn while operating machinery, equipment or tools.

5.2 **General requirements for all machines** [1910.212]

5.2.1 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.

5.2.2 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.

5.2.3 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.

5.2.4 Machines designed for a fixed location shall be securely anchored to prevent walking or moving.

5.3 **Woodworking Machinery** [1910.213]

5.3.1 **General requirements for all woodworking machinery:**

5.3.1.1 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.

5.3.1.2 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.
5.3.1.3 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.

5.3.1.4 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) Management Program for additional procedures and information.

5.3.1.5 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.

5.3.2 Table Saws
5.3.2.1 Guard the portion of the saw blade above the table and that portion of the blade above the material being cut. The hood must adjust to the thickness of the material being cut and remain in contact with it. This blade guard typically incorporates a spreader and anti-kickback fingers listed below.

5.3.2.2 Provide a spreader to prevent material from squeezing the saw or being thrown back on the operator.

5.3.2.3 Provide anti-kickback fingers that 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.

5.3.2.4 Provide push sticks for small pieces of wood and for pushing stock past the blade.

5.3.3 Band Saws
5.3.3.1 Guard the blade entirely except at the point of operation (the working portion of the blade between the bottom of the guide rolls and the table).

5.3.3.2 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.

5.3.3.3 Fully enclose the pulley mechanism and feed rolls.

5.3.3.4 Make sure the saw includes a tension control device to indicate proper blade tension.

5.3.3.5 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.
5.3.4 **Radial Saws**

5.3.4.1 Enclose the upper half of the saw (from the blade down to the end of the saw arbor) with a fixed hood. Guard the lower half with a self-adjusting, floating guard that rises and falls and automatically adjusts to the thickness of the stock.

5.3.4.2 Ensure saws used for ripping are equipped with a spreader and anti-kickback fingers.

5.3.4.3 Make sure the saw has a return device. The saw must gently return to its original position when released by the operator.

5.3.4.4 Install an adjustable stop to limit forward travel distance of the blade. The limit must prevent the saw from reaching the end of the table.

5.3.4.5 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”.

5.3.5 **Jointers**

5.3.5.1 The cutter head must be covered by an automatic (spring-loaded, self-enclosing) guard that exposes the cutter head only when the stock is being fed. The guard must automatically adjust to cover the unused portion of the head, and it must remain in contact with the material at all times.

5.3.5.2 Adjust the cylindrical cutter head so that the knife projects no more than 1/8-inch beyond the cylindrical body of the head.

5.3.5.3 Adjust the cylindrical cutter head so that the clearance between the path of the knife projection and the rear table is no more than 1/8-inch.

5.3.5.4 Provide and use hold-down push blocks when jointing wood narrower than 3-inches.

5.3.6 **Drill Presses**

5.3.6.1 Ensure all pulleys and drive belts are fully enclosed.

5.3.6.2 Ensure chuck key is not left in the chuck.

5.3.7 **Sanders**

5.3.7.1 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.
5.3.7.2 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.

5.3.7.3 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.

5.3.7.4 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.

5.3.7.5 Enclose power transmission pulleys and drive belts with a fixed guard.

5.3.8 **Planers/Moulders**

5.3.8.1 All cutting heads shall be guarded with a metal guard or cage.

5.3.8.2 Provide barriers at the loading and unloading ends to keep hands out of point of operation.

5.3.8.3 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.

5.3.9 **Woodworking Lathes**

5.3.9.1 Ensure all pulleys and drive belts are fully enclosed.

5.3.9.2 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.

6. **Metalworking Machinery**

6.1 **Mechanical Power Shears** [1910.217]

6.1.1 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.

6.1.2 A main power disconnect switch capable of being locked only in the off position shall be provided with every power shear control system.

6.1.3 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.
6.1.4 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.

6.1.5 Students are not permitted to operate mechanical power shears.

6.2 Metalworking Lathes
6.2.1 Use spring-loaded chuck keys to ensure that keys cannot be left in the chuck.
6.2.2 Provide a guard around the chuck.
6.2.3 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.
6.2.4 Provide a guard to prevent clothing and hair entanglement with the lead screw. Depending on the design, use either a telescoping metal guard or Spiroflex tape or equivalent.

6.3 CNC Machines
6.3.1 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.
6.3.2 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.
6.3.3 Verify appropriate turning speed and closely inspect chuck, clamps and all components of the turning fixtures prior to each use.

7. Abrasive Wheel Machinery (Grinders) [1910.215]
7.1 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.
7.2 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.
7.3 Work rests must be maintained within at least 1/8-inch of the wheel.
7.4 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.
7.5 Ensure wheel mounting flanges are of the proper type and size.
7.6 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.

7.7 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.


8.1 *General*

8.1.1 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.

8.1.2 Pneumatic tools must be checked to see 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.

8.2 *Handheld Nail/Stapling Guns*

8.2.1 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.

8.3 *Mechanical Power Transmission Equipment* [1910.219]

8.3.1 All belts, pulleys, gears, shafts and moving parts shall be guarded.

8.4 *Compactors and Baling Equipment*

8.4.1 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.

8.4.2 Utilize control of hazardous energy (lockout/tagout) procedure prior to clearing jams, adjusting, cleaning, repairing, or performing any other maintenance tasks. Refer to Penn’s Control of Hazardous Energy (Lockout Tagout) Management Program.
8.4.3 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.

8.5 **Fans** [1910.212]
8.5.1 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.

8.6 **Lawn Mowers** [1910.243(e)]
8.6.1 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.
8.6.2 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.
8.6.3 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.
8.6.4 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.
8.6.5 Mower must not be used without either the catcher assembly or the guard in place.
8.6.6 The blade(s) shall stop rotating from the manufacturer’s specified maximum speed within 15-seconds after declutching, or shutting off power.
8.6.7 Deadman controls, both hand and foot operated, shall automatically interrupt power to a drive when the operator’s actuating force is removed.

8.7 **Farm and Landscaping Machinery**
8.7.1 Complete routine hazard analyses of each piece of farm/landscaping machinery. Some of the key inspection points are as follows:
8.7.1.1 Roll over protection systems are in good condition and properly positioned.
8.7.1.2 Seatbelts in working condition.
8.7.1.3 Operator platforms and tool storage.
8.7.1.4 Power Take Off (PTO) master shields - Master shields shall cover the drive shaft connection points at the power source and at the implement.
8.7.1.5 PTO drivelines – rotating parts of exposed drivelines shall be covered.
8.7.1.6 PTO warning decals – Replace when they become illegible or otherwise damaged.
8.7.1.7 Hydraulic couplers and hoses are in good condition.
8.7.1.8 Lights, turn signals, brake lamps and flashers are functional.
8.7.1.9 Slow moving vehicle emblems shall be installed and clearly visible.
8.7.1.10 Fixed and flexible guards on agricultural machinery. Ensure all guards that were originally supplied with the machinery are in place and functioning as designed.
8.7.1.11 Jack stands are in good condition and lock properly.
8.7.1.12 Tires are in good condition.
8.7.1.13 Belts, chains and gear drives – insure guards are in place.

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

9. Training
9.1 Employees who operate shop machinery and power tools must complete Penn’s online Shop Safety Training Program available through Knowledgelink.
9.2 Students who work in shops or use power tools and machinery must receive training through their respective program of study. Training must be documented.
9.3 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.

10. Recordkeeping
10.1 EHRS will maintain training records of EHRS-coordinated live training. School shops shall maintain records of student training.
10.2 Documentation must include curriculum and training dates. Training records shall be maintained for as long as students use the shop.

11. Related Safety Programs

The following safety-related programs may apply to operators of machinery, equipment and power tools.
11.1 Control of Hazardous Energy (Lockout/Tagout) Management 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.
11.2 **Hearing Conservation Program** – Contact EHRS to assess noise exposure associated with machinery, equipment and tools.

11.3 **Personal Protective Equipment Program** – Contact EHRS to perform hazard analysis of tasks to assist in recommending specific personal protective equipment.

12. References

12.1 **OSHA 1910 Subpart O** – Machinery and Machine Guarding.

12.2 OSHA **Woodworking eTool**.


12.4 Farm/Agriculture/Rural Management Hazard Analysis Tool (FARM HAT). Dr. Dennis J. Murphy. The Pennsylvania State University. [www.agsafety.psu.edu](http://www.agsafety.psu.edu).