Machine Safeguarding at the Point of Operation

A Guide for Finding Solutions to Machine Hazards

MANITOBA School Boards ASSOCIATION

January 2018

ACKNOWLEDGEMENTS

The development of this reference guide for Manitoba schools was prepared with a collaborated effort. The Manitoba School Boards Association, Risk Management Department would like to thank Kristin Petaski and Mike Gordon of Workplace Engineering Solutions Inc. who were very instrumental in this endeavour.

We would also like to thank all those who shared their insights and suggestions.

DISCLAIMER

The purpose of this reference guide is to provide guidance for those responsible in the Industrials Arts programs in Manitoba schools. The intention is to assist staff to ensure that proper awareness of safety and procedures are in place to minimize risks that are inherent in Industrial Arts programs. The Manitoba School Boards Association does not accept liability or responsibility for any occurrence arising out of the use of this reference guide.

INTRODUCTION

Manitoba Schools Insurance (MSI) provides property and liability coverage for Manitoba public school boards. Risk Management is a key component of MSI, in the knowledge that proactive measures can ensure a safer environment with fewer losses and injuries. This manual is a risk management initiative intended to assist schools in implementing measures that will make these Industrial Arts programs safer than they might otherwise be.

This reference guide describes most machinery found in Manitoba schools including the hazards and solutions for each. Please take the time to review and evaluate your own work practices to ensure your guidelines are within acceptable guidelines noted in this document and CSA requirements.

Finally, some protocol outlined in this reference guide may be restricted due to school board policy. Board policy always takes precedence over this reference guide.

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Dear Mr. Darren Thomas,

Thank you for the opportunity to review the Manitoba School Board Association's "Machine Safeguarding at the Point of Operation – A Guide for Finding Solutions to Machine Hazards". The document provides excellent information that schools may use to identify machine hazards and determine safeguarding solutions. The information provided is aligned with the theme of Manitoba Workplace Safety and Health Regulation (MR217/2006) and CSA Z432-16: Safeguarding of Machinery.

It is important to note that every machine should be individually evaluated with a task-based risk assessment. This guide may be used to assist in the identification and resolution of hazards however in all cases the legal safeguarding requirements shall be found in Manitoba Workplace Safety and Health Regulation (MR217/2006) Part 16 – Machines, Tool and Robots and CSA Z432-16: Safeguarding of Machinery.

Thank you for the opportunity to assist with this document, please contact us with any questions.

Sincerely,

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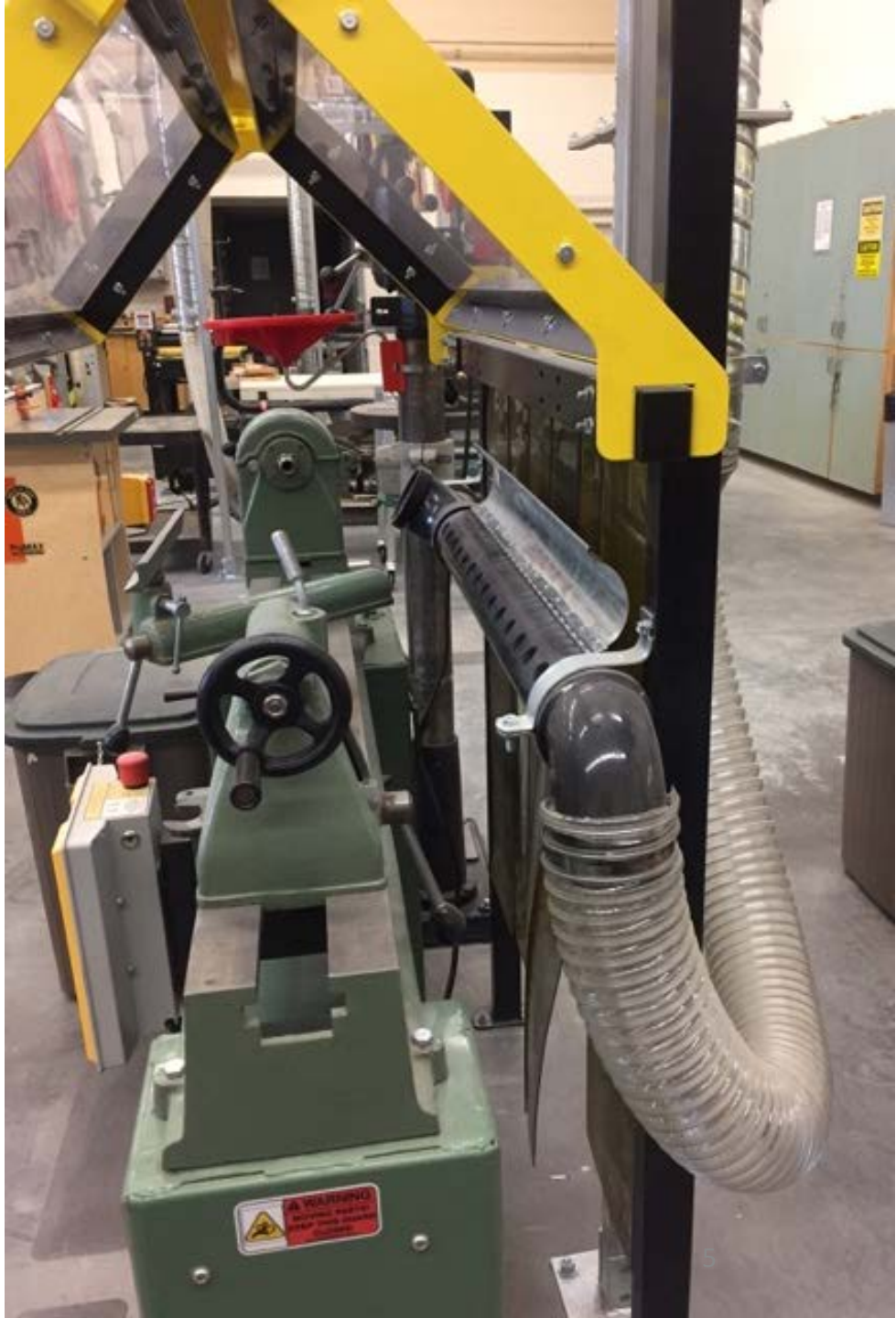
Machine Safety

Besides drawing on your own knowledge and experience, users should identify those aspects of their work that have the potential to cause harm by looking at appropriate sources of information such as guidance published by the regulator, CSA-Z432-16 safeguarding of machinery and manufacturer's instructions. The knowledge and experience of the intended users should also be considered



Abrasive Wheel Grinder

Abrasive wheels and grinding machines come in many styles, sizes, and designs. Both bench-style and pedestal (stand) grinders are commonly found in many school shops. These grinders often have either two abrasive wheels or one abrasive wheel and one special-purpose wheel such as a wire brush, buffing wheel, or sandstone wheel. These types of grinders normally come with the manufacturer's safety guard covering most of the wheel, including the spindle end, nut, and flange projection. These guards must be strong enough to withstand the effects of a bursting wheel. In addition, a work rest and transparent chip shields are often provided.

Hazards

- Bench-style and pedestal grinders create special safety problems due to the potential of the abrasive wheel shattering; exposed rotating wheel, flange, and spindle end; and a naturally occurring nip point that is created by the work rest.
- This is in addition to such concerns as flying fragments, sparks, air contaminants, etc. Cutting, polishing, and wire buffing wheels can create many of the same hazards.
- Grinding machines are powerful and designed to operate at high speeds. If the wheel shatters while in use, the fragments can travel at more than **300** miles per hour.
- Emergency Stops should meet the CSA-Z432-16 standard which includes power outage protection be red in color with a yellow background, self latching and located in operator position.

In addition, the wheels found on these machines (abrasive, polishing, wire, etc.) often rotate at several thousand revolutions per minute. The potential for serious injury from shooting fragments and the rotating wheel assemblies (including the flange, spindle end, and nut) is great. To ensure that grinding wheels are safely used in your school, know the hazards and how to control them.

Solution

- Abrasive wheels used on bench and pedestal grinding machines must be equipped with safety guards. The safety guard encloses most of the wheel – covering the flange, spindle end, and nut projection – while allowing maximum exposure of the wheel periphery. The exposure of the wheel should not exceed **90** degrees or one-fourth of the periphery.
- Because the safety guard is designed to restrain the pieces of a shattered grinding wheel, the distance between the safety guard and the top periphery of the wheel must not be more than ¼ inch. If this distance is greater because of the decreased size of the abrasive wheel, then a “tongue guard” must be installed to protect students from flying fragments in case of wheel breakage. This “tongue guard” should be adjustable to maintain the maximum ¼ inch distance between it and the wheel.
- An adjustable work rest must also be installed and maintained at a maximum clearance of 1/8 inch between it and the face of the wheel.
- In addition to offering a stable working position, this small clearance must be maintained to prevent the operator’s hands or the work from being jammed between the wheel and the rest, which may cause serious injury or the wheel to break. These machines also have long run times after they have been shut down, this should be clearly identified on the machine.
- Emergency Stop have been upgraded to a knee jerk switch with power outage protection and placed in operator position.

Solutions-continued

- All abrasive wheels must be closely inspected and ring-tested before mounting to ensure that they are free from cracks or other defects.
- Wheels should be suspended from the center mounting hole and tapped gently with a light, nonmetallic instrument. A stable and undamaged wheel will give a clear metallic tone or “ring.” If a wheel sounds dead or dull, it may be cracked. Do not use it. This is known as the “ring test.”
- The spindle speed of the machine must also be checked before mounting the wheel to be certain that it does not exceed the maximum operating speed marked on the wheel.
- Always follow the manufacturer’s recommendations.

Horizontal Bandsaw

- A horizontal band saw uses a thin, flexible, continuous metal band with cutting teeth on one edge. Horizontal bandsaws are used primarily for cutting metal stock, such as angle iron and other round flat stock. The blade runs horizontally on two pulleys through two separate guides.
- The operator secures the stock on the table and manually assists the saw as it cuts.

Band Saw Hazards

- Serious cuts or amputations can occur if the operator contacts the blade. Extreme caution is necessary because the operator's hands may come close to saw blade, and the entire run of the blade cannot be fully guarded.
- Crush hazards also exist with saws that come with pneumatic clamps, operators hands should stay clear of the clamps.

Solution

- Guard the entire blade, except at the point of operation (the working portion of the blade between the two guides). Band saw wheels must be fully encased and mechanically fastened.
- Make sure the saw includes a tension-control device to indicate proper blade tension.

Tension Control

3 sided Blade Guard

Movable anti slip mat

Vertical Bandsaw

- A vertical band saw uses a thin, flexible, continuous metal band with cutting teeth on one edge. It is versatile saw used to cut both wood and metal stock as well as to cut and trim meat. The blade runs on two pulleys, the driver and the idler, and through a work table where material is manually fed.
- In order to cut, the operator is required to hand feed and manipulate the stock against the blade. The operator must also keep the stock flat on the work table and exert the proper amount of force.

Hazards

Serious cuts or amputations can occur if the operator contacts the blade. Extreme caution is necessary because the operator's hand may come close to the saw blade and a band saw cannot be fully guarded.

Blade guard not 3-sided

No operator chip shield

Doors not mechanically fastened

Solution

- Guard the entire blade except at the point of operation (the working portion of the blade between the bottom of the sliding guide rolls and the table).
- Use an adjustable 3- sided guard for the portion of the blade above the sliding guide rolls so that it raises and lowers with the guide. Properly adjust the blade guide to fit the thickness of the stock and ensure the guard is as close as possible to the stock. Install an operator chip shield
- Bandsaw wheels must be fully enclosed and mechanically fastened.
- Emergency Stop have been upgraded to a knee jerk switch.

CNC Turning Machine

- Computer numerically controlled (CNC) machining centers and shape an assortment of precision products from automobile parts to general machine parts. Operating in either horizontal or vertical positions. CNC machinery includes machining tools such as lathes, multi axis spindles, and milling and boring machines; the functions performed by human operators are performed by a computer module. CNC machinery is either hand loaded or automatically fed.
- Most CNC machinery is partially or totally enclosed by metal enclosures, equipped with thermoplastic vision panels, most commonly polycarbonate.
- Guarded enclosures with safety interlock are another means of protecting operators and students from the moving hazards of the machine

Hazards

- Two primary hazards arise from CNC turning operations: Entanglement and the ejection of parts. Serious lacerations, fractures, amputations, or even death can occur if an operator contacts or becomes entangled in or between the tooling or rotating work piece. Similar injuries or death can also occur from being struck by ejected parts (e.g., cutters or other tools, chucks, or the work piece).
- Although the risk of injury from ejected parts is lessened due to the interlocked enclosure of CNC machinery, recent research has shown that polycarbonate materials used in the unit's vision panels can degrade after exposure to the metalworking fluids and lubricants used in the machining process.
- Over time, vision panels may not be able to contain ejected parts. Most ejections at CNC turning machines are caused by a setup error or failing to properly maintain work-holding devices.
- Unexpected movement or startup caused by faults in the control system can also cause serious injury.

Hazards

Router head not enclosed

Machine bed way not enclosed

Solutions

- To prevent access into the point-of-operation area, ensure the CNC machine is fully enclosed and equipped with an interlocked guard (door). The cutting tools should not start unless the door is in a closed position and should stop when the door is opened. Many machines lock the guard in position during operation and can only be opened when the tooling stops. If access into the point of operation is infrequent, install a fixed enclosure that can be removed only for maintenance activities.
- Automatic loading and unloading methods and automatic tool changing further reduce the exposure to the point of operation.
- To prevent injury from ejected parts, make sure the polycarbonate vision panels are strong enough to contain ejected parts. Also, verify the appropriate rotational speed for the work piece and inspect the chuck jaw assemblies, work piece clamps, and all component parts of the turning fixtures.

Cut- off saws

- Although there are many specific types of cut-off saws, they are all circular saws designed to cross-cut stock at exact lengths and angles. The following are some of the common cut-off saws used today

Chop saw

A chop saw is a lightweight circular saw mounted on a spring-loaded pivoting arm and supported by a metal base. The operator clamps the stock to the fence, pulls the blade through the work piece, and guides the saw back to its upright position. Chop saws typically do not have the cutting capacity of miter saws.

Sliding Miter Saw

- A miter saw is a versatile circular power saw mounted on a hinged frame and designed to make accurate angle cuts. When the blade is lowered in a cutting motion, the blade cuts through the work piece, passing through a slot in the base.

Hazard

- Severe cuts or amputations of the fingers or hands can occur if they come in contact with the blade. If rotating blade is not properly guarded, exposure can occur during operation or when the saw is idling.
- Overhead swing saws can pose additional hazards if the return device fails, if the saw bounces forward from a retracted position or if the saw blade is able to go past the edge of the table, possibly contacting the operator's body. Although not as common as ripsaws, hazardous kickbacks might also occur.

Solution

- Over-table cut-off saws (miter, chop, and overhead swing saws) must be provided with fixed hood guards that enclose the arbor and top half of the saw. These saws also must be equipped with a self-adjusting lower blade guard that automatically adjusts itself to the thickness of the material being cut and provides continuous protection from the blade. Most guards supplied by manufacturers are designed to move out of the way as the blade nears the cut. If a guard seems slow to return to its normal position, adjust or repair it immediately.
- Overhead swing saws must be provided with a device (i.e., counterweight) to return the saw automatically to the back of the table when released at any point of its travel. Limit chains must also be provided to keep the saw from swinging beyond the front or back edges of the table.

Solution

- Inverted (under-table) swing saws and jump saws, when idling, are guarded by their enclosure.
- During operation, a hood-type guard or clamping means must be provided for the blade portion that protrudes above the table or above the stock being cut in addition to holding down the stock.
- These saws must have a “nose guard” affixed to the saw table in front of the hood guard (or another method providing equivalent protection) to prevent accidental entry of fingers or hands into the path of the saw blade from the front, “Nose Guards,” applicable for cut-off, inverted swing cut-off, and similar saws).

Drill Press

The drill press is a versatile machine that uses a multiple-cutting-edged drill bit secured in a rotating chuck to bore and drill holes, both into wood and metal stock. Either in floor or bench-top designs, drill presses are usually arranged vertically, requiring the operator to raise and lower an operating handle in order to control the drill bit. These machines also have variable speeds and some have multiple spindles for gang drilling. The most commonly used drill press is a single-spindle, floor-mounted, belt-driven machine for non-production drilling.

Hazard

- Serious lacerations and entanglement can occur if operators contact the rotating bit or chuck, or when operators try to hold the stock by hand when drilling. If not adequately secured, the stock can spin violently and contact the operator and others nearby. Also, injuries can occur from a projected chuck key if it is left in the chuck.

Solution

- Use jigs or fixtures to fasten the stock to the bed and stabilize the work piece. This allows the stock to be secured for drilling and the operator's free hand to be positioned away from the rotating chuck and drill bit. The drill bit is more likely to grab and twist an unstable work piece. In many repetitive drilling applications, specially designed guards and shields are installed to protect the operator from the potential exposure to rotating drill chucks and drill bits. A fixed guard should be installed to cover the chuck as well as a chip shield. The access door to the motor should be mechanically fastened and the operator controls located as close to operator position as possible.

Jointer

- Jointers face and straighten wood and are used primarily to square edges. The operator passes stock over a cylindrical multiple- knife cutting head while keeping the stock flush against a guide.

Hazard

- Severe lacerations or amputations can occur if the operator’s hands and fingers come in contact with the knives. This can happen when operating an unguarded machine, jointing narrow lengths of stock when not using a jig or other holding device, or when the operator’s fingers ride along the surface of the jointer and through the self-adjusting guard while feeding the wood. Also, stock may kick back and expose the operator’s hands to the cutter head.

Solution

- A spring-loaded, self-adjusting guard must be provided to enclose the horizontal cutting head when stock is not being fed. The guard automatically adjusts to cover the unused portion of the head and remains in contact with the stock at all times. A guard must also cover the section of cutting head behind the fence (gage). For vertical-head jointers, completely enclose the cutter head except for the slot to apply the stock. This guard can be part of the local exhaust system.
- The knife projection on the cutting head must not be more than 1/8 inch beyond the cylindrical body of the head. The clearance between the edge of the rear table (infeed) and the cutting head must not exceed 1/8 inch. The opening in the table must be kept as small as possible. Hold down push shoes and sticks are highly recommended when using the jointer.

Metal Lathe

- A metal lathe is a precision turning machine that rotates a metal rod or irregular-shaped material while a cut into the material at a preset position. Like the wood lathe, the metal lathe normally consists of a headstock and base that houses one or more spindles which a work holding device (chuck) can drive the stock and the cutting tools can remove metal, producing mainly cylindrical and conical shapes.

There are basically two main types of metal lathes: Lathes for shaft work (material supported at two or more locations) and lathes for bar (bar stock introduced through the spindle) or chucking work (individual pieces secured at the chuck). Shaft lathes include engine lathes, vertical-shaft lathes, and turning centers. Bar and chucking lathes include turret lathes (vertical and horizontal) and vertical boring mills.

Hazard

- Severe injuries and death can occur primarily from being caught in or struck by rotating parts. An operator can be pulled into the lathe from working perilously close (e.g., polishing a slotted shaft with emery cloth) or wearing gloves, loose clothing, loose hair, jewelry, etc. Trapping spaces are also created between the cutting tool, its mounting, and the work piece or chuck.
- Projected parts or material such as chuck keys or unsecured work pieces can also strike nearby operators.
- Flying chips and coolant also present hazards to the operator

Solution

- Avoid wearing gloves, loose clothing, long hair, jewelry, or other dangling objects near lathe operations. Pay close attention to work pieces that have keyway slots or other surface profiles that may increase the risk of entanglement. Assess the need to manually polish (e.g., emery cloth) rotating material. If necessary, consider milling keyways or other profiles after polishing or use emery cloth with the aid of a tool or backing boards. Always use a brush or tool to remove chips.
- Cover work-holding devices (chucks) and tool trapping space hazards (especially in automatic or semiautomatic modes) with secured fixed or movable guards or shields. Vertical lathes and controlled turning centers **should be** provided with fixed or interlocked guarding that prevents access during automatic cycle.

Solution-continued

- Make sure all work pieces and work holding devices are secure and free from defects. Remove the chuck key from the chuck after securing the material. Consider using a spring loaded wrench.
- Provide a chip/coolant shield unless another guard or shield already provides protection. This does not replace the need for eye or face protection.
- *NOTE: Guards or shields used to protect lathe operators from projected parts must either be from the manufacturer or, if fabricated in-house, meet or exceed the same impact-resistance specifications as the original manufactured part. Various materials (such as polycarbonates) may possess different and less-effective impact-resistance characteristics than the original materials used by the manufacturer*

Wood Lathe

- While most tools rotate or move a blade or bit to cut, the wood lathe moves the work piece being cut. The wood lathe is used to turn stock into round objects by securing the stock between two centers: the headstock and tailstock (spindle turning), or by securing the work to the headstock only with a faceplate (facing). Spindle turning is used for long objects such as table and chair legs, while facing is used fo0r cups, bowls, and plates.
- The stock rotates rapidly while the operator applies a single-point tool to the wood. The operator holds the tool on a tool rest and advances it along the length of the tool rest to shape the stock as desired.

Hazard

- Due to its unique operation of rotating the stock being cut, the lathe presents several concerns. The primary hazards arise when using a hand tool against the rotating stock and the close proximity of the operator to the rotating parts.
- Serious injuries can occur if the tool becomes caught between the rest and the rotating stock, bringing the operator's hands in with it. Also, hands, arms, clothing, hair, or jewelry may be caught on the rotating parts and pulled into the machine simply because of the close distance the operator is from the machine's components.
- Projected or broken work pieces can be another hazard if not secured between the centers or if the work piece is defective. Furthermore, chuck keys can eject if left in the chuck. Flying wood chips from the turning operation also can pose a hazard on wood lathes.

Solution

- Cover all rotating parts and points of operation with shields.
- Cover lathes used for turning long stock with long, curved guards that extend over the top of the lathe. These shields, or guards, must protect the operator if the stock comes loose and is thrown from the machine

Wood Lathe- continued

Make sure the tool rest is secure and set close to the stock (1/8 inch). Rotate the stock by hand to make sure it clears the tool rest before turning the lathe on. Guide the turning tool on the rest only — do not attempt to support the tool with your hands.

The work piece must be secured and should be free of cracks, splits, knots, and other defects. Check for weak glue joints.

Remove chuck keys or adjusting wrenches. Develop the habit of never letting go of the chuck key or wrench when you are using it. Consider using a spring-loaded chuck wrench.

Check to make sure that the chuck is secured before turning the lathe on.

Never permit operators to wear loose clothing, long hair, jewelry, dangling objects, or gloves.

Vertical Milling Machine

A milling machine removes material from a work piece by rotating a cutting tool (cutter) and moving it into the work piece. Milling machines, either vertical or horizontal, are usually used to machine flat and irregularly shaped surfaces and can be used to drill, bore, and cut gears, threads, and slots.

The vertical mill, or “column and knee” mill, is the most common milling machine found in machine shops today. The general construction of this mill includes the quill, which moves vertically in the head and contains the spindle and cutting tools. The knee moves up and down by sliding parallel to the column. The column holds the turret, which allows the milling head to be positioned anywhere above the table.

Hand wheels move the work table to the left and right (X axis), in and out (Y axis), in addition to moving the knee, saddle, and worktable up and down (Z axis).

Hazard

- Serious injuries and entanglement can occur if the operator contacts the rotating cutter. Metal shavings and lubricating/ cooling fluids might also present a risk from the point of operation area.
- Material might spin and strike an operator if the material is not secured to the table. Injuries can also occur from a projected wrench if it is left in the spindle.

Solution

- Secure the work piece, either by clamping it onto the work table or by clamping it securely in a vise that is clamped tightly to the table.
- *NOTE: Computer numerical controlled (CNC) mills are rapidly replacing manually fed machines, mainly for versatility and production reasons. The increased automation does not normally require the operator to move the hand wheels (like the traditional machines), so operators must always keep their hands away from the point of operation. A chuck guard and spindle guard or shield that encloses the cutter head or milling bed may be considered to protect the operator from the cutting area, flying metal shavings, and lubricating or cooling fluids.*
- Make sure the tightening wrench is removed from the mill.

Planer

- Planers are most frequently used to produce smooth faces on boards and to mill them to a particular thicknesses. Planers are different from jointers because of their capacity to plane wider surfaces and the capability to control thickness.
- Planers have automatic feed systems that pull the work through the horizontally rotating blades and out the back.

Hazard

- Severe lacerations, amputations, or avulsions (tearing away) can occur if the operator's hand or arm is fed through the machine and contacts the cutting heads.
- Serious injury can also occur from kickback. A kickback can occur when lowering the table with the power on and the stock still in the machine, feeding stacked boards, or planning boards shorter than the manufacturer's recommendation.

Solution

- Keep the machine guards in place at the infeed and outfeed to prevent access, at all times.
- Keep your hands out of the machine feeding area and allow the planer to pull the stock through
- Never lower the table during operation and never feed stacked boards. Also, follow manufacturer's recommendations for allowable material dimensions.
- Keep your body to the side of the stock. Infeed outfeed guards.

Scroll Saw

Scroll saws are useful for cutting intricate curves and patterns in thin stock. They have thin blades that move rapidly up and down through the opening in the saw table. The blade is held in upper and lower chucks that pull it tight and keep it from bending. A hold-down device adjusts to the thickness of the wood being cut. The material is pushed through the moving blade.

Hazard

- Serious cuts to the fingers and hand can occur if the operator contacts the blade.
- The blade can bind or break if stock is lifted during the upstroke of the reciprocating blade or if the stock is moved aggressively.

Solution

Guard the blade above the work piece with an adjustable chip shield guard and below the table with a lower blade guard

Use an adjustable hold down device to oppose the lifting tendency of the work piece from the reciprocating blade.

Make turns slowly. Use a narrow blade for sharp turns. Consider using aids to push material through the blade.

Router Table

- Woodworking shapers and routers are machines that cut various straight and irregularly shaped (contour) profiles such as tonguing and grooving, and decorative molding. Although there are slight differences in operation, both routers and shapers use one or more cutting heads mounted on a rotating, vertical spindle. Shaper spindles are normally mounted below the stock and router spindles are often mounted above the stock.
- The primary difference in operation is how stock is fed into the cutter. Routers commonly cut either stationary or moving stock and shapers cut only moving stock. On manually fed shapers, the operator feeds and manipulates the stock against the rotating cutter while keeping the stock flat on the table. Guides can be used for irregular cuts and fences are often used for straight line shaping.

Hazard

- Amputations or severe lacerations can occur if the operator contacts the cutter head. Also, loose clothing or gloves can become entangles in the rotating cutter or spindle simply due to the operator's proximity to the cutting head.
- Routers and shapers rotate at tremendous speeds- many operating in excess of 10,000 RPM. Any imbalance or vibration of the spindle and cutter presents a significant flying object.
- Hazardous kickbacks of the stock can also occur.

Solution

- Ensure that the spindle is enclosed by the machine table or a guard. The table opening Fence and barrier-type guarding used for straight-line shaping. for shapers must provide support for the stock to within ¼ inch of the largest diameter cutter (inserts must be provided for smaller diameter cutters).
- All sections of the cutter must be safeguarded, except for the opening to allow stock to pass. For straight-line shaping, a fence must be provided to limit the depth of the cut and enclose the non-working side of the cutter. The fence should contain as small an opening as possible for the cutter and extend on either side of the spindle. The fence or an additional guarding provision must also protect the operator from above the cutter by extending beyond the largest diameter cutting head.
- For contour (free-hand) shaping, a “ring” guard or other type of adjustable guarding must be provided to protect the operator from the exposed cutter (see accompanying illustration). If properly set up, this guard may also hold down the work, minimizing kickback.
- Use templates, jigs/fixtures, feather boards, or push blocks to distance the operator’s hands from the point of operation and to aid when shaping smaller dimensioned stock. Avoid wearing loose-fitting clothing or gloves

Router-continued

- To minimize hazardous kickback, use extra care when shaping stock that contains cross grains or knots. Use a secure stop block where an interrupted cut is made. Do not back up the stock (check to see that the direction of rotation is as expected).
- Ensure the cutting head is stable and does not vibrate excessively when operated at maximum recommended speeds.

Belt Sander

- The belt sander is a general-purpose finishing tool. The belt is looped around two or more pulleys and the linear motion makes it effective for sanding with the grain of wood. Abrasive belts of various grades also make the belt sander useful for shaping.
- Belt sanders can be found in upright, vertical, and horizontal positions. When using a belt sander in an upright or vertical position, the work should be supported on a table.

Hazards

- Serious abrasion can occur from contacting the moving belt. Small work should not be abraded on the belt sander as the small piece can easily be dislodged from the operator's hands and allow contact with the belt. Nip points are created when a belt passes over or under a pulley or roller, and are often close to the point of operation. If nip points are not guarded fingers, clothing, or hair can become caught in the machine. On vertical belt sanders, the gap created between an improperly adjusted work table and the down running portion of the sanding belt can trap the operator's fingers

Nip Point

Solution

Guard the unused runs of the sanding belt.

Do not sand the face of pieces that are less than ¾-inch thick unless you use a push shoe or some other means of supporting the stock.

Guard all nip points. This can normally be accomplished by enclosing the edge of the sanding belt and the ends of the pulleys. Ensure the work table is as close as possible to the sanding belt.

Disc Sander

- The disk sander provides rotary sanding. The table (rest) on a disk sander can be at a fixed, level position or adjusted to various angles. One-half of the top half of the vertical disk is used – the half that rotates toward the table.

Hazard

Serious abrasions to the fingers and hands can occur if the operator contacts the abrasive sanding disk.

Stock can violently kick back if pressed against the portion of the sanding disk that is rotating away from the table (e.g., right side of the disk in the diagram above).

A nip point can be created if the distance between the table and the downward portion of the disk is such that the operator can be pulled into it.

Solution

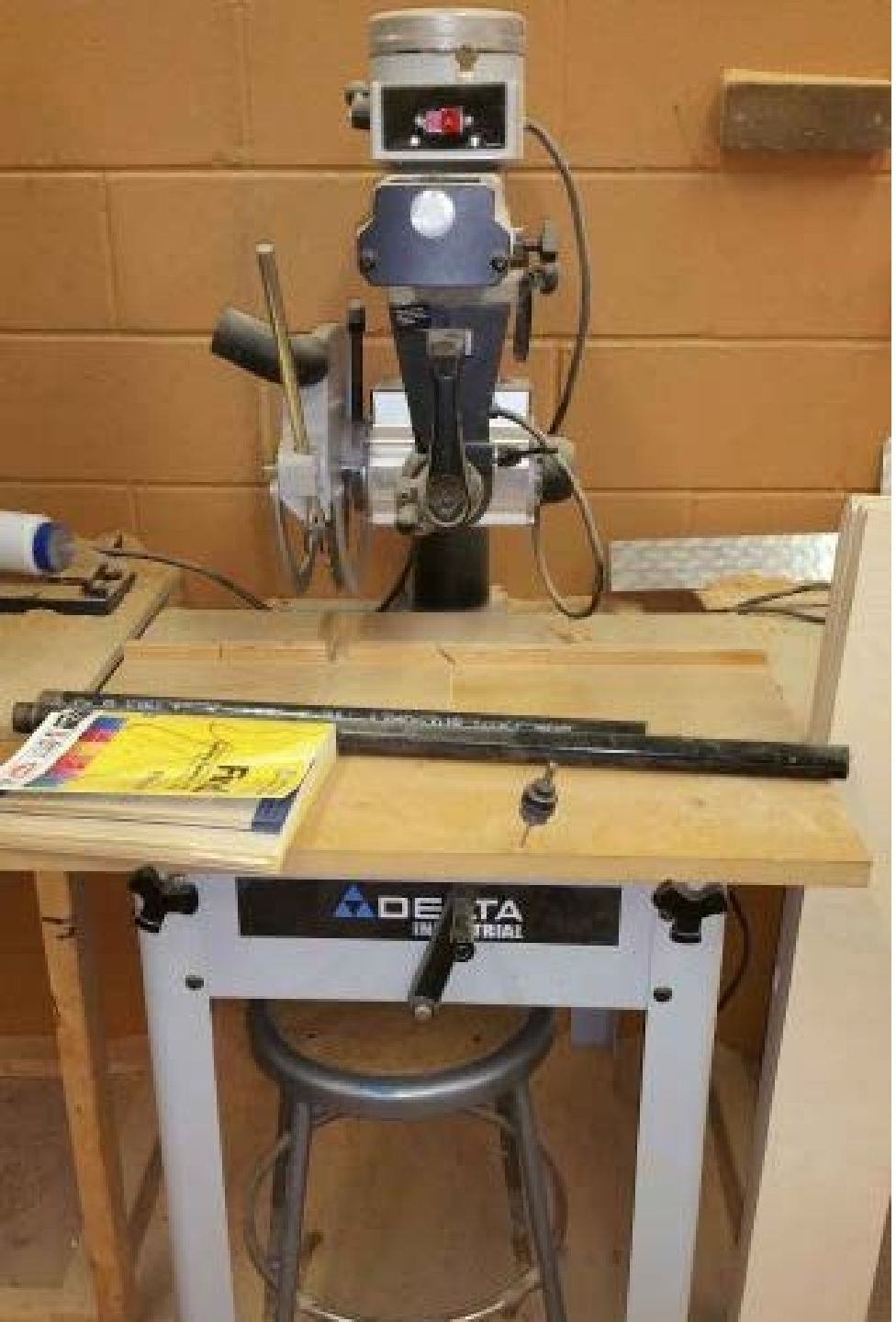
- Keep hands away from the abrasive surface and use only the downward side of the disk so that the wood is driven onto the table by the machine’s rotation.
- Do not sand pieces that are of a shape or size that can become wedged between the disk and the work table. Hold small or thin pieces of stock in a jig or holding device to prevent abrasion to the fingers or hands.
- Each disk sanding machine must have an exhaust hood (or other guard if no exhaust system is installed) that encloses the rotating disk, except for the portion of the disk above the table. This also applies to drum (spindle) sanders. The guards required a quarter moon, as well as point of operation chip shield.
- The knee jerk switch is placed on a swivel post and can be moved to either position, belt or disc depending on use.

Radial Arm Saw

- Radial-arm saws are circular saws that are normally used to cut against the grain of wood (crosscut) but can also cut with the grain (rip). For crosscutting, the operator pushes the wood against a fence and pulls the saw into the cut. For rip cuts, the blade is set parallel to the fence, and the stock is pushed through.

Hazard

- Severe cuts and amputations can occur if the operator contacts the rotating blade.
- If the saw blade is able to go past the edge of the table, the blade can contact the operator’s body.
- Stock can be thrown back at the operator if unsecured, caught in the blade, or fed in the wrong direction.



Solution

- Enclose the upper half of the saw (top of the blade to the arbor) with a fixed hood.
- Guard the sides of the bottom half of the blade with a self-adjusting guard that automatically adjusts to the thickness of the stock and remains in contact with the stock throughout the cut. The lower guard must guard the full perimeter of the blade on both sides during the cutting cycle and in the rest position. It must guard all of the saw teeth.
- Make sure the cutting head has a return device and an adjustable stop to prevent the leading edge of the saw from passing the front edge of the table, or extend the table edge. Securely fasten material to avoid unwanted movement during cuts. For ripping, install non-kickback fingers on both sides of the saw blade and use a spreader to prevent the cut in the wood form immediately closing and binding the blade.

Table Saw

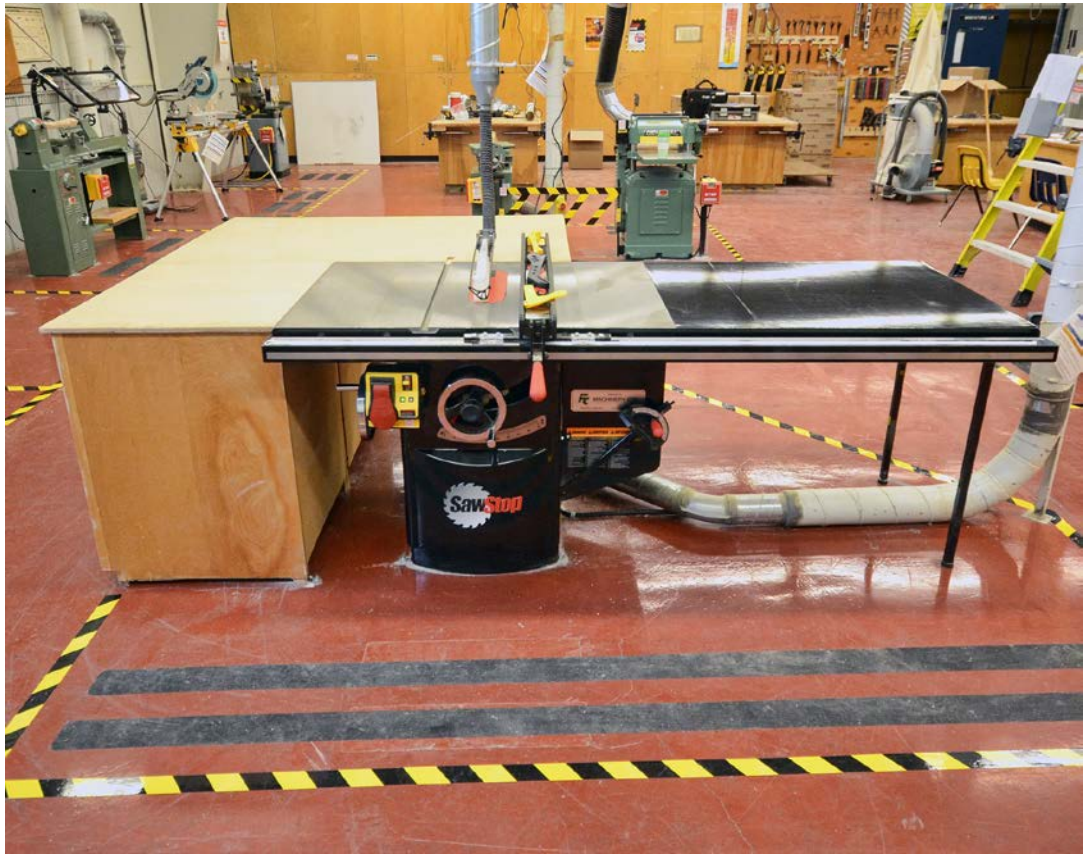
- Table saws are versatile saws used for cutting across (crosscut) and with (rip) the wood grain. They are most commonly used to rip.
- After adjusting the height and angle of the blade, the operator pushes the stock into the blade to make the cut.
- When making a rip cut, a fence is used to maintain a straight cut parallel to the blade.
- These older table saws do not provide the operator protection that Saw Stop models do, replacement should be considered.

Hazard

- Severe cuts and amputations to the fingers or hands can occur if the operator contacts the saw blade. Many serious injuries are the result of using the table saw without the point-of-operation guarding. These injuries are often a direct result of operating an unguarded machine in combination with other hazardous practices, such as placing hands very close to the blade to guide stock.
- (e.g., not using a push stick to guide stock through a cut), not firmly holding the stock causing the hands to slip off, diverting attention away from the cut (e.g., focusing on something other than the cutting operation), or removing small scraps (tailings) or finished pieces of stock from around the blade while the blade is moving.
- Although not at the point of operation, contact with the saw blade (and often a belt drive) may also be made from behind and underneath the table saw.
- Kickbacks also offer a significant hazard and occur when the blade catches the stock and throws it back toward the operator. Kickbacks, more likely to occur during ripping, can result if the blade is not maintained properly, or if safeguards are not used. Kickbacks can also occur if the operator stops guiding the stock during the cut. For example, material remaining on the table behind the saw can cause an obstruction with the stock and require the operator to stop mid-cut.

Solution

- The most common blade guard is a self- adjusting guard that encloses the portion of the saw above the table and above the stock being cut. The guard automatically adjusts to the thickness of the material being cut and remains in contact with it during the cut.
- Fixed enclosures, fixed barrier guards, or manually adjusted guards (e.g.,
- Brett-Guards) can also be used as point-of-operation guarding, provided its protection is equivalent to the protection of self-adjusting guards and it prevents employee exposure to the saw blade.
- These guards must be used under sufficient supervision and in accordance with manufacturer's instructions.
- Prevent exposure to the blade (and belt drive) located underneath and behind the table saw with a fixed guard, mechanically fasten access doors.



Solution-continued

- Use a push stick for small pieces of wood and for pushing stock past the blade. Consider using large or well designed push sticks that can not only provide a firm and stable grip of the stock but also effectively push the stock through while keeping your hand away from the blade. Combs (featherboards) or suitable jigs can be used when a standard guard cannot be used during dadoing, grooving, jointing, moulding, or rabbeting.
- Turn the power off, wait for the blade to stop, and lower the blade before removing scraps or finished pieces of stock from around the blade.
- Use a spreader and anti-kickback fingers to prevent material from squeezing the saw blade and kicking back during ripping. Ensure enough clearance behind the blade to allow the stock to completely pass through the cut. Also, provide support for material that will pass beyond the table.
- It is also highly recommended that all Table Saws be Saw Stop.

Ironworker

Ironworker are versatile, multi-station metal fabricating machines that offer component tooling options to perform punching, shearing, notching- coping, and, sometimes, bending operations. The workstations can work singly or simultaneously and all tooling moves vertically.

Ironworkers are normally powered hydraulically

Hazard

- Severe crushing injuries or amputations can occur if an operator makes contact with any of the pinch or shear points this machine provides.
- Flying or ejected parts from either the stock or the tooling can strike operators and other students in the area. Punches are hardened and will not bend as they collide with dies. If a punch is out of alignment, it is more likely to flake or even explode, causing serious harm to the operator.
- Unprotected foot pedals can also introduce the possibility of accidental cycling.

Solution

- Guard all pinch and shear points with fixed or adjustable guarding. Gaps in guard design should meet the CSA reach requirements. Most newer machines are equipped with adjustable restrictors that surround the material in-going areas and should allow just enough clearance for the material to enter.
- Beware of machines with automatic urethane hold- downs. These hold-downs, if not adjusted properly, also come down with many tons of force and can be hazardous pinch points.
- Ensure proper alignment of the punch and dies. Cover foot pedals to prevent accidental cycling.

Power Press

Power presses are metalworking machines used primarily to cut, punch, or form metal using tooling (dies) attached to the slide (ram) and bed. The slide has a controlled reciprocating motion toward and away from the bed surface and at right angles to it. It is guided in the frame of the machine – either a “C” frame [open back inclined or straight side frame-to give a definite path of motion.

The two most common types of power presses are mechanically and hydraulically powered. Though these two share common features, the mechanical power press has been the most widely used throughout industry and has been the subject of most of the research done, primarily due to its tenure in industry and the number of injuries associated with it.

Power Press-continued

- The main components for power transmission on a mechanical power press are the clutch, flywheel, and crankshaft. The slide is attached to a crankshaft with connecting rods (“pitmans”) and the crankshaft is coupled to the flywheel, which always rotates when the motor is running. A clutch is used to connect the spinning flywheel to the crankshaft. The crankshaft converts the rotary motion of the flywheel to the downward and upward motions of the press slide.
- Two different types of clutches are used on mechanical power presses: full-revolution and part-revolution clutches. Full revolution clutches, when tripped, cannot be disengaged until the crankshaft has completed a full revolution and the press slide has completed a full stroke.

Power Press-continued

The majority of part revolution clutch presses use air and a brake. When air is trapped and compressed in chambers, the clutch is engaged and the brake is disengaged. To stop the press, the reverse takes place.

Manually fed presses are cycled either by foot or by two-hand controls or trips. With foot controls, the press is activated by pressing down on a foot switch or pedal, leaving the hands free during cycling of the press. The freedom of hand movement places operators using foot controls at greater risk of sustaining an injury at the point of operation.

Approximately twice as many press injuries are from foot- controlled presses. With two-hand controls or trips, once a work piece is positioned in the press, both hands must be removed from the point of operation to depress the buttons.

The other major aspect of press operation involves safely installing, removing, and transferring the dies.

Hazard

- A machine that punches metal in a blink of an eye leaves little to the imagination as to what it can do to body parts. Severe crushing injuries, amputations, and even death can occur in the point of operation or while performing servicing tasks such as die setting or troubleshooting.
- Flying or ejected parts from either the stock or the dies can also strike operators and other students in the operation area.
- Unprotected operating controls, especially foot pedals, also can introduce the possibility of accidental cycling.

Solution

The point of operation of all power presses must be safeguarded. Safeguarding is accomplished either by barrier guarding or the use of devices. Barrier guarding prevents entry into the die area by physically enclosing the point of operation. Devices control entry by allowing the operator to reach into the die area to feed or remove parts and will either prevent a machine cycle, stop the hazardous down-stroke, or pull the operator's hands out if his or her hands are detected or remain in the point of operation. Guarding is not required if the point of operation opening is ¼ inch or less.

Safeguarding choices for mechanical power presses depend on the clutch systems. Feasible methods for full-revolution presses include fixed or adjustable barrier guarding, two-hand trips, pullbacks, restraints, or type "A" gates. Part-revolution presses are usually equipped with barrier guarding, presence-sensing devices, two-hand controls or trips, type "A" or "B" gates, pullbacks, or restraints. The safeguarding options for a part-revolution press also can be installed on hydraulic presses.

Power Press- continued

- Fixed, interlocked, or adjustable barrier guarding is best for applications where the operator does not need frequent access to the point of operation, for example, on a mechanical power press in continuous mode. An advantage to using barrier guarding is that it presents a physical barrier between people (the operator and other workers) and the machine's pinch point, in addition to capturing any flying parts from either the stock or the die.
- Barrier guarding must be designed and constructed so that people cannot reach over, under, around or through the guard and reach the pinch-point hazard. If there are openings in the barrier guard, the openings must be in compliance with the CSA -Z432-16 guard-opening requirements..

Power Press- continued

Fixed barrier guards are, as the term implies, firmly fixed to the frame of the press or the bolster plate, and do not have hinged, movable, or adjustable sections. Interlocked press barrier guarding has hinged or movable sections interlocked with the clutch/brake control so that the clutch cannot be engaged unless the guard sections are in proper position. When the interlocked guard section is opened, the press slide must either stop immediately or have already completed the die-closing portion of the stroke (full revolution clutch presses normally cannot be equipped with interlocked guarding). Adjustable barrier guarding can be adjusted for different material widths and thicknesses and still meet the acceptable guard opening distances (Attached Table reference)

Barrier opening size (smallest dimension)		Minimum distance from hazard	
mm	**inches**	**Slotted opening**	**Square opening**
0.0-6.0	0.000-0.250	≥ 13.0 mm 0.5 in	≥ 13.0 mm † 0.5 in
6.1-11.0	0.251-0.375	≥ 64.0 mm 2.5 in	≥ 48 mm 1.9 in
11.1-16.0	0.376-0.625	≥ 89.0 mm 3.5 in	≥ 66 mm 2.6 in
16.1-32.0	0.626-1.250	≥ 166.0 mm 6.5 in	≥166.0 mm 6.5 in
32.1-49.0	1.251-1.875	≥ 445.0 mm 17.5 in	≥ 445.0 mm 17.5 in
49.1-132.0	1.876–5.000‡	≥ 915.0 mm 36.0 in	≥ 915.0 mm 36.0 in

Power Press- continued

- Devices can be effective safeguards at the point of operation. They include presence-sensing devices, two-hand controls or trips, gates, pullbacks, or restraints. Presence-sensing devices (photoelectric “light curtains” are most commonly used) create an invisible sensing field and are designed to detect an operator’s hand, arm, or other body part entering the hazard area and either prevent a machine cycle or stop the hazardous motion of the machine. They are a versatile and popular method of safeguarding because they do not create a physical barrier between the operator and the point of operation, they allow complete visibility, and they can be “blanked” or “muted” (certain channels are bypassed) to allow material movement. They must be located at the proper *safety distance* from the point of operation and can only be used on part revolution presses and hydraulic presses that are capable of quickly stopping hazardous motion.

Power Press-continued

Two-hand Control on a Press

- Two-hand controls are also used on part-revolution or hydraulic presses and require the use of both of the operator's hands to concurrently depress two individual palm buttons to cycle the machine. Two hand controls only protect the operator, they do not provide protection for third parties. These controls must also require the operator to hold them down through the die-closing portion of the stroke (downstroke). Two-hand trips are similar to two-hand controls, but are usually equipped on full-revolution presses. Trips require only momentary actuation of the palm buttons, and once the buttons have been activated, they can be released quickly and the machine will make one full cycle or stroke. Of course, locating two-hand controls or trips at their proper safety distances (see below) are critical for operator safety. Also, they must incorporate both anti-tiedown and anti-repeat features. Anti-tiedown prevents "tying" one button down and still being able to cycle the machine by depressing the other. Anti-repeat prevents continuous cycling. If more than one operator is operating a press, each operator must have their own set of controls/trips.

Power Press-continued

- *Safety distance*, as applied to press safeguarding using presence-sensing devices, two-hand controls, two-hand trips, and interlocked barrier guards, is a calculation to determine where these devices must be located from the point-of- operation hazard so that hazardous motion is effectively stopped or prevented before contact can be made. Safety distance is calculated with an equation using the maximum speed that someone can approach the hazard (63 inches/second) and the total time it takes to stop hazardous motion (seconds). Additional factors such as, but not limited to, depth penetration (presence sensing) and reaction times of the control system and safeguard interface are also included. Stopping time is normally measured using the brake monitor or a portable stop-time measurement device. *The CSA Z432-16 takes more factors into account and normally results in a larger safety distance*

Power Press-continued

- Gates are movable barriers that enclose (in combination with barrier guards) the point of operation before the machine cycle can be started, and remain closed until the downstroke has completed. There are two types: Type “A” gate remains closed during entire cycle and type “B” gate remains closed during the downstroke only. Gates are normally constructed of clear polycarbonate and powered by air and gravity.
- Pull back devices use a series of cables attached to the operator’s hands or wrists . Slack is taken up during the downstroke cycle, pulling the operator’s hands from the point of operation, if they are still there. Restraint (holdout) devices are also attached to the operator using cables or straps, but must be anchored and adjusted so the operator’s hands can never reach into the point of operation.

Power Press-continued

- There is no retracting action involved. Consequently, hand-feeding tools are often necessary if the operation involves placing small material into the dies.
- It's important to remember that most devices do not provide protection from flying parts. Also, control reliability (see Glossary) and a brake monitor (see Glossary) must be incorporated in part revolution mechanical power presses using a presence sensing device, two-hand control, type "B" gate, or interlocked barrier guarding.
- Full-revolution mechanical power presses must incorporate a single-stroke (or anti-repeat) feature that allows the clutch to engage and the press to cycle only once each time the foot control or two-hand trips are depressed.
- To prevent accidental cycling, effectively cover or guard all hand and foot controls. Foot pedals must be attached to a nonslip surface to prevent the pedal from sliding.
- Hand tools can be used for placing and removing material, but they do not replace guarding. Appropriate die-setting procedures must be established and followed to ensure the safe design, handling, installation, and removal of the dies. Safety blocks must be used and enforced. Weekly inspections and regular maintenance of presses, parts, auxiliary equipment, and safeguards must be followed and documented.
- It is highly recommended when that you consider obtaining help when designing a guarding system for a press.

Power roll forming and bending machine

- Conventional metal forming and bending machines, also known as plate bending rolls, produce smooth, circular bends in sheet, strip, or coiled stock. Metal is fed between successive pairs of rolls that progressively bend and form it until the desire shape and cross section is obtained. The radius of the bend can be adjusted by changing the location of the rolls. These machines are normally equipped with instant start, stop, and reverse controls.

Hazard

Severe crushing injuries, amputations, and even death can occur if a worker is caught and drawn into the counter-rotating infeed rolls. The risk of injury is high during the initial feeding of the stock. Wearing gloves with fingertips and loose clothing also increase the risk of entanglement as well as possible degloving injuries. Students can also be struck by the moving work piece or pinned between it and a fixed structure.

Solution

Installing fixed or adjustable barrier guarding at the point of operation, can be used in the right situations. Some protection for the operator and anyone near the machine can be provided by using devices such as safety trip cables (emergency stop) and hold-down controls; however, these safety devices do not directly prevent entanglement or entrapment. They are intended to help prevent or minimize injury by stopping the machine quickly. Hold-down button or foot controls are designed to actuate roll movement only when held in the run position. The control should automatically return to the stop position when released.

A trip device (bar, tensioned wire/cable, or kick panel) is interlocked with the machine's control circuit and positioned so that it may be easily actuated by any person caught or drawn toward the rolls and will stop the machine before serious injury can occur. It should run the entire length of the machine at the front and in the back. Also, ensure the braking system is adequate, as the safety devices are effective only if the dangerous parts of the machine stop quickly. It is also highly recommended to install 3 position foot pedals on rollers.

Shear

Power squaring shears and plate shears cut sheets of metal using either mechanical or hydraulic- driven rams for the shearing action. The ram moves a non- rotary blade at a constant rate past the edge of a fixed blade. The operator feeds or places the stock between the blades, ensures it is properly positioned, and activates the cutting cycle with either foot or hand controls. The material hold-down devices, exerting a tremendous amount of force, clamp the stock immediately before the shearing action.

Two other types of shear are also used, alligator and guillotine shears. Both of these types are used to cut metal stock and scrap metal. Guillotine shears also used for paper and plastic.

Hazard

Like all machines that have operating cycles, shears present the possibility of placing a hand in the danger zone. And in the case of a shear, the consequences are severe. The primary hazard of the point of operation is the shear hazard. Since shears use blades to sever many forms and various sizes of stock, there is no doubt what can happen to hands or fingers. The hold-down devices on power squaring shears also create a serious pinch point, which can happen to hands or fingers. Serious lacerations can also occur from handling the blades.

Solution

The shear blades are normally safeguarded by the equipment manufacturer's barrier guard. If not, a barrier guard, capable of adjusting to the thickness of the stock, must be installed in front of the shear blades. *The jagged-edge barrier guard behind the hold-down devices in the picture (right) is the shear blade guard.*

Shear-continued

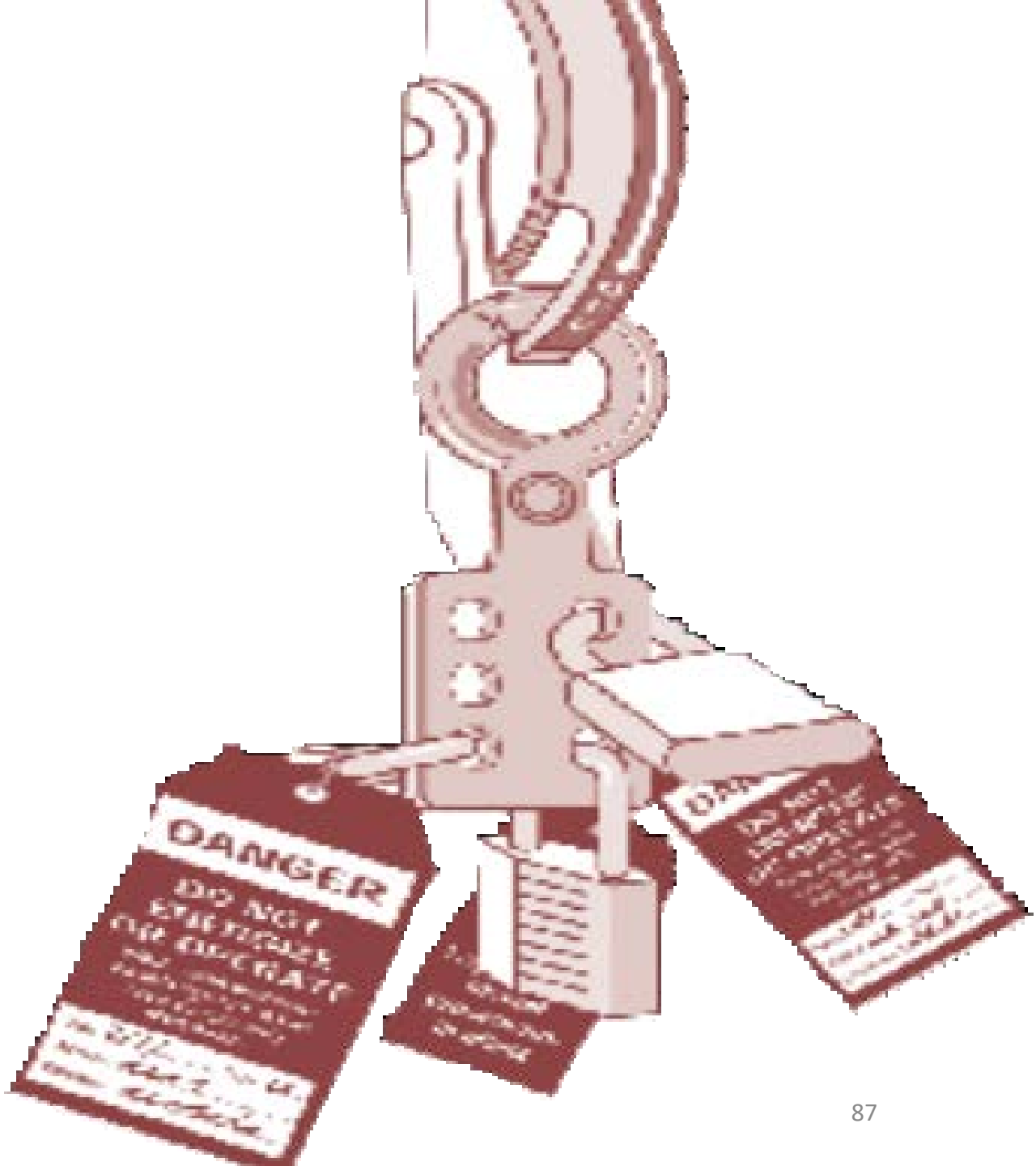
An adjustable barrier guard must also be provided in front of the hold-down devices to protect the operator from the pinch point hazard.

On mechanical shears equipped with a part- revolution clutch or for those that are hydraulically powered, light curtain presence-sensing devices or two-hand control devices can also be considered to be safeguarding options.

Wear gloves when handling the stock. In addition to gloves, appropriate mechanical devices or assistance should be used when removing, handling, and installing the blades. Hand/foot controls should be enclosed or shrouded to eliminate accidental cycling. The back of the shear, where sheared debris drops, should be barricaded

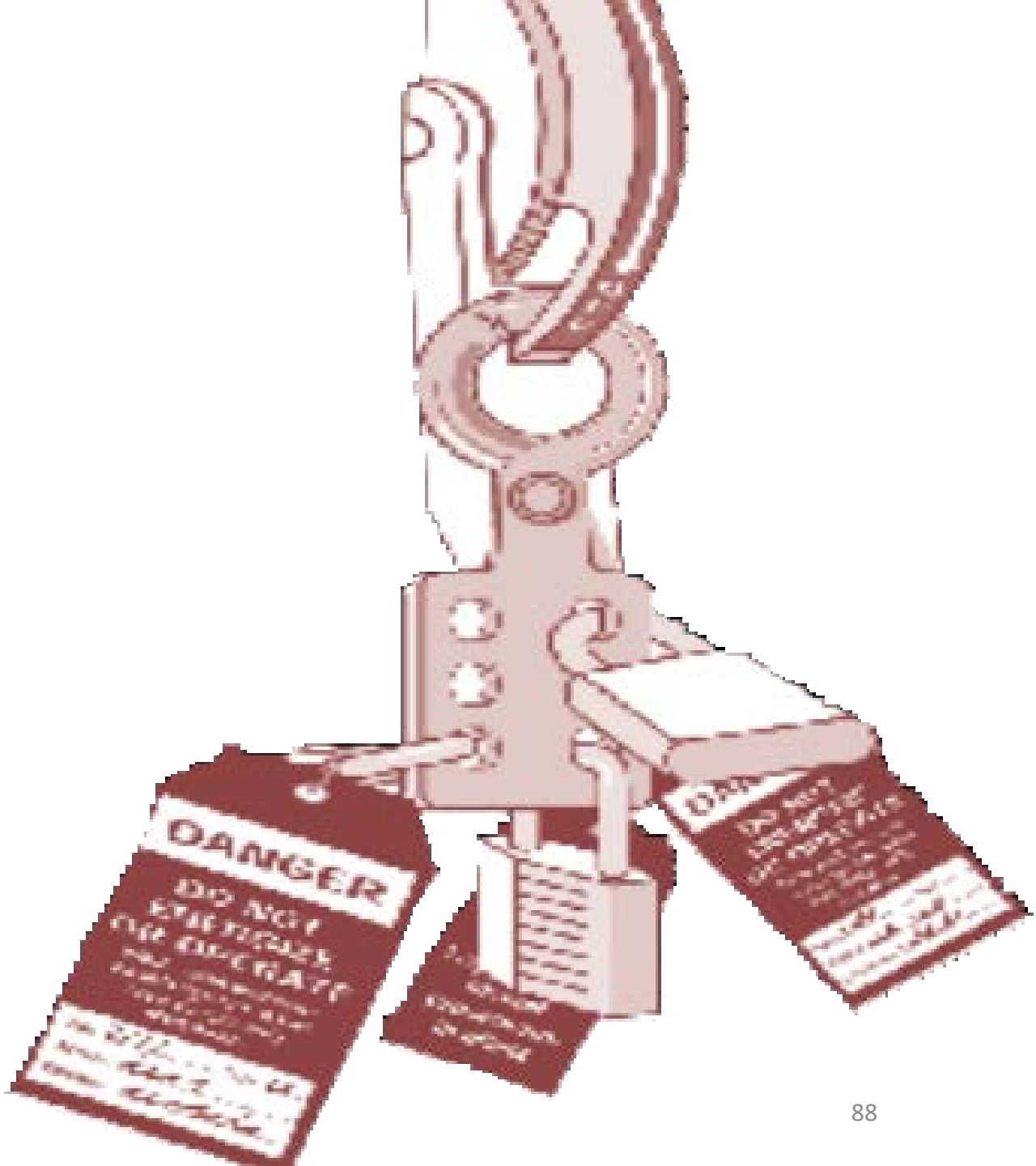
Machine Lockout

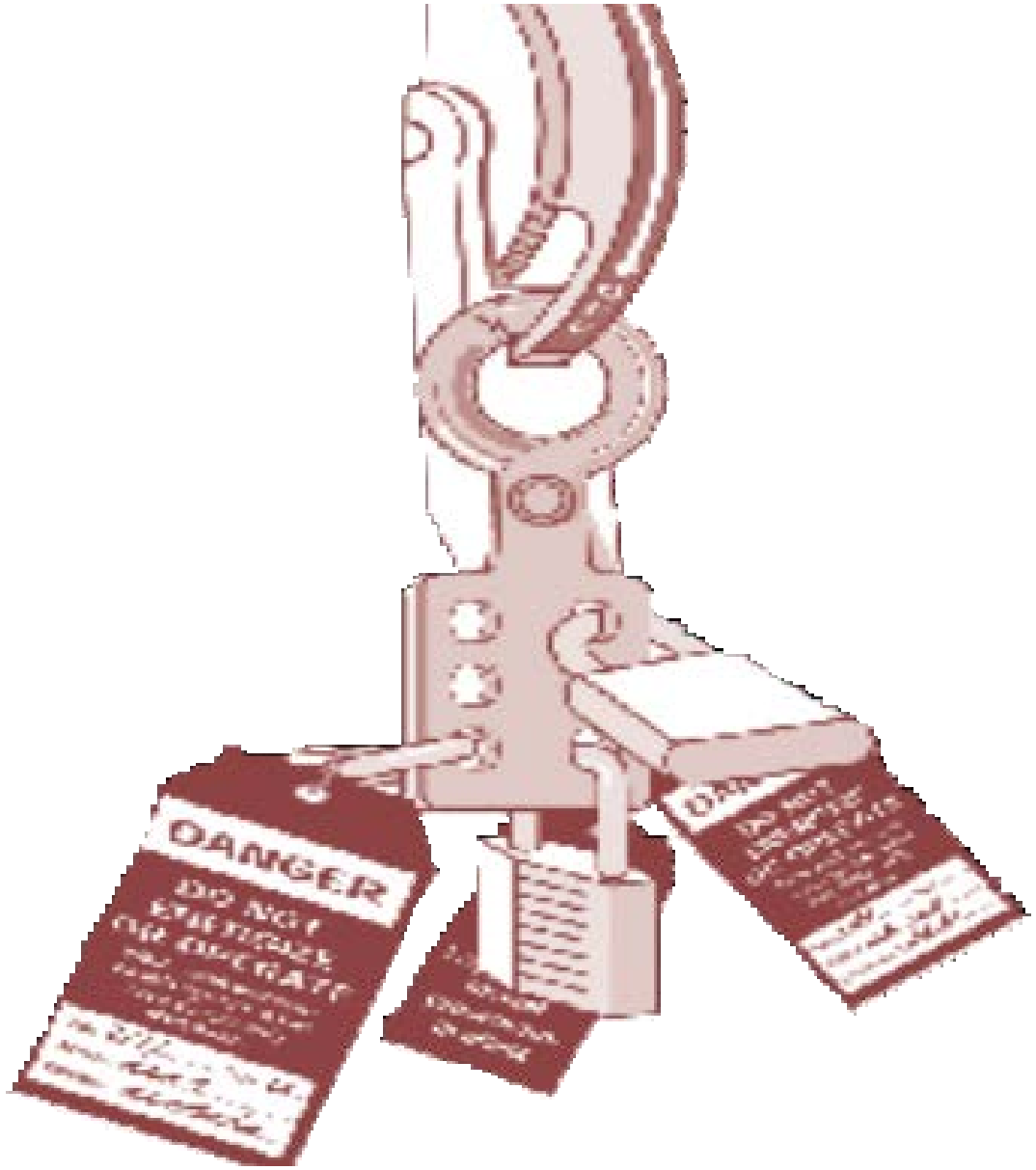
Many serious injuries and fatalities occur when somebody mistakenly thinks a machine is safely isolated from its energy source or stored energy has been relieved or blocked. Manitoba Regulations, commonly referred to as “machine lockout,” covers the maintenance of machinery and equipment where unexpected startup, movement, or the release of stored energy can cause injury to workers. In general, the standard requires that all energy sources for machinery and equipment be turned off, isolated (disconnected) and physically locked out.



Machine Lockout

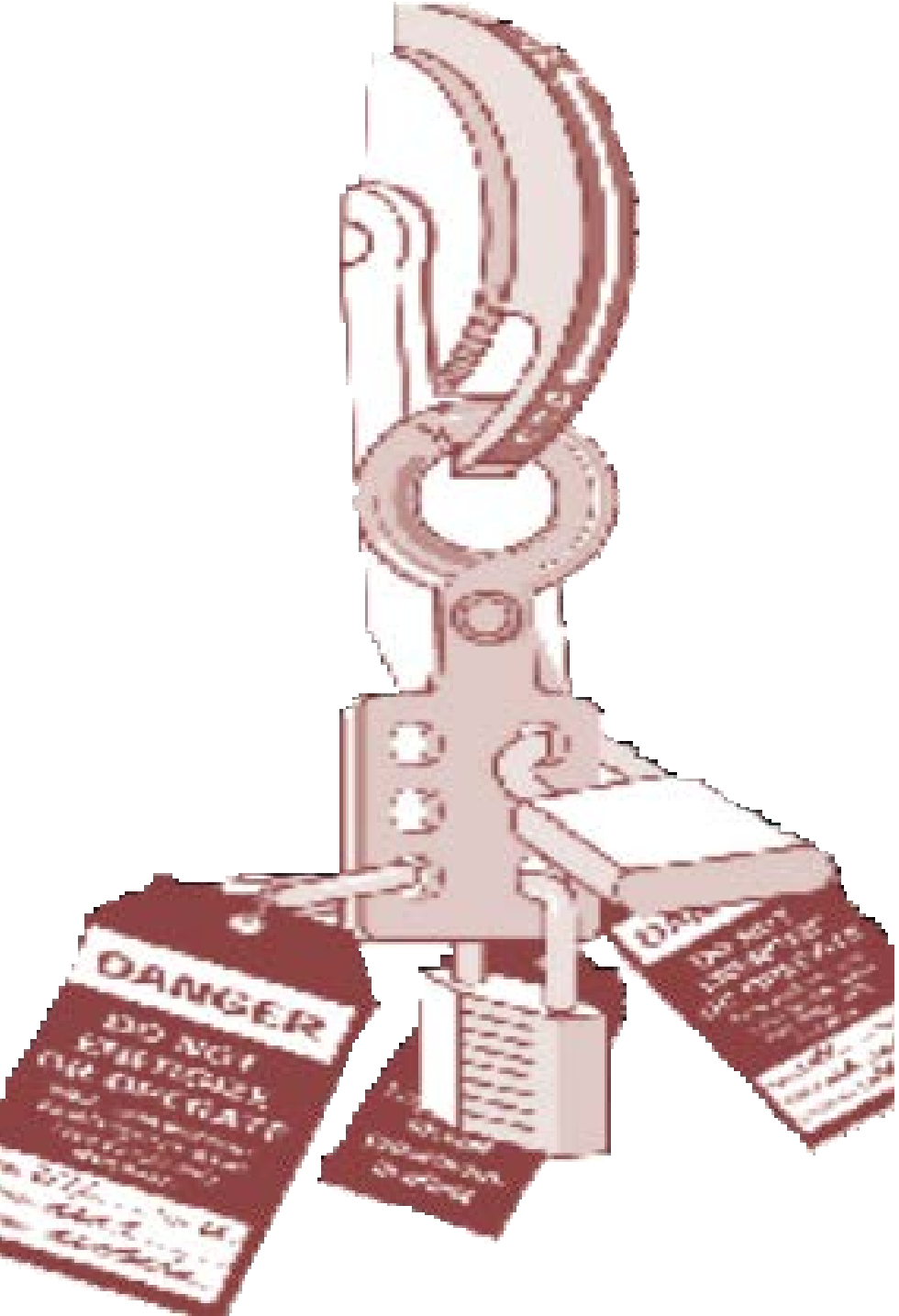
Bleeding, relieving, or blocking other stored and residual energy must also be done to ensure isolation. The final important step before service begins is to verify all energy has been de-energized and isolated. These procedures, along with training and periodic audits, must be established and enforced.





Manitoba Regulations

- 16.14(1) Subject to subsections (3) and (4), when a machine is serviced, repaired, tested, cleaned, maintained or adjusted, an employer must ensure that no worker performs work on the machine until it has come to a complete stop and the worker performing work on the machine has;
- (a) locked out the machine and removed and rendered safe any hazardous condition; or
- (b) otherwise rendered the machine inoperative in a manner that prevents reactivation and provides protection that is equal to, or greater than, the protection provided by clause (a).



Manitoba Regulations

- 16.14(3) An employer must develop and implement safe work procedures for the service, repair, testing, cleaning, maintenance or adjustment of a machine when
- (a) the manufacturer's specifications require the machine to remain operative when it is serviced, repaired, tested, cleaned, maintained or adjusted; or
- (b) there are no manufacturer's specifications and it is not reasonably practicable to lockout the machinery when it is serviced, repaired, tested, cleaned, maintained or adjusted.
-
- 16.14(4) When it is not reasonably practicable to lockout the machinery when it is serviced, repaired, tested, cleaned, maintained or adjusted, an employer must ensure that the safe work procedures developed in subsection (3) offer protection to a worker that is equal to or greater than the protection provided by a lockout procedure.

Wood Dust

Wood dust consists of tiny particles of wood produced during processing and handling of wood, chipboard, hardboard, etc. Sanding, shaping, routing, sawing, and using compressed air generally produce the greatest amount of dust.

Exposure to wood dust has long been associated with a variety of adverse health effects, including dermatitis and other allergic reactions, mucosal and nonallergic respiratory effects, and cancer. A hypersensitivity reaction leading to asthma, pneumonitis, and chronic bronchitis has been associated with exposure to wood dust, commonly from western red cedar, cedar of Lebanon, oak, mahogany, and redwood. Dust from both hardwood and softwood has also, been reported to cause cancer. The three types of cancers associated with wood dust exposure are nasal and sinus cavity cancer, lung cancers, and Hodgkin's disease.

Other common symptoms from wood dust include eye irritation, nasal dryness and obstruction, prolonged colds, and frequent headaches. Health effects can come from biological organisms such as mold and fungi that grow on the wood, or from chemicals used in some wood processing, such as formaldehyde, copper naphthenate, and pentachlorophenol.

In addition to the health effects, airborne wood dust can create the potential for fire or explosion.

Airborne dust can be adequately controlled by using dust-minimizing equipment and tools, in addition to dust control equipment such as local or central exhaust ventilation. Proper maintenance and housekeeping practices are also important. Keep ventilation ducts free from blockages and maintain ducts, filters, and other collection equipment in accordance with manufacturer's recommendations. Suitable respiratory protection must be worn if dust levels cannot be reduced to acceptable levels.

Check that the design and installation of dust-control equipment incorporates explosion precautions and control potential ignition sources such as heaters, overheated electric motors, electric sparks, and sparks from other sources such as open wood burning stoves and cigarettes.

Risk Reduction Hierarchy

- A hierarchical approach is recommended when first approaching the safeguarding of a machine or operation. Safeguarding principles should be based on preventing access during dangerous motion or preventing dangerous motion during access.

Risk Reduction Hierarchy

1. **Eliminate or substitute the hazard or exposure to the hazard**
   - Design/redesign the operation to remove exposure (e.g., automatic feeding/ejection, designed enclosures)
   - Locate the hazard where it is not accessible due to its location or distance
   - Reduce energy
   - Replacement/substitution

Risk Reduction Hierarchy

2. Engineered Controls

Fastened barrier guarding

- Metal or plastic enclosures
- Fixed metal or plastic enclosures, guarding, screens, fence, etc.
- Presence sensing
- Two hand controls
- Interlocked, Pullback and restraints (interlock or other inputs meeting safety-related performance levels)

Risk Reduction Hierarchy

3. Awareness Controls

Devices that require adjustment or actuation by the user

- Signs, symbols, lights, alarms, awareness barriers

Safeguards 137(1) Except where otherwise provided by these regulations, an employer or contractor shall provide an effective safeguard where a worker may contact: (a) a dangerous moving part of a machine; (b) a pinch point, cutting edge or point of a machine at which material is cut, shaped, bored or formed; (c) an open flame; (d) a steam pipe or other surface with a temperature that exceeds or may exceed 80° Celsius; or (e) a cooled surface that is or may be less than minus 80° Celsius.

Risk Reduction Hierarchy

- Remember, control inputs like presence-sensing devices and interlocks do not restrict or prevent access but only “sense” it. They rely entirely on their ability to both sense and switch (to instantly provide safety). It is imperative the control circuit meets appropriate performance levels related to functional safety.

- For many years, the term “control reliability” has been mainly defined by addressing the safety performance of control circuits. However, the use of the term has declined in recent years due to the widespread acceptance of European Directives and International Standards such as ISO 13849 and IEC 62061. These standards provide a more complete and verifiable means of specifying the safety performance level of control circuits [further defining five circuit categories and five performance levels based on redundancy (duplication), diversity (different techniques), and monitoring (self-checking)]. “Safety-related functions,” “safety-related control system,” or “functional safety” are other terms commonly used these days.

Risk Reduction Hierarchy

4. **Use administrative controls and aids to supplement other controls**
   - Reduce the occurrences of the task
   - Provide information, instructions (i.e., manuals) and warnings (e.g., signs, symbols, markings, lights, alarms, awareness barriers)
   - Appropriate hand tools, jigs, holders, push sticks, etc.
   - Provide hands-on training and effective supervision
   - Enforce safe work practices (e.g., safe job procedure, job hazard analysis)

Training Guidelines

An important step in machine safeguarding – a step that is often overlooked – is providing safety instruction and training on the various types of equipment the worker is expected to operate and the safeguarding the worker is expected to use.

Training Guidelines

At a minimum, this education should include:

- Discussion of hazardous exposures and control measures
- Hazardous motions (rotating, reciprocating, and transverse)
- Hazardous actions (cutting, bending, drilling, and punching, etc.)
- Potential of flying or ejected material or parts
- Effective safeguarding methods or other control measures (automatic/semi-automatic feeding/ejection, guarding by location/distance, etc.)
- Ergonomics (awkward posture, vibration, repetitive motion, forceful exertion, etc.)
- Fire or combustion hazards (dust, lubricants, hot processes, hydraulic fluid, etc.)
- Appropriate personal protective equipment and clothing
- Health hazards
  - Air quality (dust, fumes or smoke from certain metals, mist from fluids, etc.)
  - Noise and vibration
  - Metalworking fluids (danger to skin, lungs, etc.)

Training Guidelines

Equipment-specific training (hands-on)

- Proper operation of safeguards
- Lockout Training
- Limitations
- Maintenance and care
- Annual Inspection
- Adjustment and placement
- Clarification of manufacturer requirements
- Procedures to follow when safeguard is discovered damaged, missing, etc.

Training Guidelines

Equipment-specific training (hands-on)

Training and relevant retraining must be provided for new operators as well as maintenance/setup employees. Also, retrain affected students when new or altered safeguards are used, when a student is assigned to a new machine or operation, and whenever worker deficiencies are discovered.

Safeguarding strategies must include adequate management controls, such as accountability, enforcement, inspection, and maintenance. This can ensure clean and work areas that are designed for the risk inherent to the machine, properly maintained safeguards, and that lockout/tagout procedures are followed, to name a few. Finally, don’t forget personal disabilities (e.g., color blindness, hearing impairment) if relying on visual warnings (colors) or audible warnings (machine startup).

Basic Safety Principles

Although this guide addresses point-of-operation safeguarding for specific machinery, it is also important to establish and enforce safe work practices when operating and maintaining all types of equipment and machinery.

The following list includes basic rules that apply to portable and fixed machinery:

Equipment (“parts” include blades, bits, sanding belts, dies, grinding stones

- Follow the equipment manufacturer’s recommendations
- Use equipment only for the purpose for which its design is intended
- Operate the tool at the speed and tension specified by the manufacturer
- Inspect the equipment visually before use
- Remove unadjusted, defective, cracked, or worn parts from service
- Maintain sharp and clean parts
- When provided, use equipment with an exhaust or dust-collection system
- Use the appropriate size and type of part for the material and cutting action
- Check to see that guards, guides, and counterweights are properly adjusted and operable
- Avoid overheating the equipment

Work Practices

- Use only tools you can control easily
- Make sure hands are kept at a safe distance
- Follow safe procedures as outlined in the operator's manual
- Always wear eye and face protection and other appropriate personal protective equipment
- Do not wear loose clothing or long hair that may become entangled
- Check to see that power cords are kept away from the line of cut and other moving parts
- Follow proper lockout/tagout procedures during service and repair
- Never defeat the guard to expose the blade
- Never reach under the saw, work piece, or any place you can't see clearly
- Direct the operation away from your body

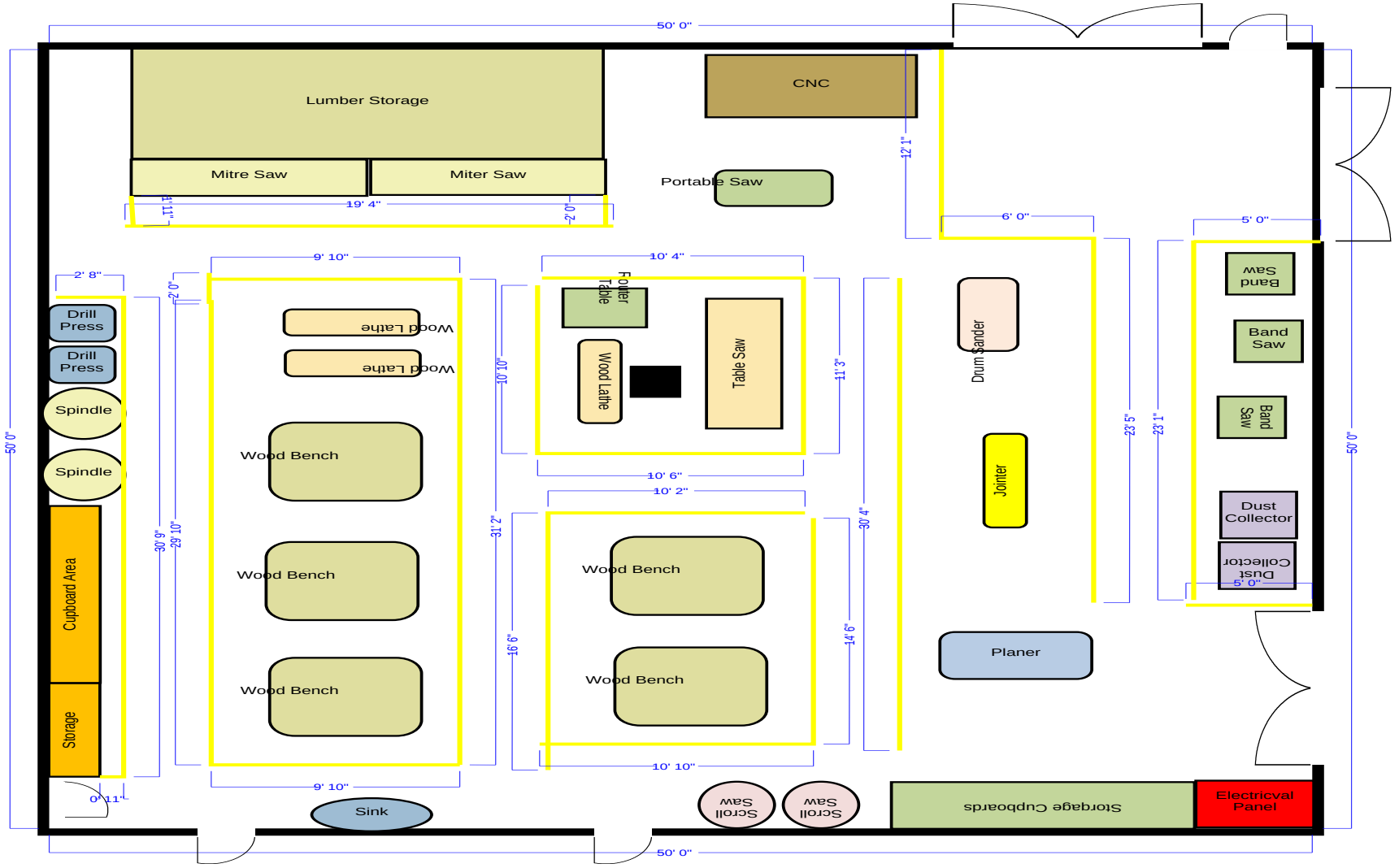
Work Environment

- Practice good housekeeping – avoid crowded, cluttered conditions
- Make sure combustible or flammable material is located away from spark-producing operations
- Provide adequate ventilation to reduce dust and other air contaminants
- Monitor noise levels and provide hearing protection when necessary

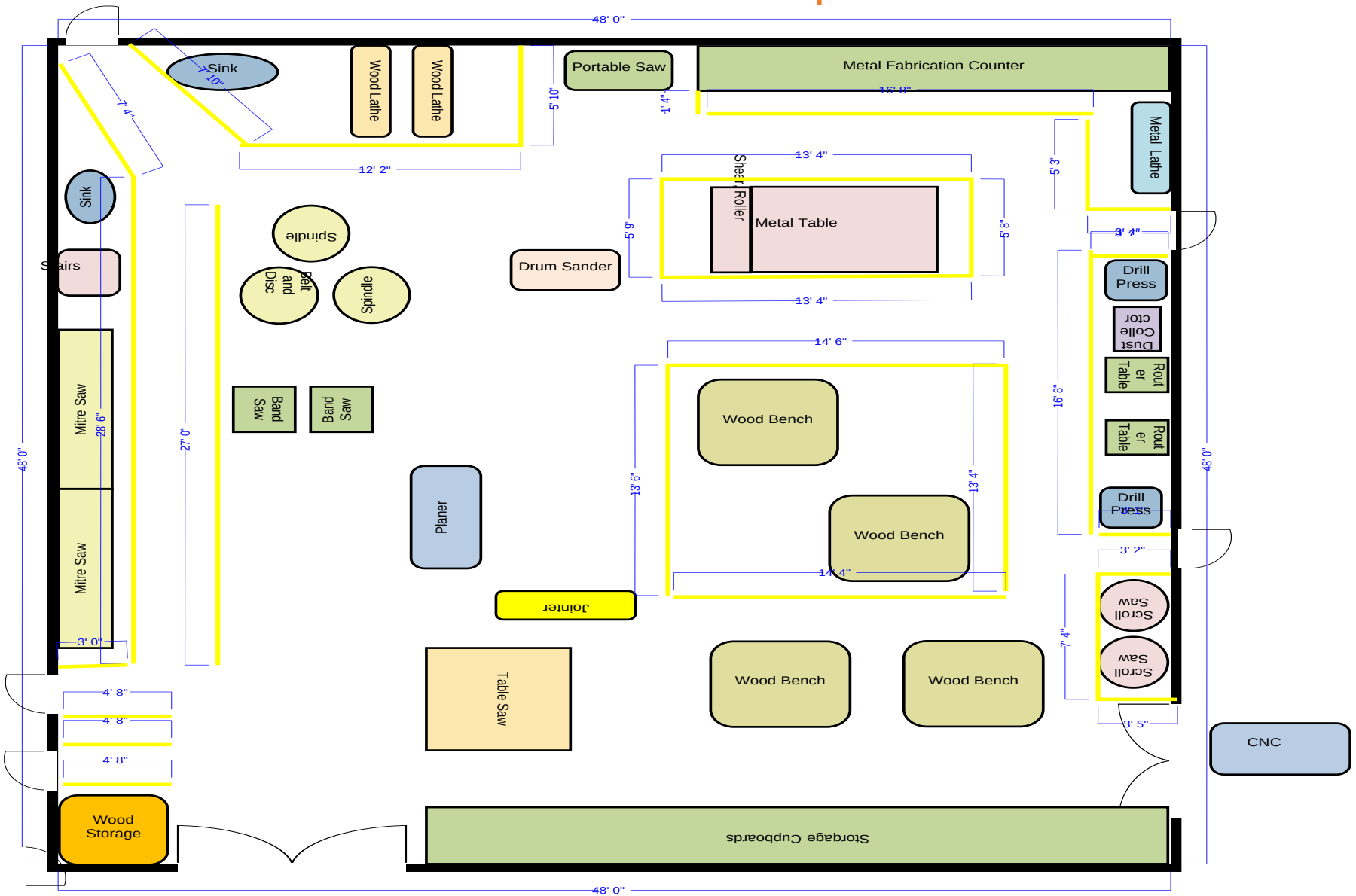
Glossary of Terms

- **Adjustable barrier guard –** A physical barrier requiring manual adjustment for various jobs.
- **Brake monitor –** A sensor designed, constructed, and arranged to monitor the effectiveness of the press braking system.
- **Control reliability (also called performance of safety-related functions) –** A part of the system that controls hazardous motion of a machine. It ensures the machine will stop when required in the event of a single component failure within the system.
- **Device –** A control or attachment that:
  - Prevents a cycle if the operator's hands are inadvertently in the point of operation
  - Maintains the operator's hands at a safe distance during the hazardous portion of a cycle
  - Restrains the operator from inadvertently reaching into the point of operation
  - Automatically withdraws the operator's hands from the point of operation as the dies close
- **Fixed (barrier) guard –** A guard that provides a physical restriction to a hazard.
- **Guard –** A physical barrier that prevents entry of the operator's hands or fingers into the point of operation. A guard:
  - Must prevent any contact to the machine hazard and must be installed to prevent contact from around, over, through, or under the guard
  - Must not allow objects to fall into moving parts or be ejected toward a worker
  - Must not create a pinch point between it and moving machine parts
  - Must be affixed to the machine and remain secure
  - Must facilitate its own inspection and allow for maintenance and lubrication
  - Must offer maximum visibility of the point of operation consistent with the other requirements
  - Must conform to other appropriate standards (ANSI, manufacturer specifications, etc.)
- **Interlocked guard –** A barrier that, when opened or removed, trips a control mechanism that stops a cycle or prevents a cycle until the guard returns to its safe position.
- **Point of operation –** The area on a machine where work is actually performed upon the material being processed.
- **Safety distance –** A calculation of how far a person's hand can move from the time it activates a device until the slide stops moving.
- **Self-adjusting guard –** A physical barrier that adjusts by the movement of stock and returns to its rest position after the stock passes through.

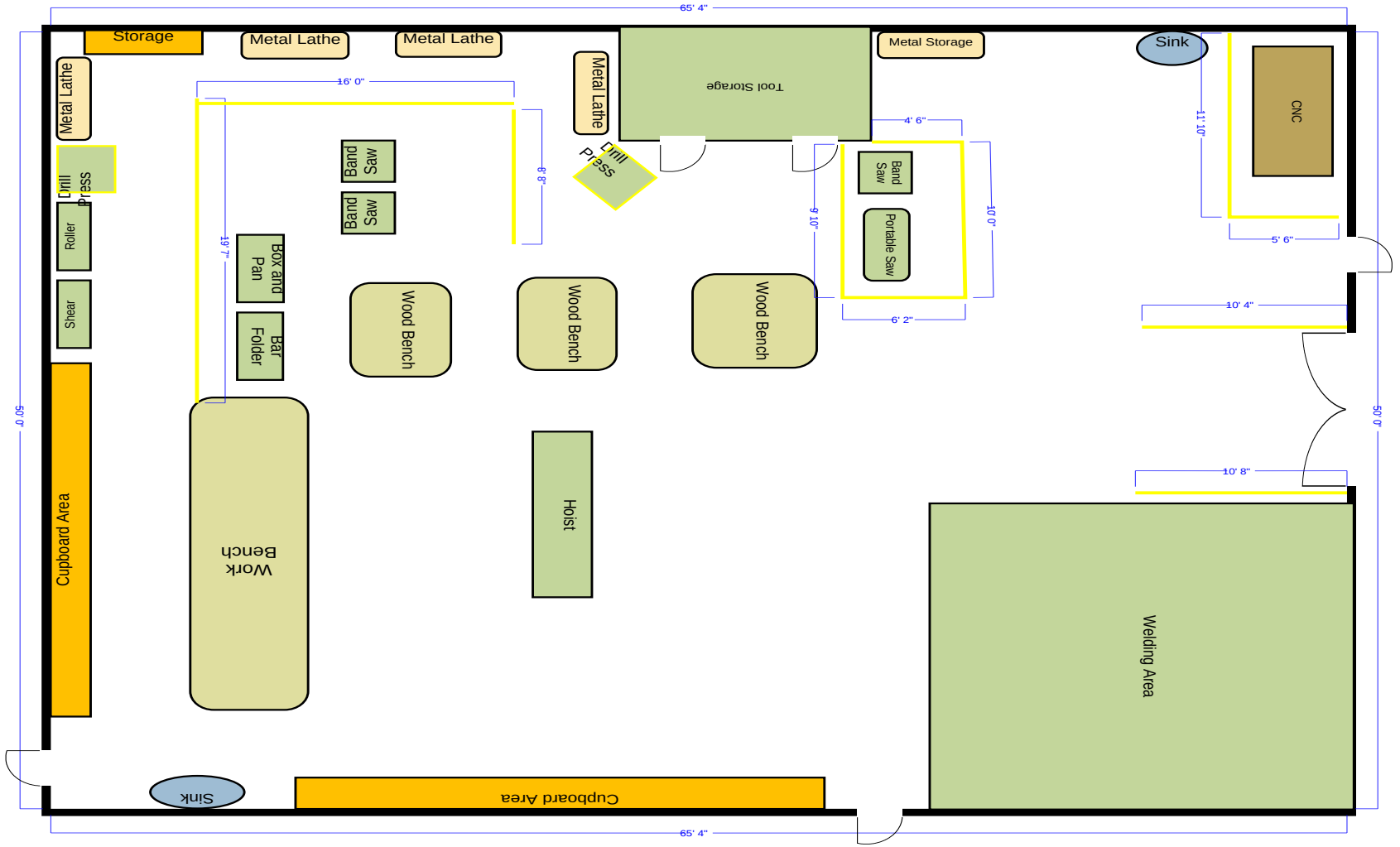
Wood Shop


50' 0"
Lumber Storage
CNC
Mitre Saw
Miter Saw
Portable Saw
19' 4"
11' 11"
2' 0"
12' 1"
6' 0"
5' 0"
9' 10"
10' 4"
2' 8"
2' 0"
Drill Press
Drill Press
Spindle
Spindle
Router Table
Wood Lathe
Wood Lathe
Wood Lathe
Table Saw
Drum Sander
Band Saw
Band Saw
Wood Bench
Wood Bench
Wood Bench
Wood Bench
Wood Bench
Jointer
Dust Collector
Dust Collector
10' 10"
10' 6"
10' 2"
11' 3"
23' 5"
23' 1"
30' 9"
29' 10"
31' 2"
30' 4"
16' 6"
14' 6"
Cupboard Area
Storage
Planer
0' 11"
9' 10"
10' 10"
Sink
Scroll Saw
Scroll Saw
Storage Cupboards
Electricval Panel
50' 0"
50' 0"

Wood Shop


48' 0"
Sink
Wood Lathe
Wood Lathe
Portable Saw
Metal Fabrication Counter
16' 8"
Metal Lathe
Sink
Stairs
Spindle
Belt and Disc
Spindle
Drum Sander
Sheet Roller
Metal Table
Drill Press
Dust Collector
Router Table
Router Table
Drill Press
Mitre Saw
Mitre Saw
Band Saw
Band Saw
Wood Bench
Planer
Wood Bench
Jointer
Scroll Saw
Scroll Saw
Table Saw
Wood Bench
Wood Bench
CNC
Wood Storage
Storage Cupboards
48' 0"

Metal Shop


65' 4"
Storage
Metal Lathe
Metal Lathe
Metal Lathe
Tool Storage
Metal Storage
Sink
CNC
Metal Lathe
Drill Press
Roller
Shear
16' 0"
8' 8"
19' 7"
Band Saw
Band Saw
Box and Pan
Bar Folder
Wood Bench
Wood Bench
Wood Bench
Drill Press
Band Saw
Portable Saw
9' 10"
10' 0"
6' 2"
4' 6"
11' 10"
5' 6"
10' 4"
50' 0"
Cupboard Area
Work Bench
Hoist
10' 8"
Welding Area
Sink
Cupboard Area
65' 4"