MACHINE–GUARDING CHECKLIST

Guarding Requirements

1. Do the guards prevent workers' hands, arms, and other body parts from making contact with dangerous moving parts? Yes ❑ No ❑
2. Are the guards firmly secured and not easily removable? Yes ❑ No ❑
3. Do the guards ensure that no objects will fall into the moving parts or explode out? Yes ❑ No ❑
4. Do the guards permit safe, comfortable, and relatively easy operation of the machine? Yes ❑ No ❑
5. Can the machine be oiled or greased without removing the guard? Yes ❑ No ❑
6. Does the machine automatically shut down when the guard is removed? Yes ❑ No ❑
7. Can the existing guards be improved? Yes ❑ No ❑

Mechanical Hazards: Point of Operation

1. Is there a point-of-operation guard provided for the machine? Yes ❑ No ❑
2. Does it keep the operator's hands, fingers, body out of the danger area? Yes ❑ No ❑
3. Is there evidence that the guards have been tampered with or removed? Yes ❑ No ❑
4. Can you suggest a more practical, effective guard? Yes ❑ No ❑
5. Can you make changes on the machine to eliminate point-of-operation hazard entirely? Yes ❑ No ❑

Mech. Hazards: Power Transmission Apparatus

1. Are there any unguarded gears, sprockets, pulleys or flywheels on the apparatus? Yes ❑ No ❑
2. Are there any exposed belts or chain drives? Yes ❑ No ❑
3. Are there any exposed set screws, key ways, collars, etc.? Yes ❑ No ❑
4. Are starting and stopping controls within easy reach of the operator? Yes ❑ No ❑
5. If there is more than one operator, are separate controls provided? Yes ❑ No ❑

Mechanical Hazards: Other Moving Parts

1. Are guards provided for all hazardous moving parts of the machine, including auxiliary parts? Yes ❑ No ❑

MACHINE–GUARDING CHECKLIST

Education & Training

1. Do operators and skilled trades workers have the necessary education and training in how to use the guards? Yes ❑ No ❑
2. Does the education include examples of workers in your workplace or elsewhere who might have lost their life or their limbs from lack of machine guarding? Yes ❑ No ❑
3. Have production workers and skilled trades workers been trained in where the guards are located, how they provide protection, and what hazards they protect against? Yes ❑ No ❑
4. Have production workers and skilled trades workers been trained in how and under what circumstances guards can be removed? Yes ❑ No ❑
5. Have workers been trained in the procedure to follow if they notice guards that are damaged, missing or inadequate? Yes ❑ No ❑
6. Do skilled trades workers have the necessary education and training in how to build the safety aspects of guards? Yes ❑ No ❑

Protective Equipment & Proper Clothing

1. Is protective equipment required? Yes ❑ No ❑
2. If protective equipment is required, is it appropriate for the job, in good condition, kept clean and sanitary, and stored carefully when not in use? Yes ❑ No ❑
3. Is the operator dressed safely for the job (no loose fitting clothing or jewelry)? Yes ❑ No ❑

Machinery Maintenance & Repair

1. Have skilled trades workers received up-to-date instructions on the machines they service? Yes ❑ No ❑
2. Do skilled trades workers lock out the machine from all of its energy sources before beginning repairs? Yes ❑ No ❑
3. Is the maintenance equipment itself properly guarded? Yes ❑ No ❑

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1-888-220-FLIP (3547) – www.flipproductions.com
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IF.G.01.00272.A.01

12/2006 **BK109**

Safeguarding in Manufacturing

A Companion Guide to

Safeguarding Machinery and Equipment

WORK SAFE BC

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Hierarchy of Safeguarding Controls

MOST Effective	Safeguarding Controls
1. Elimination/ Substitution	❑ Eliminate human interaction in the process ❑ Eliminate pinch points ❑ Automate material handling
2. Engineering Controls	❑ Mechanical hard stops ❑ Interlocked guards ❑ Barrier guards ❑ 2-handed controls ❑ Presence-sensing devices
3. Awareness	❑ Computer warnings ❑ Lights, beacons, ❑ Warning signs/labels ❑ Strobes, beepers ❑ "Restricted Space" painted on floor ❑ Horns and sirens
4. Training & Procedures	❑ Safe work procedures ❑ Training ❑ Safety Equipment Inspections ❑ Lockout
5. PPE LEAST Effective	❑ Safety eyewear ❑ Gloves ❑ Hearing protection ❑ Respirator ❑ Face shield ❑ Hardhat ❑ Steel toe safety boots

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This Infoflip is a companion guide and is merely intended to draw attention to some hazards and preventative safeguarding measures: the user is required to do a complete hazard analysis

For more information, please refer to the full manual:

Safeguarding Machinery and Equipment

General Requirements

(WorksafeBC #BK101)

This infoflip was produced to help:

- **Employers** to comply with the Occupational Health and Safety Regulation (OHSR) and Part 3 of the *Workers Compensation Act*, and to exercise due diligence in providing a safe work environment
- **Supervisors** to assess risks to their workers from harmful contact with machinery and equipment, and to evaluate safeguarding solutions that satisfy the competing needs of safety, production, and quality assurance
- **Workers** to gain greater awareness of the hazards associated with equipment operation and maintenance, and of the safeguarding protection they have a right to expect
- **Suppliers** to understand the requirements for machinery and equipment to conform to the *Workers Compensation Act* and the OHSR
- **Individuals** involved in risk assessment, maintenance, operations management, and health and safety committees.

1 Overview and Terminology

Safeguarding is the first line of defence in ensuring the safety of workers operating powered machinery and equipment. It protects workers when machinery/equipment is in operation. Safeguarding should consider the **Hierarchy of Safeguarding** – choose the most effective option.

Steps to Effective Safeguarding

1. **Recognize the hazard (2)**
2. **Assess the risk (3)**
3. Develop and/or apply safeguarding to eliminate the risk to an acceptable level
4. Ensure required communication, orientation and training is performed
5. Evaluate safeguarding for its effectiveness and make adjustments as required.

Do not confuse safeguarding with lockout, which protects workers when machinery or equipment is shut down for maintenance (including repairs and clearing jams). Training and supervision are essential to ensure worker safety for any activity around machinery.

Terminology

Safeguards

This is the umbrella term for measures that give workers effective protection from harmful contact with hazardous moving parts or other harmful conditions. Safeguards include barrier guards, safety devices, shields, awareness barriers, warning signs, etc., used singly or in combination.

Guards/Barrier Guards

These are physical barriers or covers that are designed, constructed, and installed to prevent contact with moving parts, e.g., belts and drive chains. They are reliable and cost-effective solutions when access to moving parts is not needed during operation. They usually require low maintenance if properly designed and installed.

MUST and SHOULD

"Must" – a requirement or standard in Part 12, OHSR

"Should" – a course of action that, although not specified in the OHSR, will improve workplace safety

Alternatives to barrier guards are interlocked movable barrier guards, two-hand controls, and electronic presence-sensing devices, e.g., light curtains and pressure-sensitive mats. These solutions are more complex/technical but may be the only option when access to danger areas is required during normal operation, e.g., when materials are fed into a machine for processing.

Personal Protective Equipment (PPE)

Personal protective equipment may have to be used even when other machine hazards are effectively safeguarded. In some cases, such as operating a powered forging hammer, the only protection available to the operator, besides training and safe work procedures, may be eye and face protection, hearing protection, and hand protection.

1 Overview and Terminology

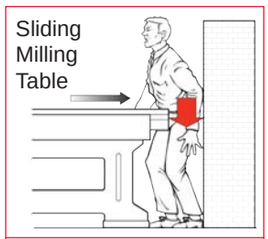
2 Hazard Recognition

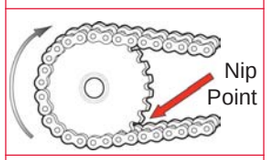
Most machines have three principal components: a power source (often an electrical motor), a power train that transfers moving energy, and tooling where machine's work is performed. Hazards from these components generally involve belts, pulleys, chains, sprockets, gears, shafts, and couplings used with the power train, and the operations and processes completed by the tooling.

Recognizing Mechanical Hazards

Observe how moving parts of a machine operate and how parts of a worker's body may come into contact with them.

- Parts that rotate (e.g., shafts or couplings), present a risk of entanglement/snagging. Two or more parts rotating together (e.g., feed rolls, V-belt and pulley drives), create nip points
- Parts that slide or reciprocate (e.g., dies in punch presses), create shearing or crushing hazards.
- Parts that rupture or fragment (e.g., abrasive wheel), may cause impact injuries.





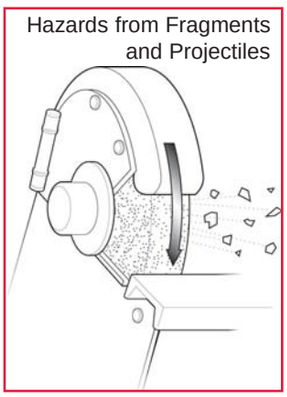
Common Hazards

Some machinery/equipment can endanger a worker in more than one way. For example, an abrasive wheel can explode and cause serious impact injuries. Or, a worker can receive minor abrasions from accidental contact with the wheel.

Recognizing Health Hazards

Without safeguards, control measures, and **PPE (1)**, a worker may be exposed to:

- Toxic/corrosive chemicals that irritate or pass through skin
- Airborne substances, e.g., oil mist, metal fumes, solvents
- Heat, noise, and vibration
- Ionizing radiation such as X-rays and gamma rays
- Non-ionizing radiation such as ultraviolet light (UV), radio frequency (RF) energy, lasers
- Biological contamination/waste
- Soft tissue injuries resulting from repetitive motion, awkward posture, extended lifting, and pressure grip



Recognizing Other Hazards

- Slips/falls from and around machinery during maintenance
- Unstable equipment not secured against falling over
- Fire or explosion
- Pressure injection injuries from the release of fluids and gases under high pressure
- Electrocution from faulty/ungrounded electrical components

2 Hazard Recognition

3 Risk Assessment

The two most important factors affecting risk are:

- How likely will an accident occur – **Measure of Probability**
- How serious will the injuries be – **Measure of Severity**

Combining the two factors determines the level of risk. For example, if the likelihood that a worker will come in contact with dangerous moving parts of a machine is low, and if he does, the expected injury is only a mild abrasion, the risk level is very low. However, if harmful contact is almost certain and expected injuries are very severe, the risk level is extremely high.

Assessing Risk

A risk assessment must involve the operator, maintenance personnel, and the supervisor. You should also consult with manufacturers, suppliers of safeguards, and safety professionals. Each party sees the machine from a different perspective, and will provide a valuable contribution.

Follow the **steps to effective safeguarding (1)**. Gathering information for a risk assessment may require repeated observations, especially when determining what the worker does when normal production flow is interrupted. Do not limit your assessment to the question, “What is a worker likely to do?” Try to determine ALL possible actions, i.e., if someone can access a hazard, a safeguard is warranted.

Factors Affecting the Probability of Injury

Factors that increase the probability of contact with unguarded hazardous machine moving parts include:

- Lack of familiarity with the machine
- Hand-feeding a machine activated by a foot control
- Reaching into a machine to clear jams and misfeeds
- Boredom and repetition
- Frequent access to danger areas of the machine for setup and adjustments
- Lack of operator training and experience
- Machine cycle speed

Machine Risk Assessment Survey

A Machine Risk Assessment Survey form is available at:

www2.worksafebc.com/PDFs/manufacturing/Machine_Risk_Assess_Survey.pdf

The form can be revised and adapted to suit your needs – use it to prioritize your safeguarding measures:

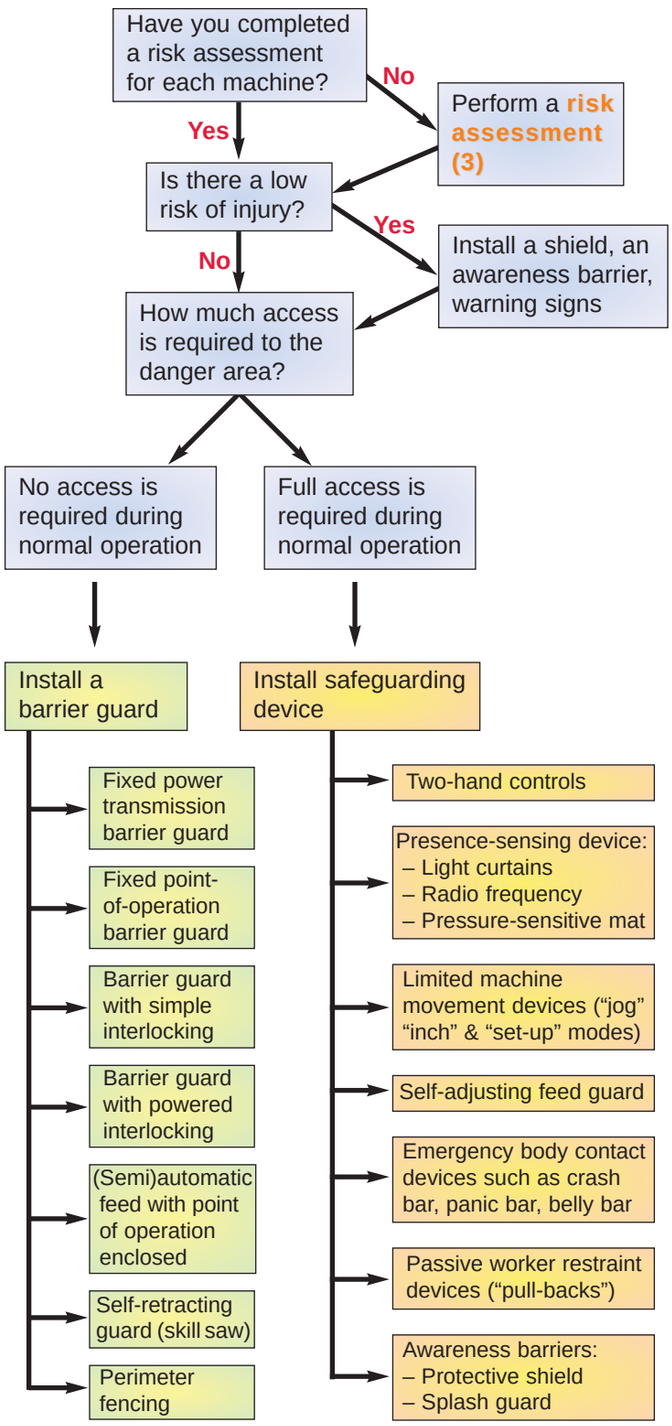
- Identify/describe each hazardous machine motion and condition (e.g., rotating shaft, nip point, shearing part, punching/impact hazard, flying debris, abrasive/hot surface, electrical hazard, hot/toxic fluid or vapour, etc.)
- Describe in detail the worst injury that would reasonably occur (e.g., death, loss of sight, spinal damage, amputation/crushing, respiratory damage, loss of consciousness, burns, fracture, bruising, cuts, abrasions)
- Estimate the severity (fatal, major/irreversible, serious/reversible, minor) and the likelihood (unlikely, possible, probable, certain) of injury
- Calculate the level of risk by factoring the severity of the injury multiplied by the likelihood of its occurrence

3 Risk Assessment

4 Selecting the Right Safeguard

The most effective safeguard is a device or system that provides the maximum protection for the minimum impact on normal machine operation. Use the guide below to determine the most effective safeguard.

Safeguard Selection Guide



4 Selecting the Right Safeguard

5 Barrier Guards

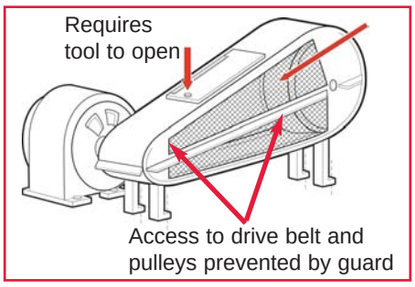
As per the **Hierarchy of Safeguarding Controls**, barrier guards provide the most effective protection to workers.

Fixed Barrier Guards

Protect workers from hazardous moving parts or harmful fluids and projectiles, particularly when access is not normally required during operation. Fixed barrier guards **must**

- Physically prevent a worker from reaching around, over, under, and through the guard to the danger area.
- Not create additional pinch points or other hazards
- Safely contain broken parts (such as belts and chains)
- Allow for safe lubrication and minor adjustments.

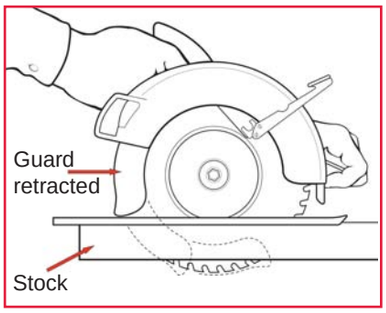
Unless interlocked with a control system, barrier guards **must** be secured with at least one fastener requiring a tool for removal. When a barrier guard must be moved aside to enable a worker access to a point of operation or feed point during normal operation, the guard **must** be interlocked to disable the control system until guard is put back in place and control system is reset.



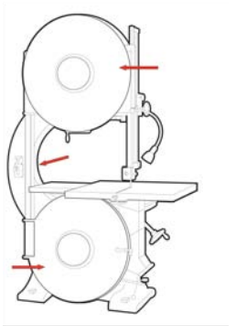
Fixed barrier guards **should** offer good visibility to feed points, stand up to normal wear and tear, meet normal production and quality needs and be difficult to modify or defeat.

Self-adjusting (self-retracting) Guards

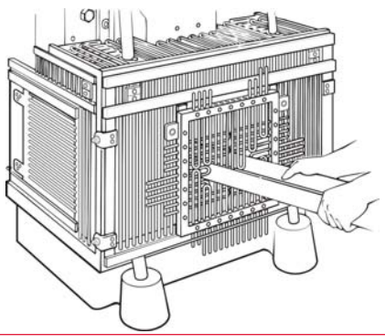
Although a self-retracting guard of a handheld circular saw (as shown on right) works very well, guards designed for right-handed people can often cause problems for left-handed persons.



Adjustable Guards

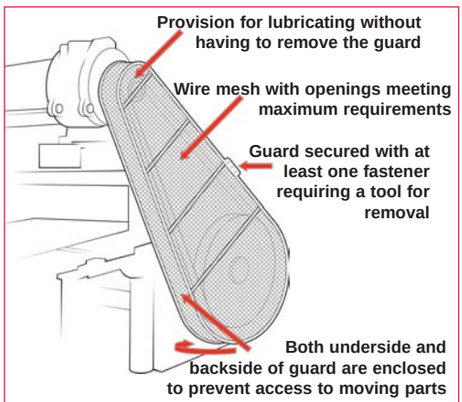


Adjustable Band Saw Guard



Adjustable Power Press Feed Guard

5 Barrier Guards



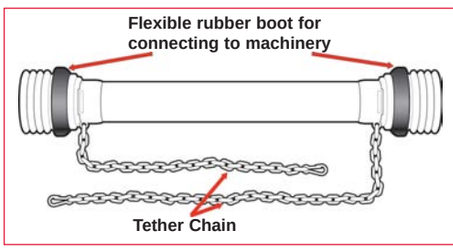
Typical V-Belt/Chain-Sprocket Guard

Chain-Sprocket & V-Belt Guards

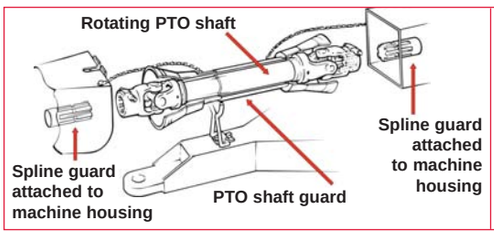
Power transmission parts typically consist of belts, pulleys, chains, sprockets, gears, shafts, and couplings. Contact with these moving parts accounts for a large number of preventable injuries. It is usually a straightforward task to fabricate and install guards for these hazards by following appropriate **grid guard design considerations (7)**.

PTO (Power Take-Off) Drive Shaft Guards

Unguarded PTO drive shafts are frequently used on tractors to power portable agricultural machinery. Because equipment is powered for frequent, short periods, installing guards over these drives is often neglected. Install a chain or cable tether at each end of the PTO drive shaft guard so that the guard can be readily secured to the tractor or portable equipment when not in use.

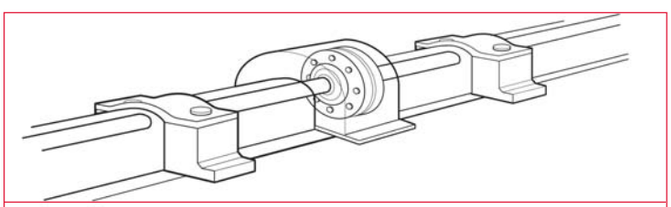


PTO Drive Shaft Guard with tether chain attached to each end of the guard



Cutaway view of **PTO Drive Shaft** and typical guard

Rotating Shaft and Coupling Guard



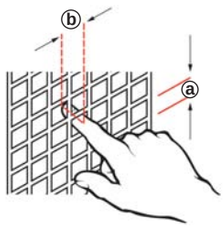
Typical Design of Rotating Shaft and Coupling Guard

7 Grid Guard Design Considerations

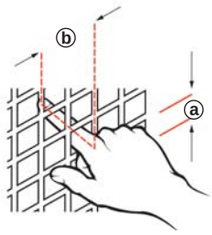
Grid Guards and Enclosures

These guards generally consist of woven wire, or expanded or perforated metal and must be installed with sufficient clearance to prevent any person from reaching through the openings and contacting the danger point. This is done by placing the guard at a safe distance from hazardous moving parts. Test the effectiveness of guard openings with the machinery locked out and safely at rest.

Grid Guard Opening and Distance to Danger Point

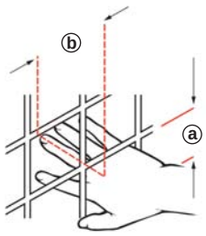


If **a** is between 4 mm and 8 mm (3/16 " and 3/8 "), **b** must be at least 15 mm (5/8 ")

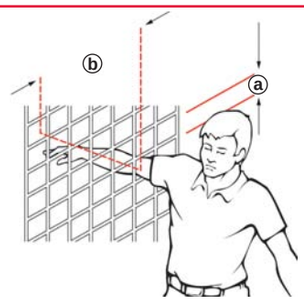


If **a** is 8 mm – 12 mm (3/8 " – 1/2 "), **b** must be at least 80 mm (3 1/8 ")

If **a** is 12 mm – 20 mm (1/2 " – 3/4 "), **b** must be at least 120 mm (4 3/4 ")



If **a** is 20 mm – 30 mm (3/4 " – 1 1/8 "), **b** must be at least 200 mm (7 7/8 ")



If **a** is 30 mm – 150 mm (1 1/8 " – 6 "), **b** must be at least 850 mm (33 1/2 ")

Point-of-Operation (Feed) Guards

Point-of-operation guards (also known as feed guards) often enable the operator to insert flat stock into a machine. Feed guards must ensure that the worker's hands cannot access the danger point. Note in the table below how the openings between the horizontal guarding members decrease as the worker's fingers come closer to the pinch point.

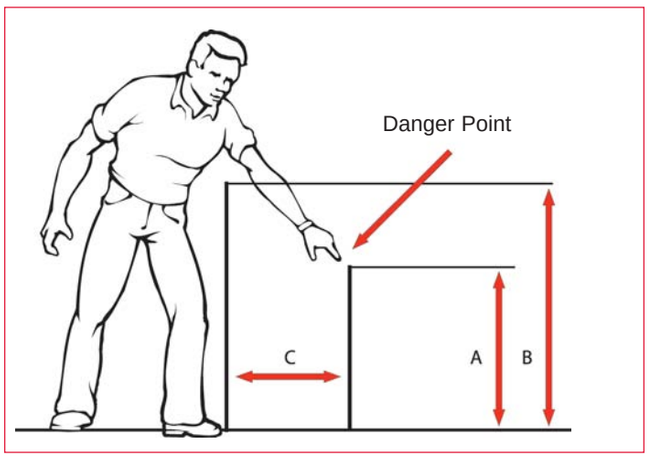
Maximum Permissible Openings in Feed Guards

Barrier Opening Size (smallest dimension)		Minimum Distance From Hazard	
mm	in	Slotted opening	Square opening
6.1 – 11	1/4 – 3/8	≥64 mm (2-1/2 ")	≥ 48 mm (2 ")
11.1 – 16	3/8 – 5/8	≥ 89 mm (3-1/2 ")	≥ 66 mm (2-5/8 ")
16.1 – 32	5/8 – 1-1/4	≥ 166 mm (6-1/2)	≥ 166 mm (6-1/2 ")
32.1 – 49	1-1/4 – 2	≥ 445 mm (17-1/2 ")	≥ 445 mm (17-1/2")
49.1 – 132	2 – 5	≥ 915 mm (36 ")	≥ 915 mm (36 ")

7 Grid Guard Design Considerations

8 Protective Barriers

Protective barriers such as rail enclosures or perimeter fences should be at least 1.8 m (6 ') high. If this is not practical, use the figure and table below to find the reach distance from the guardrail or perimeter fence to the danger point. For example, if the height of the danger zone (**A**) is 1,400 mm (55 ") and its horizontal distance (**C**) from the proposed protective barrier is 1,000 mm (40 "), the height of the protective barrier (**B**) must be at least 1,120 mm (44 ").



Recommended Height of Protective Barrier Based on Distance to Hazard

Danger Zone (A) Height mm (")	Fixed Barrier/Protective Structure Height (B) mm (")								
	1000 (40)	1120 (44)	1400 (55)	1600 (63)	1800 (71)	2000 (78)	2200 (86)	2400 (94)	2500 (98)
	Horizontal Distance to Danger Zone C, mm (")								
2500 (98)	–	–	–	–	–	–	–	–	–
2400 (94)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	–
2200 (86)	600 (24)	600 (24)	500 (20)	500 (20)	400 (16)	350 (14)	250 (10)	–	–
2000 (78)	1100 (43)	900 (36)	700 (28)	600 (24)	500 (20)	350 (14)	–	–	–
1800 (71)	1100 (43)	1000 (40)	900 (36)	900 (36)	600 (24)	–	–	–	–
1600 (63)	1300 (51)	1000 (40)	900 (36)	900 (36)	500 (20)	–	–	–	–
1400 (55)	1300 (51)	1000 (40)	900 (36)	500 (20)	100 (4)	–	–	–	–
1200 (48)	1400 (55)	1000 (40)	900 (36)	500 (20)	–	–	–	–	–
1000 (40)	1400 (55)	1000 (40)	900 (36)	300 (20)	–	–	–	–	–
800 (32)	1300 (51)	900 (36)	600 (24)	–	–	–	–	–	–
600 (24)	1200 (48)	500 (20)	–	–	–	–	–	–	–
400 (16)	1200 (48)	300 (12)	–	–	–	–	–	–	–
200 (8)	1100 (43)	200 (8)	–	–	–	–	–	–	–
0 (0)	1100 (43)	200 (8)	–	–	–	–	–	–	–

8 Protective Barriers

Legal Background Information

Topics discussed in this infoflip, and other related issues, are based on the following legislation:

Safeguarding: Operational Health and Safety Regulation (OHSR), Part 12

> "Safeguarding protects workers when machinery or equipment is in **operation**"

Training & Supervision: *Workers Compensation Act*, Sections 115-17

> "Training and Supervision is needed for all aspects of equipment **operation and maintenance**".

Lockout: Operational Health and Safety Regulation (OHSR), Part 10

> "Lockout protects workers when machinery or equipment is shut down for **maintenance**".

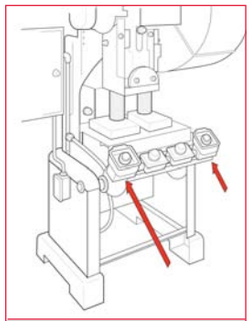
The OHSR, associated policies and guidelines, and excerpts/summaries of the *Workers Compensation Act* are available on www.worksafebc.com. Some publications may also be available in print:

(604) 232-9704 or toll-free 1-866-319-9704

9 Two-Hand Controls and Trips

Two-Hand Controls

Both controls (buttons, levers, sensors) must be activated at the same time and kept engaged throughout the hazardous portion of the machine cycle. If the controls are released the machine either stops or returns to top of stroke (the position that opens the dies). This type of machine operation is called **part revolution clutch (12)** or friction clutch, and is found with pneumatic clutches/brakes and with hydraulically powered machinery such as brake presses.



Two-Hand Controls Power Press

Two-Hand Trips

Both controls must be activated at the same time to initiate the machine cycle but releasing the controls will not interrupt the machine cycle. This type of machine operation is called **full revolution clutch (12)** or mechanical clutch.

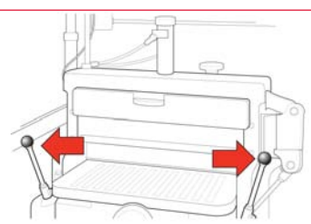
Two-hand controls and trips must be:

- Protected against unintended or accidental operation, i.e., surrounding the activating button with a “ring” guard
- Separated or otherwise designed to require both hands to activate controls (no hand-and-elbow operation)
- Designed so that both hands must be released before another cycle can be initiated (“anti-repeat” feature). The design should also prevent the operator from tying down one of the controls by using tape, rubber band, wedge, etc., (“anti-tie down” feature
- Located a safe distance from the nearest hazard so that the operator cannot reach it with a hand/other body part before the hazardous machine cycle has stopped. This safe distance is calculated using a “Hand Speed Constant” of 1,600 mm (63 ") per second (sec.), considered the speed of a person reaching into a machine’s point of operation to retrieve an object or correct a fault.

In a simple example, the safe location of a two-hand control for a machine that comes to a complete stop 1 sec. after the controls are released is 1,600 mm (63 ") from the nearest point of operation. For a machine that stops in 1/2 sec., the safe distance is 800 mm (31-1/2 "), etc.

WARNING

Two-hand controls alone may not provide sufficient safeguarding. Additional barrier guards may be required to protect workers other than the operator.



Two-Hand Controls (Paper Guillotine)

To find the precise stopping time of a machine cycle requires specialized measuring equipment.

Safeguarding of Machinery: CSA Standard Z432

9 Two-Hand Controls and Trips

10 Presence-Sensing Devices

Devices such as light curtains, proximity sensors, and safety mats do not prevent access to hazardous points of operation. They simply prevent dangerous machine motion by sending a stop signal if any part of a worker's body is in the danger area when a machine cycle is initiated. Choose this type of safeguard when frequent access is needed for loading parts and making adjustments, and physical guarding is restrictive.

There are many technical factors, such as machine control reliability and safety distance, that affect the proper selection and positioning of presence-sensing devices.

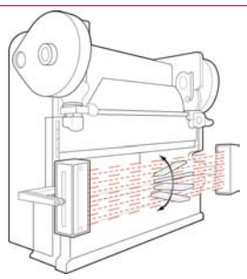
CSA Standard Z432, Safeguarding of Machinery
CSA Standard Z142, Punch/Brake Press Operation
CSA Standard Z434, Industrial Robots/Robot System

Presence-Sensing Device Limitations

- They may not provide sufficient safeguarding when used alone; additional barrier guarding may be required
- Do not use for machines with a full-revolution clutch
- Review the requirements of relevant standards before installing a presence-sensing device
- Use only during production, not as substitute for lockout.

Photoelectric Light Curtains

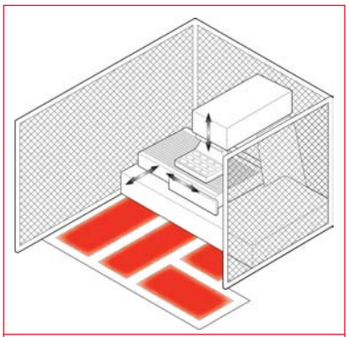
These devices emit a "curtain" of harmless infrared light beams in front of the hazardous area. When any of the beams is blocked, the light curtain control circuit sends a stop signal to the machine's control system. This type of safeguard offers the maximum protection with the minimum impact on normal machine operation. It is particularly well suited to safeguarding brake press operations. Note: steam or dust can inadvertently affect a light curtain.



Light Curtain: Brake Press

Pressure-Sensitive Safety Mats

These devices are used to guard the floor area around a machine. A matrix of interconnected mats is laid around the hazard area, and the proper amount of pressure (such as an operator's footstep) will cause the mat control unit to send a stop signal to the guarded machine. Pressure-sensitive mats are often used within an enclosed area containing several machines, such as flexible manufacturing or robotics cells. When access into the cell is required (for example, in the case of robot "teaching"), the mats prevent dangerous motion if the operator strays from the safe area.



Safety Mat: Stamping Machine

10 Presence-Sensing Devices

11 Safety Interlocks

Movable openable barrier guards interlocked with the machine's power source (electrical, pneumatic or hydraulic) can be a reliable and cost-effective solution. The control power is routed through the interlock's safety contact so the machine will not operate if the guard is in the open position.

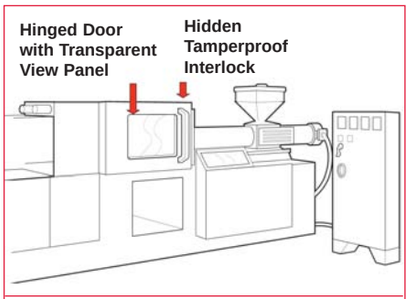
Safeguarding of Machinery: CSA Standard Z432

Simple Interlocking

The interlocked guard can be opened during operation, and the machine will stop.

Power Interlocking

The power interlocking device locks the guard door closed and will not release it until the machine comes to a safe stop. It is used with machinery such as tumblers and centrifuges, where the coasting-down time may take several seconds to several minutes, such as a households' spin cycle washing machine.



Interlocked Gate Guard – Horizontal Injection Molding Machine

Considerations For System Selection

- Most interlock switches are intended for use in production processes. They may not have the integrity and reliability required for worker safety; check with the manufacturer
- Where the **risk assessment (3)** indicates a high level of risk, the integrity of the safety interlock circuit may require monitoring. In addition, the use of redundant interlocks may be required
- Safety-rated interlock switches feature positive-break normally closed contacts. This ensures that the electrical contacts are forced open by a non-resilient mechanical action. This means that they do not rely on spring action to open the contacts. The international symbol for positive-break contacts is ⊕
- Interlock switches should be tamper-resistant and difficult to defeat or bypass using readily available means (piece of wire, tape, simple hand tool, etc.). Safety interlock manufacturers address this by designing two-piece keyed interlocks or interlocks using coded magnet sensors
- Interlocks should be installed using "positive-mode" mounting. When mounted in the positive mode, the non-resilient mechanical mechanism that forces the normally closed (NC) contacts to open is directly driven by the safety guard. In this mounting mode, opening the safety guard physically forces the NC contacts to open
- Power interlocks may require that certain parts of the machine retain a supply of power when the machine is shut down. The implementation of lockout procedures should address this concern. Lockout must be performed if this safeguard becomes ineffective.

11 Safety Interlocks

12 Movable Gates

This unique safeguarding application provides protection to an operator when hand-feeding parts into various machines such as a punch press.

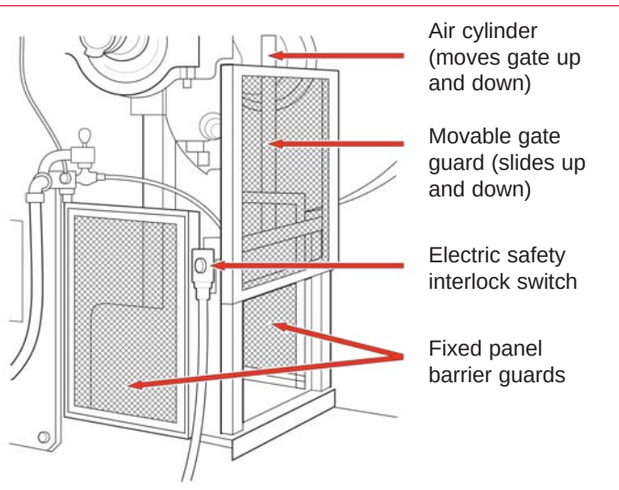
When the machine completes its cycle or returns to top of stroke (in the case of a power press), the gate automatically opens, allowing the operator to remove the formed part. The operator then places a feed stock (blank) into the machine and activates the controls to start another cycle. This can be done with either a foot control, a single hand control, or preferably **two-hand controls (9)**. The gate must close before the machine can cycle. A low-pressure air cylinder attached to the gate performs this closing function. If there are any obstructions under the gate (such as the operator's hands), the gate will not fully close. The interlock switch will prevent further machine operation until the obstruction has been removed and the controls reset.

There are **"A" Type and "B" Type movable gate guards**. "A" Type safeguards machines with **full revolution clutches (9)** and uses the following steps to complete a typical cycle:

① Place part in machine and initiate the cycle. As long as there are no obstructions, the gate will close.
② The machine makes one complete cycle.
③ The gate opens after the cycle has ended.

The "B" Type protects the operator only on the downstroke of press cycle (or closing stroke of a machine). Therefore, it can only be used to safeguard machines with **part revolution clutches (9)**. It uses the following steps to complete a typical cycle:

① Place part in machine and initiate the cycle. As long as there are no obstructions, the gate will close.
② Once the machine reaches the portion of the cycle where the point-of-operation hazard has been eliminated, and before the cycle has ended, the "B" gate opens, allowing the operator to remove the formed part.



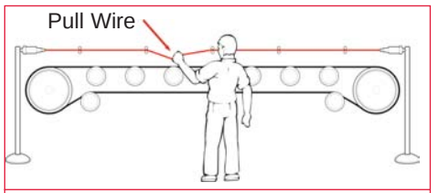
Movable Interlocked Gate Mounted on a Punch Press

12 Movable Gates

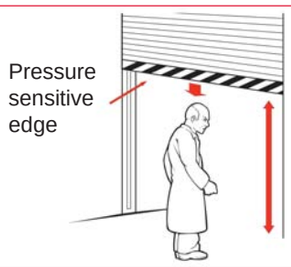
13 Pull Wires – Trip Wires – Contact Bumpers

These safeguarding devices function somewhat like presence-sensing devices. The difference is that they may permit access to the actual danger area before they are activated and send a stop signal to the machine. Consequently, they entail a limited risk of injury, however, they may be the only reasonable choice of safeguarding when other, more effective means are not practical.

Whenever possible, grab wires, pull wires, and contact bars such as “crash bars,” “belly bars,” and similar devices should be mounted so that they will be activated involuntarily as the worker approaches the danger area. For example, a worker accidentally falling onto a conveyor belt would automatically activate the emergency trip wire.



Emergency Trip Wire (Conveyor)

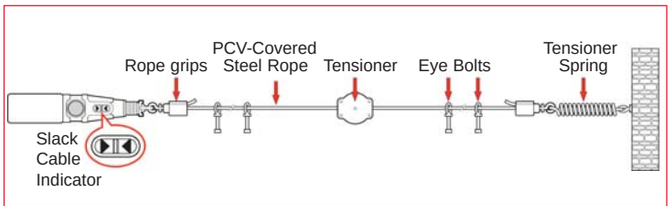


Safety Contact Bumper – Overhead Door Machine

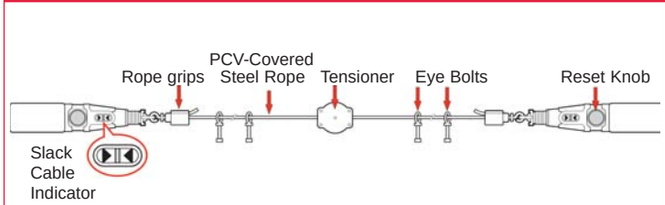
A pre-shift inspection and test should be done wherever these devices are installed.

Grab Wire and Pull Wire Devices

These devices usually allow the worker a “first/last chance” to stop the machine in the event of accidental contact. They must be selected and mounted so that pulling the wire/cable from any direction will activate the emergency stop. The activating switch must also sense a broken or slack cable condition, and automatically activate the emergency stop.



Pull Wire System With One Emergency Stop Switch. Note wall-mounted tension spring; activation by pulling from any direction.

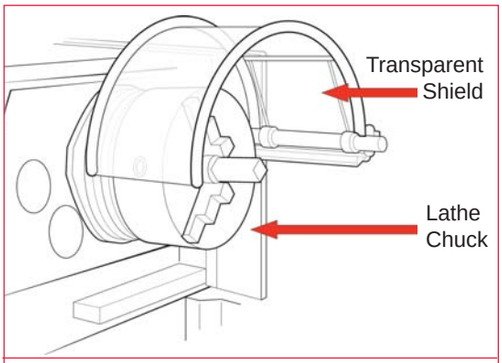


Pull Wire System With Two Emergency Stop Switches.
The switch is activated by a pull from any direction.

13 Pull Wires – Trip Wires – Contact Bumpers

14 Shields – Awareness Barriers

Shields



Awareness Barrier: Lathe Chuck

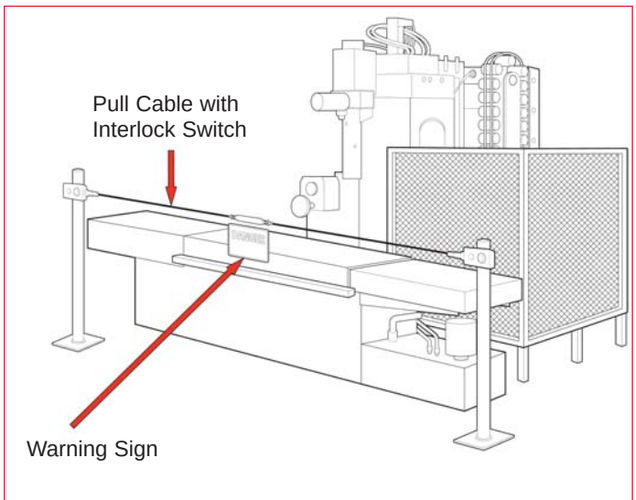
Shields, often in the form of transparent barriers, are typically installed on lathes, milling machines, drill presses and boring machines. They can also be used on woodworking machines. They are generally intended to deflect chips, sparks, swarf, coolant, or lubricant away from the operator and other workers in the machine area. Besides providing some protection as a barrier, most shields also provide good visibility into the point of operation.

Awareness Barriers

Awareness barriers include installations such as electrically interlocked pull cable assemblies installed in the rear area of machines such as brake presses and shears to restrict worker entry. These areas are often out of the operator's view. The machine is stopped if someone pulls or loosens the cable. It is recommended that a sign denoting the danger be placed on the pull cable.

Although shields and awareness barriers offer some degree of safeguarding, they cannot be considered guards because they only restrict but do not prevent access to danger areas.

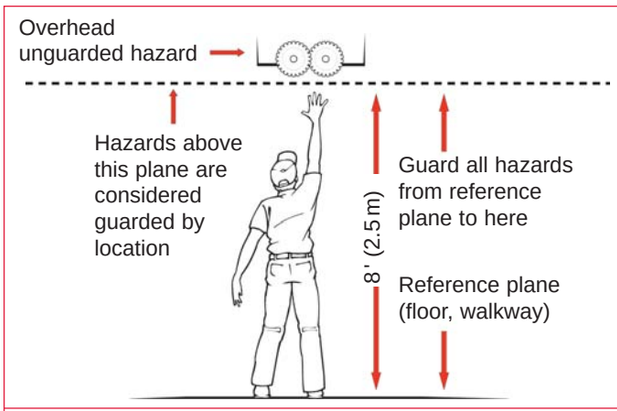
When installing these devices and before moving them from their normally applied position, always turn off power to the machine; follow lockout procedures if there is a risk of accidental startup.



Awareness Barrier: Sliding Table

14 Shields – Awareness Barriers

With the body upright and standing at full height, the safe clearance when reaching upward to an unguarded hazard is a minimum of 2.5 m (8 ') (see below). Any hazardous moving parts beyond this distance are considered to be guarded by location. If access to hazardous locations is gained by use of ladders, scaffolds, and so on, temporary guarding or lockout procedures must be used.



Safe Distance For Reaching Up To An Unguarded Hazard

Safeguarding Equipment With Infrequent Access

When the question is raised of safeguarding equipment that is located out of the way of normal work areas, comments such as “nobody ever goes there” or “we access that equipment only when it is locked out” are sometimes heard.

The fact that a worker can access unguarded moving parts that are not already safeguarded by location means that accidental contact can occur. And an accident will occur over time, although the level of risk on any given day may be quite low. It is not a question of whether these locations will be safeguarded but rather of establishing priorities and determining which machinery in the plant will be safeguarded first based on a **risk assessment (3)** and machine survey.

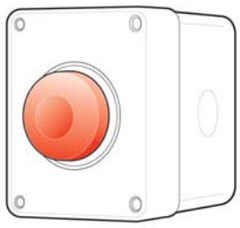
The Occupational Health and Safety Regulation permits safeguarding installations in place before January 1, 1999, to have unguarded parts more than 2.1 m (7 ') but less than 2.5 m (8 ') above the floor, walkway, or platform, unless the work process presents an undue risk to workers or until such time as the installation is substantially overhauled or renovated.

16 E-Stops

“E-stop” is the industry term for Emergency Stop. It is a red mushroom-shaped stop button that is manually depressed in the event of an emergency condition, upset condition, or accident. An emergency stop is not considered a primary safeguarding device.

E-Stop With Run Button & Main Power Disconnect

Because it requires intentional activation, an emergency-stop device seldom prevents accidents; it is an after-the-fact device. It may, however, prevent an unsafe machine operation from continuing and, when activated, will stop a machine after an accident has occurred.



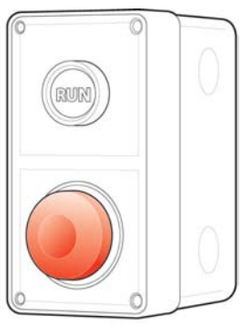
Standard E-Stop

The various published safeguarding standards contain specific requirements for E-stops, including how many are required and where they should be located.

E-Stop Installation Requirements

The following requirements apply to all E-stop installations:

- Mushroom-shaped and red in colour
- Located within immediate and unimpeded reach of the operator or other persons directly affected by the machine operation
- Designed to allow immediate activation with any part of the body (no ring guards or recessed position)
- Requires a manual push to activate and a manual pull to reset; remains in the depressed position when activated (not a “hold-to-run” type switch)
- A check for safe machine operation is required before an E-stop is reset
- Must be hard-wired into the control circuit to allow the magnetic coil to drop out (cannot be routed through a Programmable Logic Controller [PLC] except for monitoring purposes)
- The machine must not restart merely by pulling out and resetting the E-stop. A second, independent control must also be activated before the machine will restart.



E-Stop With Run Button

16 E-Stops