Part 25 Tools, Equipment and Machinery

Highlights

- Section 364 requires employers to ensure that machinery or equipment used to move, raise or lower workers is designed by the manufacturer or certified by a professional engineer as being appropriate for that purpose.

- Section 367 requires that machinery not be started or operated if doing so endangers the operator or another worker.

- Sections 372 and 373 present requirements applicable to elevated conveyor belts, including restrictions on the movement of workers above and below them.

- Section 375 requires the guards of hand-held grinders to cover 120 degrees of the grinding accessory, as opposed to the previous requirement of 180-degree coverage. Less coverage exposes more of the grinding accessory, improving access into tight grinding locations and reducing kickback.

- Sections 377 through 383 specify requirements specific to saw blades, saw wheels and saws.

- Section 384 presents requirements applicable to industrial robots.

Requirements

Section 362 Contact by clothing, etc.

Any type of clothing, jewellery or hair that hangs down near the moving parts of machinery, equipment or tools creates a potential hazard. Serious injuries including amputation have occurred when a worker's clothing, jewellery or hair has been caught in moving equipment or machinery.

Subsections 362(1) and 362(2)

These subsections describe both employer and worker responsibilities. A hazard assessment helps determine the risk of a worker's clothing, jewellery or hair being caught. Practices to decrease the risk of workers being caught in machinery may include such things as:

(a) wearing clothing that fits close to the body and cannot get caught on moving parts;
(b) avoiding loose cuffs, belts, ties or protruding buckles that are easily caught on equipment;
(c) where long sleeves or pant legs are worn, elasticized or closely buttoned cuffs, velcro closures or ties should be used;
(d) wearing coveralls to contain or control clothing;
(e) wearing close fitting leather or insulated work gloves that are less likely to become caught than loose fitting handwear. In some circumstances it may not be appropriate to wear gloves at all if there is a risk of them getting caught in moving parts;
(f) ensuring boots are laced using all eyelets and tucking in bootlaces;
(g) tying back long hair and covering it with a hairnet that is snug to the head;
(h) covering a long beard with a net to contain it;
(i) not wearing jewellery and accessories such as chains or scarves with loose ends;
(j) removing a fall protection lanyard rather than wearing it draped over a shoulder; and
(k) rings can increase the damage to a finger or result in amputation when a hand is crushed. Rings should be removed if a hazard is present.

Subsection 362(3)

It is important that workers with certain medical conditions wear medical alert bracelets to obtain prompt treatment if required. Medical alert bracelets with a breakaway or tear away band allow workers to do this while maintaining safety.

Breakaway bands should be tested to ensure that there is no danger of the worker getting caught. If breakaway medical alert bracelets are not available, consider attaching the medical alert tag to some other breakaway band or lanyard or linking it through bootlaces.

Section 363 Machines close together

This section outlines the employer's responsibility to ensure that workers are not in danger because of machines being too close together. It is important to identify the boundaries that separate restricted areas from areas where workers can move safely. The layout of machinery and equipment must allow workers to move without risk of being struck by or caught on moving or protruding parts of the equipment.

To ensure worker safety, a machine or its dangerous parts should be positioned so that hazardous areas are not accessible or do not present a hazard to a worker during the normal hours of operation. The assessment should start with identifying the specific clearances required by each machine or component in the automated system. Issues to consider when positioning machinery include:

(a) the operation of the machine;
(b) operator/worker interaction with the machine;
(c) other tasks performed in the area;
(d) visibility when moving around the machinery; and
(e) the need to move supplies in the area.

Section 364 Moving workers

Machinery or equipment used to move, raise or lower workers must be specifically designed for that purpose. Machinery or equipment intended to move, raise or lower materials may not have the safety features or factor of safety designed into it to allow it to be safely used with workers.

Examples of machinery or equipment for which the design is critical and to which specific requirements of the OHS Code apply include

(a) rigging [see subsection 292(1)],
(b) fork-mounted work platforms intended to support a worker [see subsection 349(2)],
(c) suspended man baskets [see section 350], and
(d) the travelling block or tugger of an oil derrick [see section 770].

Section 365 Starting machinery

Subsection 365(1)

This subsection addresses the use of alarm systems when starting machinery. The start-up of machinery can cause injury to workers near the machine if they are not aware that the machine is being started and the machine is not appropriately guarded. If a machine operator cannot see the machine or parts of the machine being operated from the control panel or operator's station, *and moving machine parts may endanger workers*, an alarm system must be installed. The alarm system may include sirens, buzzers, horns, flashing lights or a combination of these alarms. A combination of both visual (flashing lights) and audible (siren, buzzer or horn) alarm systems provides the best protection.

Alarm systems should be automatic. They should be constructed and located so that they provide a recognizable audible or visual signal to workers. Audible devices should have a distinctive sound and be able to be heard above the surrounding noise, including the noise of the machine being operated.

An alarm system is not required if moving machine parts that could endanger workers are guarded.

Subsection 365(2)

The alarm system must be effective at warning workers that a machine is about to start. It must be loud enough or bright enough to attract workers' attention while allowing them sufficient time to reach a safe location. Time delays should be in place so that the warning provides workers with enough time to move to a safe postion.

Section 366 Preventing machine activation

The employer must install positive means to prevent equipment from starting up when a worker is feeding material into the equipment or a part of the worker's body is within the machine's danger zone.

Methods of accomplishing this include:

(1) presence-sensing devices such as:
   (a) photoelectric devices that use a system of light sources and controls that can interrupt the machine's operating cycle. If the light field is broken, the machine stops and will not cycle or will not start. This device is to be used

only on machines that can be stopped before the worker reaches the danger area;

(b) radiofrequency (capacitance) presence-sensing devices that use a radiofrequency beam that is part of the machine control circuit. When the capacitance field is broken, the machine stops or will not activate. This device is only to be used on machines that can be stopped before the worker reaches the danger area. This requires the machine to have a friction clutch or other reliable means of stopping;

(c) electromechanical sensing device that has a probe or contact bar that moves to a predetermined position when the operator initiates the machine cycle. If there is an obstruction preventing it from moving to its safety position, the control circuit does not allow the machine to cycle;

(2) two-hand controls require the use of both hands at the same time to activate the machine. The operator's hands are out of the danger area. The controls must be designed so that they cannot be operated with one hand and another part of the body; and

(3) two-hand trips require the operator to press two buttons at the same time to start the machine. Once the machine is started the operator's hands are free to perform other tasks. The controls must be designed so that the operator cannot use one hand and another body part to activate the machine.

Section 367 Operator responsibilities

The machine operator is responsible for checking the machine and the surrounding area to ensure that both the operator and other workers are not at risk of being caught or struck by moving equipment. This may include such things as checking visually and verbally to make sure workers are not in the immediate vicinity of the machinery, and activating warning alarms. Having a second worker check the area may be necessary in some situations. Convex mirrors may be used to allow the operator to see obstructed areas.

Section 368 Controls

The employer is responsible for ensuring that operational controls on equipment are designed, located, or protected to prevent unintentional activation. If appropriate, the controls must be suitably identified to indicate their nature or function.

A control is anything — a switch, lever, pedal button, knob, dial or keyboard — used by an operator to affect a system's operation. Preventing unintentional activation is often done be recessing start buttons so they cannot be accidentally activated or covering buttons with a guard.

People expect things to behave in certain ways when they are operating controls, and safety may be jeopardized if controls are operated in the wrong way. The position and design of machine controls is important. Speed and ON-OFF controls are particularly important and should be readily accessible. Controls should be standardized on similar machinery so that operators can shift from one machine to another without having to use different controls. The function of the control must be suitably identified.

Controls can be identified based on their

(a) shape and texture — useful where illumination is low or where a control needs to be identified and operated through touch only,
(b) location — grouping controls for the same operations together in one area or always having a particular function in the same location on different control panels, or
(c) colour — useful for quick visual identification of various controls and for grouping controls for a particular operation. Common examples are green for start and red for stop.

Controls can also be labelled with words or symbols.

Section 369 Immobilizing machinery

The worker is responsible for making sure that a machine, or part of or extension to a machine, is not left unattended or in a suspended position unless the machine is immobilized and secured against accidental movement.
For powered mobile equipment this means setting parking brakes and transmission locks and lowering any blades, buckets or forks to the ground. The wheels may sometimes need to be blocked.

Section 370 Drive belts

Drive belts include power transmission belts such as flat belts, round belts, V-belts, etc. Conditions such as misalignment at loading points, sidewinds, rain, snow and build-up of product can interfere with the alignment or “train” of belts.

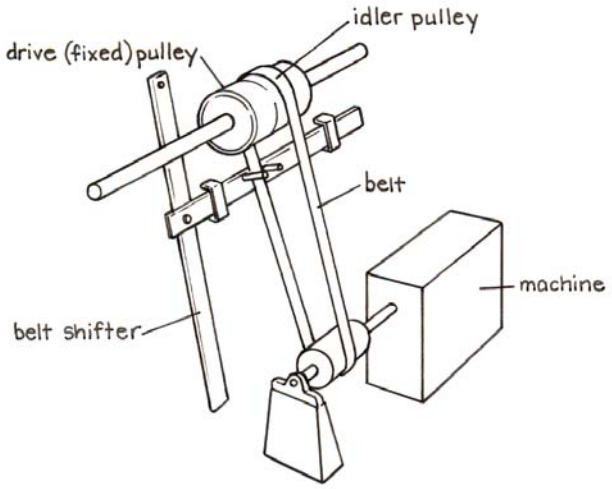
Subsection 370(1)

Realigning belts is one of the highest risk activities. When realignment is attempted on a moving belt, workers can get hands, tools or clothing caught in machinery, be struck by components, or be pulled into pinch points where they may lose a limb or be crushed. Under no circumstances is a worker allowed to manually shift a belt while it is in motion or while the machine or motor is energized.

Subsection 370(2)

A belt shifter is a device for mechanically shifting belts from tight to loose pulleys or vice versa, or for shifting belts on cones of speed pulleys (see Figure 25.1). Permanent drive belts must be provided for all loose pulleys on a machine and must be constructed so that the drive belt cannot creep back onto the driving pulley.

Figure 25.1 Example of mechanical pulley shifting device



Section 371 Continuous-feed machinery

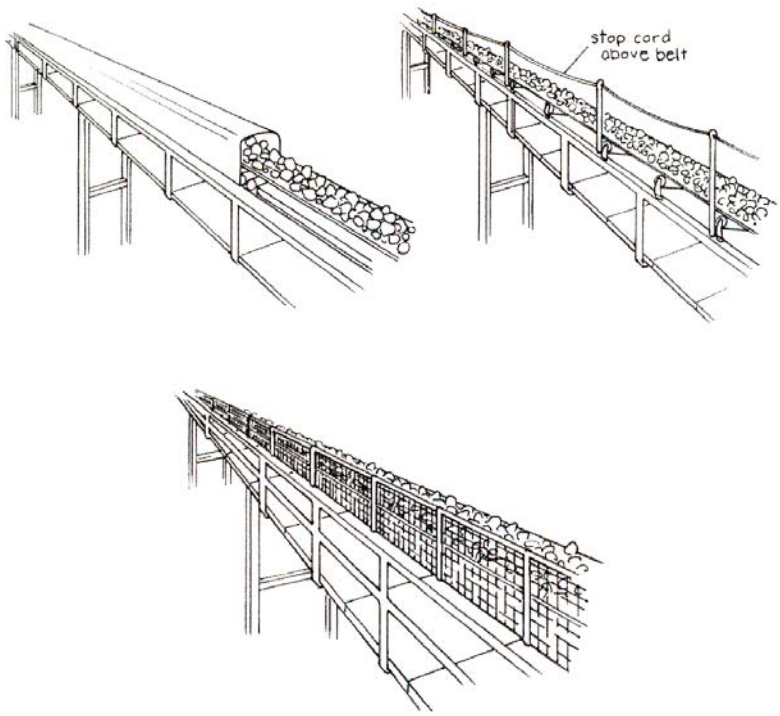
This section requires the machine's feeder device to be able to be stopped independently of the machine's processing mechanism. This usually allows the feeder device to come to a full stop fairly quickly if, for safety reasons, the feeder must be stopped.

Section 372 Elevated conveyors

Elevated conveyors may present a hazard to workers from falling objects. Suggested safeguarding of elevated conveyors (see Figure 25.2) includes

(a) covering the entire length of the conveyor,
(b) installing expanded metal along the length of the conveyor,
(c) installing guardrails, and
(d) emergency stop cords along the entire length of the conveyor.

Figure 25.2 Examples of conveyor safeguarding



For more information

http://employment.alberta.ca/documents/WHS/WHS-PUB_bp008.pdf
Best Practices on Conveyor Safety

www.msha.gov/s&hinfo/equipguarding2004.pdf
MSHA's Guide to Equipment Guarding
U.S. Department of Labour, Mine Safety and Health Administration (2004)

Conveyor side walls must be high enough to prevent materials from falling out of the conveyor. The trough the conveyor is running in must be of sufficient strength to prevent a worker who is using a designated walkway beneath the conveyor from being injured by falling materials or objects. A wide variety of materials are available for guard construction such as wire mesh panels, expanded metal, or solid sheet metal. The choice of material is generally dependant upon the size and weight of the material being handled.

A worker must use a walkway to cross a conveyor belt if the conveyor belt is moving or the conveyor belt is motionless but has not been locked out. A moving conveyor, or a motionless conveyor that suddenly and unexpectedly begins moving, could cause a worker to fall. If the worker falls onto the moving surface, the worker could be drawn into dangerous process equipment.

Similarly, crossing under a moving conveyor belt at a location other than a walkway may be dangerous. Such walkways are specially designed to offer protection from overhead falling objects and exposure to operating mechanisms.

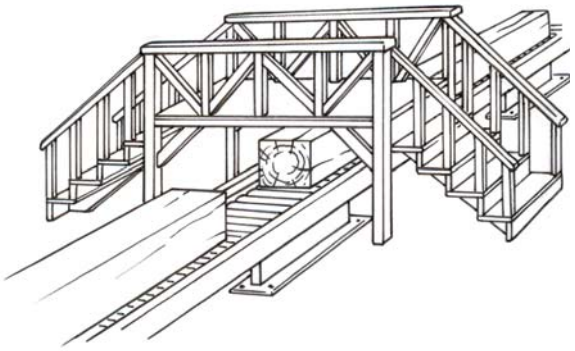
Section 373 Crossing conveyor belts

Common types of incidents with conveyor belts involve workers being struck by objects or getting caught in the moving equipment.

Subsection 373(1)

Workers crossing over a conveyor belt are at a risk of falling onto the conveyor belt or getting caught in moving parts. To prevent this, a bridge that is at least 1 metre wide with adequate guardrails must be in place (see Figure 25.3).

Figure 25.3 Example of bridge over conveyor belt



Good practices include solid construction of crossover bridges, including steps and guardrails on both sides. The steps and floor of the walkway should be surfaced with non-slip material.

If the conveyor belt is locked out, workers may cross over the conveyor belt at locations other than where a bridge is located.

Workers crossing under a conveyor may be at risk of injury due to objects falling from the conveyor belt or getting caught in the moving parts of the conveyor belt. Workers must only cross under conveyor belts where they are protected from falling materials and moving parts.

Section 374 Actuated fastening tools

An actuated fastening tool is a tool that uses a pneumatic, hydraulic, explosive or electric source of energy to bring about its action. Improper use of an actuated fastening tool can cause serious injury or death. The trigger of an actuated fastening tool should not operate unless the worker is in control of the tool and is holding the trigger in the ON position. The trigger should not be mechanically held in the ON position unless the manufacture's specifications permits it to be operated in this way. Workers must be trained to properly use such tools.

For more information

www.ccohs.ca/oshanswers/safety_haz/power_tools/powder.html
Powder-Actuated Tools

www.ccohs.ca/oshanswers/safety_haz/power_tools/pneumat.html
Pneumatic Tools — Basic Safety

Section 375 Grinders

Subsection 375(1)

Grinding machines shape materials by bringing them into contact with a rotating abrasive wheel or disk. Hazards associated with grinders include
(a) eye injuries, if appropriate eye protection is not worn,
(b) contact with moving parts,
(c) using broken or cracked grinding wheels,
(d) reaching across or near rotating grinding wheels,

(e) grinding on the side of a wheel not designed for this type of use,
(f) vibrations and excessive speed that cause a wheel or disk to shatter,
(g) using the wrong type, a poorly maintained, or unbalanced wheel or disk,
(h) incorrectly holding the work, and
(i) incorrectly adjusted tool rest or a grinder that does not have a tool rest but should.

Workers operating grinders must be trained to safely and correctly operate the equipment. Appropriate personal protective equipment must be worn.

Grinders must be operated in accordance with the manufacturer's specifications and where required, be equipped with a grinder guard. Guards protect the operator and should not be removed as serious injuries can occur. Guards should enclose the wheel as completely as the nature of the work permits.

In using the various types of abrasive wheels and disks, the manufacturer's stated running speeds in revolutions per minute (RPM) and operational procedures must be followed. Before a grinding wheel is installed, its size and maximum rated speed must be checked against the manufacturer's specifications. The maximum rated speed must be equal to or greater than the maximum speed of the grinder shaft. The hazard associated with grinding wheels is that they tend to shatter into pieces (due to centrifugal force) with the potential of injuring both operators and bystanders.

If a hand held grinder is being used, the object being ground must be secured and unable to move.

Subsection 375(2)

Almost all guards on hand held grinders cover one-half or 180 degrees of a grinding disk's circumference. This subsection allows guards to be cut back to cover 120 degrees of the grinding disk's circumference. Doing so exposes more of the grinding disk, allowing the disk to be used in tighter, difficult-to-get-at grinding locations, and may reduce the danger of grinder kickback with some work pieces.

Subsection 375(3)

If a tool rest is installed on a fixed grinder, the employer must ensure that the manufacturer's specifications are followed if they exist or the tool rest is
(a) installed in a manner compatible with the work process,
(b) securely attached to the grinder,
(c) set at or within 3 millimetres of the face of the wheel, and
(d) set at or above the centre line of the wheel.

Many wheels have broken and caused injury to operators because work has become wedged between the tool rest and the wheel. The tool rest should be substantially constructed and securely clamped not more than 3 millimetres from the face of the wheel. The position of the tool rest should be checked frequently. The tool rest height must be set at or above the centre line of the wheel.

Subsection 375(4)

An abrasive wheel is made of bonded abrasive and only the periphery or circumference of an abrasive wheel is usually designed for grinding. If grinding on the side is required, then wheels designed for this purpose that are either cemented or bolted to a steel or flexible backing plate can be used.

Workers are responsible for making sure that they do not grind material using the side of an abrasive wheel unless the wheel has been designed for that purpose.

The tool rest of a fixed grinder must never be adjusted while the wheel is in motion. The tool rest may slip, strike the wheel and break it, or the operator may catch a finger between the wheel and the rest.

For more information

 www.ccohs.ca/oshanswers/safety_haz/abrasive_wheels/safeuse1.html
Use of Portable Grinders

 www.ccohs.ca/oshanswers/safety_haz/metalworking/surfacegrinders.html
Surface Grinders

 www.ccohs.ca/oshanswers/safety_haz/abrasive_wheels/mounting.html
Wheel Mounting on Portable Grinders

Section 376 Chain saws

A chain saw is a powered saw that uses an articulated chain with integral cutting teeth running around a bar of flat steel. Serious injuries can result from the unsafe use of chain saws including kickback, falling while carrying a saw or when sawing, strains and sprains from carrying and working with a heavy saw, hand-arm vibration syndrome, being cut by contact with the chain while it is in motion, being cut by the chain when it is not in motion, eye injuries from debris or fragments, hearing damage and many others.

Subsection 376(1)

There are many different brands, models and sizes of chain saws. A chain saw must be operated, adjusted, and maintained according to the manufacturer's specifications. Kickback is the main cause of chain saw injuries. A kickback is the sudden and potentially violent rearward and/or upward movement of the chain saw. It is often caused be the chain striking wood or other objects, or can be caused by binding or pinching in the cut. All chain saws used at the work site must be designed or equipped with a mechanism that minimizes the risk of injury from kickback when the saw is in use.

Anti-kickback devices found on chain saws include

(a) safety nose or guard — prevents contact with the chain at the end of the chain (see Figure 25.4),
(b) safety chains — designed to reduce the tendency of catching or "hanging-up" in the wood, and
(c) chain brakes — stops the chain as the chain bar rises upwards and the hand pivots against the brake switch (see Figure 25.5).

Figure 25.4 Example of chain saw nose guard

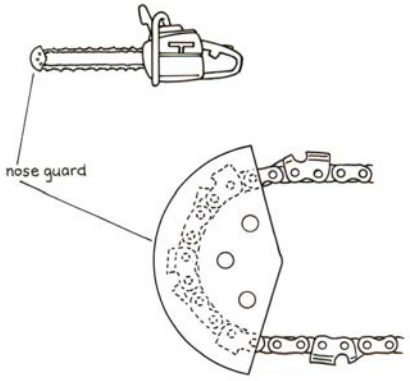
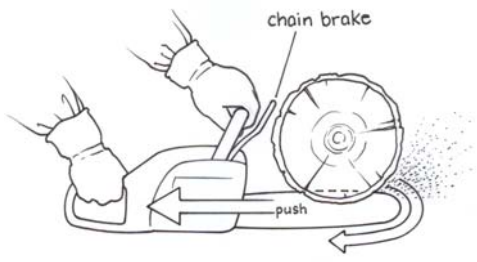


Figure 25.5 Example of chain brake that helps prevent chain saw kickback



Subsection 376(2)

Workers must ensure that the chain saw's motor is off and movement has completely stopped before attempting to adjust, clean, maintain or repair the chain or chain saw.

For more information

www.osha.gov/SLTC/etools/logging/manual/logger/chain_saw/chain_saw.html
Chain saw information and online tutorial

http://www2.worksafebc.com/Portals/Forestry/FallingAndBucking.asp
Industry Prevention Resources for Forestry – Falling and Bucking

Section 377 Circular saw blades

The characteristics and conditions of circular saw blades are important safety factors for the operators who use them. Workers must follow the manufacturer's specifications and instructions for care and use of saw blades.

It is good practice to inspect the saw blade for cracks every time the teeth are filed or set. As soon as a crack is detected, the blade should be removed from service. If cracked blades are left in service the crack may grow larger and cause partial fragmentation.

Circular saw blades with cracks of any size that are adjacent to the collar line of the saw, or with a crack anywhere else on the saw that exceeds the limits specified in Table 1 of Schedule 8 of the OHS Code (shown as Table 25.1), must be removed from service and either replaced or repaired before it is used again.

Table 25.1 Circular saw blade crack limits
(appears as Table 1 of Schedule 8 in the OHS Code)

Saw blade diameter (millimetres)	Maximum length of crack (millimetres)
up to 300	13
301 to 610	25
611 to 915	38
916 to 1220	50
1221 to 1525	64
> 1525	76

A circular saw blade with a crack of any length that is located near the periphery (edge) must be removed from service and replaced or repaired. The blade may be returned to service if it is repaired or if the crack is prevented from getting longer by slotting, centre punching, drilling or another effective means.

Circular saws must be properly tensioned before being used. Saw blades that have not been tensioned properly may wobble which can cause a saw blade to fracture. After repairs are made to a circular saw blade, it must be retensioned by a person who has been specifically trained to do this.

Section 378 Band saw blades and wheels

The most common cause of band saw injuries is an operator's hands coming into contact with the blade, such as when hand-feeding stock.

Band saw blades (other than a shake band saw blade) with a crack that exceeds the limits specified in Table 2 of Schedule 8 of the OHS Code (shown as Table 25.2) must be removed from service and either replaced or repaired.

Table 25.2 Band saw blade crack limits
(appears as Table 2 of Schedule 8 of the OHS Code)

Width of band saw blade (millimetres)	Maximum length of crack (millimetres)
up to 125	1/10 of saw width
126 to 300	13
> 300	19

To reduce the risk of injury it is good practice to inspect the band saw prior to each use. Cracked or broken blades should be removed immediately.

Any band saw blade (other than a shake band saw blade) with a crack not exceeding the limits outlined above must be removed from service until the crack is repaired or the crack is prevented from getting longer by centre punching or some other means. After repairs are made to a band saw blade, it must be retensioned by a person who has been specifically trained to do this.

Shake band saws are generally smaller than other band saws. Shake band saw blades with any size crack must not be used.

Section 379 Band saw wheels

This section outlines the specific requirements for rim thickness of band saw wheels. Unless otherwise specified by the manufacturer or certified by a professional engineer, a cast steel band saw wheel that is 25 millimetres inboard from the rim edge must have a minimum rim thickness of:

Table 25.3 Rim thickness of band saw wheels

Wheel diameter	Minimum rim thickness
up to and including 1.8 metres	14 millimetres
greater than 1.8 metres to 2.75 metres	16 millimetres
more than 2.75 metres	17.5 millimetres

Band saw wheels that are more than 1.2 metres in diameter must be tested for cracks at least once every 12 calendar months by a competent worker.

A band saw wheel that has been exposed to excessive heat must be removed from service until the wheel manufacturer or a professional engineer certifies that it is safe for continued use.

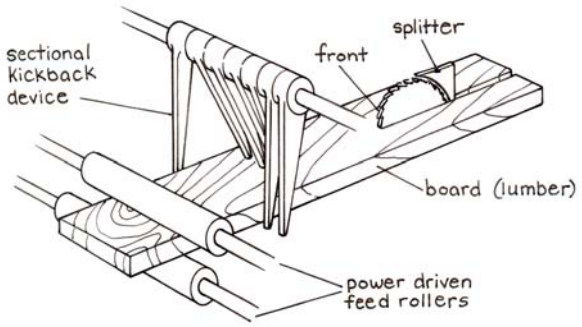
For more information

www.osha.gov/SLTC/etools/sawmills/band.html
Sawmills eTool — Band Saws

Section 380 Power-fed circular saws

A kickback occurs during a ripping operation when part or all of the work piece is violently thrown back to the operator. This section outlines the employer's responsibility to ensure that power-fed circular rip saws with horizontal power-driven infeed rolls are equipped with a sectional non-kickback device located in front of the saw blade across the full width of the feed rolls. Non-kickback devices may include the use of anti-kickback fingers (see Figure 25.6).

Figure 25.6 Example of anti-kickback fingers



When a resaw is being used, it must be equipped with a splitter and a cover. The splitter reduces the hazard of the board being thrown back against the worker because it does not allow the lumber to touch the rear of the blade. The function of the cover is to prevent dust and chips from being thrown back at the worker.

Section 381 Cut off saws

Workers may sustain hand injuries when using cut off saws in a variety of ways including
(a) when the blade coasts or idles,
(b) when a worker tries to remove a sawed section of board or a piece of scrap, or
(c) when a worker measures boards or places them in a position for the cut.

A worker may also be struck by the saw if it bounces forward or the return device falls.

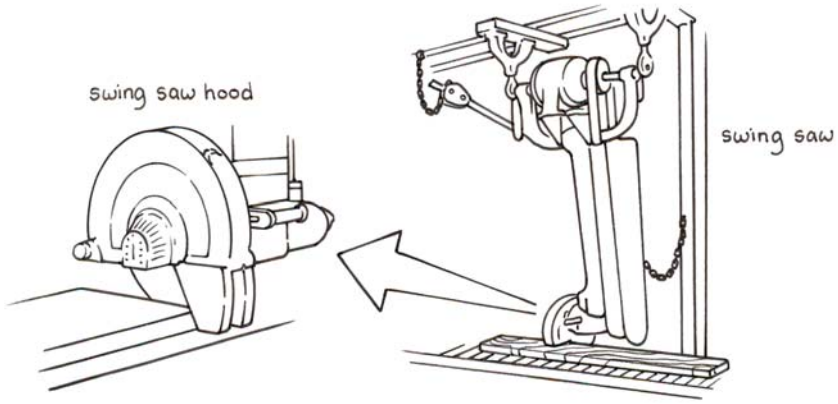
Hand operated cut-off saws (other than radial arm saws) must be equipped with a device that returns the saw automatically to the back of the table when the saw is released at any point in its travel. This prevents the saw from being left in a hazardous position.

Radial arm saws are exempt from this requirement because of the occasional need to lock these saws into a particular position for ripping and mitering.

A limit device must be in place to prevent a swing or sliding cut-off saw from travelling past the outside edge of the cutting table. This may be done by using a limit chain or other device that prevents the saw from swinging beyond the back or front edges of the table. Another device should keep the saw from rebounding from its idling position.

The limit device prevents the worker from operating the saw in an unsafe position (see Figure 25.7).

Figure 25.7 Example of automatic return and blade guard on a swing cut-off saw



Section 382 Sawmill head rig

This section outlines the employer's responsibilities for circular head saws in sawmill head rigs. The term "head rig" means a combination of head saw and log carriage used for the initial breakdown of logs into timbers, cants, and boards. A sawyer is a worker in a sawmill who operates the head rig or main saw.

The employer must make sure that circular head saws have adjustable guides and splitters that are located not more than 75 millimetres from the back of the head saw, and that extend not less than 250 millimetres above the carriage bench. Adjustable guides maintain true tracking of saw circumference and control flexing of the saw.

The employer must also ensure that the upper half of a top saw on a circular head rig is covered. The employer must also ensure that circular head saw guide adjustment controls are operated remotely from the guides.

Section 383 Sawmill log carriage

A log carriage is a framework, mounted on wheels, that runs on tracks or in grooves parallel to the face of the saw. Carriages also contain an apparatus that holds a log securely while advancing towards the saw.

A sawmill log carriage must have a substantial buffer stop at each end to limit travel. The carriage must have a safety device that keeps blocks not less than 30 millimetres from the saw. Each head block must be equipped with a dog and there must be sweepers at the front and back of the carriage to clear obstructions from the track.

The sawyer's lever, operating the drive of the carriage, must be designed and constructed to operate in the opposite direction from the direction the carriage travels if the operator's position with respect to the carriage could put the operator in danger.

This is applicable in cases where a sawyer is positioned parallel to the carriage track so that if he or she is struck by a broken limb or loses his or her footing, his or her forward motion will send the carriage away from the saw. If the mill is equipped with controls located at right angles to the carriage track, this provision is not required.

A security device holds the carriage tight to the track when the log turning device is in operation. Devices that turn logs on the carriage tend to exert a great deal of pressure.

Maintaining the carriage drive control mechanism and the log-turning control in neutral if the operator is not at the control may be done by using a specialized mechanical lockout device on the carriage and log turning controls.

For more information

www.osha.gov/SLTC/etools/sawmills/carriages.html
Log Carriages/Carriages Runways

Section 384 Robots

Subsection 384(1)

Robots are machines specifically designed and programmed to perform certain operations. They are part of today's workplace and are used in a variety of applications such as spray painting, arc and spot-welding, materials handling, assembly, and machine loading and unloading.

CSA Standard Z434-03 (R2008), *Industrial Robots and Robot Systems — General Safety Requirements*, applies to the manufacture, remanufacture, rebuild, installation, safeguarding, maintenance and repair, testing and start-up of industrial robots and robot systems. The Standard also includes requirements for worker training.

Robot safety can be divided into three major areas:
(1) safety in the process of manufacturing, remanufacturing, and rebuilding of robots;
(2) robot installation; and
(3) safeguarding workers exposed to hazards associated with the use of robots.

A hazard assessment as required by section 7 of the OHS Code must be conducted to identify potential hazards and appropriate controls when working with robots. A sample risk assessment process is included in the CSA standard. A risk assessment for robot safety may consider:
(a) size, capability, and speed of the robot;
(b) applications and process;
(c) anticipated tasks that will be required for continued education;
(d) hazards associated with each task;
(e) anticipated failure modes;
(f) probability of occurrence and probable severity of injury; and
(g) level of expertise of exposed workers and the frequency of exposure.

The robot and robot system must be equipped with adequate safeguarding devices to protect workers against hazards. Safeguarding should eliminate or control the hazard. A hierarchy of safeguarding controls is recommended in the CSA standard and summarized in Table 25.4.

Table 25.4 Hierarchy of safeguarding controls

Most effective	(1) Elimination or substitution	▪ eliminate human interaction in the process ▪ eliminate pinch points (increase clearance) ▪ automated material handling
	(2) Engineering controls (safeguarding technology)	▪ mechanical hard stops ▪ barriers ▪ interlocks ▪ presence-sensing devices ▪ two hand controls
	(3) Enhancing worker awareness of hazards	▪ lights, beacons, and strobes ▪ computer warnings ▪ signs ▪ restricted space painted on floors ▪ beepers ▪ horns ▪ labels
	(4) Training and procedures (administrative controls)	▪ safe job procedures ▪ safety equipment inspections ▪ training ▪ lockout
Least effective	(5) Personal protective equipment	▪ safety glasses ▪ ear plugs ▪ faceshields ▪ gloves

Source: CSA Standard Z434-03 (R2008), Table A.1

Types of safeguards

Safeguards that prevent workers from entering a restricted work area include:

(1) *barriers* — a physical means of separating the worker from the hazards;

(2) *interlocking safeguarding devices* — the operation of one control or mechanism allows or prevents the operation of another. These devices may be mechanical or electrical and must
   (a) have a key, plug or actuating device that is not easily duplicated,
   (b) be tamper-resistant and not be defeated intentionally without tools,
   (c) provide a means for secure attachment, and
   (d) be provided with documents stating the standards the product meets, the standard the product is independently certified to meet, and their safety circuit performance;

(3) *safeguarding devices that signal a stop* — examples include
   (a) safety light curtains, screens,
   (b) area scanning safeguarding devices,
   (c) radiofrequency (RF) capacitance safeguarding devices,
   (d) safety mat systems,
   (e) single and multiple bean safety systems, and
   (f) two-hand control systems;

(4) *safeguards that limit robot motion* — a restricted space must be established by installing a limiting device that minimizes the total distance a robot can travel. Limiting robot motion may be accomplished be means integral to the robot or by external limiting devices. Limiting devices redefine the space for a robot to perform its task. The restricted area is made smaller than the maximum space. The robot's movement zone should be restricted to the range of motion a particular operation or installation requires; and

(5) *presence sensing safeguarding devices* — are used to detect intrusion into an area where a hazard may exist and include
   (a) photoelectric cells,
   (b) pressure-sensitive mats, and
   (c) light or sound curtains.

Subsections 384(2) through 384(8)

Repealed.

Section 385 Teaching a robot

Often a robot is programmed by being physically guided by an operator through a desired sequence of tasks. Teaching may be done by
(a) use of a TEACH pendant — a control box that resembles a TV remote control. The operator uses it to walk the robot through the program steps slowly and recording each step, or
(b) the operator taking the end of the robot arm and leading it through a pattern of motions.

In either case, the worker doing the teaching will be within the restricted work envelope of the robot.

For more information

www.osha.gov/SLTC/robotics/index.html
Robotics

http://ohsviewaccess.csa.ca/
CSA Standard Z434-03 (R2008), *Industrial Robots and Robot Systems — General Safety Requirements*. Canadian Standards Association, 2003