

# Machine Safety

## Introduction

In Ontario today people are still becoming injured, sick or killed as a result of hazards around machinery and equipment in every industry.

There are numerous potential hazards around machinery and equipment.

## Safety Hazards

- Contact with Moving Parts
  - Contact with Electricity, Heat, Fire, Cold, Other Energies
  - Contact with Pressurized Gas Or Liquid
- Where you feed materials into the machine: loading, cleaning.
  - Where the machine cuts, turns, drills, shapes, punches, or moves in any way: cleaning and maintenance, trouble shooting and repair, adjusting, setting up.
  - At the gears, wheels, cylinders, belts, rollers, chains, cables, sprockets, cams: cleaning and maintenance, trouble shooting and repair, adjusting, setting up.
  - Around lift trucks and moving equipment.
  - Around conveyors, elevators, and cranes.
  - Around any machinery and equipment that can release energy on you.

## Health Hazards

- Contact with Harmful Chemicals
- Contact with Harmful Noise, Radiation, Vibration
- Lack of Adequate Workplace Ergonomics: handling and process design
- Harmful Actions to the Environment and Community

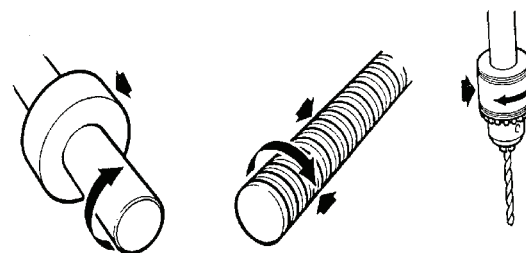
## Safety Hazards

### Where?

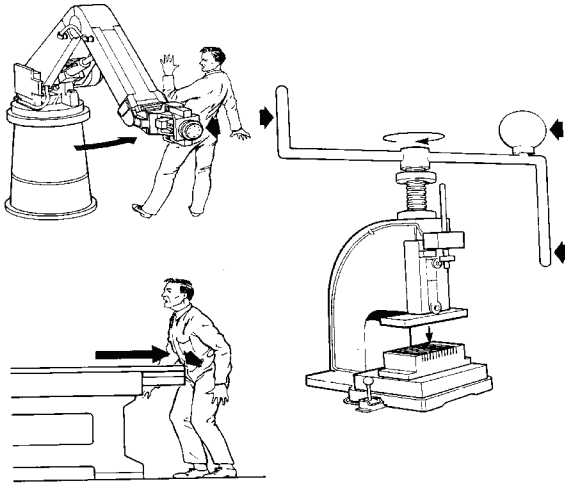
- At the controls: starting or stopping, set-up, adjusting.

## Types of Machine Motion

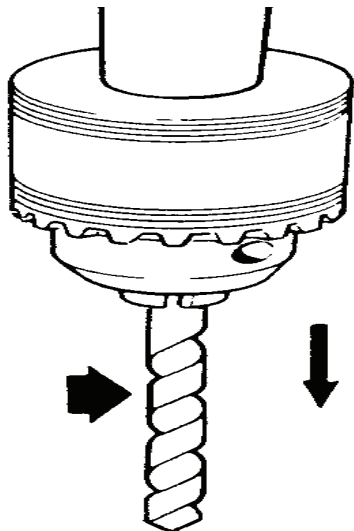
The diagrams below show **rotational motion hazards** with various machinery parts and equipment: at pulley, drill, circular saw, rollers, grinding wheel, lathe, shaft, router, milling, boring machine, gear and chain, pulley and belt, *nip points*, roller/gear *in-running nips*, etc.



The diagrams below show **reciprocating motion hazards** with various machinery parts and equipment: at press, jig saw, drill press, cutters, shears, stitching and sewing machines, guillotine blades, shear action of cutting die, punch action of press, power hammer, riveter, robotic arm, etc.



The diagrams below show **transverse motion hazards** with various machinery parts and equipment: at conveyor belt, band saw, belt sander, lift truck, robots, drill press, press, etc.



## What Can happen?

These motions have different actions and can therefore result in one or several types of injury.

Motion	Action	Type of Injury
Rotating	Cutting/ Trapping	Laceration/ Amputation
Back and Forth, Up and Down	Impact/ Struck by	Fracture/ Amputation
Straight Line	Entanglement/ Pulled by	Sprain/Strain Fracture Amputation

## Contact with Electricity, Fire, Heat, Cold, other Energies

### Where?

You can contact electricity, heat, fire, or cold:

- at power panels, electrical circuits, power lines, ovens, and heating elements
- around chemical containers, vats, pipes, pumps, and compressors
- around cranes, hoists, other lifting devices
- during service and repair jobs

### What can happen?

Without protective guards and devices on machines, without following safe work procedures, or having the right personal protection:

- you could get hurt if you make contact with: **electricity (e.g. faulty ground), flames, hot or cold materials**, and surfaces around machinery
- you can suffer **burns – and in some cases freeze injuries** – around welding, soldering jobs, freezing equipment, electrical panels and circuits, molten, baking, heating, steaming, extruding, plating jobs

- you can be burned or crushed if fuel catches fire and chemical equipment explodes
- you can get hurt if **equipment or materials fall** due to uncontrolled gravitational or mechanical energies, such as problems with incorrectly slinging/rigging or lifting loads by crane or hoist
- machine lubricants, degreasers, coolants, protectants, releasing agents, paint, fuel, cleaners
- at plating jobs, vats, tanks
- during service and repair jobs
- piping systems, valves, sumps, reservoirs

## Contact with Pressurized Gas or Liquid

### Where?

You can contact high pressure liquid or gas:

- at nozzles of pressurized cleaning and painting spray lines, air jets
- around injectors, autoclaves, extruders, chemical containers, vats, pipes, pumps and compressors
- during cleaning, service, and repair jobs

### What can happen?

Without guards on machines, without following safe work procedures, or having the right personal protection:

- you could get hurt if you make contact with high pressurized gas or liquid
- pressurized gas or liquid can **puncture skin, cut, and blind** you
- pressurized air or liquid can inject you with **harmful chemicals or bacteria**

## Contact with Harmful Chemicals

### Where?

You can contact harmful chemicals at or around machinery and equipment. Chemical liquids, dusts, fumes and gases can travel throughout the workplace:

- at or near production and paint jobs, welding, soldering, cutting, boring, grinding, tapping, reaming, lapping, drilling, broaching

### What can happen?

Without guards on machines, without following safe work procedures, or having the right personal protection – especially complying with specific WHMIS requirements:

- you could get hurt if you make contact with splashed chemical liquids, powders, dusts, fumes, vapours, mists, and gels or grease used around machinery
- you could contact harmful chemicals that can burn, explode, corrode, poison, or irritate, e.g., metal working fluids, lubricants

## Contact with Harmful Noise, Radiation, Vibration

### Where?

You can contact harmful noise or radiation at or around machinery and equipment. Sound waves and radiation energy can travel throughout broader zones in the workplace:

- at stamping, sawing, grinding, polishing jobs
- at welding, cutting jobs
- at finishing, curing job

### What can happen?

Without guards on machines, without following safe work procedures, or having the right personal protection:

- some equipment can release harmful noise or radiation that can destroy your hearing, blind you, burn, or damage your internal organs (e.g., certain kinds of radiation)
- some equipment vibrations can injure soft body tissues, joints

## Harmful Lack of Adequate Workplace Ergonomics: Handling and Process Design

### Where?

- Excessive repetition of tasks.
- Excessive force used in tasks.
- Prolonged and repetitious, **awkward postures** during work.
- Mechanical stress, excessively stressful handling.
- Vibration.
- Excessive and prolonged cold, heat, poor lighting, noise.
- Any of the above, not excessively necessarily, but in combination.

### Awkward Handling Postures alone may include:

- elbows raised above wrist height
- excessive wrist bending/deviation
- pinching materials/products/tools constantly or constant hammering
- forearm rotation or twisting constantly
- extreme elbow bending/flexion
- back bending/flexion, twisting or lateral bending excessively

### Inadequate Workplace Design alone may include:

- improperly designed hand tools: for any user, or specific individual
- improperly designed work stations/surfaces: forces worker to adapt against body design
- improperly measured working heights/levels
- improper process: excessive specialization or excessive line speed: lack of job physical variety or muscle relief for any user, or specific individuals

### What can happen?

- Soft tissue injury: e.g. sprain can happen.
- Injury causes accident: e.g. sprain can cause fall or dropping, then set off another accident.
- Trigger Finger: repeated finger flexion, prolonged gripping.
- Carpal Tunnel Syndrome: repeated wrist extension or flexion, ulnar deviation, excessive pinch force.
- Raynaud's Phenomenon: in fingers due to prolonged use of vibrating tools.
- Tenosynovitis: forceful pinching, ulnar deviation, prolonged gripping.
- Epicondylitis: prolonged and excessive rotation of the forearm.
- Tendinitis: in biceps from forceful flexion of the forearm.
- Rotator Cuff Tendinitis: from working repeatedly with arms above shoulder level.

## Legislation

Workplace machine safety law in Ontario is based on the *Occupational Health and Safety Act* and *Regulations for Industrial Establishments* (R.R.O. 851/90).

In the *Act*, the sections dealing with responsibilities of employers (s.25), supervisors (s.27) and workers (s.28) set out general duties with respect to machine safety.

The Industrial Establishments Regulations (IER) has the following more specific provisions:

- **Preventing Access to Exposed Part:** guards must protect person from moving part. (IER, s.24)
- **In-running Nip Hazard, Guard or Device:** guards must protect person from these hazards. (IER, s.25)

- **Waste Stock and Protection:** guards must protect person from processed materials, not just the moving machinery/equipment parts. (IER, s.26)
- **Emergency Stop on Machine:** machine must have this, easy to see and reach. (IER, s.27)
- **Operating Control for Machine:** control that acts as a guard must be in safe zone for operator, cannot be operated accidentally, and must not be made ineffective, e.g., tied down. (IER, s.28)
- **Start Up Warning Devices:** needed where no visibility of moving parts. (IER, s.33)
- **Conveyors:** provision of guards. (IER, s.34)
- **Lockout:** lockout requirements (IER, S.42, 42.1)
- **Stopping and Blocking Machine:** the machine must be motionless and moving parts blocked before any cleaning, oiling, adjusting, repairing or maintaining work is done on any part of the machine. (IER, s.75)
- **Starting a Machine:** controls and other control mechanisms must be locked out as well as other precautions (e.g., blanking off, energy release) where starting the machine or equipment may endanger the worker. (IER, s.76)

There are also separate standards which apply:

#### **Canadian Standards Association (CSA)**

CAN/CSA-Z432-04 Safeguarding of Machinery (focus in this guideline).

CAN/CSA-Z434-03 Industrial Robots and Robot Systems – General Safety.

CAN/CSA-Z142-02 Code for Punch Press and Brake Press Operation: Health, Safety, and Guarding Requirements.

CAN/CSA-Z460-05 Control of Hazardous Energy – Lockout and Other Methods

## Controls

There are several means for controlling machine hazards:

- Safety Guards and Devices.
- Safety Procedures and Practices.
- Personal Protection.

## Safety Guards and Devices

- Guards and safety devices can help protect you from dangerous contact.
- Guards, barriers, and safety devices must prevent your fingers, arms – or your whole body – from getting into a danger zone.
- Guards must be designed and placed correctly: right size opening and distance to person.
- Guards must work well and fit the machine right – always.

## Types of Guards

- Fixed Barriers
- Interlocking Guards: electrical, mechanical
- Adjustable and Self-adjusting Guards

## Types of Safety Devices

- Pullbacks and Holdbacks
- Presence-sensing Devices
- Two-hand Control
- Safety Blocks
- Tools: Feeding/Holding Tools

## Safety Procedures and Practices

Safety practices and procedures include:

### Proper lockout procedure

Use lockout procedures before service, maintenance, or repair jobs on machines/equipment.

### Job/task standard operating procedures

Safe work steps to check, set up machines, start, and finish job or task.

### Inspection and maintenance

For the machinery, guards, and your entire work area, regularly and often.

### Emergency preparation and regular drills

To be prepared and able to respond effectively to minimize loss.

### Human factor planning

To allow you regular relief and change from repetitive tasks on production lines, to avoid fatigue, strains, sprains, and other injuries or accidents through regular breaks and task variety.

### Training

WHMIS and chemical health and safety, inspecting your workplace and housekeeping, emergency response.

## Lockout procedure

A proper lockout procedure has seven steps:

1. **Prepare for shutdown:** gather required materials, notify appropriate personnel.
2. **Shut down the equipment:** Disconnect power/shut down and release energy that can move any part of the machine (electricity, gravity, air/fluid/steam pressure, springs or mechanical).
3. **Isolate the Equipment:** Isolate the system from all energy sources.

4. **Attach locks/locking devices and tags:** Sign and attach warning tag(s).
5. **Control stored energy:** Use safety blocks between dangerous parts that could move and injure.
6. **Verify isolation of equipment:** Test controls to see that the machine can't go and has no built-up energy left.
7. **Release from lockout control:** This will ensure safe return to service for all workers

## Job/task analysis

Job/task analysis provides a process for developing actual working procedures – how the job is performed – with appropriate controls in place for health, safety and environmental protection.

## Inspections

Types of Inspections:

- Pre-start up, pre-operational
- Monthly plant inspection (JHSC)
- Manufacturer's recommendations
- Supervisory/management inspection
- Maintenance
- MOL inspection

## Summary

Effective and efficient inspections are procedures meant to verify that work is being carried out according to predetermined safe standard operating procedures. \*Also, inspections verify the state of appropriate, safe physical conditions with effectively controlled components, process equipment, and materials.

\*Standard Operating Procedures are developed through the use of Job/Task Analysis. Owner's/Manufacturer's manuals' recommended procedures are helpful, especially for high priority processes and critical tasks.

## Emergency preparation

The company should have an emergency policy and procedure contained in an emergency plan.

- **Know the signs** of possible emergencies.
- **Know how to shut down** your equipment in case of emergency.
- **Know where to find** the fire extinguishers.
- **Know when and how to use** the fire extinguishers.
- **Know where to find** the first aid area and first aid kit.
- **Know whom to call** for help in a health or safety emergency.
- **Know where to go** in case of emergency.

## Human factors planning

Human factors planning is part of workplace machine safety and health. A significant number of Ontario injuries involve not only amputations and similar trauma, but many less dramatic strains, sprains, and related overuse/repetitive task injuries, which are, however, serious.

The following checklist questions can be used to identify work activity “symptoms” that may have potential for developing into real problems that require control. (“Yes” answers indicate a concern that needs follow up and correction, e.g., professional advice for control.)

## Human Factors Checklist

Yes

1. Is the worker exposed to unrelieved repetitive movements in the job process?
2. Does the worker’s task demand **moving too frequently, with excessive force, or too long?**
3. Is the worker’s **body position, e.g., arms, legs, back, neck in poor alignment/awkward** postures?
4. Is the workstation/**equipment improperly placed/disorganized** causing poor movement?
5. Are tools and other **equipment designed to prevent healthy** working positions?
6. Are processes and **workstations designed to force long reaches,** stretches, deep bends?
7. Is the **worker uncomfortable during any tasks** or procedures of the job?
8. Can any **body part get caught in moving parts,** between objects, have harmful contact?
9. Is the **worker exposed to slips, falls, trips,** strains from lifting, pulling, pushing, heat/cold?
10. Is **excessive noise or vibration, poor lighting,** or adverse weather affecting performance?
11. Is the **worker exposed to any risk of falling** or from falling objects?
12. Is the **worker exposed to possible contacts** with electricity, toxic, caustic, corrosive chemicals, dusts, fumes, vapours, gases, mists, etc.

## Machine Safety Checklist

Mechanical Hazards	Yes	No
<b>The point of operation:</b>		
1. Is there a point-of-operation safeguard provided for the machine?		
2. Does it keep the operator's hands, fingers, body out of the danger area?		
3. Is there evidence that the safeguards have been tampered with or removed?		
4. Could you suggest a more practical, effective safeguard?		
5. Could changes be made on the machine to eliminate the point-of-operation hazard entirely?		
<b>Power transmission apparatus:</b>		
1. Are there any unguarded gears, sprockets, pulleys, or fly-wheels on the apparatus?		
2. Are there any exposed belts or chain drives?		
3. Are there any exposed set screws, key ways, or collars?		
4. Are starting and stopping controls within easy reach of the operator?		
5. If there is more than one operator, are separate controls provided?		
<b>Other moving parts:</b>		
1. Are safeguards provided for all hazardous moving parts of the machine, including auxiliary parts?		
<b>Non-mechanical Hazards:</b>		
1. Have appropriate measures been taken to safeguard workers against noise hazards?		
2. Have special guards, enclosures, or personal protective equipment been provided, where necessary, to protect workers from exposure to harmful substances used in machine operation?		
<b>Electrical hazards:</b>		
1. Is the machine installed in accordance with appropriate standards and codes?		
2. Are there loose conduit fittings?		
3. Is the machine properly grounded?		
4. Is the power supply correctly fused and protected?		
5. Do workers occasionally receive minor shocks while operating any of the machines?		

<b>Mechanical Hazards</b>	<b>Yes</b>	<b>No</b>
<b>Training:</b>		
1. Do operators and maintenance workers have the necessary training in how to use the safeguards and why?		
2. Have operators and maintenance workers been trained in where the safeguards are located, how they provide protection, and what hazards they protect against?		
3. Have operators and maintenance workers been trained in how and under what circumstances guards can be removed?		
4. Have workers been trained in the procedures to follow if they notice guards that are dangerous, missing, or inadequate?		
<b>Protective Equipment and Proper Clothing:</b>		
1. Is protective equipment required?		
2. Have operators and maintenance workers been trained in where the safeguards are located, how they provide protection, and what hazards they protect against?		
3. Is the operator dressed safely for the job (that is, no loose fitting clothing or jewelry)?		
<b>Machinery Maintenance and Repair:</b>		
1. Have maintenance workers received up-to-date instruction on the machinery they service?		
2. Do maintenance workers lock out the machine from its power sources before beginning repairs?		
3. Where several maintenance persons work on the same machine, are multiple lockout devices used?		
4. Do maintenance persons use appropriate and safe equipment in their repair work?		
5. Is the maintenance equipment itself properly guarded?		
<b>Other Items to Check:</b>		
1. Are emergency stop buttons, wires, or bars provided?		
2. Are the emergency stops clearly marked and painted red?		
3. Are there warning labels or markings to show hazardous areas?		

*\*Checklist courtesy of University of North Carolina at Bowling Green.*

## Key personal controls

### Use personal protection

- Use the right protective equipment and clothing for the job.
- Practice proper hygiene practices.

### Follow authorized use procedure

- Do not operate, service, maintain, or repair a machine unless trained and authorized to do it.

### Report any problems

- Report to supervisor/manager any problems around machines and guards, for example:  
Broken or **missing** guards and devices.
- **Loose** parts, **unusual** noise, leaks, or vibration.
- **Strange** odours, heat, smoke, dust, fumes.
- **Messy** work area and floor, not enough light.
- **Damaged** or **dirty** PPE or PPE that fits badly.
- **Unhealthy** reactions, skin rashes, dizziness, hearing problems.

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Industrial Accident Prevention Association

Toll-free: 1-800-406-IAPA (4272)

Website: [www.iapa.ca](http://www.iapa.ca)