Principles of Machine Guarding
A good rule to remember is:

Any machine part, function, or process which may cause injury must be safeguarded.

Where the operation of a machine or accidental contact with it can injure the operator or others in the vicinity, the hazards must either be eliminated or controlled.

*If it moves, it merits your attention!*
Goals

1. Describe the basic hazards involving machinery including points of operation and power transmission devices.

2. Introduce control measures through effective machine guarding principles and methods.

3. Get the most BANG for the $$$.
The purpose of machine guarding is to protect against and prevent injury from....

Points of operation
Allowable point of operation guard clearances (ANSI B11.x):
The purpose of machine guarding is to protect against and prevent injury from....

Points of operation

Flying Chips or Sparks
The purpose of machine guarding is to protect against and prevent injury from:

- Points of operation
- Flying chips and sparks
- Nip points
The purpose of machine guarding is to protect against and prevent injury from:

Points of operation
Flying chips and sparks
Nip points
Moving parts
Allowable machine guarding clearances for other than points of operation (T8CCR 3944):

**Within two inches:** openings allow access to less than ½ inch diameter.

**Within four inches:** openings allow access to no larger than ½ inch diameter.

**Four to fifteen inches:** excludes objects larger than 2 inches dia. or guard has 1 inch wide slats.

**Fifteen to twenty inches:** Guardrails.
Where Mechanical Hazards Occur

Three basic areas require safeguarding
1. Points of Operation

The point is that location where an operation is performed on stock or material:

- Cutting,
- Shaping,
- Boring,
- Forming,
- etc., or....
Where Mechanical Hazards Occur

1. Points of Operation

...that point or location where stock or material is fed to the machine.
Point of Operation

Hold down fingers (clamps)
Awareness Barrier

Rear View of Power Squaring Shear
Where Mechanical Hazards Occur

2. Power Transmission Devices

The components which transmit energy to the part of the machine performing the work.
Where Mechanical Hazards Occur

2. Power Transmission Devices

Flywheels  Pulleys
Rods  Cams
Couplers  Spindles
Chains  Sprockets
Gears  Shafts
Crank  Belts
STOP
EHS CRITICAL EQUIPMENT
DO NOT TAMPER WITH, CALIBRATE, MAINTAIN OR MODIFY WITHOUT AUTHORIZATION FROM EH&S DEPARTMENT
Where Mechanical Hazards Occur

3. All Other Moving Parts

All hazardous parts which move while the machine is working.

Reciprocating
Rotating
Transverse
Feed mechanisms
Part Two: Safeguarding

There are many ways to safeguard machines!

Determine the appropriate safeguarding method.

Consider:

- the type of operation and material
- the size or shape of stock
- the method of handling
- the physical layout of the work area
- production requirements/limitations
Part Two: Safeguarding

1. Guards
   - Fixed
   - Interlocked
   - Adjustable
   - Self-adjusting
Part Two: Safeguarding

2. Devices

Presence Sensing
Pullback
Restraint
Safety Controls
Gates
3. Location/Distance

4. Feeding/Ejection Methods
   Automatic/Semi-Auto feed
   Automatic/Semi-Auto ejection
   Robotics
Effective Safeguarding

- Must be in conformity with any appropriate standards.
- Must not present a hazard in itself nor create interference.
- Allows safe maintenance and lubrication.
Must not allow product or objects to fall into moving parts or onto people.

Get Buy-in from Operators, PM Tech, Lube and Maintenance Techs.
First Safeguarding Strategy: Guards

Guards are barriers which prevent access to danger areas.
First Safeguarding Strategy: Guards

Fixed Guard Characteristics:

- A permanent part of the machine. Tools are needed for removal.
- Not dependent upon moving parts to perform its intended function.
- Constructed of sheet metal, screen, wire cloth, bars, plastic, or substantial material.
- Usually preferable to all other types because of its simplicity and permanence.
Part Two: Safeguarding

As a general rule, power transmission apparatus is best protected by fixed guards that enclose the danger areas.
Enclosed chain & sprocket
**First Safeguarding Strategy: Guards**

**Interlocked Guard Characteristics:**

When this type of guard is opened/removed:

- The tripping mechanism and/or power automatically shuts off or disengages.
- The machine cannot cycle or be started until the guard is back in place.
First Safeguarding Strategy: Guards

Interlocked Guard Characteristics (continued):

– They may use electrical, mechanical, hydraulic, or pneumatic power or any combination of these.

– Replacing the guard must not automatically restart the machine.

– PM is important because sometimes they fail and sometimes they are sabotaged!
Interlocked guarding can be defeated!

This was taped down.

Good opportunity for RCA.
First Safeguarding Strategy: Guards

Adjustable Guards

- These guards allow flexibility in accommodating various sizes of stock
First Safeguarding Strategy: Guards

Self-Adjusting Guards

The openings of these guards are determined by the movement of the stock.

– As the operator moves the stock into the danger area, the guard is pushed away, providing an opening which is only large enough to admit the stock.

– After the stock is removed, the guard returns to the rest position.
Second Safeguarding Strategy: Devices

A safety device may perform one of several functions.
Second Safeguarding Strategy: Devices

- **Presence-Sensing Devices**
  
  **Photoelectric (optical)**
  
  - Uses a system of light sources and controls which can interrupt the machine's operating cycle.

  **Radiofrequency (capacitance)**
  
  - Uses a radio beam that is part of the machine control circuit.
  
  - When the capacitance field is broken, the machine will stop or will not activate.
Second Safeguarding Strategy: Devices

It may stop the machine if a hand or any part of the body is inadvertently placed in the danger area.
Second Safeguarding Strategy: Devices

• Restraint
  – The restraint (holdout) device utilizes cables or straps that are attached to the operator's hands at a fixed point
  – The cables or straps must be adjusted to let the operator's hands travel within a predetermined safe area - there is no extending or retracting action involved
Second Safeguarding Strategy: Devices
Second Safeguarding Strategy: Devices

- **Pullback**
  - Pullback devices utilize a series of cables attached to the operator's hands, wrists, and/or arms.
  - This type of device is primarily used on machines with stroking action.
  - When the slide/ram is up between cycles, the operator is allowed access to the point of operation.
Identify the Action
Second Safeguarding Strategy: Devices

- **Two Hand Controls**
  - Requires constant, concurrent pressure by the operator to activate the machine
  - With this type of device, the operator’s hands are required to be at a safe location (on the control buttons) and at a safe distance from the danger area
Second Safeguarding Strategy: Devices
Second Safeguarding Strategy: Devices

- **Two Hand Trips**
  - This device requires concurrent application of both the operator’s control buttons to activate the machine cycle, after which the hands are free.
  - Must be far enough away to prevent *intentional* contact.
Second Safeguarding Strategy: Devices

- **Gates**

- Provide a barrier which is synchronized with the operating cycle of the machine in order to prevent entry to the danger area during the hazardous part of the cycle.
First Safeguarding Strategy: Guards

Interlocked guards:

– Vertical balers built to ANSI Z245.2 American National Standard for Refuse Collection, Processing, and Disposal Equipment-Stationary Compactors-Safety Requirements do not comply with Title 8 CCR 4353(h).
Another Safeguarding Strategy

• Guarding by Location/Distance
  – The machine or its dangerous moving parts are positioned so that hazardous areas are not accessible or do not present a hazard during normal operation
    – walls or other barricades (fences)
    – height (above worker)
    – size of stock (single end feeding, punching)
Is this adequate guarding by location?
Another Safeguarding Strategy

- Auto/Semi-auto Feeding and Ejection
  - Automatic and Semi-automatic Feeding
Another Safeguarding Strategy

Feeding and Ejection
  – Automatic Ejection
Another Safeguarding Strategy

Feeding and Ejection

- Semiautomatic Ejection
Another Safeguarding Strategy???

- **Robotics**
  - Machines that load and unload stock, assemble parts, transfer objects, and perform other tasks
  - They perform work otherwise done by the operator
  - Best used in high production processes requiring repeated routines
Miscellaneous Aids

**Does** not give complete protection from machine hazards, but may provide the operator with an extra margin of safety.

**Examples:**
- Awareness barriers
- Shields
- Holding tools
- Push sticks or blocks