MODULE 4

Safety Hazards In Machines

What hazards exist?

- Crushed by or drawn into equipment
- Struck by moving parts
- Struck by failed components or particles

Key parts of machines

1. **Point of operation**: where work is performed on the material, such as cutting, shaping, boring, or forming of stock.
2. **Power Transmission Device:** transmits energy to the part of the machine performing the work
   - Includes flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, cranks, and gears.

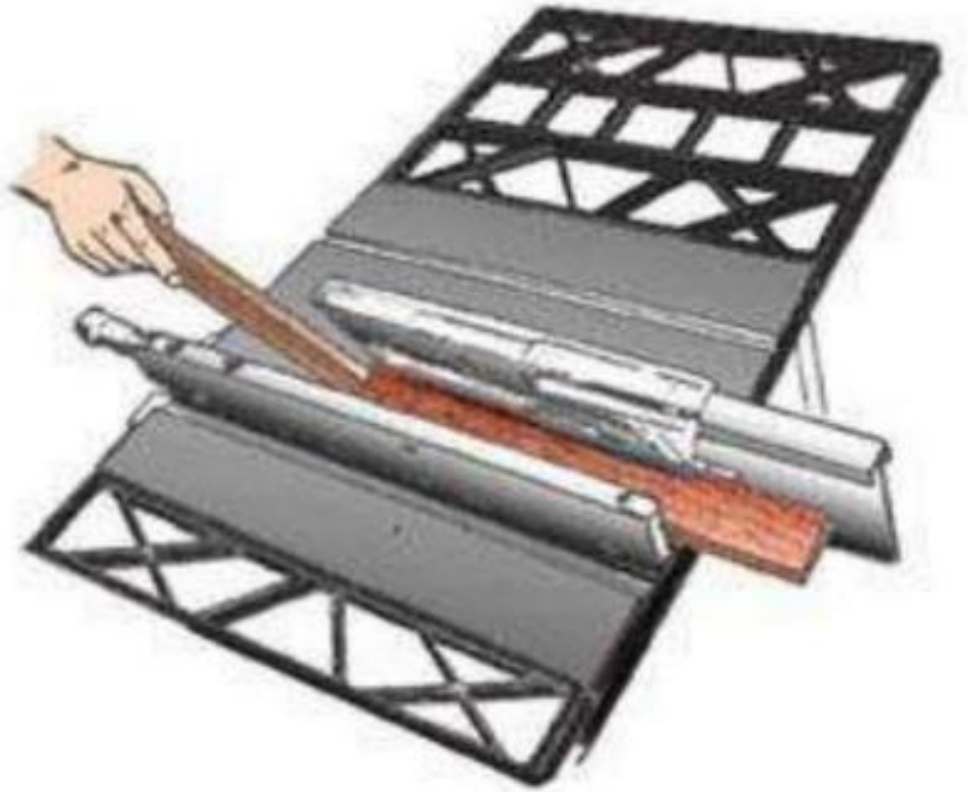
Key parts of machines

3. **Operation Controls**: Control mechanisms

A mechanical or electrical power control shall be provided on each machine to make it possible for the operator to cut off the power from each machine without leaving his position at the point of operation.

4. Other moving parts: can include reciprocating, rotating, and transverse moving parts, feed mechanisms, and auxiliary parts of the machine

- Point of Operation - work such as bending, punching, cutting on the material – P.O.O.
- Nip point - location where machine pieces come together such as belts and a pulley, two in-running rollers, etc.



Hazards to be Guarded

- Things to guard include
  - In-running nip points
  - Rotating equipment
  - Flying chips or sparks
  - Belts or gears
  - Parts that impact or shear

Rotating Parts

- Can grip hair or clothing
- Can force the body into a dangerous position
- Projecting pieces increase risk

In-Running Nip Points

- Between 2 rotating parts
- Between rotating and tangential parts
- Between rotating and fixed parts which shear, crush, or abrade

Reciprocating Parts

- Risk of being struck between stationary and moving part

Transverse motion

- Continuous straight line motion
- Worker struck or caught in pinch or shear point

Cutting action

- Direct injury from cutting action
- Flying chips or sparks
- Saws, drills, lathes, mills

Punching action

- Ram stamps materials
- Danger at point of operation

Shearing action

- Powered blade that shears materials
- Hazard at point of operation

Bending action

- Power applied to a slide to stamp/shape materials
- Hazard at point of operation

Principle of Machine Guarding

- **Prevent contact** between hazardous moving parts and body or clothing
- **Secure guard:** not easily removed
- **Protect from objects** falling into machinery
- **Create no new hazards:** sharp/rough edges
- **Create no interference** with job/comfort/speed
- **Allow safe lubrication:** lubricate the machine without removing guards if possible

Principles of Machine Safety

- Unless a particular hazard is removed, the risk associated with such a hazard can never be completely eliminated.
- The approach most commonly used is referred to as the hierarchy of controls, from preferred to least desirable, as follows:
- **(a) elimination;**
- **(b) substitution;**
- **(c) engineering controls;**
- **(d) administrative (procedural) controls; and**
- **(e) personal protective equipment (PPE).**

Machinery Guards

Guarding

- A guard can perform several functions: it can deny bodily access, contain ejected parts, tools, off-cuts or swath, prevent emissions escaping or form part of a safe working platform.
- Guarding is commonly used with machinery and equipment to prevent access to:
- • rotating end drums of belt conveyors
- • moving augers of auger conveyors
- • rotating shafts
- • moving parts that do not require regular adjustment
- • machine transmissions, such as pulley and belt drives,
- chain drives, exposed drive gears
- • any dangerous moving parts, machines or equipment.

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

2.Devices

Presence Sensing
Pullback
Restraint
Safety Controls
Gates

3.Location/Distance

4. Feeding/Ejection Methods

Automatic/Semi-Auto feed Automatic/Semi-Auto ejection

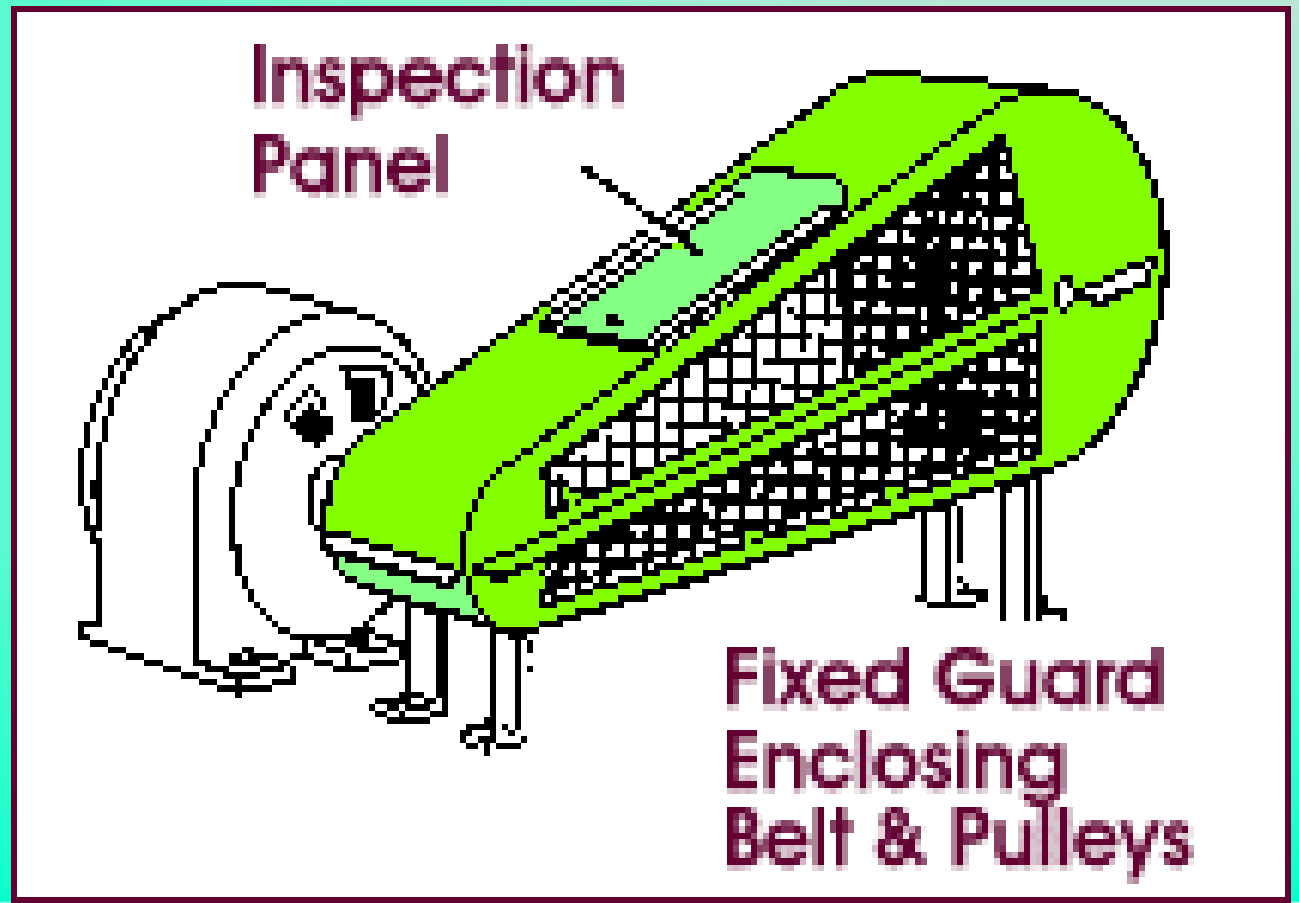
5. **Robotics**

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, Maintenance Technicians etc

First Safeguarding Strategy: Guards

- Guards are barriers which prevent access to dangerous areas of machines.
- Common guard types include door guards, gate guards, fence guards



First Safeguarding Strategy: Guards

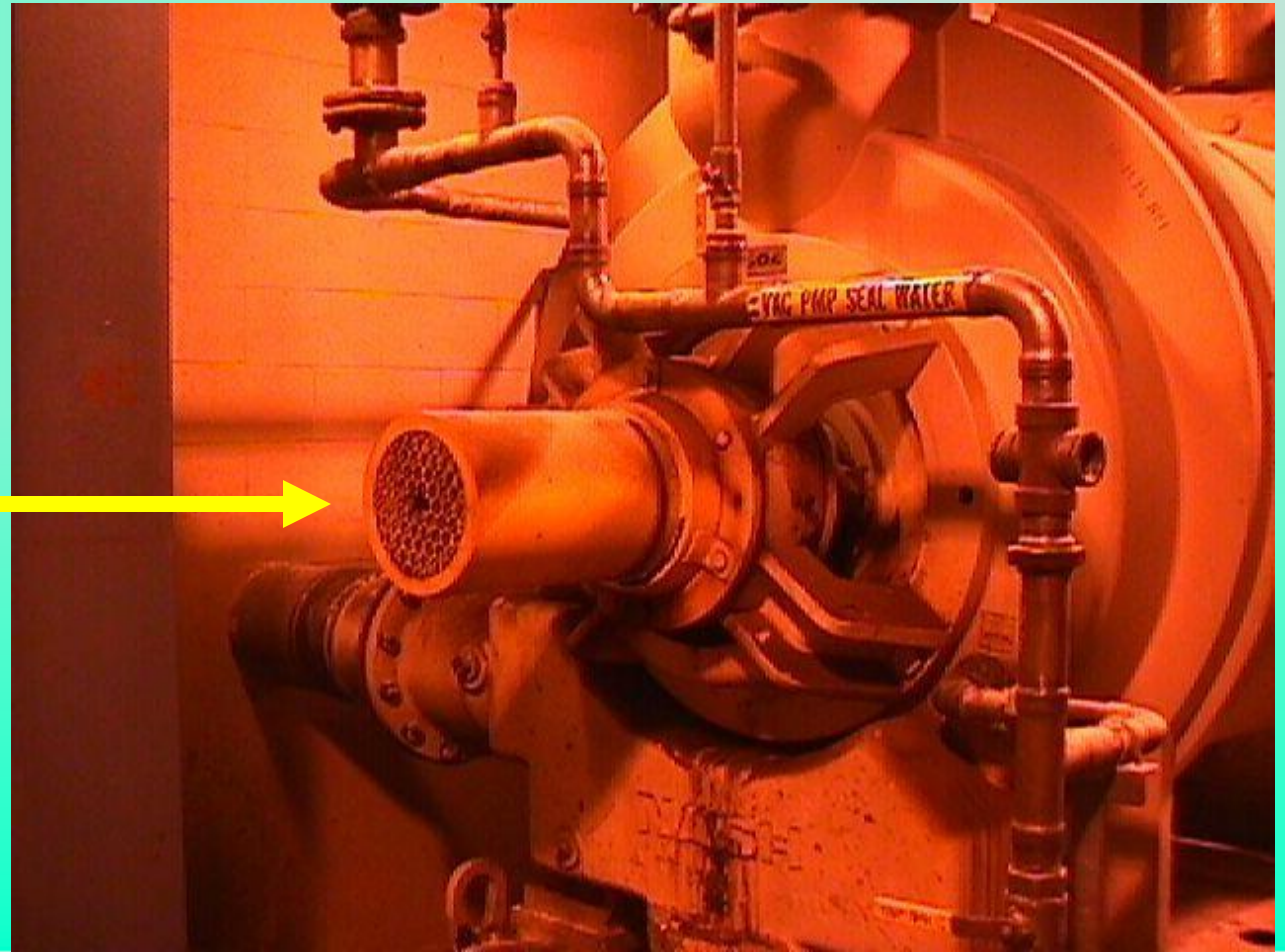
Fixed Guard Characteristics:

- 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 shaft end



Fixed Guard

Safeguarding Action

- Provides a barrier

Advantages

- Can be constructed to suit many specific applications
- In-plant construction is often possible
- Can provide maximum protection
- Usually requires minimum maintenance
- Can be suitable to high production, repetitive operations

Limitations

- May interfere with visibility
- Can be limited to specific operations
- Machine adjustment and repair often require its removal, thereby necessitating other means of protection for maintenance personnel

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 moving parts of the machine are stopped
- 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.
- Permanent Maintenance is important because sometimes they fail and sometimes they are sabotaged!

Interlocked Guard

Safeguarding Action

•Shuts off or disengages power, stops the moving parts and prevents starting of the machine when the guard is open; should require the machine to be stopped before the worker can reach into the danger area

Advantages

•Can provide maximum protection

•Allows access to the machine for removing jams without time consuming removal of the fixed guards

Limitations

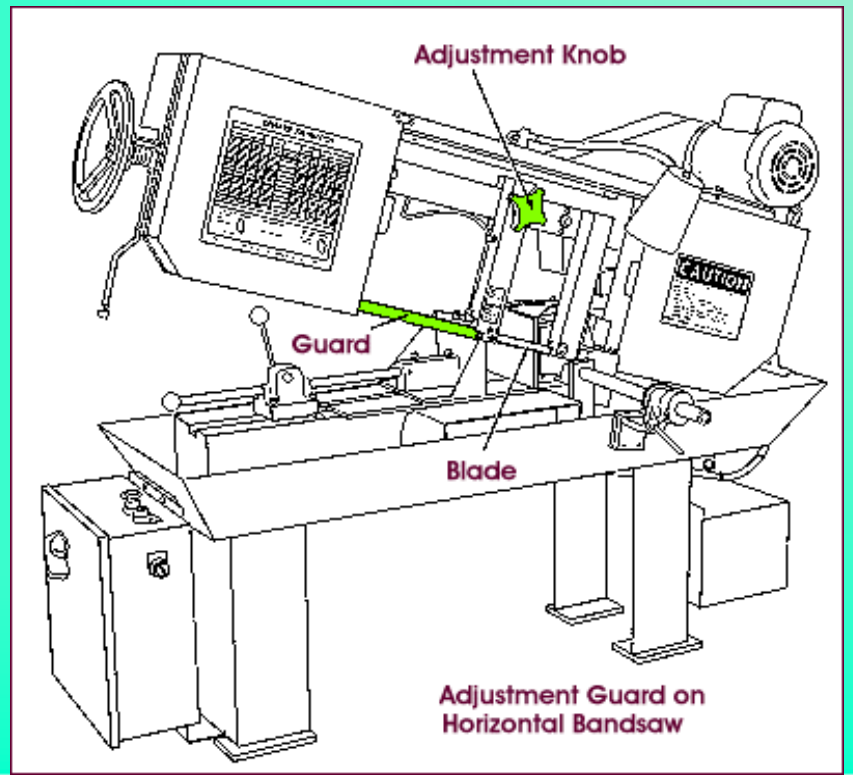
•Requires careful adjustment and maintenance

•May be easy to disengage

First Safeguarding Strategy: Guards

Adjustable Guards

- These guards allow flexibility in accommodating various sizes of stock



Adjustable Guards

Safeguarding Action

- Provides a barrier that may be adjusted to facilitate a variety of production operations

Advantages

- Can be constructed to suit many specific applications
- Can be adjusted to admit varying sizes of stock

Limitations

- Hands may enter danger area - protection may not be complete at all times
- May require frequent maintenance and/or adjustment
- The guard may be made ineffective by the operator
- May interfere with visibility

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.
- This guard protects the operator by placing a barrier between the danger area and the operator.
- The guards may be constructed of plastic, metal, or other substantial material.
- Self-adjusting guards offer different degrees of protection.

Adjustable Guards

Safeguarding Action

•Provides a barrier that moves according to the size of the stock entering the danger area

Advantages

•Off-the-shelf guards are often commercially available

Limitations

•Does not always provide maximum protection
•May interfere with visibility
•May require frequent maintenance and adjustment

Second Safeguarding Strategy: Devices

- A safety device may perform one of several functions.
- It may stop the machine if a hand or any part of the body is inadvertently placed in the danger area; restrain or withdraw the operator's hands from the danger area during operation; require the operator to use both hands on machine controls, this keeping both hands and body out of danger; or 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.

Second Safeguarding Strategy: Devices

- **Presence-Sensing Devices**

  photoelectric (optical)

  – The photoelectric (optical) presence-sensing device uses a system of light sources and controls which can interrupt the machine's operating cycle.

  – If the light field is broken, the machine stops and will not cycle.

  – This device must be used only on machines which can be stopped before the worker can reach the danger area

Second Safeguarding Strategy: Devices

- **Presence-Sensing Devices**

  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.
  - this device shall only be used on machines which can be stopped before the worker can reach the danger area.
  - This requires the machine to have a friction clutch or other reliable means for stopping.

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.

- **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

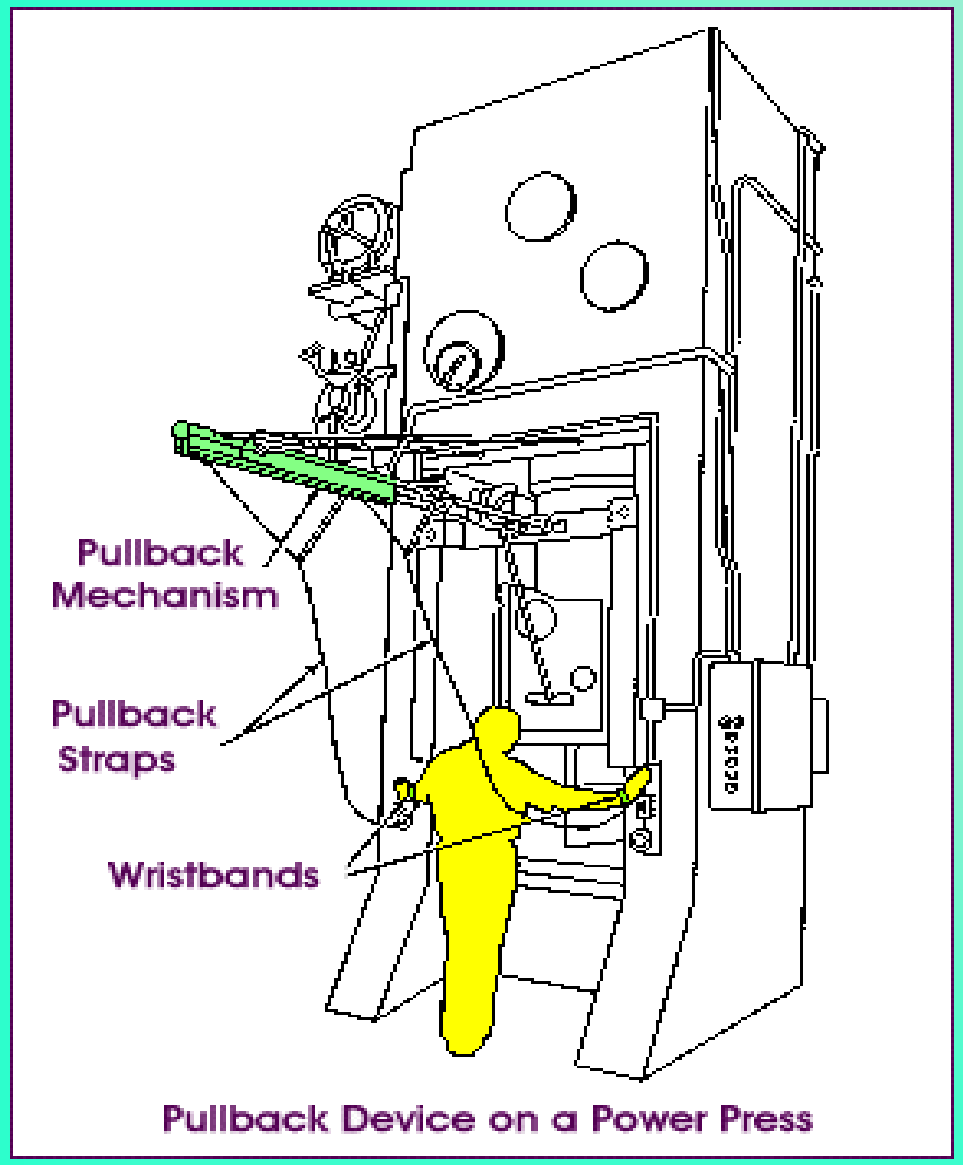
- **Pullback**

– 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

– It allows access to the point of operation when the slide/ram is up

– When the slide/ram begins to cycle by starting its descent, a mechanical linkage automatically assures withdrawal of the hands from the point of operation.

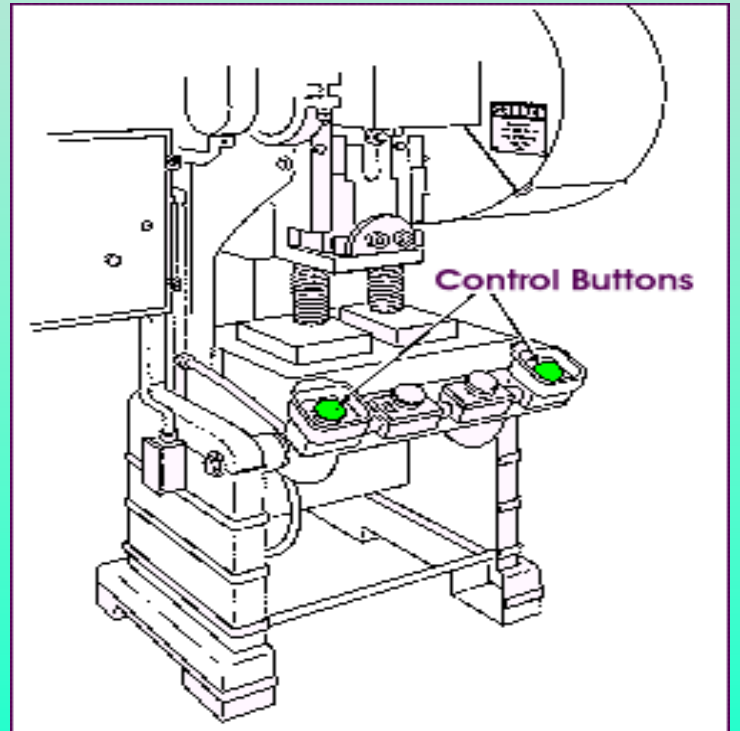


Pullback Device on a Power Press

- A pullback device on a straight-side power press.
- When the slide/ram is in the "up" position, the operator can feed material by hand into the point of operation
- When the press cycle is actuated, the operator's hands and arms are automatically withdrawn

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 while the machine completes its closing cycle.



Two-hand Control Buttons on Part-revolution Clutch Power Press

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

- The gate is a moveable barrier that protects the operator at the point of operation before the machine cycle can be started
- Gates are, in many instances, designed to be operated with each machine cycle.
- To be effective, the gate must be interlocked so that the machine will not begin a cycle unless the gate guard is in place.
- It must be in the closed position before the machine can function.
- If the gate is not permitted to descend to the fully closed position, the press will not function.

Another Safeguarding Strategy

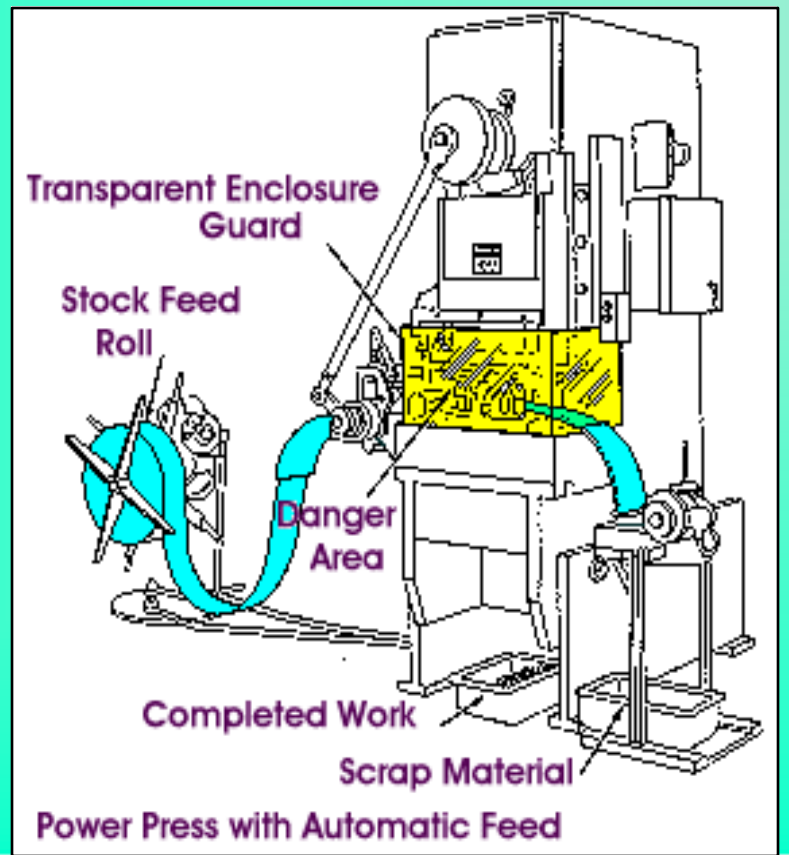
- **Guarding by Location/Distance**
  - The machine or its dangerous moving parts are positioned so that hazardous areas are not accessible or do not present a hazard during normal operation
    - walls or other barricades (fences)
    - height (above worker)
    - size of stock (single end feeding, punching)

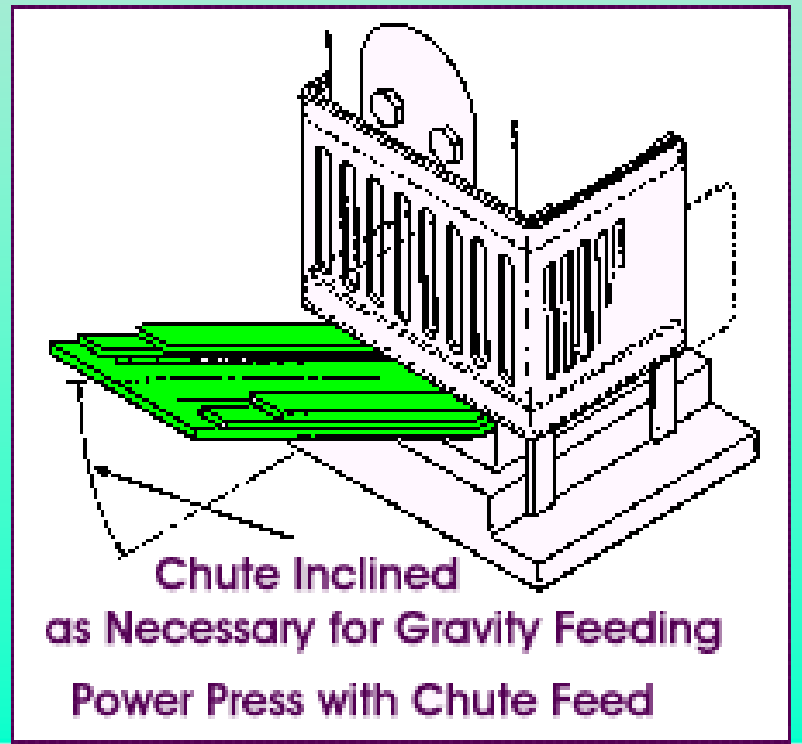
Another Safeguarding Strategy

- **Automatic and/or semi-automatic feed and ejection**
  - Automatic and/or semi-automatic feed and ejection methods do not require the operator to place his or her hands in the danger area.
  - Guards are still required to protect the operator,by eliminating the need for operator involvement in the danger area, employees are less likely to be injured.

Another Safeguarding Strategy

- **Auto/Semi-auto Feeding and Ejection**
  - Automatic and Semi-automatic Feeding

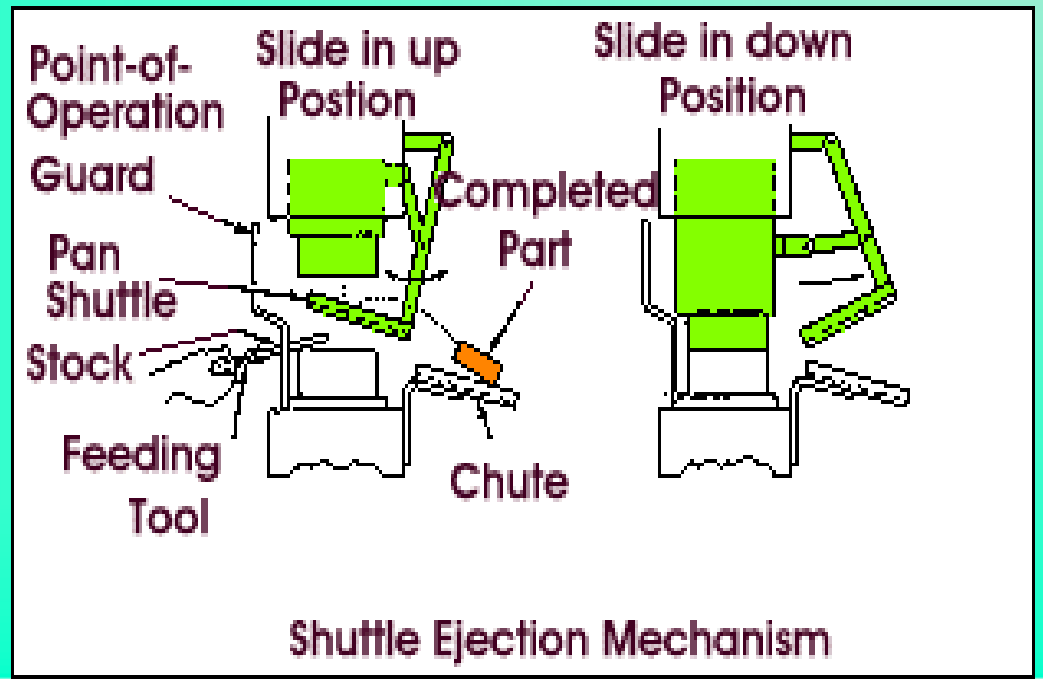




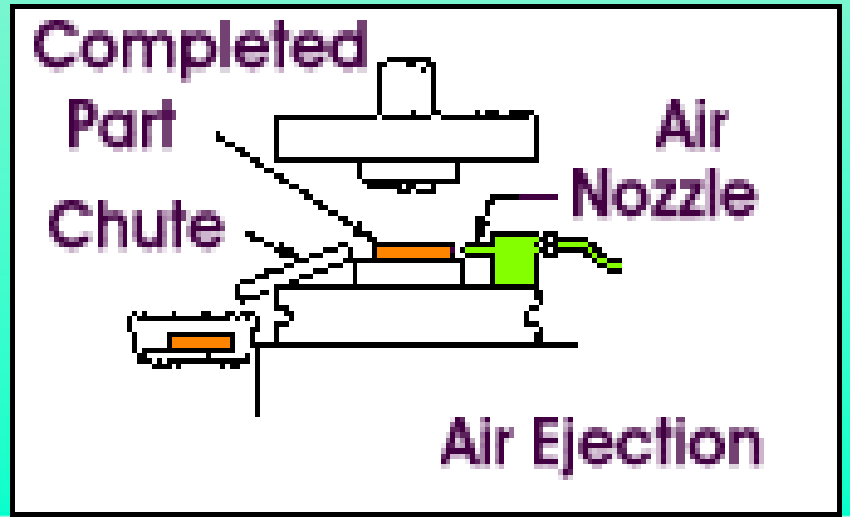
Another Safeguarding Strategy

Feeding and Ejection

- Automatic Ejection



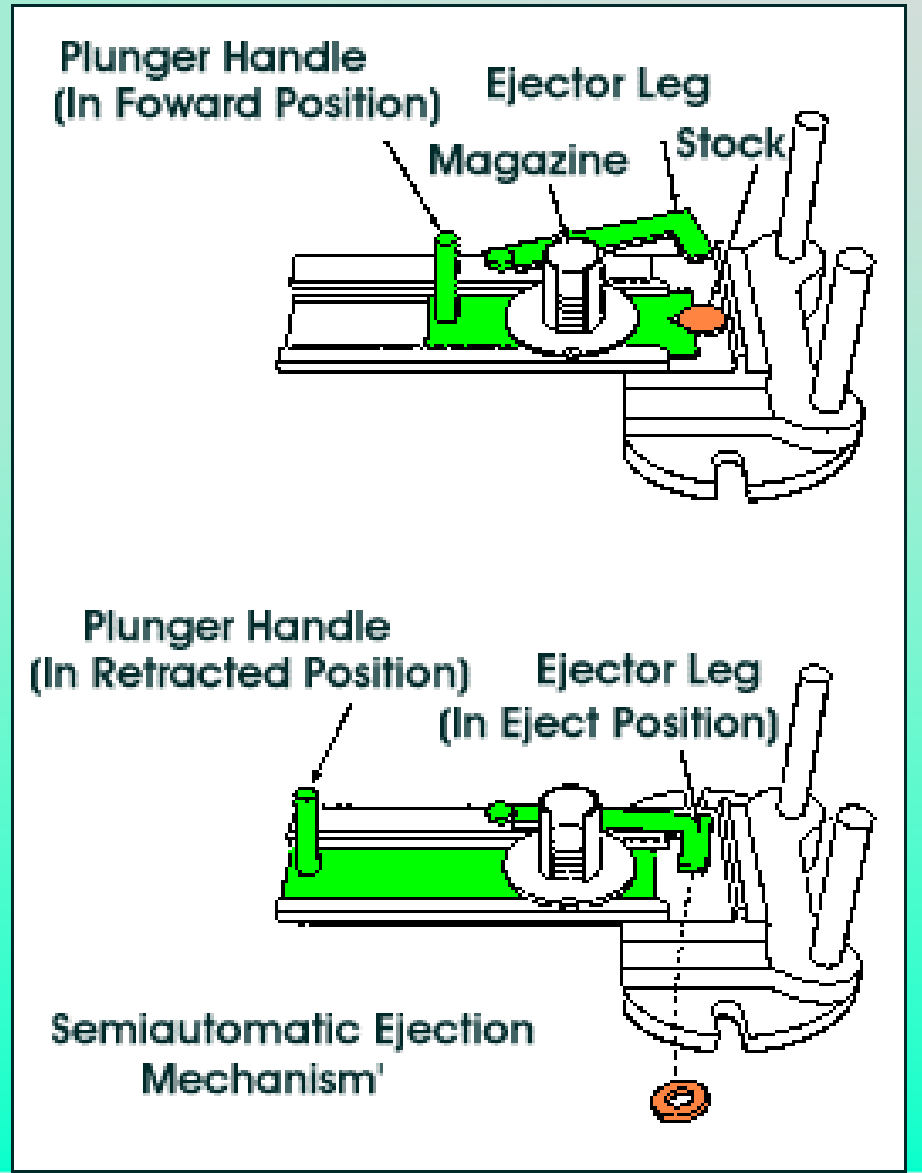
Shuttle Ejection Mechanism



Another Safeguarding Strategy

Feeding and Ejection

- Semiautomatic Ejection



Another Safeguarding Strategy

- **Robotics**

– The use of robots can help reduce hazards to workers

– These are 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.

– Eg:Awareness barriers,Shields,Holding tools,Push sticks or blocks

Mechanical Power Presses

- Mechanical Power Presses are machines that transmit force to cut, form, or assemble metal or other materials through tools or dies attached to or operated by slides.
- 3 types of Mechanical Power Presses
  - Mechanical
  - Hydraulic
  - Pneumatic
- A Mechanical Press is a machine that exerts pressure to form or shape or cut materials or extract liquids or compress solids.
- A Press is a mechanically powered machine that punches, shears, forms or assembles metal or other materials by means of cutting, shaping or combination of dies attached to slides or rams.
- A Press consists of a stationary bed (or anvil), and a slide (or slides) having a controlled reciprocating motion toward and away from the bed surface, the slide being guided in a defined path by the frame of the press.

- Major components of a Mechanical Press are;
  - The Frame
  - Motor
  - Flywheel
  - Crankshaft
  - Clutch
  - Brake

- Main Hazard
  - **AMPUTAIONS**
    - Placing hand into point of operations
    - Unguarded or inadequately guarded presses
    - Deactivating or over-riding safeguards
- Safeguards most commonly used:
  - Barrier guards attached to fixed surfaces
  - Presence-Sensing devices
    - Radio Frequency Sensors
    - Light Curtains
    - Pullback Devices
    - Fixed Guards

Safety in Turning

Safety Precautions

- Lathe hazardous if not operated properly
- Important to keep machine and surrounding area clean and tidy
- Accidents usually caused by carelessness

Safety Precautions

- Always wear approved safety glasses
- Rollup sleeves, remove tie and tuck in loose clothing
- Never wear ring or watch

Safety Precautions

- Do not operate lathe until understand controls
- Never operate machine if safety guards removed
- Stop lathe before measure work or clean, oil or adjust machine
- Do not use rag to clean work or machine when in operation
  - Rag can get caught and drag in hand

Safety Precautions

- Never attempt to stop a lathe chuck or driveplate by hand
- Be sure chuck or faceplate mounted securely before starting
  - If loose, becomes dangerous missile
- Always remove chuck wrench after use
  - Fly out and injure someone
  - Become jammed, damaging wrench or lathe

Safety Precautions

- Move carriage to farthest position of cut and revolve lathe spindle one turn by hand
  - Ensure all parts clear without jamming
  - Prevent accident and damage to lathe
- Keep floor around machine free from grease, oil, metal cuttings, tools and workpieces
  - Oil and grease can cause falls
  - Objects on floor become tripping hazards

Safety Precautions

- Avoid horseplay at all times
- Always remove chips with brush
  - Chips can cause cuts if use hands
  - Chips become embedded if use cloths
- Always remove sharp toolbit from toolholder when polishing, filing, cleaning, or making adjustments

Safety Precautions When Dealing With Boring

- Handling boring mills is a complex job that requires specialist precaution aimed at protecting yourself, your colleagues, and your staff from bodily injuries.
- Use the right tool for the right job
  - ✓One of the primary causes of industrial injuries is broken drilling heads. By having the right tooling edge matched with the right operational spindle speed for the right work piece, the chances of industrial accidents are greatly reduced

- Always have protective clothing
  - ✓There is a need to have the right protective gear on. This minimizes the chances of industrial accidents, since your body is always covered in the right clothing.
  - ✓For a safer operational environment, the clothing used should be tight enough to protect you from having loose hangings that can be easily trapped in the revolving mill parts. Protective optical ware should also be used at all times to protect your eyes from exposure to work piece off-cuts.

- Know your machine
  - ✓Having proper technical knowhow about your machine gives you a competitive edge in increasing your safety.
  - ✓In fact, less experienced boring machine users have been proven to be thrice as likely as their experienced peers to cause machine-related accidents.
  - ✓Therefore, only personnel with the right skills should be granted the green light to work with the boring mills.
- Service your machines regularly
  - ✓Regular repairing and servicing of your boring tools give them a precise way of delivering on your expectations.
  - ✓It also safeguards your company from technical breakdowns resulting from poorly maintained boring tools.

Safety in Milling

DO NOT use this machine unless you have been instructed in its safe use and operation and have been given permission

PERSONAL PROTECTIVE EQUIPMENT

Safety glasses must be worn at all times in work areas.

Long and loose hair must be contained.

Gloves must not be worn when using this machine.

Sturdy footwear must be worn at all times in work areas.

Close fitting/protective clothing must be worn.

Rings and jewellery must not be worn.

PRE-OPERATIONAL SAFETY CHECKS

- ✓ Locate and ensure you are familiar with all machine operations and controls.
- ✓ Ensure all guards are fitted, secure and functional. Do not operate if guards are missing or faulty.
- ✓ Check workspaces and walkways to ensure no slip/trip hazards are present.
- ✓ Ensure cutter is in good condition and securely mounted.
- ✓ Check coolant delivery system to allow for sufficient flow of coolant.

OPERATIONAL SAFETY CHECKS

- ✓ Keep clear of moving machine parts.
- ✓ Follow correct clamping procedures. Keep overhangs as small as possible and check workpiece is secure.
- ✓ Set the correct speed to suit the cutter diameter, the depth of cut and the material.

ENDING OPERATIONS AND CLEANING UP

- ✓ Switch off the machine when work completed.
- ✓ Remove milling cutters and store them safely.
- ✓ Before making adjustments and measurements or cleaning swarf accumulations, switch off and bring the machine to a complete standstill.
- ✓ Leave the machine and work area in a safe, clean and tidy state.

POTENTIAL HAZARDS AND INJURIES

- Sharp cutters.
- Hair/clothing getting caught in moving machine parts.
- Eye injuries.
- Skin irritation.
- Metal splinters and burrs.
- Flying debris.

DON'T

- Do not use faulty equipment. Immediately report suspect machinery.
- Never leave the machine running unattended.
- Do not leave equipment on top of the machine.

Safety in Grinding Machines

- **GRINDING MACHINES**

Grinding is a material removal and surface generating process used to shape and finish components made of metals.

SAFETY PRECAUTIONS

- Grinding machines are used daily in a machine shop. To avoid injuries follow the safety precautions listed below.

- Wear goggles for all grinding machine operations.
- Check grinding wheels for cracks before mounting.
- Never operate grinding wheels at speeds in excess of the recommended speed.

- Never adjust the workpiece or work devices when the machine is operating.
- Do not exceed recommended depth of cut for the grinding wheel or machine.
- Remove workpiece from grinding wheel before turning machine off.
- Use proper wheel guards on all grinding machines.
- On Grinders, adjust tool rest 1/16 to 1/8 inch from the wheel.

Personal Protective Equipment

Safety glasses must be worn at all times in work areas.

Sturdy footwear must be worn at all times in work areas.

Rings and jewellery must not be worn.

Long and loose hair must be contained.

Close fitting/protective clothing must be worn.

Hearing protection must be used when using this machine.

HOUSEKEEPING

- Switch off the grinder.
- Leave the machine in a safe, clean and tidy state.

POTENTIAL HAZARDS

- Hot Metal Sparks.
- Noise.
- Sharp edges and burrs.
- Entanglement.
- Wheels ‘run on’ after switching off.
- Eye injuries.

Safety in Gas Welding

- Most farms and small shops have some type of equipment for welding and cutting metals.
- Acetylene is the most commonly used fuel gas.
- Acetylene is very flammable and hazardous, and can ignite at a wide range of concentrations.
- Oxygen won't burn or explode, but it helps other objects burn at greater rates.
- Gases are stored in cylinders which can rupture.
- A cylinder containing compressed gas can shoot through the air like a rocket if its valve is damaged or broken.

Storage and Handling

- Keep cylinders away from physical damage, heat, and tampering.
- Securely chain equipment to prevent falling.
- Store away from flammable and combustible materials.
- Store extra gas and oxygen cylinders separately.
- Store in an upright position.
- Close cylinder valves before moving.
- Protective caps or regulators should be kept in place.
- Roll cylinders on bottom edges to move—***Do not drag.***
- Allow very little movement when transporting.

General Gas Welding Safety Tips

- Inspect equipment for leaks at all connections using approved leak-test solution.
- Inspect hoses for leaks and worn places.
- Replace bad hoses.
- Protect hoses and cylinders from sparks, flames, and hot metal.
- Use a flint lighter to ignite the flame.
- Stand to the side (away from the regulators) when opening cylinder valves.
- Open cylinder valves very slowly to keep sudden high pressures from exploding the regulators.
- Only open the acetylene cylinder valve ¼-¾ turn; leave wrench in place so the cylinder can be quickly closed in an emergency.
- Open and light acetylene first, then open and adjust oxygen to a neutral flame.
- Follow the manufacturer's recommendations for shutting off the torch. If the guidelines are not readily available, the commonly accepted practice is to close the oxygen valve first.
- When finished, close cylinder valves, bleed the lines to take pressure off regulators, neatly coil hoses, and replace equipment.
- Have a fire extinguisher easily accessible at the welding site.

Personal Protective Equipment

•Infrared radiation is a cause of retinal burning and cataracts. Protect your eyes with safety glasses.

•Protect your body from welding spatter and optical radiation hazards with protective clothing. Such as:

- Woolen or heavy cotton clothing
- Flame-proof apron
- Welding gloves
- Properly fitted clothing that is not frayed or worn
- Shirts should have long sleeves
- Pants should be straight legged and covering shoes
- Fire-resistant welder's cap or shoulder covers are needed for overhead work

•Check protective clothing equipment before each use to make sure it is in good condition.

•Keep clothes free of grease and oil.

Proper Ventilation

- Be sure there is adequate ventilation available when welding in confined areas or where there are barriers to air movement.
- Natural drafts, fans, and positioning of the head can help keep fumes away from the welder's face.

VENTILATION IS SUFFICIENT IF:**

- The room or welding area contains at least 10,000 cubic feet for each welder.
- The ceiling height is not less than 16 feet.
- Cross ventilation is not blocked by partitions, equipment, or other structural barriers.
- Welding is not done in a confined space.

**If these space requirements are not met then the area needs to be equipped with mechanical ventilating equipment that exhausts at least 2000 cfm of air for each welder, except where local exhaust hoods or booths, or air-line respirators are used.

What is Arc Welding?

- Arc welding is most commonly used to join two pieces of metal
  - *The welder creates an electric arc that melts the base metals and filler metal (consumable) together so that they all fuse into one solid piece of metal*

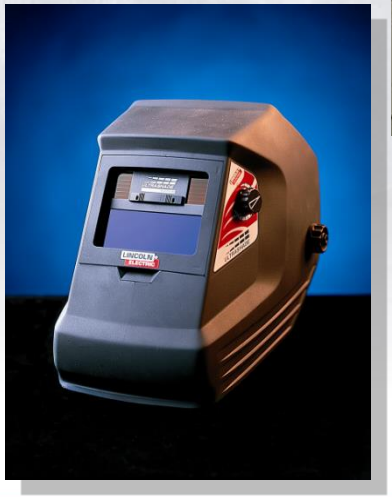
Steel Pipe – Tack Welded

Root Pass or "Stringer Bead"

Final weld after several beads are made

Arc Welding Safety

- Protect yourself and others from potential hazards including:
  - *Fumes and Gases*
  - *Electric Shock*
  - *Arc Rays*
  - *Fire and Explosion Hazards*
  - *Noise*
  - *Hot objects*



Fumes and Gases

- Fumes and gases can be hazardous to your health
- Keep your head out of the fumes
- Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from your breathing zone and the general area
- See product labeling and MSDS for ventilation and respirator requirements

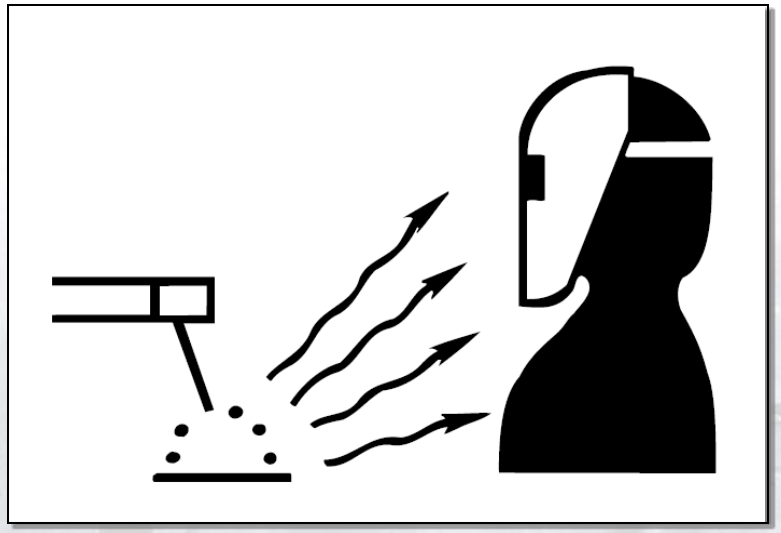
Electric Shock

- Electric shock can kill
- Do not touch live electrical parts
  - *Primary Voltage –230, 460 volt input power*
  - *Secondary Voltage – 6 to 100 volts for welding*
- Insulate yourself from work and ground
- Follow all warnings on welding equipment

Do not make repairs yourself, alert your instructor immediately!

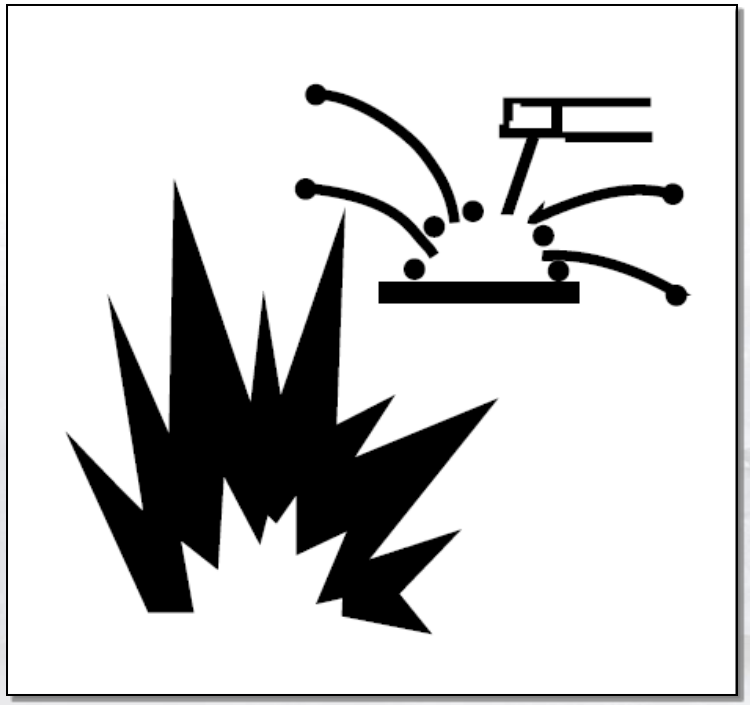
Arc Rays

- *Arc rays can injure eyes and burn skin*
- *The welding arc is brighter than the sun*
- *Precaution must be taken to protect your eyes and skin from UV radiation*
- *Wear correct eye and body protection*



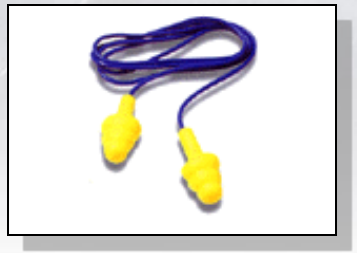
Fire and Explosion Hazards

- Welding sparks can cause fires and explosions
- Sparks and spatter from the welding arc can spray up to 35 feet from your work
- Flammable materials should be removed from the welding area or shielded from sparks and spatter
- Have a fire extinguisher ready
- Inspect area for fires 30 minutes after welding



Noise

- Loud noises can damage your hearing
- Keep loud noises at a safe level by using proper hearing protection such as:
  - *Ear plugs*
  - *Ear muffs*

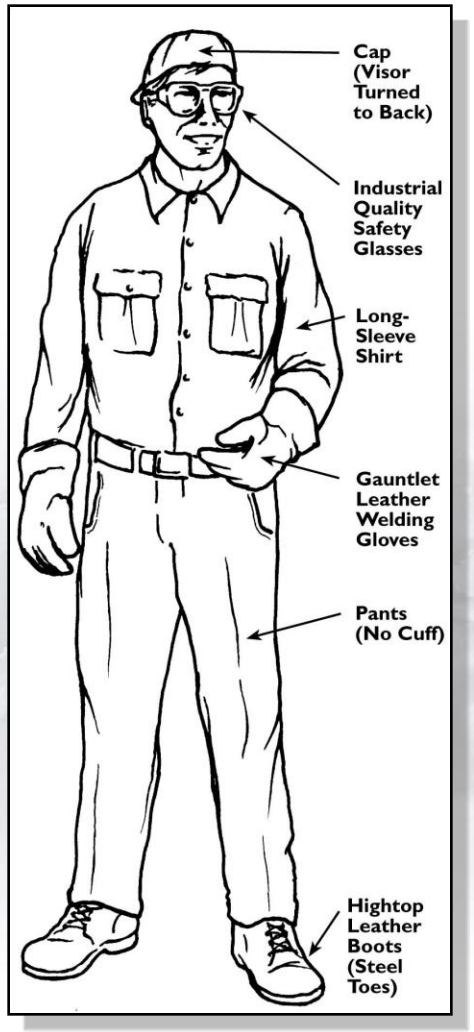


Protective Clothing

Welders must wear protective clothing for

- *Protection from sparks, spatter and UV radiation*
- *Insulation from electric shock*

- Protective clothing includes …
  - *Fire-proof clothing without rolled sleeves, cuffs or frays*
  - *Work boots*
  - *Welding gloves, jackets, bibs, and fire-proof pants*
  - *Welding cap, helmet and safety glasses*
  - *Ear protection – ear plugs and muffs*



MATERIAL HANDLING

-is the art and science involving the moving, packaging and storing of substance in any form.

Importance of Material Handling

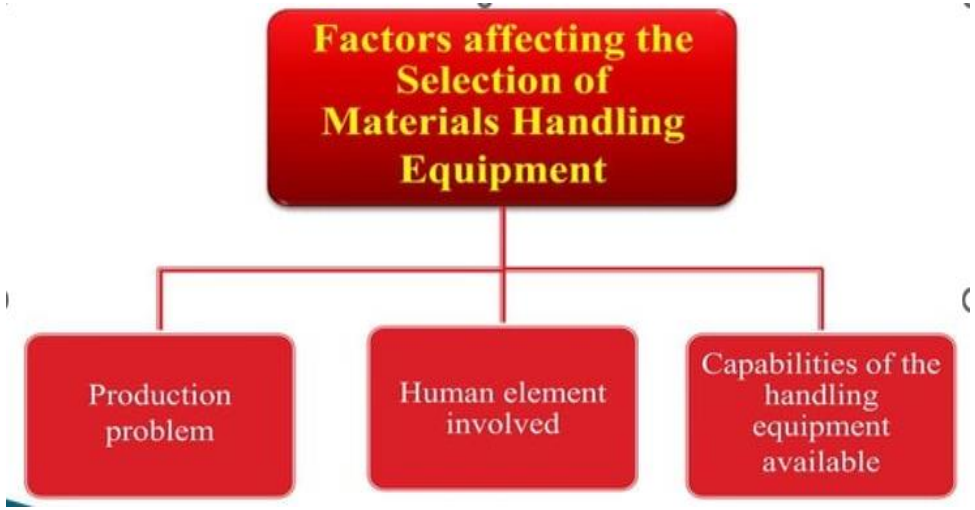
- Function of production control
- Concerned with scheduling of production control
- Material Handling adds value to product cost
- Material Handling increases effectiveness of in plant layout by reducing the cost

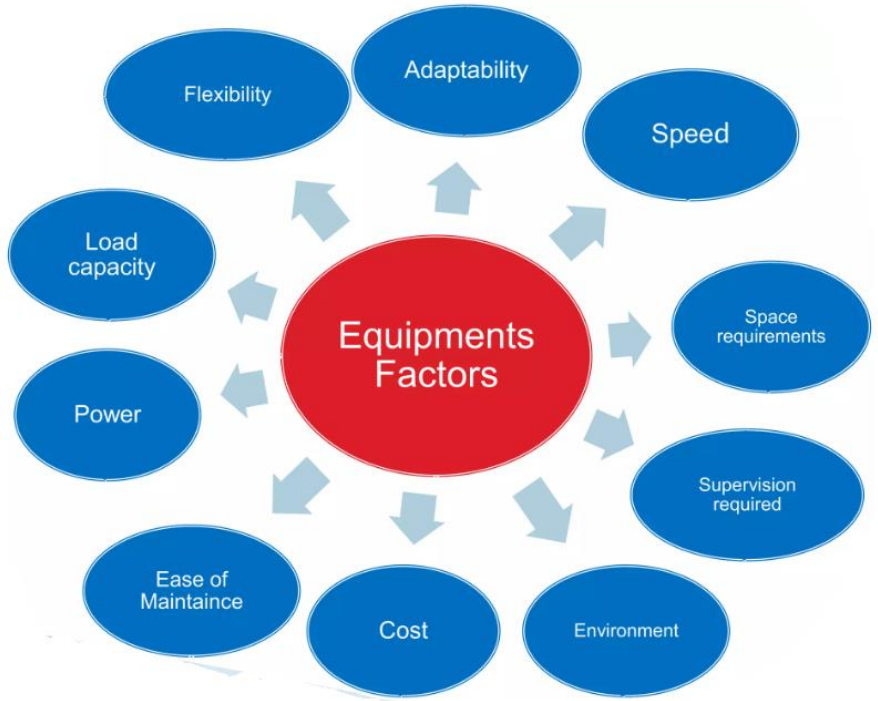
Objectives of Materials Handling

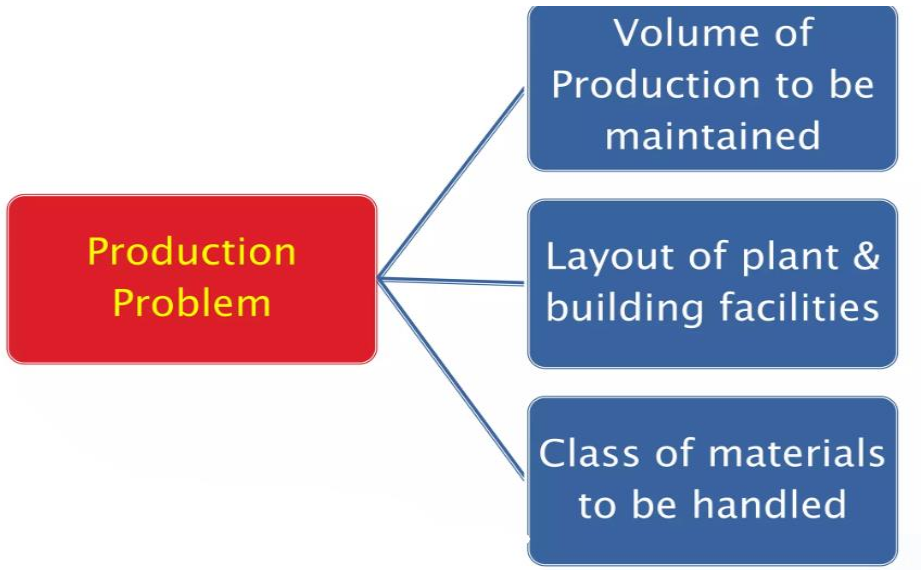
- To Lower unit materials handling cost
- To reduce manufacturing cycle time
- To provide better control of the flow of materials
- To provide better working conditions
- To provide Contribution for better quality by avoiding damages to products
- To Increase storage capacity
- To provide higher productivity at lower manufacturing costs

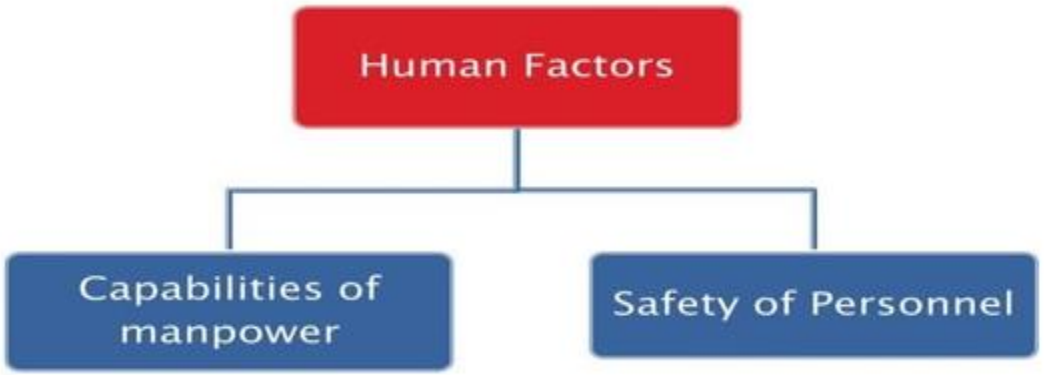
Material Handling Principles

- Material should be moved as little as possible
- Reduction in time by using shortest routers and mechanical material handling equipment
- The material movement should be in lots rather than in individual units
- Design of material handling equipment should be such that it can increase the effectiveness
- Gravity should be used
- Rehandling and back tracking of materials should be avoided
- Periodically Repairing ,Maintaince & Checkup of existing material handling equipments


Factors affecting the Selection of Materials Handling Equipment
Production problem
Human element involved
Capabilities of the handling equipment available


Equipments Factors
Flexibility
Adaptability
Speed
Load capacity
Space requirements
Power
Supervision required
Ease of Maintaince
Cost
Environment


Production Problem
Volume of Production to be maintained
Layout of plant & building facilities
Class of materials to be handled


Human Factors
Capabilities of manpower
Safety of Personnel

Types of Material Handling Systems

1. Equipments oriented systems :-
   a) Convey or Systems
   b) Tractor transfer system
   c) Fork lift truck
   d) Industrial truck system
   e) Underground system
2. Material Oriented Systems
   a) Unit handling system
   b) Bulk handling system
   c) Liquid handling system
3. Methods oriented system
   a) Manual systems
   b) Automated systems
   c) Job shop handling system
   d) Mass production system
4. Function oriented system
   a) Transportation systems
   b) Conveying systems
   c) Transferring systems
   d) Elevating systems

Types of Materials Handling Equipment

1. Conveyers
2. Cranes, Elevators and Hoists
3. Industrial Trucks
4. Auxiliary Equipments

1. Conveyors-

- Gravity or powered devices
- Used for moving loads from one point to point over fixed paths.

Belt Conveyor-Motor driven belt usually made of metal fabric

Chain Conveyor-Motor driven chain that drags material along a metal side base.

Roller Conveyor- Boxes , large parts or units loads roll on top of a series of rollers mounted on a rigid frame.

Pneumatic Conveyor-

High volume of air flows through a tube carrying materials along with air flow.

2. Cranes, Elevators and Hoists

These are overhead devices used for moving varying loads intermittently between points within an area.

Cranes –Devices mounted on overheard rail or ground wheels or rails .They lift, swing and transport large and heavy materials

Elevators –Types of cranes that lift materials –usually between floors or buildings

Hoists- Move vertically or horizontally. May be air hoist , electric hoist, chain hoist

3. Industrial Trucks- May be electric, deisal, gasoline or gas powered

Eg: Fork Lift Truck, pallet truck

Auxiliary Equipments-Devices or attachments used with handling equipments to make their use more effective and versatile

Eg: Skid boxes, Expendable Pallet

Manual Handling

- Manual handling means using physical strength to move materials .
- This method increases the possibilities of injuries and adds to the cost of product.
- To reduce the number of material handling injuries and increase the efficiency, material handling to be minimized by combining and eliminating operations or mechanization.
- Even after all elimination and mechanization there will be still objects to be lifted manually for which the following factors are to be taken into consideration for safe acts in materials handling.

Potential Manual Material Handling Hazards

- Workers frequently cite the weight and bulkiness of objects that they lift as major contributing factors to their injuries.
- Bending, followed by twisting and turning, were the more commonly cited movements that caused back injuries.
- Other hazards include falling objects, improperly stacked materials and various types of equipment.
- The employer should make their employees aware of potential injuries that can occur when manually moving materials including the following:-
  - Strains and sprains from lifting loads improperly or from carrying loads that are either too large or too heavy;
  - Fractures and bruises caused by being struck by materials or by being caught in pinch points, and
  - Cuts and bruises caused by falling materials that have been improperly stored or by incorrectly cutting ties or other securing devices

Training and constant supervision will reduce the unsafe acts :

1. Inspect materials for sleeves, jagged edges burns, rough or slippery surfaces.
2. Get a firm grip on the object.
3. Keep fingers away from material resting points, especially when setting down on the rollers.
4. When handling timber, pipe or other long objects keep hands away from the ends to prevent them from being pinched.
5. Wipe of greasy, wet, slippery or dirty objects before trying to handle them.
6. Most strains and back injuries occur while lifting and setting down objects by hands.

PROPER METHOD OF MANUAL HANDLING :

a. Consider the size, weight and shape of the object to be carried. Do not lift more than the object that can be handled comfortably. If necessary get help from others.

b. Set feet solidly. One foot can be slightly ahead of the other for increased effectiveness. Feet should be enough apart to give good balance and stability(approximately the width of the shoulder).

c. Get close to the load as possible. Bend legs about 90 degrees at the knees. Crouch do not squat. It takes about twice as much effort to get up from squat.

d. Keep the back as straight as possible. Bend at the hips, not the middle of the back.

e. Grip the object firmly. Maintain the grip while lifting or carrying. Before changing or adjusting the grip set the object down again.

f. Straighten the legs to lift the object, and at the same time bring the back to a vertical position. Look upward when beginning to lift.

g. Never carry a load you cannot see over or around. Make sure the path of travel is clear. Carry the object close to the body.

h. Never turn at the waist, to change the direction or to put an object down. Turn the whole body and crouch down to lower the object. To keep hands from being pinched against down first, so that the fingers can be removed from under the sides.

Team Lifting and Carrying

a. When two or more men must carry a single object, they should adjust the load so that it rides in level and so that each person carries an equal part of the load. Trial lifts can be made before proceeding.
b. When two men carry long sections of pipe or any lengthy material, they should not carry on the same shoulder and walk in unison. Shoulder pads will prevent cutting of shoulders and help to reduce fatigue.
c. When a gang of men carries a heavy object like a rail, the foreman or the leader should direct the work and special tools such as tongs should be used.
d. Normally the gang leader has different signals, like blowing whistle or hand clapping for different operations of which the men are familiar.
e. New employees and men who move slowly need special attention.

Handling materials of Specific Shapes

Sheetmetal:

Sharp edges of sheet metal is to considered and leather hand gloves and safety boot to be used

BarrelandDrum:

Barrel lifting handle or manila rope to roll up or down on a ramp to be used.

Glasspanes:

Hand gloves and long leather sleeves, apron, leg guard and safety boot to be worn.

Longobjects:

Long pieces of pipes, bars, timber should be carried over the shoulders with the front end raised to prevent striking other employees. Shoulder pads to protect abrasion on the shoulder to be used.

Scrapmetals:

The irregularly shaped jagged, mingled objects and strips or pieces may fly when piece is removed from a pile. Workmen should wear goggles, leather gloves, safety boot, leg guard and apron.

Gascylinders:

Compressed gas cylinders should be handled carefully. Do not drag the cylinders on floors.

Boxes,cartons&sacks:

The best way to handle boxes and cartons is to grasp the alternate top and bottom corners.

While handling materials manually the safety equipments should be appropriate to the type of material. Where toxic or irritating solids are handled, workmen should take daily showers to remove the materials from the persons.

Mechanical Material Handling Safety

- Heavy materials which are not safe to handle manually must be handled by mechanical means and this includes lifting, transporting, stacking, loading and unloading by means of palletizer, chain pulley block, forklifts, conveyors or cranes and hoists.
- ***Mechanical material handling*** avoids a high risk of musculoskeletal disorders resulting from manual material handling.
- ***Mechanical material handling*** helps increase levels of productivity in the workplace. There is no doubt that machines can do many tasks more quickly and efficiently in less time which human cannot do.

Hazards in Mechanical Material Handling

1. Use of equipment and machinery without valid OSHA inspection certificates.
2. Inadequate and wrong selection of handling tools and machines.
3. Mechanical damage and faulty equipment.
4. Congested space for operation.
5. Incompetent operator.
6. Overloading of machines, tools and equipment.
7. Loading and transporting unbalanced materials.
8. Poor rigging and lifting.
9. Over speeding and unauthorized operation
10. Use of machines without machine guard.

Risk in Mechanical material handling

1. Poorly maintained tools, equipment and machines are prone to accidents due to failure of electrical, mechanical, and hydraulic systems that can cause serious injury to personnel and property damage.
2. Risk of load failure due to inadequate and incorrect selection of handling tools and machinery.
3. There is a risk of collision with property or personnel due to congested operating space.
4. An untrained and unauthorized machine operator can cause serious accidents and injure other personnel.
5. Risk of material failure during handling due to overloading of machines, tools and equipment.
6. Equipment can fall due to improper loading and transportation, poor rigging and lifting, and over speeding by unauthorized operation.
7. The use of machines without guards presents a high risk of serious injury.

Dos

1. Use lifting tools and hoists of adequate capacity.
2. Only authorized persons should use the equipment and machines.
3. The identification number and the safe working load must be marked on all tools and hoists.
4. Check the functioning of emergency switch, limit switches and over load alarm before actually starting the operation of lifting machines.
5. Estimate the weight, distance, and hazards before lifting the load.
6. Store lifting tools and hoists in a designated location.
7. Use appropriate personal protective equipment
8. Keep the speed slow while approaching at destinated location.

9. Stay alert and maintain eye contact on load and nearby man movement.

10. Special care should be taken when using the forklift and other portable hydraulic equipment.

11. When lifting the load with slings, make sure that all sharp corners are padded with soft material.

12. Barricade the area where the lifting operation is performed.

13. Use appropriate plate clamps to lift metal plates.

14. Use beam clamps for lifting beams.

15. Use an appropriate guide rope while lifting and shifting the material.

16. Apply an appropriate protective coating to keep tools in good condition.

Don’ts

1. Don’t use faulty tools and tackles.
2. Don’t stand under a suspended load.
3. Don’t lift the metal plates by using web slings only.
4. Don’t use the equipment for any other purpose than intended.
5. Don’t allow personnel to move underneath lifted load.
6. Don’t load the machines and equipment above its safe working load.
7. Don’t use makeshift arrangement for lifting the material.
8. Don’t use equipment, tools, hoist and tackles with a missing label or tag.
9. Don’t drag chains, ropes or cables on the floor.
10. Don’t use chemical contaminated web slings, wire sling or belt without re-inspection.
11. Don’t use a hoist, slings, chains and other lifting tools and tackles that have lost more than 10% of its breaking strength.

Manual Handling Risk Assessment

- A manual handling risk assessment is used to identify hazards that may cause musculoskeletal injuries to workers when they perform manual handling.
- Similar to a regular risk assessment, a manual handling risk assessment is carried out to identify and evaluate risk factors.
- Specifically activities of lifting, putting down, carrying, moving, and handling objects during work operations.
- It is primarily carried out by health and safety officers.
- Once a manual handling risk assessment is completed, health and safety workers work to develop processes and preventive measures.
- Assessing manual handling risks is crucial to protect workers from musculoskeletal disorders (MSDs), increase job satisfaction, and improve quality of work.

How do you carry out a manual handling risk assessment?

- **Determine the task**
  - Ask the workers how the task is done. Establish the scope of the manual handling activity and its important stages. This helps pinpoint the exact moment an injury may happen.
- **Retrieve essential information**
  - This includes technical information such as load factors of TILE. Load factors to consider are the weight, size, and shape. Another essential information is knowing what postures will the worker be in, size of the space, number of manual handling tasks, and the employee's technical knowledge.
- **Determine the risk factors**
  - Find out the hazards and risk factors. Every factor needs evidence on why it's a potential risk for the manual handling activity.
- **Identify potential improvements**
  - Consult with the personnel using the objective results of the manual handling risk assessment. These improvements should reduce or prevent injury due to manual handling activity. HSA suggests developing a safe system of work plan and to use equipment when possible.
- **Review the changes**
  - A staff member should do regular inspections to check the effectiveness of the implemented improvements. Risk assessments are a continuous process that should be updated regularly and revised when necessary.

4 Key Areas of Manual Handling

- When performing manual handling risk assessments, the assessor mainly focuses on the 4 key areas of manual handling which is often referred to as the acronym TILE (Task, Individual, Load, and Environment)
- In some safety circles, “other factors” have been identified as another key area for evaluating manual handling risks, turning the assessment method into TILEO (Task, Individual, Load, Environment, and Other factors).

- **Task:** Manual handling tasks that are too strenuous, involves long distances, and availability of rest and recovery.
- **Individual:** This involves the worker's capabilities such as no training, lack of experience, unfamiliar with the job, physical capabilities, and prior history of injuries.
- **Load:** This risk can be caused by objects that are too heavy, too large, difficult to grasp or reach, obscures the worker's view, and unbalanced, unstable or if its contents can move.
- **Environment:** Hazards because of insufficient work space, uneven or slippery floors, unstable platforms, heat stress, and poor lighting.
- **Other factors:** monotonous tasks at a high pace and prolonged work without resting, among others.

Use Proper Lifting Techniques

- Avoid lifting heavy items above chest height.
- Use the “big toe” test to test the weight of the object. If you can push the item with your toe, it is safe to move it alone. If not, ask for help.
- When picking up a heavy item from the ground, stand close to the load with your feet shoulder-width apart.
- Squat down, bending at your knees, keeping your back as straight as possible.
- Make sure you have a firm grasp on the object before lifting. Use handles, if available.
- If you are lifting with a partner, coordinate lifting time.
- Once the object is lifted off of the ground, carry it as close to your body as possible to prevent the object from losing its center of gravity and falling to the ground.

Solutions for Pulling

- Keep your feet hip-width apart.
- When bending forward to pull, drop your hips and bend your knees. Concentrate on keeping your core muscles tight to decrease pressure on your back.
- Always face the object you are pulling. Take small, backward steps once you start to move.

Push Before Pulling

- It is safer to push rather than pull.
- Keep your back straight and bend your knees.
- Do not twist at your hips to push, but rather keep your core tight and use your legs and body weight to move the object.
- Face the load squarely rather than at the top or bottom of the object.

How to Maintain hooks

1. Before use, hooks must be inspected by an experienced rigger.
   2.Remove a hook from service if any of the following are in evidence:
   a. Cracks, nicks or gouges
   b. Twist exceeding 10 degrees from plane of unbent hook
   c. Damage or malfunction to the latch
   d. Throat opening exceeding 15 percent
   e. Wear exceeding 10 percent of original dimension
   f. Damage from heat
   g. Unauthorized repairs
3. Cracks, nicks and gouges should be removed by a qualified person. Grind lengthwise, following the contour of the hook.
4. If removing the damaged area results in a loss of more than 10 percent of the original dimension, the hook must be replaced.
5. Never repair, alter or reshape a hook by welding, heating, burning or bending, unless approved by the hook manufacturer.
6. When lifting, ensure the hook, not the latch, supports the load. The sling or lifting device must always be seated properly in the bowl of the hook.
7. Never side load, back load or point load a hook. All reduce hook strength and create an unsafe condition. Point loading can reduce hook capacity as much as 60 percent.

CLAMP Maintenance

- Routine maintenance keeps clamps in top condition so they can live their best and longest lives.
- **New Clamp Use**:
  - ✓ No matter what type of woodworking clamps you're using, the maintenance process begins the moment you unwrap. If your clamp has a bar, it's important to properly prepare it before use.
  - ✓ Use a clean cloth that's been lightly dipped into mineral spirits and wipe the bar down. Do this until all adhesive is gone and the bar is dry, with no resin coming off of it. To keep glue from sticking during future glue-ups, apply a coat of paste wax to the bar and buff clean.
  - **During clamp use**

✓ Keeping your clamps clean will extend their life span and ensure your workspace (and final product) stays free of marks or residue.

✓ The easiest way to prevent glue from adhering to your clamps is to use a protective layer – like painter's tape, packing tape, or parchment paper – between your project and your clamp

After clamp use

- Once a clamp’s job is finished, remove it from the workpiece immediately.
- After every use, wipe each part of the clamp with a dry cloth.
- Clearing any dust or debris will ensure there’s no buildup, and keeping clamps clean will help to avoid slippage when working on your next project.
- Any dirt, dust, or debris has the potential to damage your clamp’s working ability and can even leave marks or stains on the surface of your workpiece.
- You can also regularly buff your bar with paste wax, keeping all the moving parts of your clamp in top condition and preventing rust development.

Clamp storage

- Always store clamps away from heat in a secure, safe, dry place.
- When possible, separate clamp heads to prevent them from sticking together.
- Consider investing in clamp racks or carts to keep clamps stored properly.

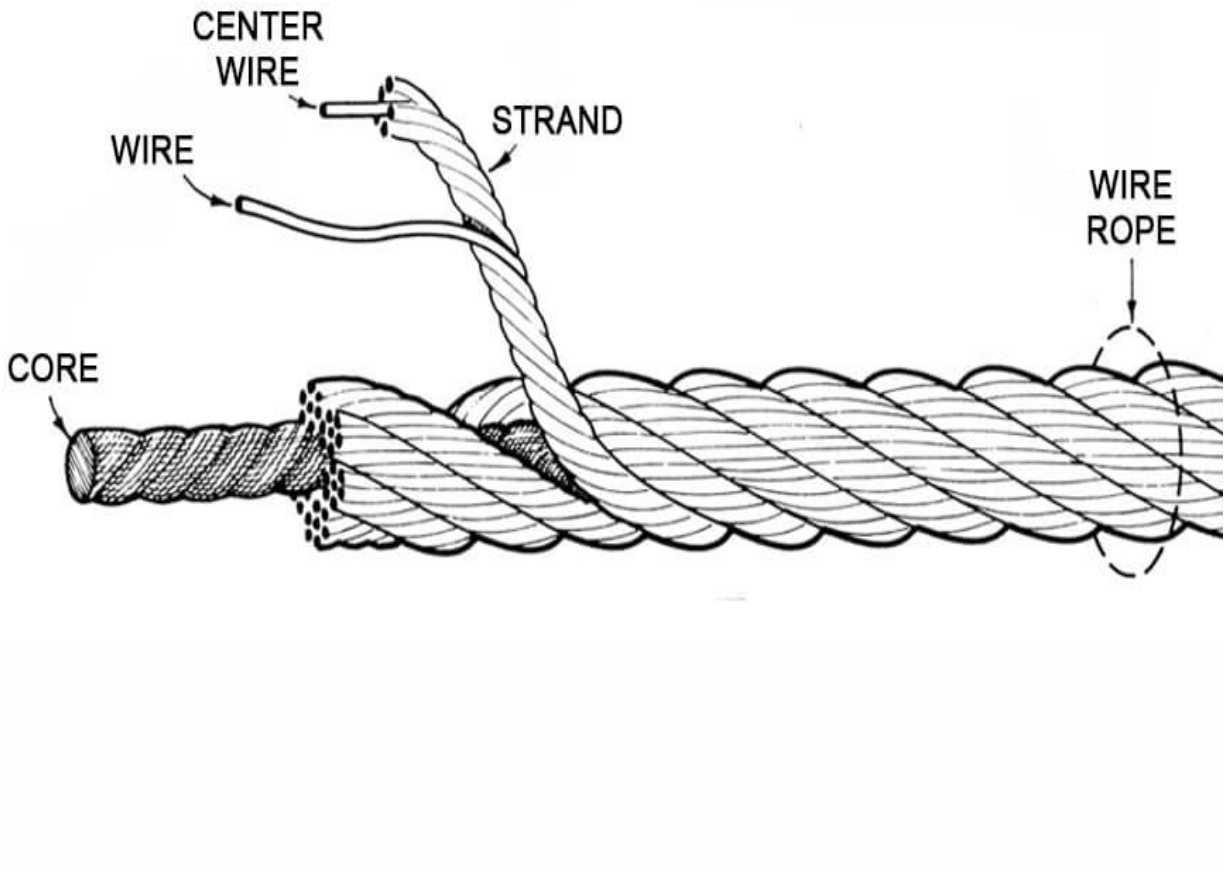
How to Maintain Wire Rope

- Put on gloves before handling and checking the condition of your wire ropes.
- Wire ropes should be cleaned at intervals using a brush to remove hardened deposits of grease, which prevent the penetration of lubricants.
- Do not use solvents for cleaning. They may destroy the textile or synthetic components which make up the wire rope.
- The wire rope must be checked over its entire length.
- Check the level of wear and the proper functioning of the sheaves: One defective sheave in a circuit may result in premature wear to the wire rope.

How to Maintain Wire Rope

- Apply grease using the product recommended by the manufacturer. The lubrication intervals must take the specific conditions of usage into account: proximity to the coast, metallurgical or chemical environment, harsh climatic conditions, etc.
- All wire ropes showing a broken strand, a collection of visible broken wires, deformation, corrosion, kinks, pleats, crushing, etc. should be scrapped.
- A worn or damaged wire rope should only be replaced with a rope recommended by the equipment manufacturer.
- When replacing the wire rope, it must be possible to brake the drum (coil) to prevent the rope from unwinding too fast or dragging when winding up.
- The length of the new wire rope should match the crane configuration and should cover all drum winding layers.

WIRE ROPE



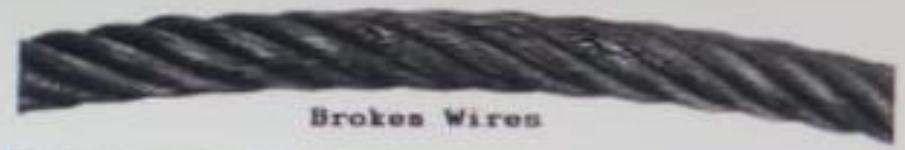
Wire Rope Wear and Damage

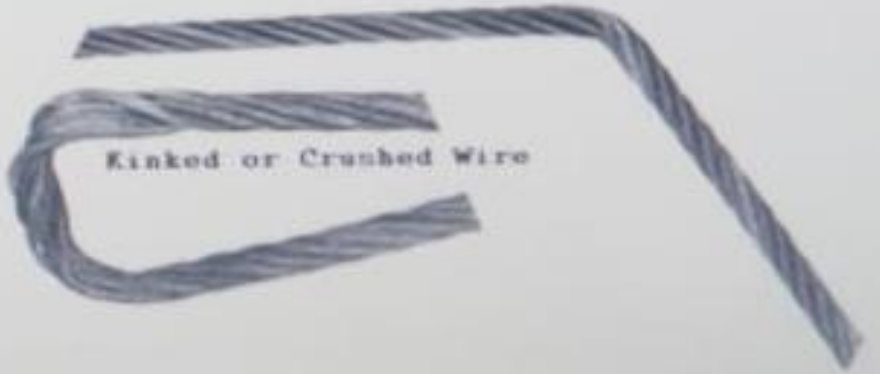
Typical Rope Damage

A wire rope which has jumped a sheave

A rope failing from fatigue after bending over small sheaves

Rope break due to excessive strain





BROKEN WIRES

KINKED WIRE

ABRADED/WORN WIRE

POPPED CORE

CORROSION

HEAT DAMAGE

BIRD CAGING

DAMAGED FITTINGS

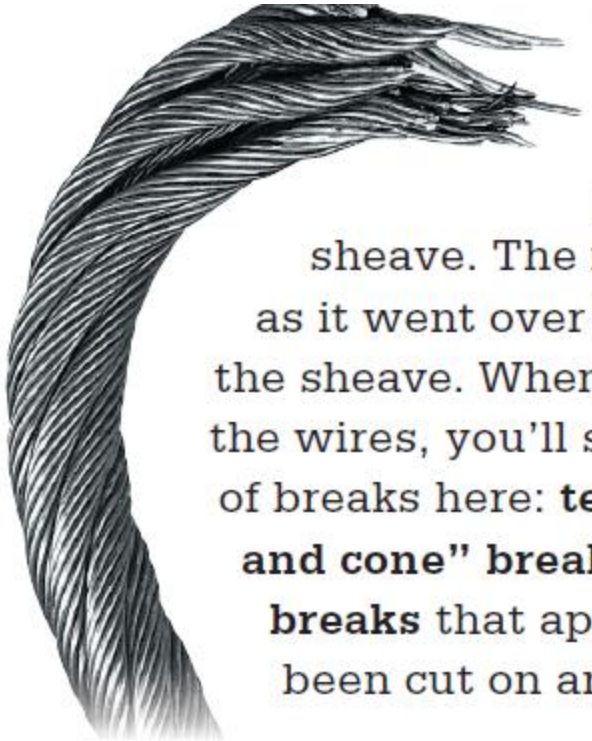
A **"birdcage"** is caused by sudden release of tension and the resulting rebound of rope. These strands and wires will not be returned to their original positions. The rope should be replaced immediately.

This shows a typical failure of a rotary drill line with a poor cutoff practice. These wires have been subjected to continued **peening**, causing fatigue type failures. A predetermined, regularly scheduled cutoff practice can help eliminate this type of problem.

This is a wire rope with a **high strand** – a condition in which one or more strands are worn before adjoining strands. This is caused by improper socketing or seizing, kinks or dog-legs. At top, you see a closeup of the concentration of wear. At bottom, you see how it recurs every sixth strand in a 6 strand rope.

A **kinked wire rope** is shown here. It's caused by pulling down a loop in a slack line during handling, installation or operation. Note the distortion of the strands and individual wires. This rope must be replaced.

This is **localized wear** over an equalized sheave. The danger here is that it's invisible during the rope's operation, and that's why you need to inspect this portion of an operating rope regularly. The rope should be pulled off the sheave during inspection and bent to check for broken wires.



Here's a wire rope that has jumped a sheave. The rope **"curled"** as it went over the edge of the sheave. When you study the wires, you'll see two types of breaks here: **tensile "cup and cone" breaks** and **shear breaks** that appear to have been cut on an angle.

Drum crushing is caused by small drums, high loads and multiple winding conditions.

Corrosion

- Corrosion may be external or internal, general or localized.
- It is recommended that a wire rope should be discarded when the surface of the wires is severely roughened or pitted, or if the wires are slack within the strands due to wastage.
- Corroded wire rope leads to loss of metallic cross-section.

Abrasion, Peening

- Abrasion, peening impact the outer surfaces of wire rope.
- Abrasion is a form of metal loss or erosion, and peening describes metal deformation.
- Both of these phenomena occur when a wire rope contacts other metallic surfaces, or when it passes over a drum or sheave(pulley wheel).

Bird Caging

- Bird caging is a severe form of wire rope distortion that causes the individual outer strands of a cable to unravel and expand, creating a bird cage shape at the damage site.
- Bird caging is usually caused by sheaves that impart unintentional rotation. When a non-rotation resistant cable experiences torsion caused by excessively tight, or incorrectly positioned sheaves, it triggers the outer cable strands to lift away from their normal position

- Bird caging poses a severe hazard.
- To prevent future issues, the damaged cable should be immediately removed from operation, and the sheaves remedied.

Kinks

- A kink is the permanent deformation of strands in a wire rope caused by unintended bending and twisting.
- This usually occurs when the rope is twisted into a tight loop and then snapped back to a straight direction, leaving a permanent curve at the bend site.
- Though kinks often result from improperly handling or installing wire rope, they can also appear during service if a heavy load is released suddenly, or if a wire rope bends around too small of a sheave.
- Kinks always result in permanent strand damage
- If not addressed in a timely manner, kinks pose a severe safety hazard.

Hearing Conservation Program in Production industries

- Hearing conservation programs are designed to prevent hearing loss due to noise.
- Hearing conservation programs require knowledge about risk factors such as noise and ototoxicity, hearing, hearing loss, protective measures to prevent hearing loss at home, in school, at work, in the military and, and at social/recreational events, and legislative requirements
- Regarding occupational exposures to noise, a hearing conservation program is required by the Occupational Safety and Health Administration (OSHA) "whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels (dB) measured on the A scale (slow response) or, equivalently, a dose of fifty percent.“
- This 8-hour time-weighted average is known as an exposure action value.

Benefit of a hearing conservation program

- The primary benefit of a hearing conservation program is that it prevents occupational hearing loss and the resulting disability.
- More effective communication between employees and management which improves the quality of production.
- Other benefits include:
  - reduced injury and illness rates;
  - reduced stress and fatigue related to noise exposure;
  - increased work efficiency;
  - an overall higher quality of life for employees; and
  - reduced direct/indirect costs.

Elements of a hearing conservation program

- Hazard identification and exposure monitoring
- Control methods (using the hierarchy of controls)
- Hearing protection devices (selection, use, and maintenance)
- Audiometric testing
- Hazard communication, education, and training
- Recordkeeping, and
- Continuous monitoring and improvement (program review).