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# Industrial Process Safety

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# Types of Energy

- Mechanical
- Hydraulic
- Pneumatic
- Chemical
- Thermal

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# Hazards in the Workplace

- Heating and cooling
- Machines
- Compressed gasses
- Flammable processes
- Toxic processes
- Height
- Uneven walking surfaces

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# Hazards of Mechanical Processes

- Common injuries caused by mechanical processes
  - Puncturing
  - Cutting and tearing
  - Shearing
  - Crushing
  - Breaking
  - Straining and Spraining

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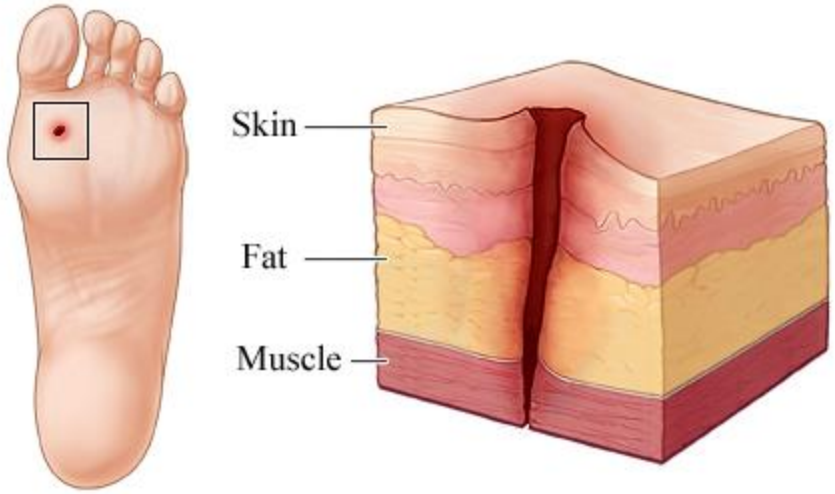
# Puncturing

- Machines can sometimes have sharp tools that can puncture the skin

- Puncturing occurs when an object is penetrates through the body and then is pulled straight out. The greatest hazard associated is potential damage to internal organs



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# Cutting and Tearing

- Cutting refers to the action that happens when a part of the body comes into contact with a sharp edge.
- The seriousness of the injury done to skin has to do with how much damage was done to the skin, veins, arteries, muscles and bone

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# Shearing

- Injuries that occur when the wound is a clean cut, often resulting in an amputation

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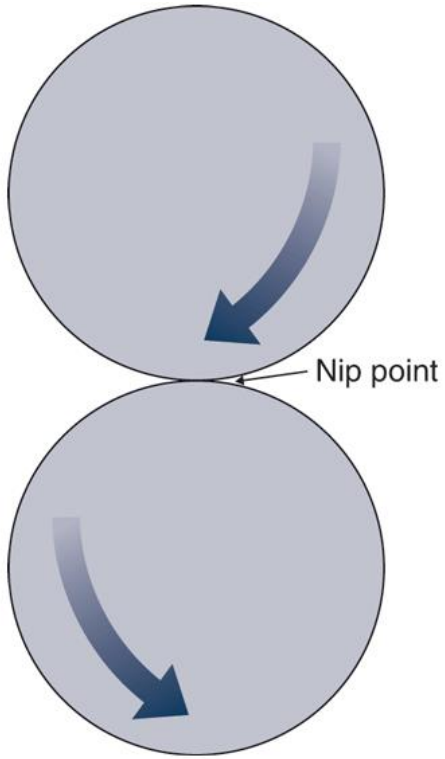
# Crushing

- Occurs when the body is caught between two surfaces that move together
- Often involves more than 1 bone and is usually more severe than a simple break
- 2 types:
  - Squeeze point
  - Run-in point



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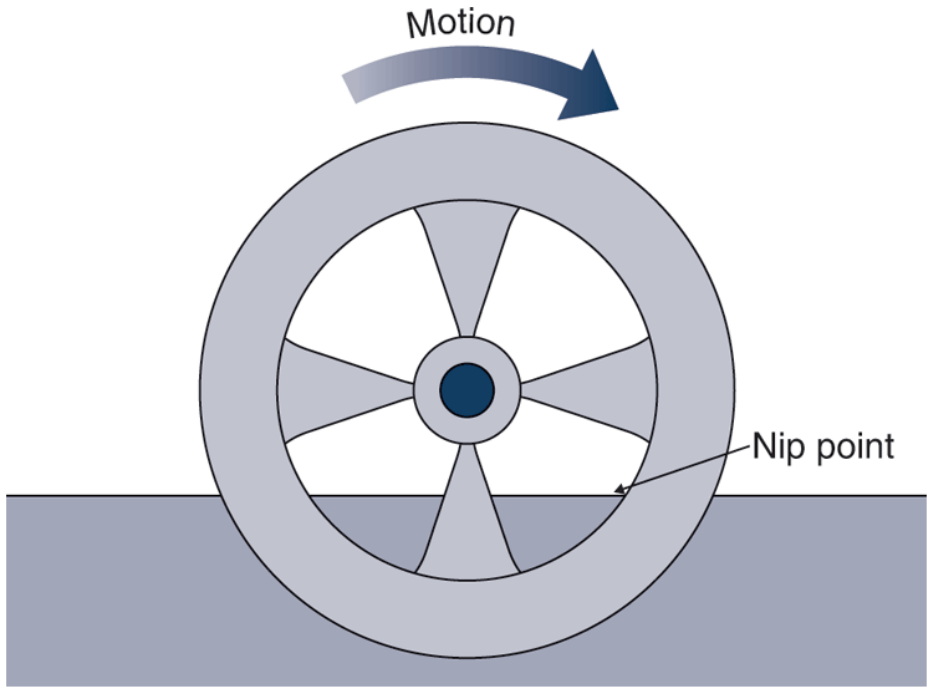
# Crushing

- Squeeze points exist where two hard surfaces, when at least one is in motion, are moved close enough together to crush objects between them

- Run- in points exist where two objects, one of which is rotating, become closer together.



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# Breaking

- Occurs when part of the body gets caught in a machine that might be used to deform materials

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# Straining and Spraining

- Occurs when one of the soft tissues (a ligament or muscle) is over exerted and is either stretched to far or torn.
- Usually an ergonomic issue

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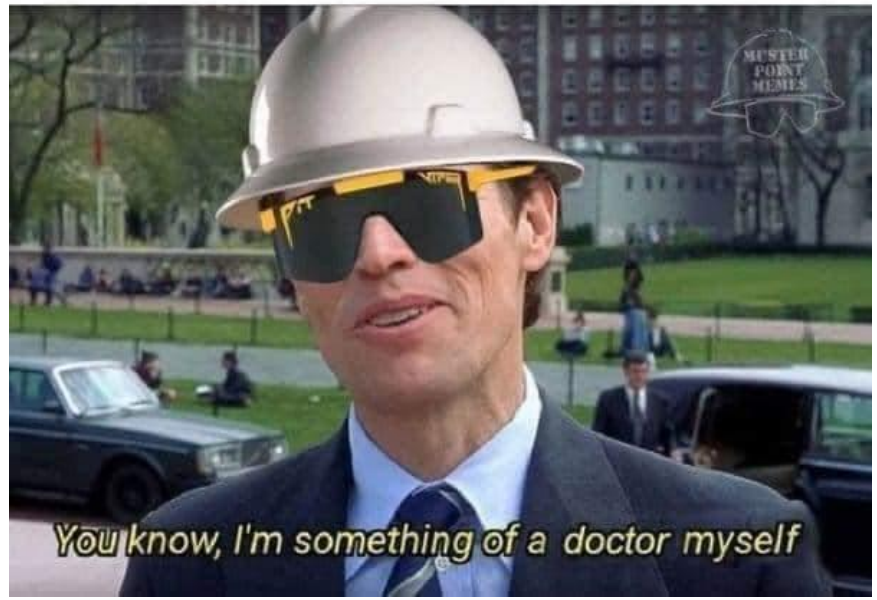
# First Aid

- Even minor cuts and abrasions can result in infection – it is important to clean and cover the wound appropriately
- If the wound is severe, call emergency services and report the incident to your supervisor
- If you have not taken a CPR and First Aid Class, I highly recommend it

When you fix the giant cut on your hand with electrical tape and a dirty rag then go right back to work.

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# Knowledge Check 1

- What is the difference between a puncture injury and a cutting injury?

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# Knowledge Check 1

- A puncture injury occurs when the body is pierced by a sharp object and then that object is pulled straight out

- A cutting injury is often lateral and the sharp object is not pulled straight out

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# Temperature Extreme Hazards

Most people think about really hot things when they think of temperature hazards, but processes can involve very cold temperature hazards as well!

- Dry Ice temp: -78 °C
- Liquid Nitrogen temp: -196 °C

- Something even just as cold as an ice pack can give ice burns if exposed for a long period of time

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# Thermal Stress: Heat Stress

- **Heat Stress** is the net heat load which a worker may be exposed from the combined contributions of metabolic effect of work and environmental factors (air temperature and humidity)
  - Heat stress can be made worse by high humidity environments and hot environments
- **Heat Strain** is the overall physiological response resulting from heat stress
- Heat stress is important to monitor because it can cause:
  - Heat exhaustion
  - Heat rash
  - Heatstroke
  - Heat cramps
  - Fainting
  - Death

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# Thermal Stress: Heat Stress

- Recognize heat stress
  - Core body temp greater than 38.5 °C
  - Rapid heart rate
  - Sudden nausea, fatigue and dizziness or lightheadedness
- Prevent heats stress by:
  - Allowing frequent water breaks
  - Wear clothing that facilitates cooling
  - Monitoring conditions using a hygrometer
  - Allowing breaks in a cool environment
  - Working in the shade
  - Monitor employees (especially if they are high risk) for heat related stress

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# Thermal Stress: Cold Stress

- **Cold Stress** is the body's core temperature response to extreme cold temperatures

**Effects of Reducing the Core Body Temperature**

| Core Temperature | | |
|---|---|---|
| °C | °F | Body's Response |
| 37.6 | 99.6 | Normal rectal temperature |
| 36.0 | 96.8 | Metabolic rate increases |
| 35.0 | 95.0 | Pronounced shivering |
| 33.0 | 91.4 | Severe hypothermia |
| 30.0 | 86.0 | Progressive loss of consciousness begins |
| 24.0 | 75.2 | Pulmonary edema |
| 20.0 | 68.0 | Cardiac standstill |

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# Thermal Stress: Cold Stress

- It is important to keep the body's core above 36 ˚C (96.8 ˚F) and prevent injury to body extremities as those can be damaged more easily by cold
- Even if the exposure to cold is non-fatal, it can cause impaired judgment, reduced alertness and loss of muscular function
- Exposure of exposed skin should be not allowed in temperatures below -32 ˚C (-25.6 ˚F) and that number is different for workers immersed in water or whose clothing gets wet (35.6 ˚F)

- Prevent Cold Stress
- Wear/Provide clothing and items that help regulate temperature
- Allow frequent breaks to warm employees
- Minimize work during extreme cold
- Monitor employees for cold related injury or illness

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# Thermal Burns

Burns can come in the form of heat burns and cold burns and come in different degrees

- First Degree
  - Minor and results in a mild inflammation of the skin (sunburns). Usually causes the skin to become red and mildly sensitive or painful
- Second Degree
  - Blisters will form on the skin. It might be superficial that will heal with little to no scarring but a deep second degree burn will feel leathery to the touch when healing
- Third Degree
  - Dangerous and can be fatal depending on the amount burned. Penetrates all layers of the skin and may burn body tissue as well. Third degree burns that cover more than 75% of the body will usually be fatal.

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# Treatment of Thermal Burns

Call 911 for work related burns

- Hold the affected area under cool (not cold) running water
  - Use cold compresses if water is not available
- Remove restrictive clothing (rings, belts, jewelry)
  - Burn injuries can swell quickly
- Don’t apply ointments or creams
  - These can hold in heat

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# Chemical Hazards

- Chemical hazards can affect multiple parts of the body including skin, lungs, eyes and nervous system

| Chemical | Potential Harmful Effect |
|---|---|
| Acetic acid | Tissue damage |
| Liquid bromide | Corrosive effect on the respiratory system and tissue damage |
| Formaldehyde | Tissue hardening |
| Lime | Dermatitis and eye burns |
| Methylbromide | Blisters |
| Nitric/sulfuric acid mixture | Severe burns and tissue damage |
| Oxalic acid | Ulceration and tissue damage |
| White phosphorus | Ignites in air causing thermal burns |
| Silver nitrate | Corrosive/caustic effect on the skin |
| Sodium (metal) | Ignites with moisture causing thermal burns |
| Trichloracetic acid | Tissue damage |

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# Chemical Burns

- Chemicals should be flushed with copious amounts of water when they come into contact with the body
  - Eye wash stations/ chemical showers should be available in places that handle harmful chemicals

ANSI Z358.1-2004 states that eyewash stations should be visually inspected and activated every week for plumbed stations. Portable eyewash stations are just to be visually inspected for fullness and for growth or debris and the fluid

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# Reducing the Risk of Chemical Hazards

- Isolate the process with guarding and shielding as well as containment procedures
- Change the process to use less hazardous chemicals or to limit exposure to the chemicals in use
- Use fume hoods to get rid of harmful vapor
- Use PPE to limit human contact with harmful chemicals

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# Knowledge Check 2

- How often does ANSI specify that plumbed eye wash stations should be tested?

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# Knowledge Check 2

ANSI Z358.1-2004 states that plumbed eyewash stations need to be tested (activated) weekly and checked for growth and debris

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# Pressurized Equipment Hazards

- Is defined as a dangerous condition presented by a pressurized system
  - This can include equipment or material that is ejected out of a piece of machinery or air or other fluid that can be sprayed at high velocity

The surrounding environment or even your own body can also be a pressurized system and can cause decompression sickness from expanding nitrogen bubbles in the bloodstream

OSHA defines “high pressure” as anything over 900 psi

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# Pressure Hazards

- Pressure hazards can result from boilers, pressurized lines, steam lines etc

- Hazards include

1. Leaks
2. Pulsation
3. Vibration
4. Release of pressurized content
5. Whiplash of broken tubing or pipes

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# Cracking/ Leaking Hazards in Pressurized Systems

- Hazards caused by cracking or leaking in pressurized systems and vessels can include
  - Complete structural failure leading to an explosion or rapid expansion of contents
  - Leaking of hazardous material that could include suffocation or poisoning
  - Fire
  - Chemical or thermal burns

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# Reducing pressurized hazards

- Systems that deal with pressurized components should have adequately rated piping to handle the pressurized contents as well as monitoring and instrumentation to identify potential hazards before they occur.
- Reducing the amount of fittings and joints reduces the likelihood for leaks
- Placing engineering controls such as guards and shields and restricting access for non-authorized personnel around pressurized systems also reduces the chance for injury
- Frequent testing of pressurized systems including non-destructive pressure testing can reduce the risk of structural failure

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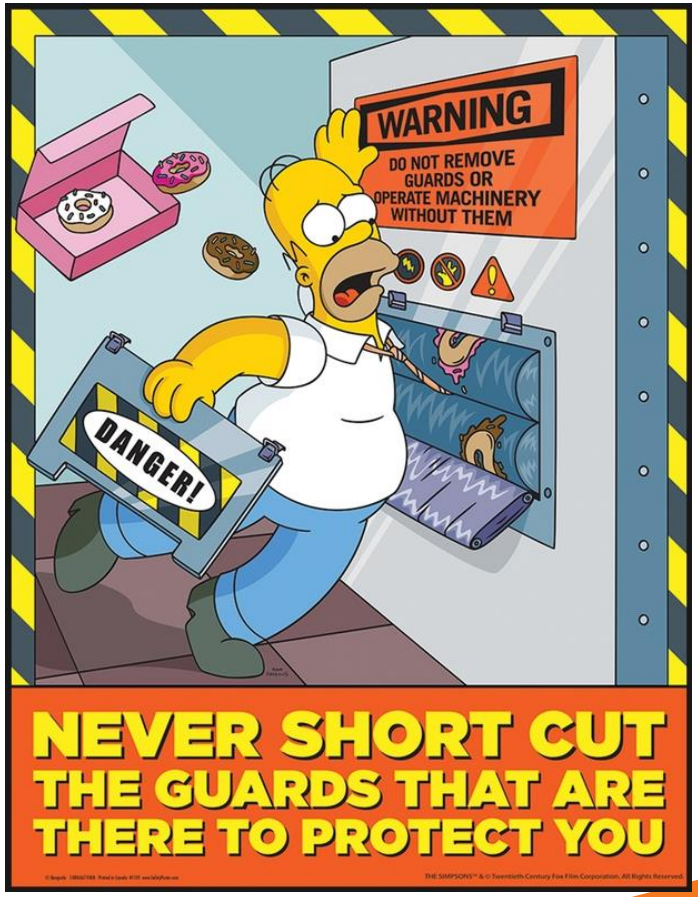
# Safeguarding

- Safeguarding Equipment means putting in physical barriers that protect workers from accidental contact with the moving equipment in machines
- Guards against
  - An individual making contact with the machine (usually the moving part) because of inattention caused by fatigue, distraction, curiosity or deliberate chance-taking
  - From debris caused by the machine via flying metal chips, chemical splashes, hot metal splashes, or kickback
  - Injury caused by the direct result of machine malfunction, including mechanical or electrical failure

  - See OSHA Guidelines for Machine Guarding 1910.211 through 222

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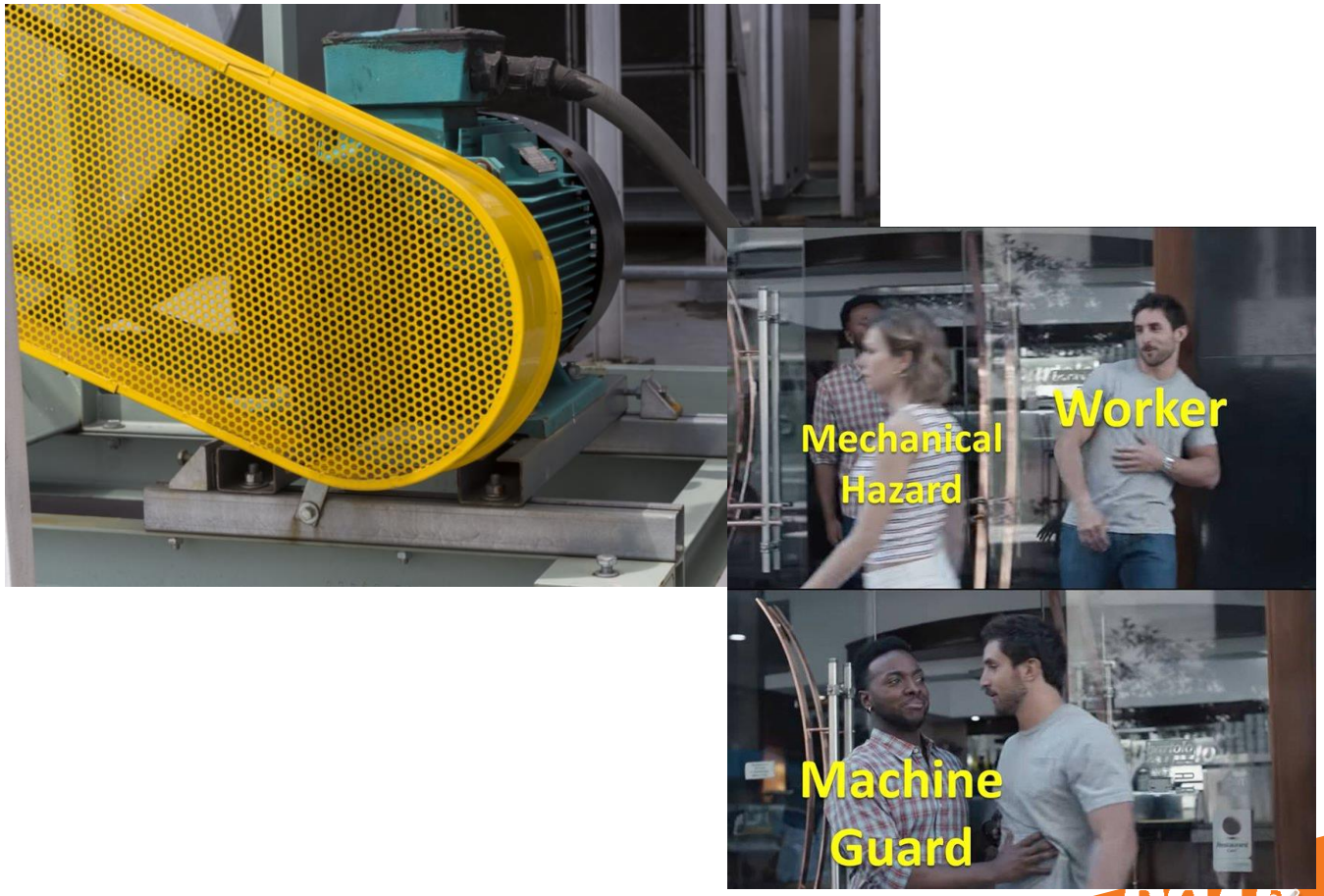
# Machine Guarding

- The act of placing a physical barrier to prevent accidental injury caused by a machine
- They must
  - Prevent accidental contact
  - Be secure and durable
  - Protect against falling objects
  - Create no new hazard
  - Create no interference
  - Allow safe maintenance



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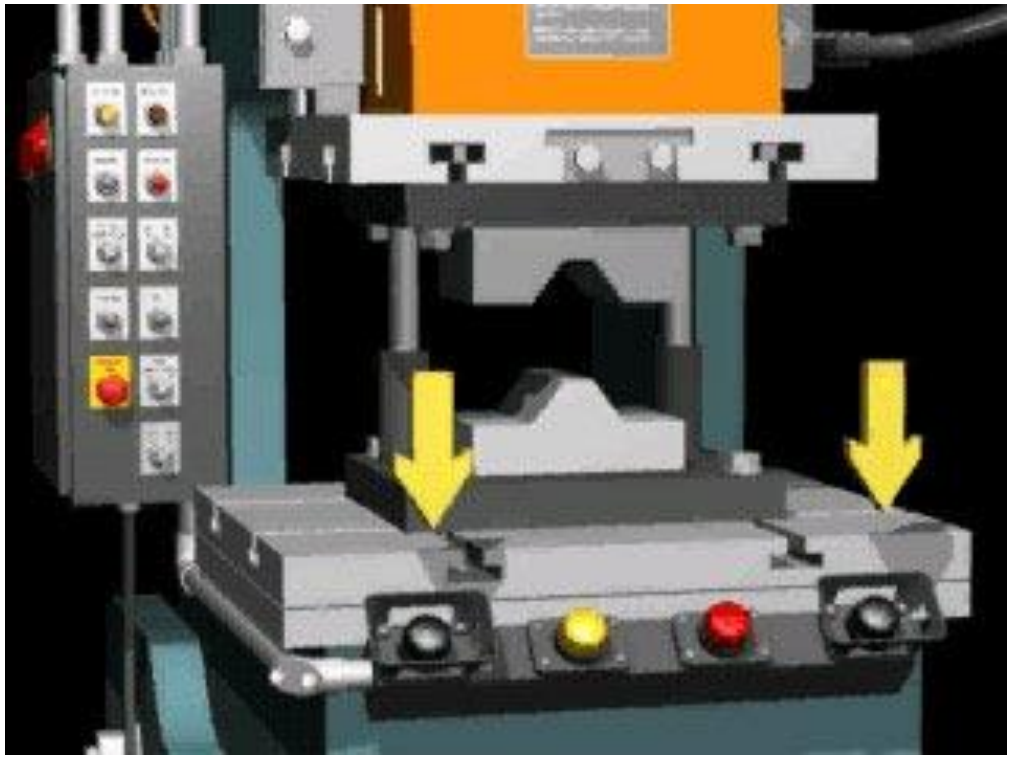
# Safety Switches

- Designed to only to operate when the body is outside the area of operation

- Can come in many different forms
  - Two hand control
  - Dead man’s switches



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# Emergency Switches

- Emergency shutoff switches, or Emergency Power Off (EPO) devices are designed to turn off a piece of equipment when something comes in contact with them, or when a cabinet door is opened, a safety mechanism is removed or other maintenance-related situations

- They are used to shut off equipment in an abnormal situation

- Do not disconnect these or “rig” them in any way to bypass them. It is important to maintain these in proper working order

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# Emergency Switches

- Large machinery should also have a manual emergency shut-off switch within reach of the employee or those around them
- They should be a push button that is clearly marked and visible from a distance.
- These will kill power to all downstream processes


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# Keep Yourself Safe from Hazards

- Long hair, loose clothing and lanyards all pose a significant risk when working around rotating machinery

- Be sure to:
- Tie back all long hair
- Remove all loose clothing/ secure loose clothing
- Remove or tuck in any jewelry or lanyards to prevent accidental snags
  - (wear lanyards with a quick release)

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# Keep Yourself Safe from Hazards

- Degloving involves the removal of skin and other soft tissues from extremities
- One of the most common causes is rings – be sure to remove rings and other jewelry prior to doing work to prevent hand injury

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# End of Show

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