IETP4115: Integrated Engineering Team Project

Workshop and Laboratory Safety

NOVEMBER , 2022/23

Learning Outcome

At the end of this lesson, the students will be able to:

- Understands the need for safety in workshops and laboratories.
- Exercise safe working principles in workshops in laboratories.
- Capable of handling various challenges in workshops and laboratories.

Training Outlines

- Safety, Accident Causation, Effects of Accidents and Accident Prevention
- Mechanical Hazards and Machine Safeguarding
- Falling, Impact, Acceleration and Lifting Hazards
- Electrical & Radiation Hazards
- Laboratory safety
- Fire Safety and Prevention
- Personal Protective Equipment

Safety, Accident Causation, Effects of Accidents and Accident Prevention

- Safety: is the **state** in which the **risk** of harm to persons or property damage is **reduced** to, and **maintained** at or below, an **acceptable level** through a continuing process of **hazard identification** and **risk management**
- safety is a positive sense of security in a work area which is free from accidents and incidents.
- In simple words, safety means freedom from the occurrence of risk of injury or loss.
- As regards, industrial safety, it means the protection of employees/workers from the danger or risk of industrial accidents.
- In other words, industrial safety refers to protection against accidents occurring in the industrial establishments

An accident

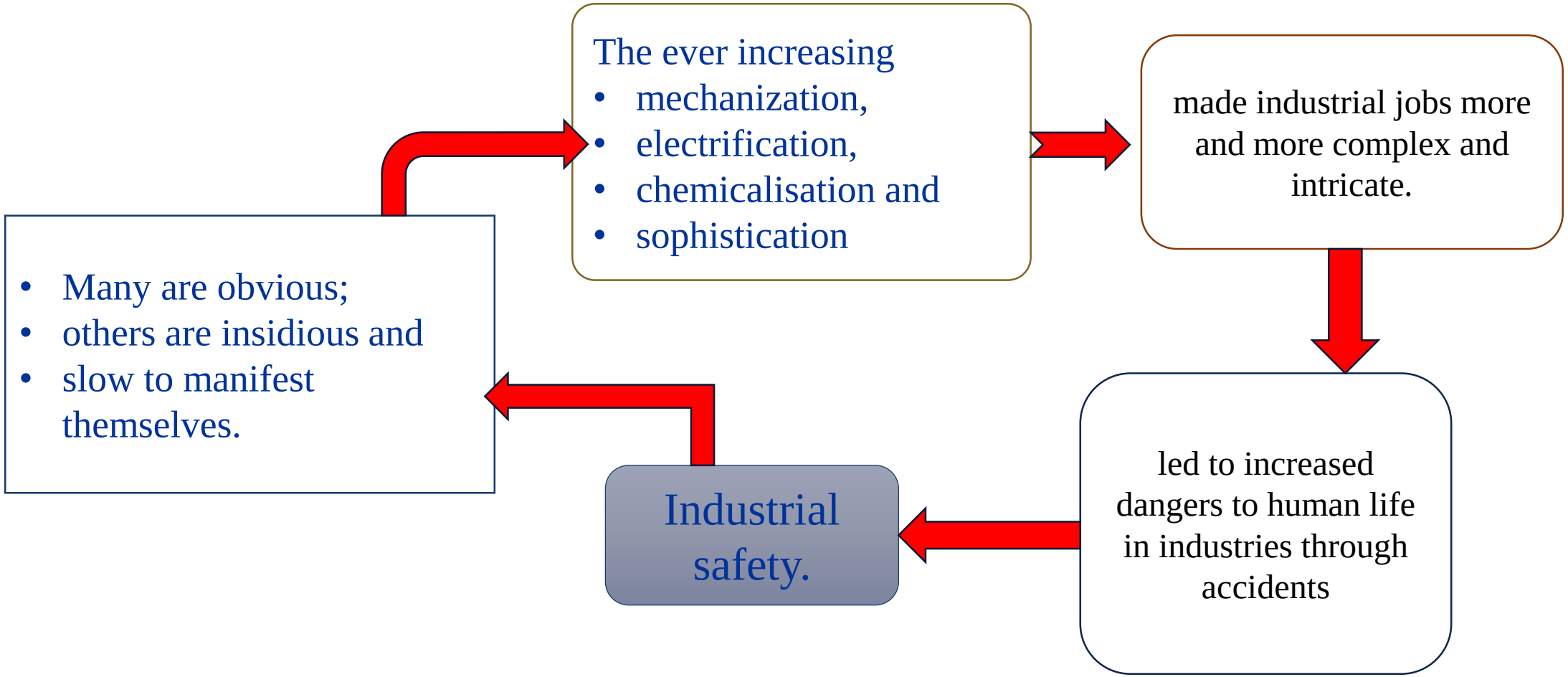
1. A sudden and unexpected occurrence in the industry which interrupts the orderly progress of the work.
2. Any unexpected or unforeseen deviations from the normal plant operation which results in an adverse interruption of the orderly progress of the activity resulting in an injury or damage to property or both.

- “It is an occurrence in an industrial establishment causing bodily injury to a person that makes him unfit to resume his duties temporarily or permanently”.

- an unplanned and uncontrolled event in which an action or reaction of an object, a substance, a person, or a radiation results in personal injury.

Accident Causation

- All works include some hazards and accidents.



The Cause of Accidents

- No accident occurs automatically. Instead, certain factors cause accidents.
- It has been noticed that an accident does not have a single cause but a multiplicity of causes, which are often closely related.
- The Workshop, laboratory and industrial safety experts have classified the various causes of accidents into three broad categories of
  - **unsafe conditions,**
  - **unsafe acts and**
  - **Environmental factors (other causes).**

Unsafe working conditions

- Unsafe working conditions are the biggest cause of accidents.
- It is known as technical causes. Some of these are

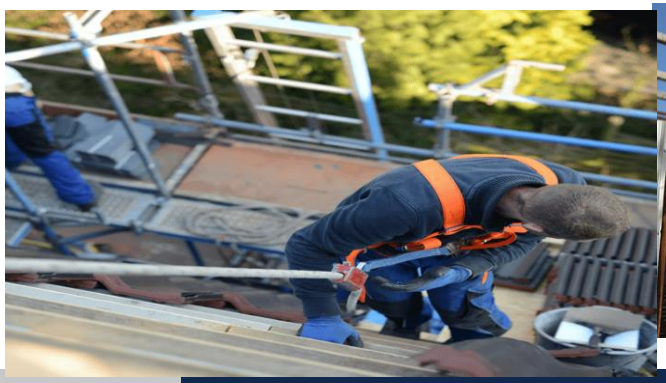


- Defective plants, tools, equipment's, machines, and materials.
- faulty layout and location of plan
- Congestive workplace.
- Excessive noise.
- Fire and explosive hazards.
- Hazardous atmospheric conditions.

- Poor lighting or inadequate lighting arrangements.
- Poor ventilation.
- Radiation exposure.
- Improper guarded equipment's
- Unguarded moving parts.
- Unsafe storage, inadequate safety devices, etc.









Unsafe working conditions

- Besides, the psychological reasons such as working overtime, monotony, fatigue, tiredness, frustration and anxiety are also some other causes that cause accidents.
- Safety experts identify that there are some high danger zones in an industry.
- These are, for example, hand lift trucks, wheel-barrows, gears and pulleys, saws and hand rails, chisels and screw drivers, electric drop lights, etc., where about one-third of industrial accidents occur.

- Industrial accidents occur due to certain acts on the part of workers. These acts may be the result of lack of knowledge or skill on the part of the worker, certain bodily defects and wrong attitude.
- Some of the unsafe acts are:

- operating without authority,
- failure to use safe attire or personal protective equipment's
- *Being over-confident*
- Taking Shortcuts
- *Starting a Task with Incomplete Instructions*
- *Poor Housekeeping*
- *Ignoring Safety Procedures*
- *Mental Distractions from Work*

- *Failure to Pre-Plan the Work*
- careless throwing of material at the work place,
- working at unsafe speed, i.e., too fast or too low,
- using unsafe equipment, or using equipment's unsafely,
- removing safety devices,
- taking unsafe position under suspended loads, distracting, teasing, abusing, quarrelling, etc
- one's own accident prone personality and behavior, etc.









Environmental or Other Causes

These causes arise out of unsafe situational and climatic conditions and variations. These may include

- excessive noise,
- very high temperature,
- humid conditions,
- bad working conditions,
- unhealthy environment,
- slippery floors,
- excessive glare,
- dust and fume,
- arrogant behavior of domineering supervisors, etc.

Exercise one

1. **A worker needs a electrical switch rewired. A work request is submitted and the work scheduled for the following week. The employee decides, I need this sooner and tries to rewire the switch. The employee receives an electrical shock after failing to lock out the energy source. Discus the unsafe conditions and unsafe act exercised by the employee.**

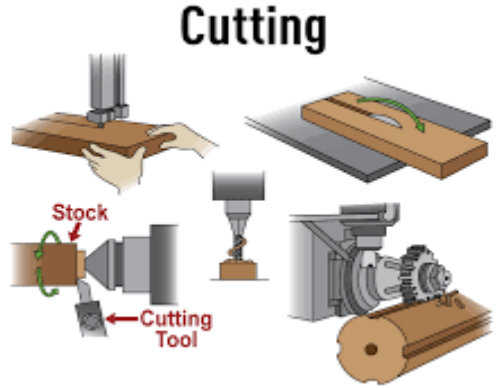
Mechanical Hazards and Machine Safeguarding

Mechanical Hazards and Machine Safeguarding

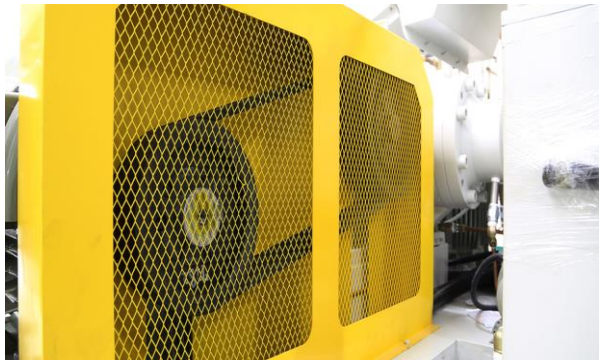
- Mechanical hazards are those associated with power driven machines, whether automated or manually operated.
  - ➢ Concerns about such hazards date back to the Industrial Revolution and the earliest days of mechanization.
  - ➢ Failure to provide proper machine guards and enforce their use can be costly for companies

➢ Mechanical accidents that comes from not properly guarded or unguarded moving parts of machines are implicated in thousands of workplace injuries every year.

➢ Small gains in productivity obtained by willfully bypassing mechanical safeguards on machines can cost companies huge fines & medical bills.

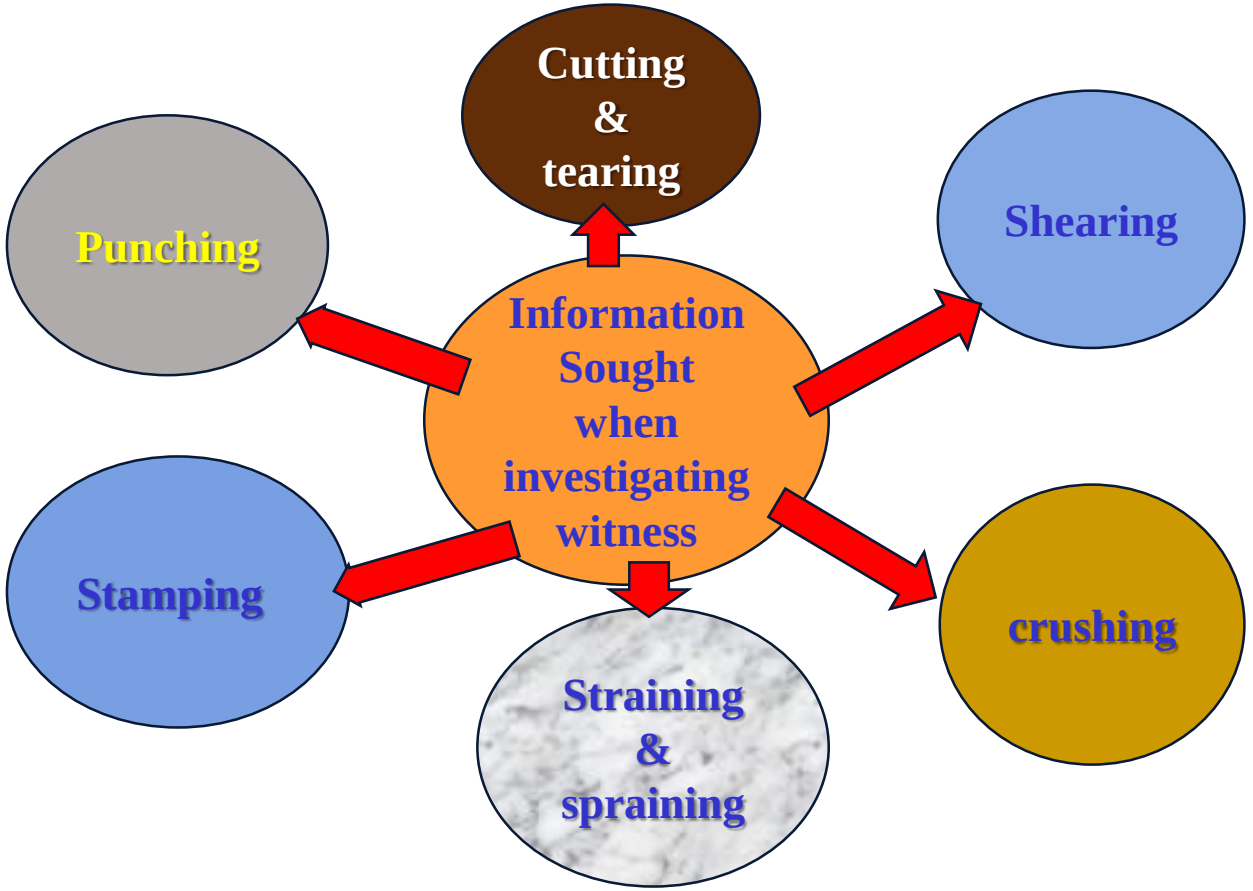






COMMON MECHANICAL INJURIES

- In industrial settings, people interact with machines aimed to drill, cut, shear, punch, chip, staple, stitch, abrade, shape, stamp, and slit.
- If workers fail to follow safety precautions, these procedures can happen to humans, instead of work pieces.



Strains/Sprains, Cuts, Shearing Injuries

- A **strain** results when muscles are overstretched or torn, a **sprain** results from torn ligaments in a joint.
  - Strains and sprains can cause swelling and intense pain.
- A **cut** occurs when a body part comes in contact with a sharp edge.
  - Seriousness of cutting or tearing depends on damage done to skin, veins, arteries, muscles, and even bones.
- Power-driven **shears** for severing paper, metal, plastic, elastomers & composites are widely used.
  - Such machines often amputated fingers & hands when operators reached under the shearing blade, and activated the blade before fully removing their hand.







Crushing Injuries

Crushing injuries occur when a part of the body is caught between hard surfaces that progressively move together

- crushing anything between them.

• Two categories: squeeze-point types & run-in points.

Squeeze-point hazards exist when two hard surfaces, at least one of them moving, push close enough together to crush objects between them.

Run-in point accidents exist where two objects, at least one of which is rotating, come progressively closer together.

- Body parts can also be crushed in other ways.
- A heavy object falling on a foot; A hammer hitting a finger.

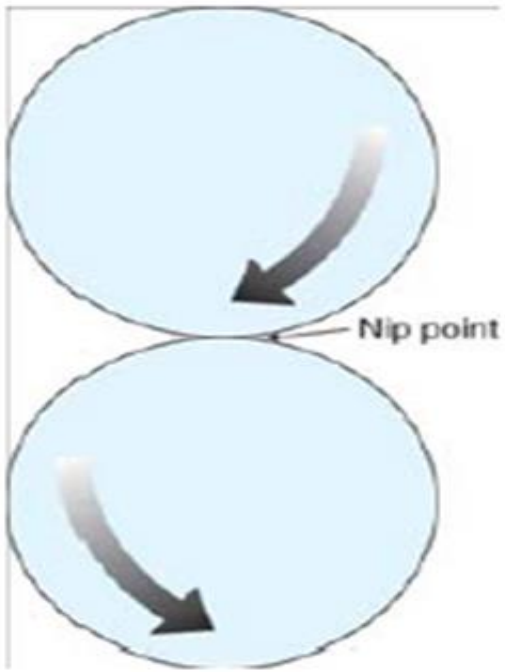


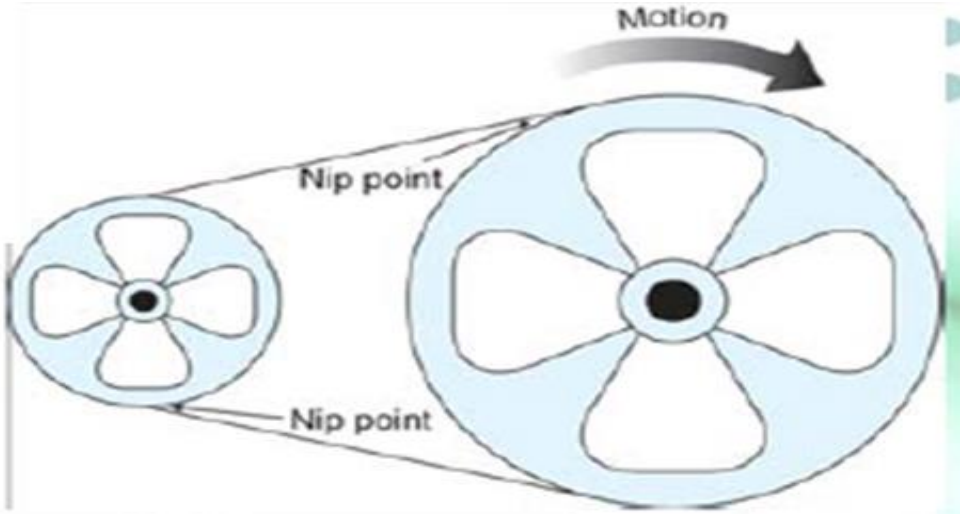


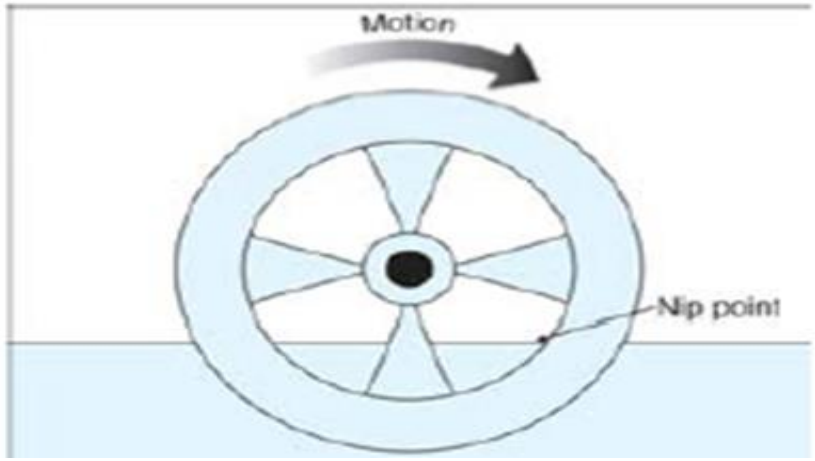




Meshing gears and belt pulleys are examples of run-in points













Breaking

Machines used to deform engineering materials in a variety of ways can also *fracture* and break bones.

- A *simple fracture* is a break that does not pierce the skin.
- A *compound fracture* is a break that has broken through the surrounding tissue and skin.
  - A *complete fracture* divides the affected bone into two or more separate pieces.
- An *incomplete fracture* leaves the affected bone in one piece but cracked.
- A *transverse fracture* is a break straight across the bone.
- A *comminuted fracture* exists when the bone is broken into a number of small pieces at the point of fracture.







Puncturing

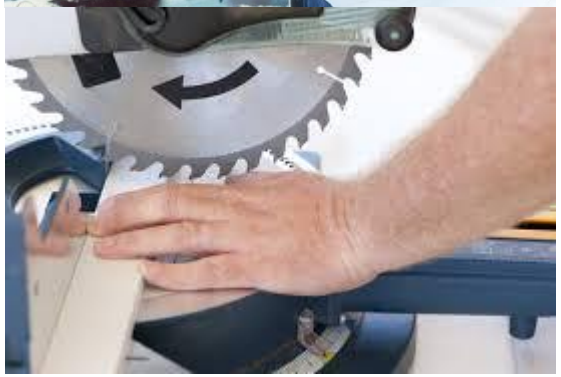
Punching Action begins when power causes the machine to hit a slide (ram) to stamp or blank metal or other material.



The accident occurs at the point of operation where the employee typically inserts, holds, or withdraws the stock by hand.



Puncturing results when an object penetrates straight into the body and pulls straight out.



Creating a wound in the shape of the penetrating object.

- The greatest hazard is potential for damage to internal organs.

Hazardous Activities

Employees operating and caring for machinery perform various activities that present potential amputation hazards.

- Machine set-up/threading/preparation
- Machine inspection
- Normal production operations,
- Clearing jams
- Machine adjustments
- Cleaning of machine
- Lubricating of machine parts and
- Scheduled and unscheduled maintenance.*





Requirements for Machine Guarding or Safeguards

Prevent contact - Safeguards should prevent contact with any potentially harmful machine part.

Be secure and durable - Workers cannot render them ineffective by disabling them .

- Durable enough to withstand the rigors of the workplace.

Protect against falling objects - Shield moving parts from falling objects, which can hurled out, creating a projectile.

Create no new hazard - Safeguards should overcome the hazards in question without creating new ones.

Create no interference - Safeguards that interfere with progress of work are likely to be disregarded or disabled by workers feeling the pressure of production deadlines.

Allow safe maintenance - More frequently performed maintenance tasks (lubrication, etc.) accomplished without the removal of guards. Sharp edges, unfinished surfaces, or protruding bolts

Allow safe lubrication - if possible, be able to lubricate the machine without removing the safeguards

MACHINE GUARDING SELF-ASSESSMENT

Questions for machine guarding self-assessments:

- Are all machines that might expose people to rotating parts, nip points, flying chips, sparks, flying particles, or other similar hazards properly guarded?
- Are all mechanical power transmission belts and the nip points they create properly guarded?
- Are all exposed power shafts located less than seven feet above the working level properly guarded?
- Are hand tools regularly inspected on a systematic basis for burred ends, cracked handles, and other potentially hazardous conditions?
- Are power saws & similar equipment properly guarded? Are the tool rests within 1/8” or less of grinding wheels?

MACHINE GUARDING SELF-ASSESSMENT

Questions for machine guarding self-assessments:

- Do all employees who handle and store gas cylinders and valves know how to do so without causing damage?
- Are all compressed gas cylinders inspected regularly and systematically for obvious signs of defects, deep rusting, or leakage?
- Are all air receivers periodically and systematically inspected, including safety valves?
- Are all safety valves tested regularly, systematically, and frequently?
- Is compressed air used to clean tools, machines, equipment, and parts reduced to less than 30 pounds per square inch (psi)?

Lockout/Tagout Language

Energized - Machines, equipment & tools are energized if they are connected to an energy source, or contain stored or residual energy even after being disconnected.

Energy-isolating device - Any mechanical device that physically prevents release or transmission of energy.

Energy source - Any source of power that can activate a machine or piece of equipment.

- Electrical, mechanical, hydraulic, pneumatic, chemical, thermal.

Energy control procedure - Written document containing all information needed to properly control hazardous energy when shutting down a machine or equipment.

Energy control program - Program to prevent accidental or inadvertent

Lockout/Tagout Language

Affected employee - Employees who perform their jobs in areas in which the procedure in question is implemented and service/maintenance operations are performed.

- Do not implement energy control procedures unless authorized.

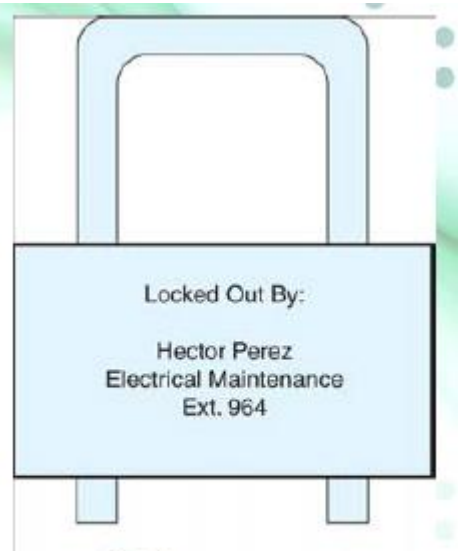
Authorized employee - Employees who do machine service/maintenance & use lockout/tagout procedures.

Capable of being locked out - A device is capable of being locked out:

- If it has a hasp to which a lock can be attached
- If it has another appropriate integral part through which a lock can be attached
- If it has a built-in locking mechanism
- If it can be locked without permanently dismantling, rebuilding, or replacing the energy-isolating device.

Lockout/Tagout Language

- **Lockout -** Placing a lockout device on an energy-isolating device to prevent accidental or inadvertent energizing of a machine during servicing.
- **Lockout device -** Any device that uses a positive means to keep an energy-isolation device in the safe position to prevent accidental/inadvertent energizing.





GENERAL PRECAUTIONS

- All operators should be trained in the safe operation and maintenance of their machines.
- All machine operators should be trained in emergency procedures to take when accidents occur.
- All workers should know how to activate emergency shutdown controls.
- All workers Know where the controls are and how to activate them.
- Inspection, maintenance, adjustment, repair & calibration of safeguards should be carried out regularly.
- Supervisors should ensure that safeguards are properly in place when machines are in use.
- Employees who disable or remove safeguards should be disciplined appropriately.

- Operator teams of the same system should be trained in coordination techniques, and proper use of devices that prevent premature activation by a team member.
- Operators should be trained/supervised to dress properly.
    - ➢ No long hair, loose clothing, neckties, rings, watches, etc.
- Shortcuts that violate safety principles & practices should be avoided.
- Pressures of deadlines should never be the cause of unsafe work practices.
- Workers who work around machines—but do not operate them—should be made aware of emergency procedures to take when an accident occurs.

Falling, Impact, Acceleration and Lifting Hazards

Fall Hazard

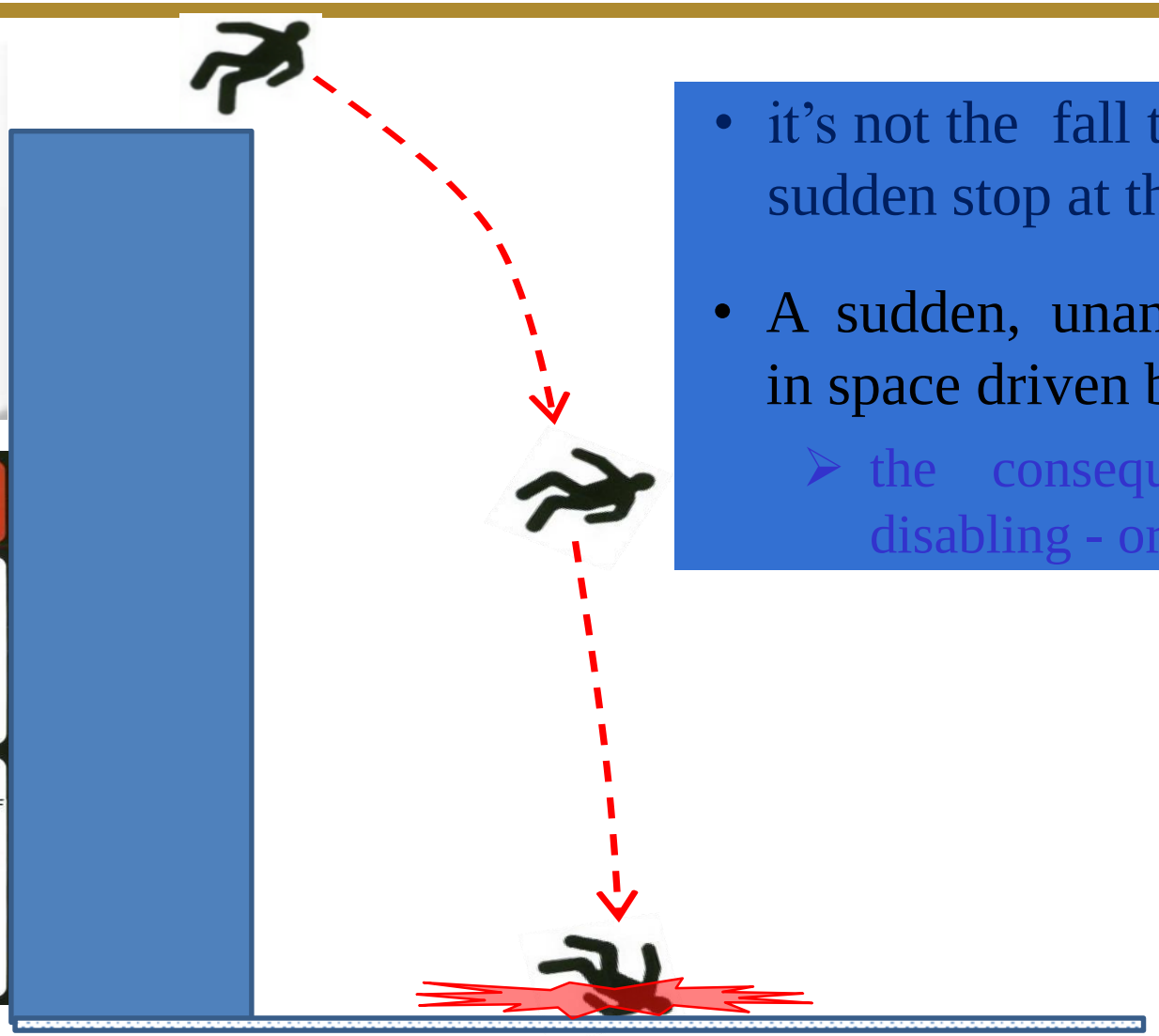
- **Falling** is the action of a person or animal losing their footing and ending up in a lower position, often on the ground.
- It is the second-leading cause of accidental death worldwide and a major cause of personal injury.
- Falls are a major safety & health concern.
  - Over 16% of all disabling work injuries result from falls.



Fall Hazard







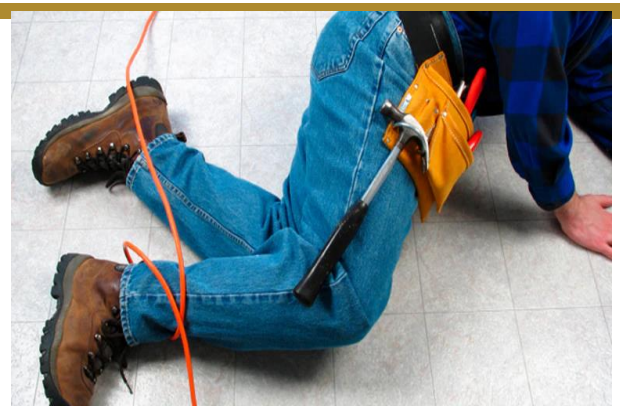
- it's not the fall that hurts but the sudden stop at the end
- A sudden, unanticipated descent in space driven by gravity
  - ➢ the consequences are often disabling - or deadly

Fall Hazard

- A fall can be fatal, especially if head injuries are incurred.
- Falls are a major cause of accidental death in the home and the workplace.
- The consequences of a fall depend on three major factors:
  - Velocity of the initial impact
  - Magnitude of deceleration upon impact
  - Orientation of the body upon impact

Causes of Falls

- **A foreign object on the walking surface**
  - ➢ any object that is in a position to trip someone or cause a slip.
- **Design flaw in the walking surface**
  - ➢ uneven surfaces, poorly designed floor coverings, etc.
- **Slippery surfaces**
  - ➢poor choice of material, accidental spills, poor housekeeping etc.
- **An individual's impaired physical condition**
  - ➢visual impairment/distraction, lack of awareness etc.







Kinds of Surface Falls

- **Trip and fall**
  - accidents occur when workers encounter an unseen foreign object in their path.



- **Stump and fall**
  - accidents occur when a worker's foot suddenly meets a sticky surface or a defect (i.e. cracked sidewalk) in the walking surface.



- **Step and fall**
  - accidents occur when a person's foot encounters an unexpected step down (e.g. a hole in the floor or a floorboard that gives way).

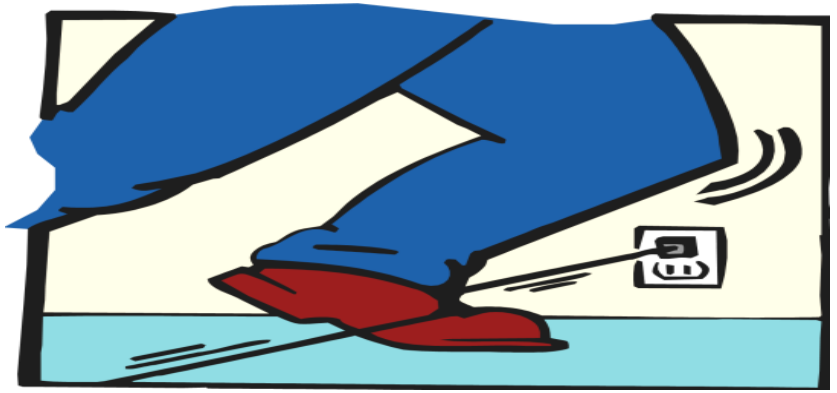
- **Slip and fall**
  - accidents occur when the worker's center of gravity is suddenly thrown out of balance (e.g. an oily spot causes a foot to shoot out from under the worker).



Walking & slipping

- Walking on an unstable platform can be hazardous to a worker's health

- What is unstable platform?
  - A surface with obstruction and/or lacking of traction



Strategies For Preventing Slips And Falls

- **Choose the right surface material**
  - with the highest possible coefficient of friction.
- **Retrofit an existing surface**
  - place friction enhancement devices e.g. carpet, skid strips, grooves etc..
- **Practice good housekeeping**
  - keep the surface area clean and dry.
  - Erect warning signs when cleaning or mopping.

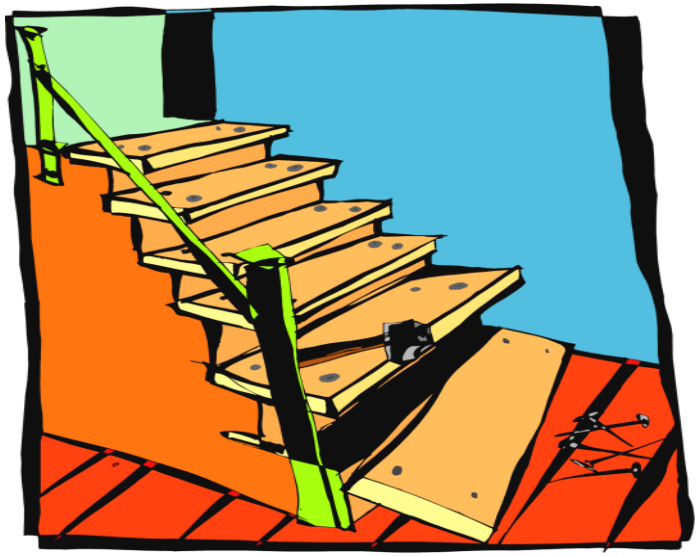


Strategies For Preventing Slips And Falls

- **Require non-skid footwear**
  - wear shoes with special non-skid soles.



- **Inspect surfaces frequently**
  - There should be frequent inspections and action should be taken immediately when a hazard is identified (spill, object).
  - Especially vital in the construction industry.



Fall Protection



- It is recommended that any employee working higher than 6 feet must be provided with fall protection.



- This height limit is known as the **trigger height**.
- Fall protection devices: e.g. guardrails, safety nets, fall restraint system, fall arrest system etc.





Ladder Hazards

- Ladders present unique opportunities for unsafe acts and unsafe conditions (increased potential for falls).





- Employees who use ladders must be trained in proper selection, inspection, use and storage.



The Dos and Don’t Dos

















Ladder Hazards

- Ladders with missing or broken parts.
- Using a ladder with too low weight rating.
- Using a ladder that is too short for the purpose.
- Using metal ladders near energized electrical equipment.
- Objects falling from ladders.





Ladder Hazards



Ladder Inspection

Inspect ladders before each use!

- All rungs and steps are free of oil, grease, dirt, etc.
- All fittings are tight.
- Spreaders or other locking devices are in place.
- Non-skid safety feet are in place.
- No structural defects, all support braces intact.
- Make sure the ladder is placed on an even surface.



Ladder Safety

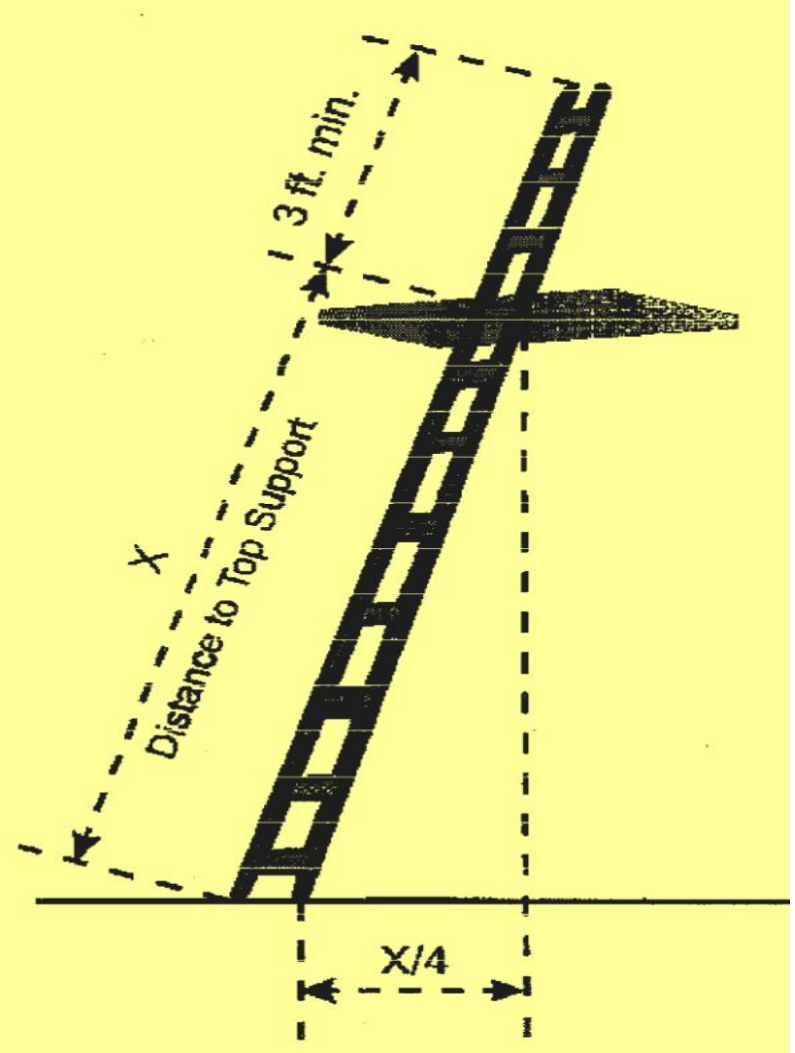
- Never allow more than one person on a ladder.
- Use tool belts or hand lines to carry objects.
- Do not lean out from the ladder in any direction.
- If you have a fear of heights – don't climb a ladder.
- Do not allow others under a ladder in use.





Ladder Setup

- Place ladder on a clean slip free level surface.
- Extend the ladder 3-4 feet above the top support, if used to access roof or other elevated surface.
- Anchor or secure the top of the ladder when the 3-4 feet extension is not possible.
- Place the ladder base ¼ the height of the ladder from the wall when using a straight ladder.



What's wrong?

Very creative but not a good idea…





What's wrong?

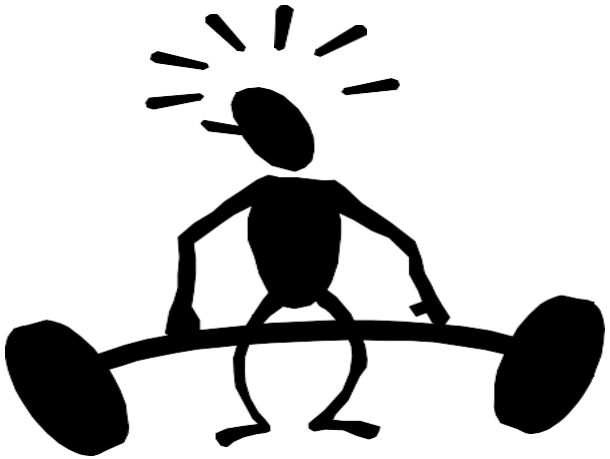
How about this?





Lifting Hazards

- Back injuries are common workplace problems.
- Back injuries are typically caused by **improper lifting**, ergonomic factors and personal lifestyles.
- Most back injuries can be prevented.







Safe Lifting



STAND close to the load



Bend your knees, not your back!

Let your legs do the lifting

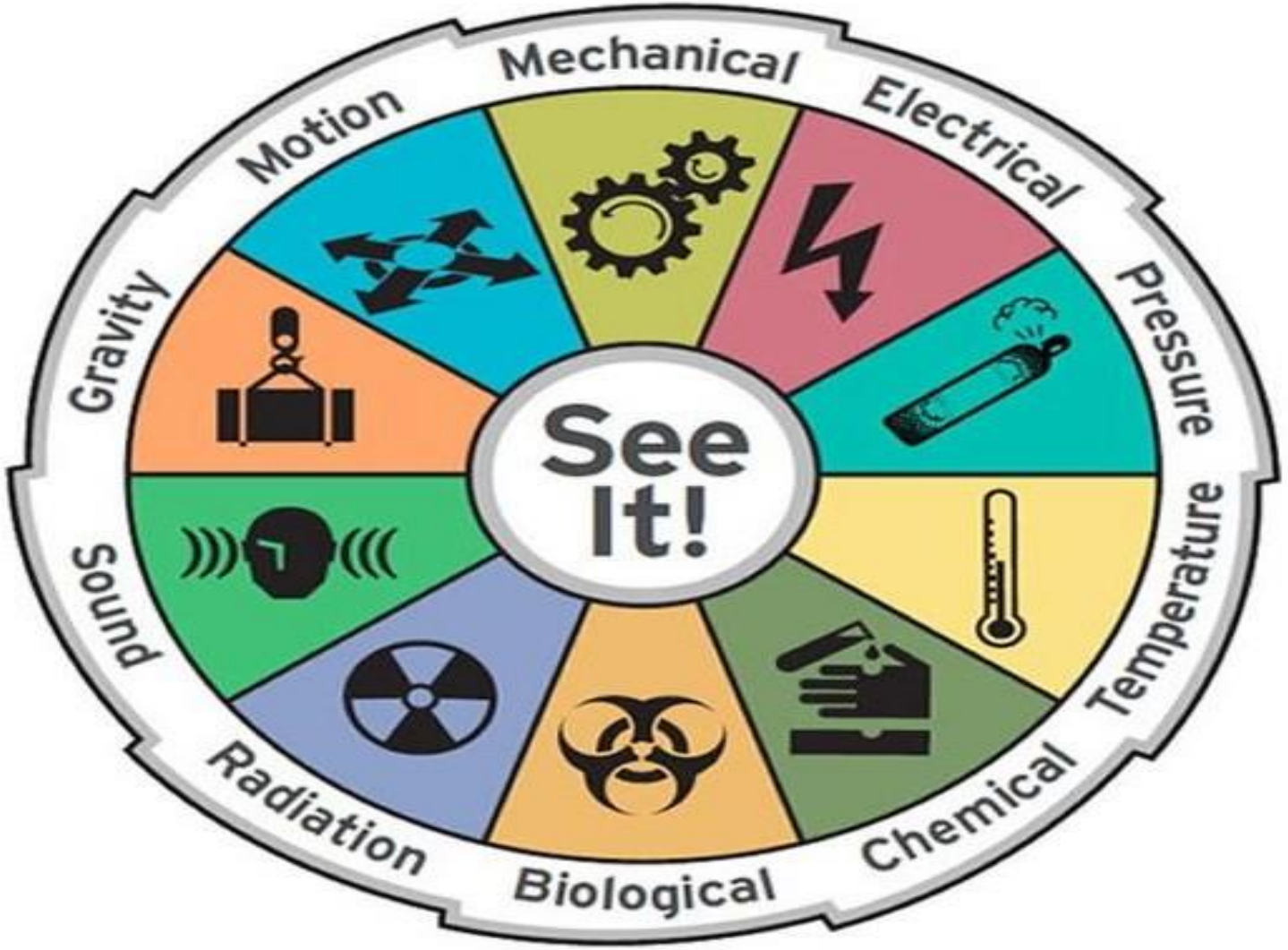


Get Help with heavy or awkward loads!



Use the right tools!

Electrical & Radiation Hazards





ELECTRICAL HAZARDS

Electrical & Radiation Hazards

WHAT IS ELECTRICAL HAZARDs

- "A dangerous condition where a **worker could make electrical contact** with energized equipment or a conductor, and **from which the person may sustain an injury** from shock; **and/or, - there is potential for the worker to receive** an arc flash burn, thermal burn, or blast injury"

TYPES OF ELECTRICAL HAZARDS

- An electrical hazard can be defined as a serious workplace hazard that exposes workers to the following:



TYPES OF ELECTRICAL HAZARDS

BURNS - A burn is the most common shock-related injury. Burns from electricity are one of three types:

- Electrical,
- Arc/Flash or
- Thermal Contact





ELECTROCUTION - is fatal that means it can kill.

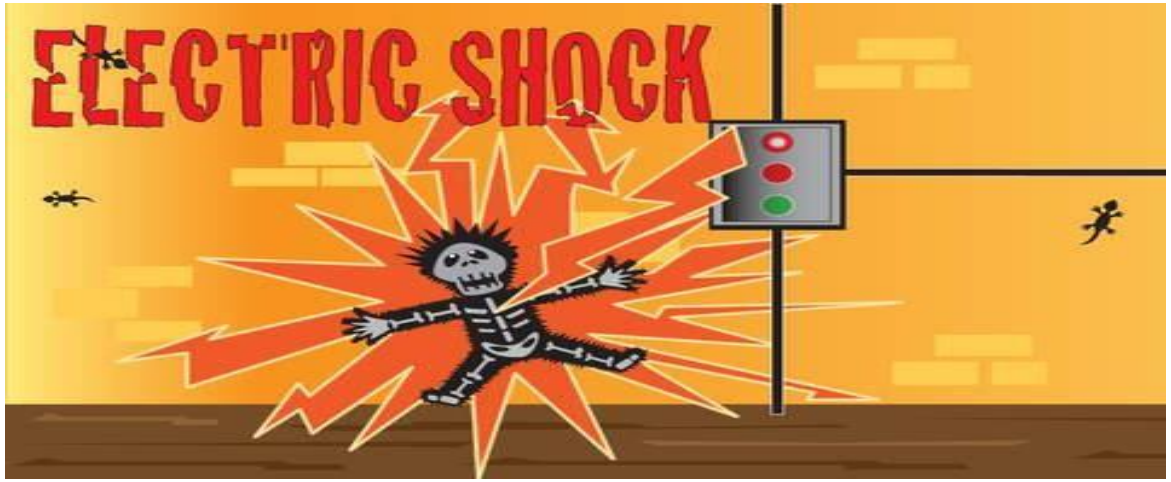
- **Electrocution** results when a human is exposed to a lethal amount of electrical energy.

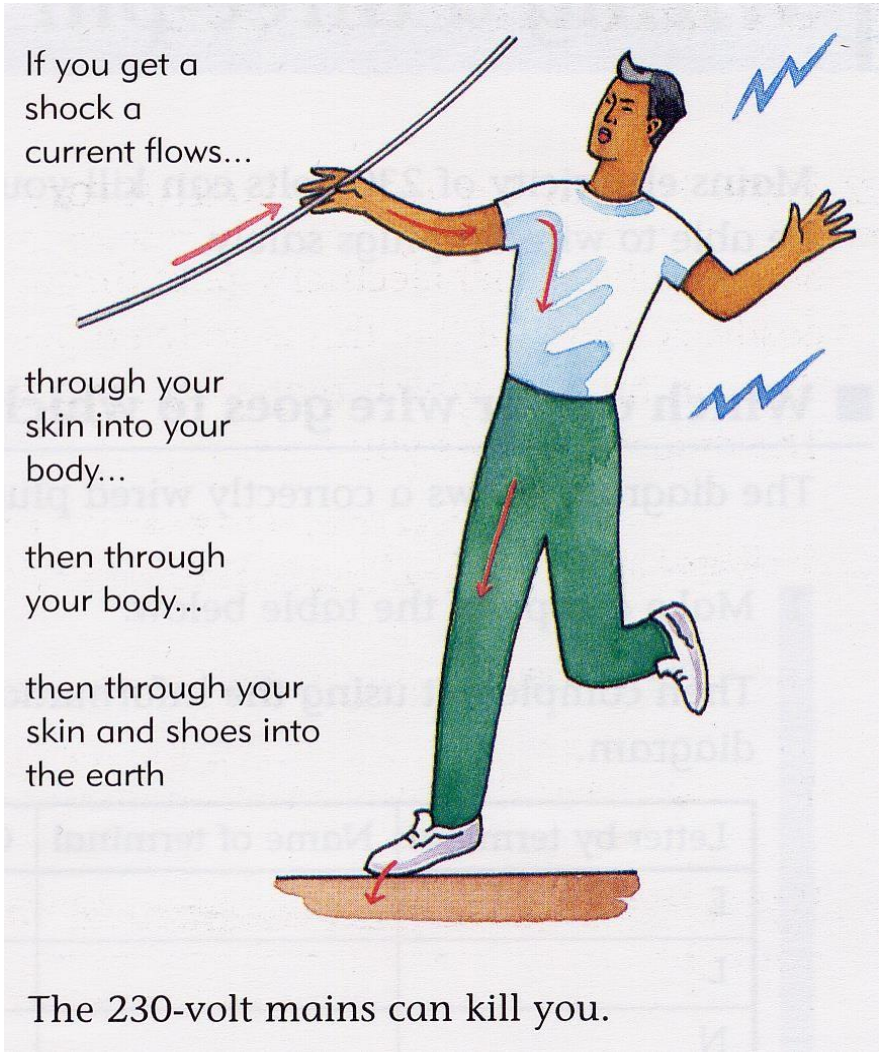
TYPES OF ELECTRICAL HAZARDS

SHOCK - Electric shock occurs when the human body becomes part of the path through which current flows.

- LOW VOLTAGE DOES NOT MEAN LOW HAZARD







TYPES OF ELECTRICAL HAZARDS

ARC FLASH/BLAST

- An arc flash is the **sudden release of electrical energy through the air** when electric current flows through an air gap between conductors.
- An arc flash gives off thermal radiation (heat) and bright, intense light that can cause **burns.**
- High-voltage arcs can also produce considerable pressure waves by rapidly heating the air and creating a blast.





TYPES OF ELECTRICAL HAZARDS

FIRE - Most electrical distribution fires result from problems with '**faulty wiring**'.



Cords in poor condition can **overheat** or cause sparks and start a **fire**.

EXPLOSIONS - An explosion can occur when electricity ignites an explosive mixture of material in the air.



THE CAUSES OF ELECTRICAL HAZARDS





- Damaged insulation
- Overloading
- Overheating
- Wet conditions
- Poor or loose connections
- Store or use flammable/explosive materials near electrical equipment





IMPACTS TO HUMANS

Depends on:

- ✓ Current and Voltage
- ✓ Resistance
- ✓ Path through body
- ✓ Duration of shock



- "Let Go" Threshold is the current level where we lose control of our muscles and the electricity causes muscles to contract (freeze effect) until the current is removed.
- If you witness a “freeze”
  - Shut off the power
  - Use a non-conductive object to knock the person free of the contact

IMPACTS TO HUMANS



	> 300 mA Death almost certain; if survive will have badly burnt organs and probably require amputations.
	75 – 300 mA – usually fatal; ventricular fibrillation of the heart and death
	• **1 0mA** – Faint tingle • **> 3 mA** – Painful shock • **6 – 9 mA** – "Let-go" current for women & men • **10 - 30 mA** – Muscles contraction "**Freeze**". It may not be possible to "let go" • **30 – 75 mA** – respiratory muscles can become paralyzed; pain

DETECTION OF ELECTRICAL HAZARDS



Continuity tester

- *to ensure a grounding wire is electrically continuous throughout the extension cord or power tool*



Receptacle wiring tester

- *to verify that an AC wall outlet is wired properly*



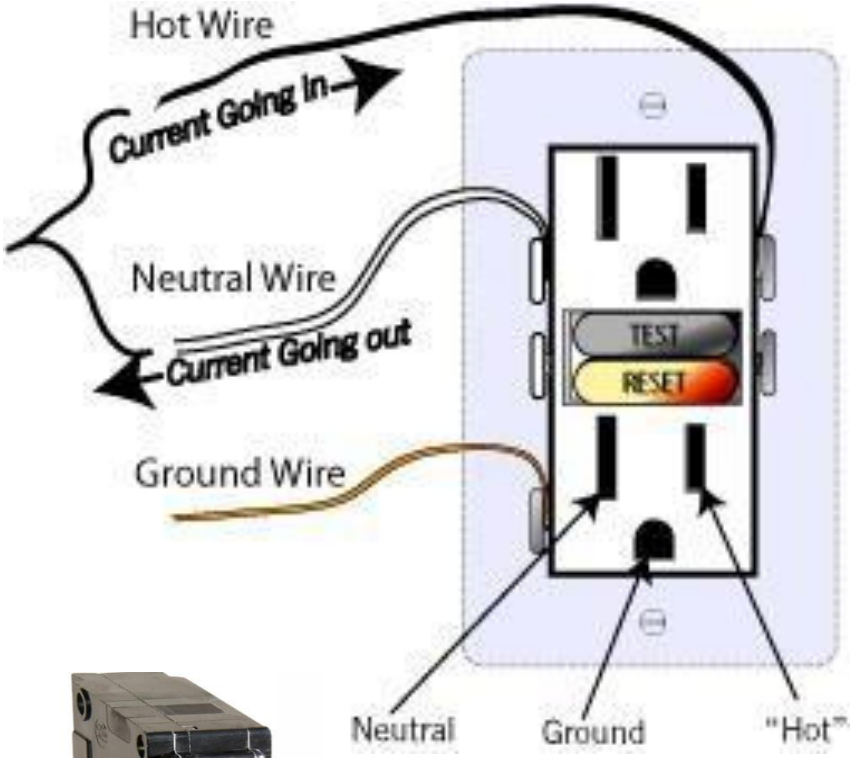
Circuit tester

- *to verify that an AC wall outlet is wired properly*

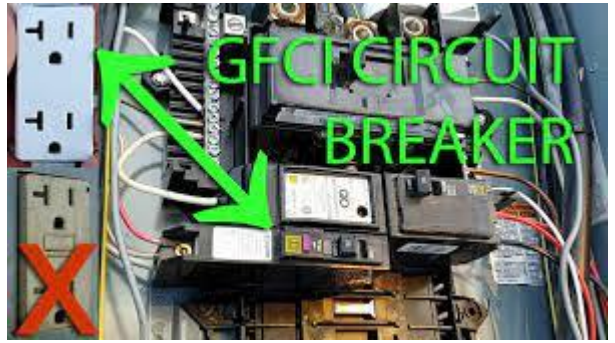
CONTROL OF ELECTRICAL HAZARDS

A ground fault circuit interrupter (GFCI)

- A GFCI is a fast-acting circuit breaker.
- It shuts off an electric power circuit when it detects that current is flowing along an unintended path, such as through water or a person.
- It senses small imbalances in the circuit caused by current leakage to ground.



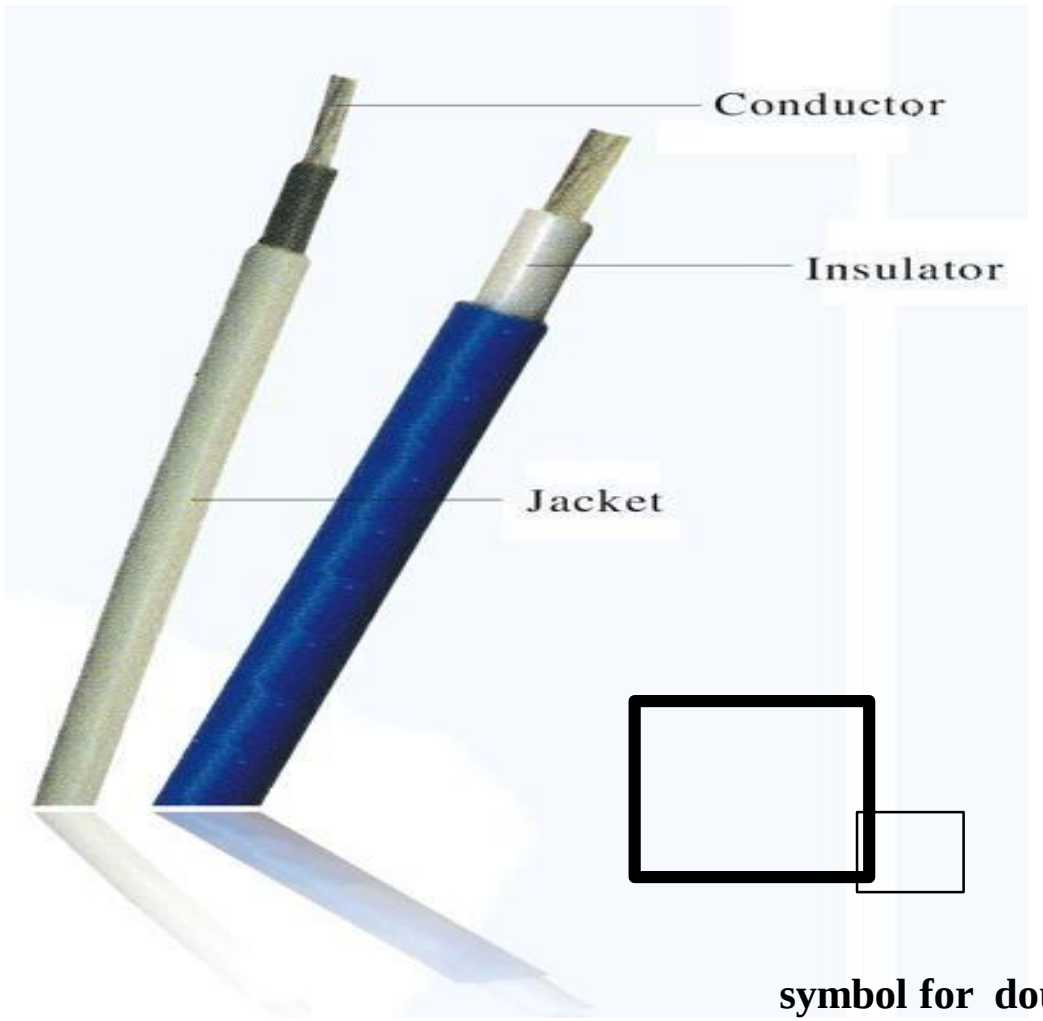




CONTROL OF ELECTRICAL HAZARDS

✓ Double insulation

- Some appliances have casing made of insulating materials , such as plastics. Thus, they have **double insulation**.
- Hand-held electrical appliance, such as hair dryer, is protected by **double insulation**.



symbol for double insulation

CONTROL OF ELECTRICAL HAZARDS

✓ Fuses

- An electric fuse is a device which is used to limit the current in an electric circuit.
- The fuse protects the circuit and the electrical appliances from being damaged – when there is too much current, the fuse melt.
- Fuses in plugs are made in standard ratings (3A, 5A, 13A etc...)



symbol

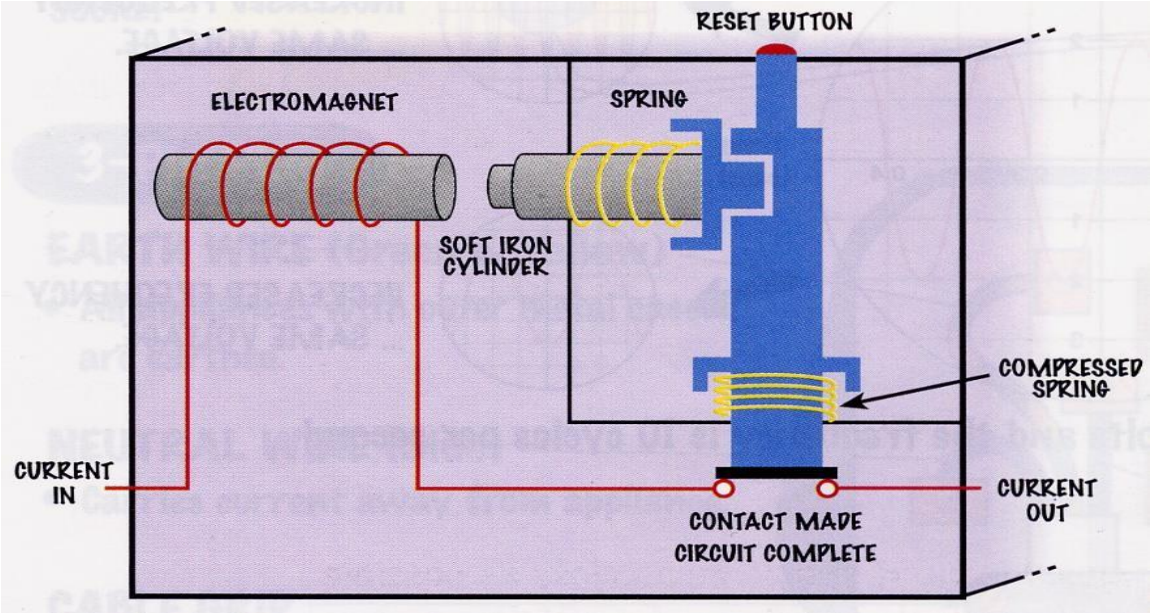


CONTROL OF ELECTRICAL HAZARDS

Circuit breaker

- A circuit breaker (CB) is automatically operated electrical switch designed to protect an electrical circuit from damage caused by current overload or short circuit.

- Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.



Circuit breakers work quicker than fuses. (saves lives)

CURRENT BECOMES TOO HIGH → ELECTROMAGNET ATTRACTS SOFT IRON CYLINDER → PAIR OF CONTACTS ARE SEPARATED → CIRCUIT BROKEN → CABLE OR APPLIANCE IS PROTECTED

CONTROL OF ELECTRICAL HAZARDS

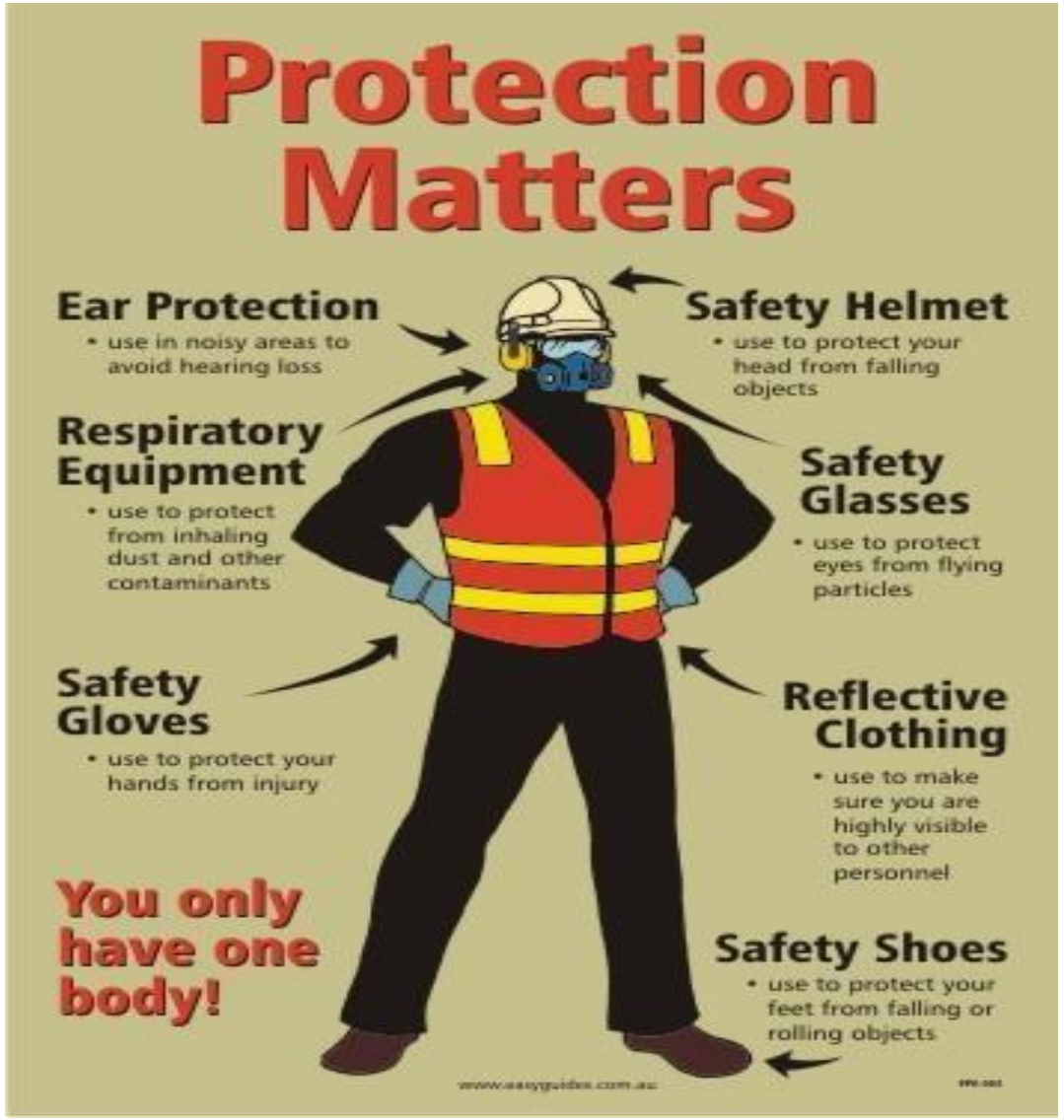
- ✓ **Circuit breaker**



CONTROL OF ELECTRICAL HAZARDS

✓ **PPE**

Wear non conductive glove, shoes and shirt.

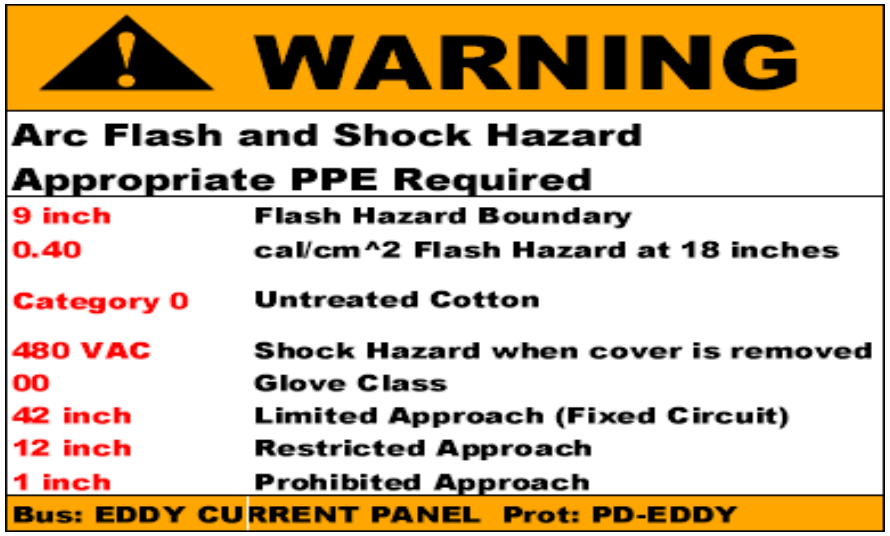


SIGNS AND LABELS

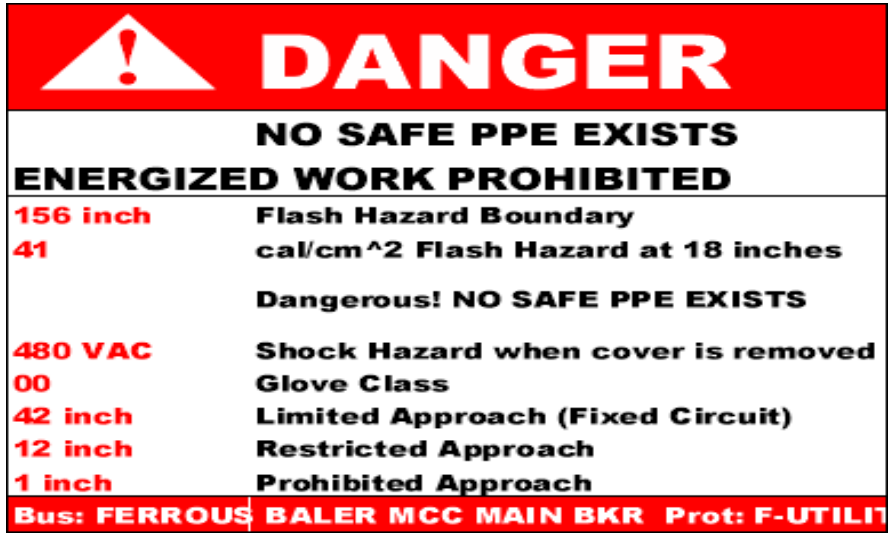












SUMMARY



- Electricity will try to reach ground even if it means going through a person
- Even the "small" voltage can cause serious injury

- Always inspect power tools and cords and do not use them if damaged
- Do not attempt to repair electrical equipment unless trained and qualified

Electricity is essential but, if improperly used, it can be DEADLY!

Laboratory safety

Introduction

- **Laboratory safety** is the key to reducing injury and illness. There are many exposures in the laboratory that pose a hazard to your health and you may have never considered them as a hazard before.

Let's Get Started!

- Working in a laboratory can be an exciting experience.
- It can also pose many threats and hazards that a traditional classroom does not.
- That is why it is important to know your surroundings.
- Know where the exits to your room are.
- There may be more than one exit which could be critical in the case of an emergency.



Know Your Surroundings

- Know where the fire alarm is in proximity to your laboratory. Is it right down the hall or is it in the stairwell? If there is a fire, a quick response is the best response. Have your supervisor show you the closest alarm. The fire safety training will detail the safety procedures for your lab.



Hazardous Substance

Many laboratories contain hazardous substances.

A hazardous substance is defined as a material/substance that poses a physical or health hazard. This includes both chemicals and biological agents.

A Biohazard is defined as any organism that is capable of replication and is capable of causing disease in human, animal or plant.

There are differences between a physical hazard and a health hazard. Let's take a look.

Health Hazard

A health hazard has the following characteristics:

- Carcinogen
- Toxic or highly toxic
- Reproductive Toxins
- Irritants
- Corrosives
- Sensitizers
- Hepatotoxins
- Nephrotoxins
- Neurotoxins

Physical Hazard

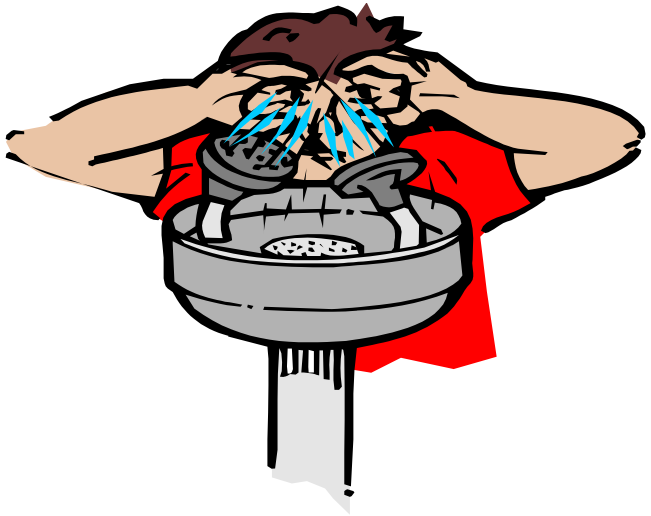
A physical hazard has the following characteristics:

- Explosive
- Flammable
- Oxidizer
- Pyrophoric
- Organic peroxide
- Compressed gas
- Combustible liquid
- Unstable (Reactive)
- Water-reactive



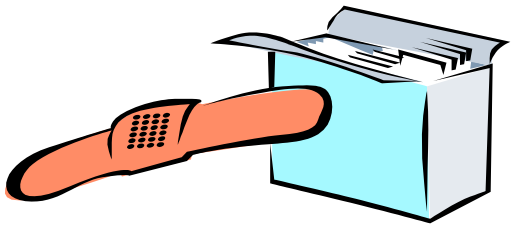
When physical hazards and health hazards exist, it is very important to know where the eye wash/safety shower is located. Unexpected accidents do occur and knowing where to go at the time of an emergency can reduce injury/illness.







- First aid kits have a variety of quick relief items.
- If your lab has a first aid kit, find out where it is. If more than first aid is needed, it is recommended to go to Student Health Services for further treatment.
- In an event that would require more than first aid to be treated, report it to the Student Health Services office as soon as possible.



Know What Hazards are Present

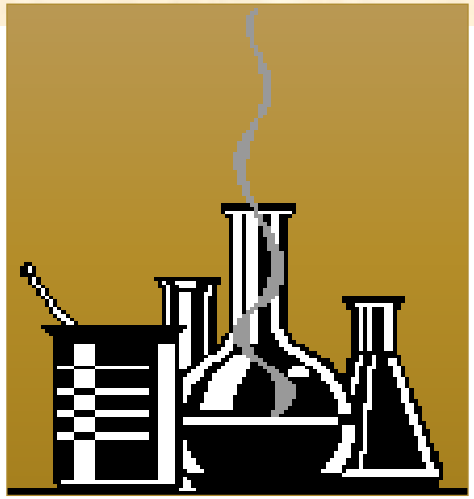


Hazards in your Lab

Each lab is faced with different hazards. There could be exposure to biological, chemical, or radioactive material, which may pose a variety of physical and/or health hazards.

Chemicals Hazards in your Lab

- Chemicals can pose a significant hazard. They should be limited to the use under a properly working fume hood.
- Chemicals can release hazardous fumes which not only harm the environment, but they can be a major health threat.
- They must be handled carefully and disposed of properly.



Hazards in your Lab

- When a chemical is in the laboratory, the hazards of that chemical must be communicated to you.
- a Chemical Hygiene Plan (CHP) is required to relay information regarding procedures, equipment, PPE, and work practices that are capable of protecting workers from health hazards.
- Your advisor is in charge of providing the information contained in the CHP to you.

Lab Safety

- It is important to take responsibility for your actions and to keep in mind that irresponsible acts could have lasting future effects.
- As the hazards increase, the risks increase, and the responsibility must increase.

Lab Attire

You should remember the following:

- ✓No open-toed shoes
- ✓No shorts unless a lab coat is used
- ✓Restrain hair when working with hazardous materials
- ✓Remove protective clothing in public
- ✓Use the proper Personal Protective Equipment for the job





Personal Habits in the lab

Personal habits play a large role in minimizing hazards. The following measures must be taken:

- Do not eat, drink, smoke, chew gum or apply cosmetics, or remove/insert contact lenses while in the laboratory
- Do not store food or beverages in the lab or in chemical refrigerator
- Do not mouth pipette
- Wash hands before leaving laboratory or after handling contaminated material





Safe Practices in the Lab

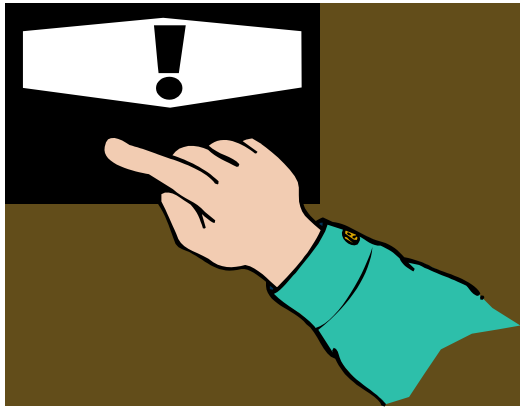
These safe practices should be followed to ensure safe working conditions:

- Do not use chipped or cracked glassware
- When working with hazardous materials, have a second person nearby
- Know emergency procedures
- Keep the laboratory neat and clean
- Use hazardous chemicals under a fume hood and biohazardous materials under a biosafety cabinet (BSC)
- Decontaminate as needed
- All procedures should be performed to minimize aerosol



Chemical Labeling

- It is important to know as much about a chemical as possible.
- The most dangerous substance is the one that has **no label**. Communicating information is essential in the science field.
- Labeling is also required for chemicals that are in a secondary container unless it is to be used within an 8 hr period.
-



Labeling



When labeling the secondary container the following information must be included:

- Identity of the hazardous chemical
- Appropriate hazard warnings
- Name and address of the chemical manufacturer, importer, or other responsible party.



Fire Safety and Prevention



Fire







Photo from: http://flogginnoggin.wordpress.com



Photo from: www.fire-resistance.demon.co.uk

Algeria Refinery Blast, January 2004







Fire

Fire, or combustion, is a rapid oxidation- reduction reaction.

In a fire, the burning substance (fuel) combines with an oxidant (oxygen) to produce smoke, heat and generally visible light.

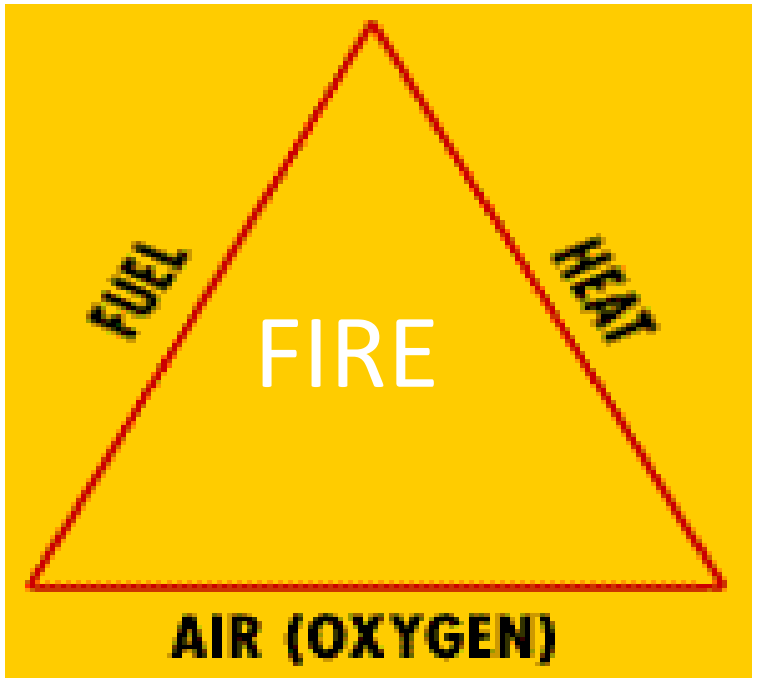
Fire hazards are the various conditions within an environment that can elevate the risk of fire.

Three elements required to start and sustain a fire are: fuel, heat and oxygen.

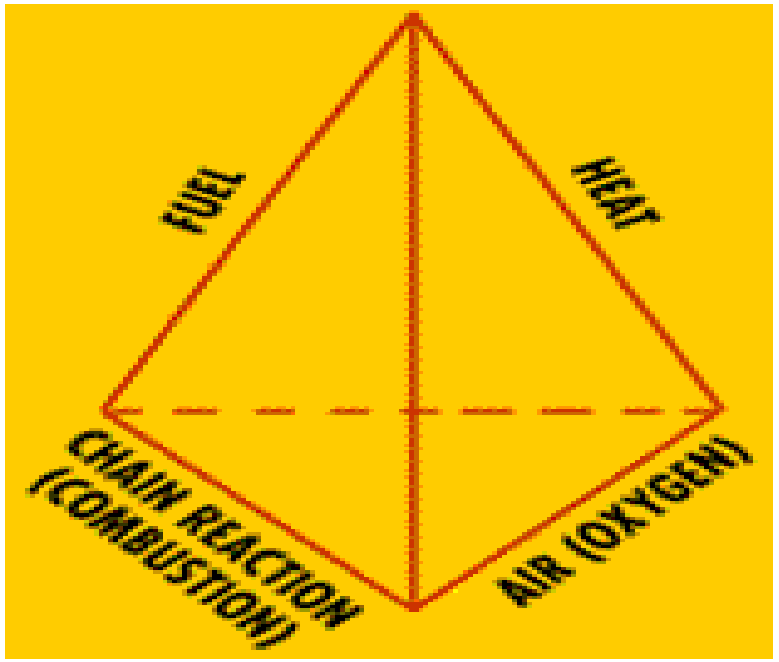
Leading Causes of Fires and Fire Deaths

- Mishandling of flammable materials and excess of heat are leading causes of industrial fires.
- Cooking is the leading cause of home fires. Cooking fires often result from unattended cooking and human error, rather than from mechanical failure of stoves or ovens.
- Careless smoking is the leading cause of fire deaths.
- Smoke alarms and smolder-resistant bedding and upholstered furniture are significant fire deterrents.

Fire Triangle & Fire Tetrahedron



Fire Triangle: Smoldering Mode



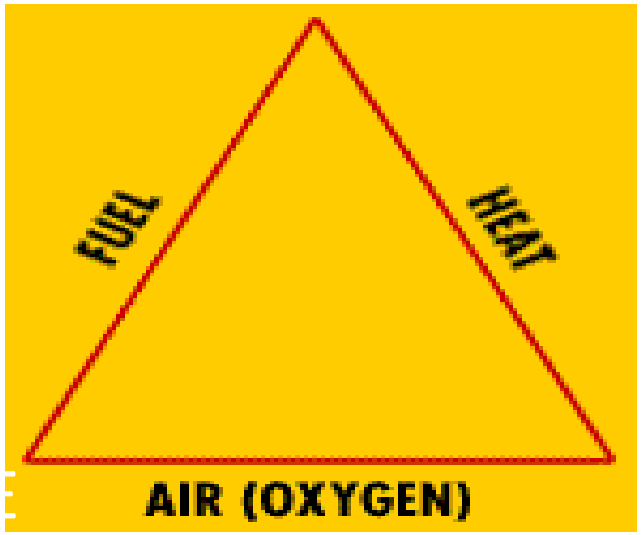
Fire Tetrahedron: Flaming Mode

Fire Triangle

Three elements are necessary for a fire to occur:

=> fuel
=> oxygen
=> heat (ignition)

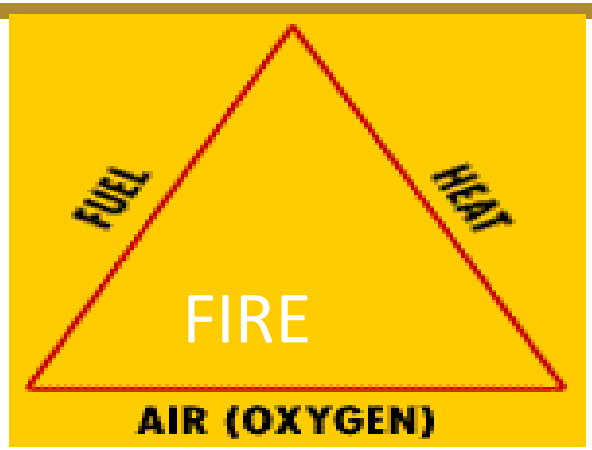
interrelated by the fire triangle



- When a fuel is heated to a sufficiently high temperature, it will ignite and continue to burn as long as the fuel remains at the proper temperature and sufficient oxygen is present.

Fire Triangle - Fuel

- Fuel is what feeds the fire.
- It must be present within desirable concentration limits for combustion to occur.



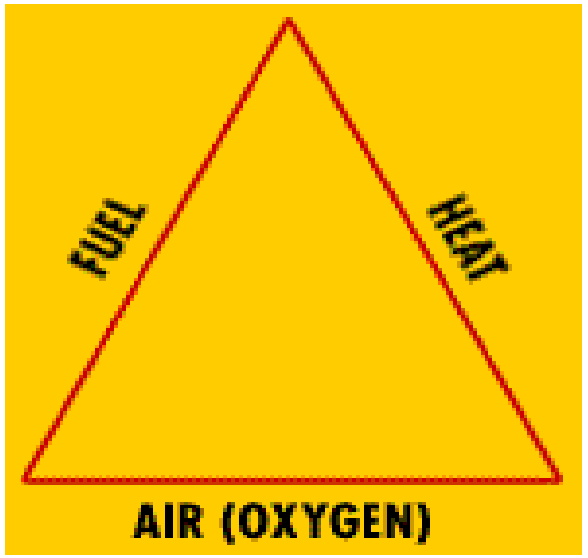
Fuel can be categorised as

=> Liquids: petrol, paint, acetone, oil, etc.

=> Solids: plastics, woods, metal particles, coal, etc.

=> Gases: hydrogen, carbon monoxide, propane, etc.

Fire Triangle - Heat

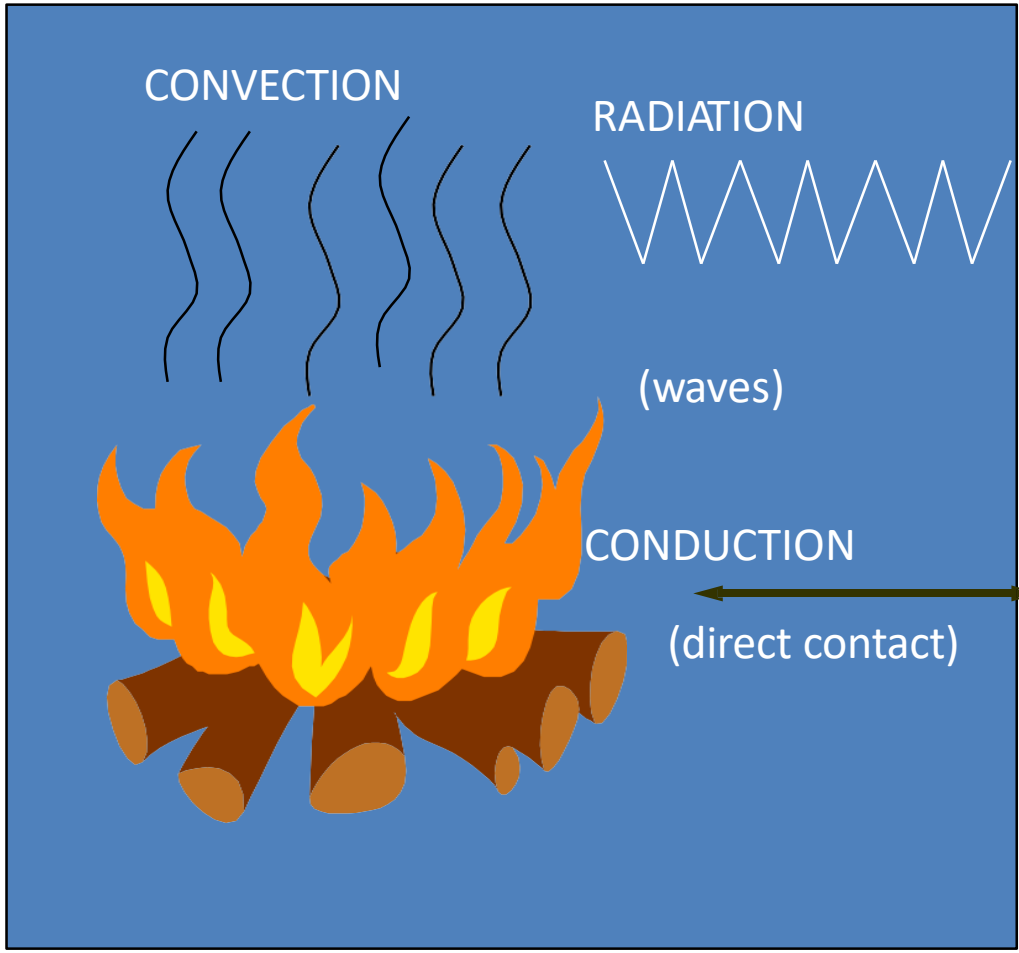


- In order for there to be a fire, heat must be introduced
- Heat energizes the fuel and oxidizer molecules so they collide with each other with sufficient velocity and force to initiate and/or sustain a reaction.
- Examples of heat sources (ignition sources) are electrical arcs and sparks, static electricity, hot surfaces, and mechanical and chemical sparks.

Fire Triangle - Heat

Heat can be transferred in 3 ways:

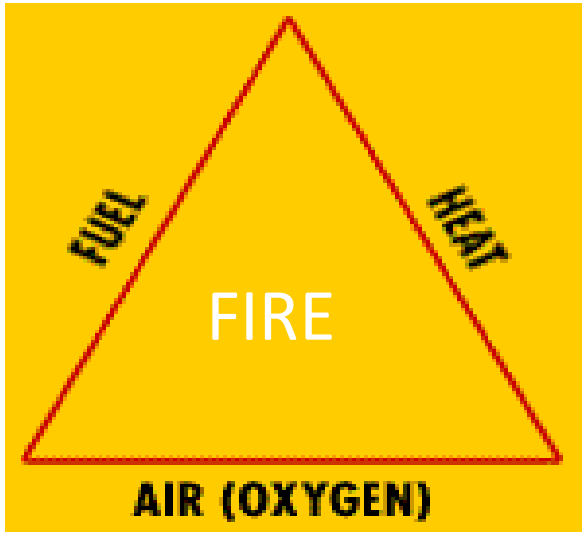
- **Conduction** = transfer of thermal energy in the form of kinetic energy via a medium.
- **Convection** = transfer of thermal energy via the movement of hot fluids.
- **Radiation** = transfer of thermal energy via electromagnetic waves.



Fire Triangle: O_2

— Atmospheric air is 21% oxygen.

— When heat is applied to a fuel in the presence of oxygen, it makes the fuel and oxygen molecules move faster.



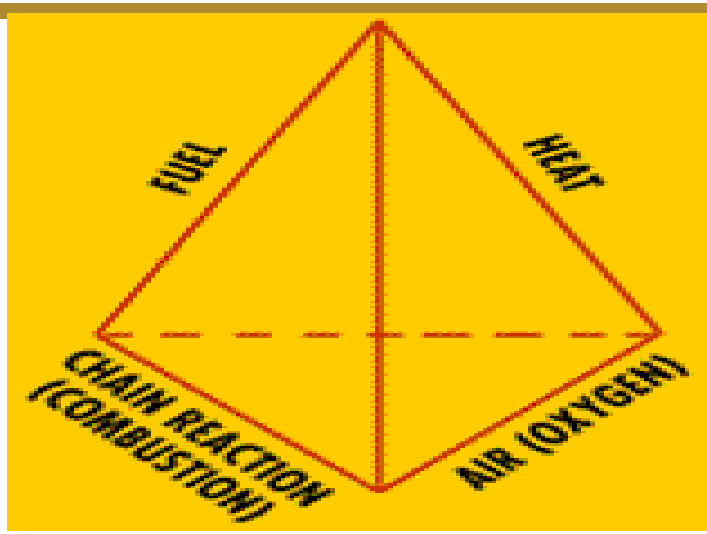
— When the molecules collide and stick together, they will react to start a fire.

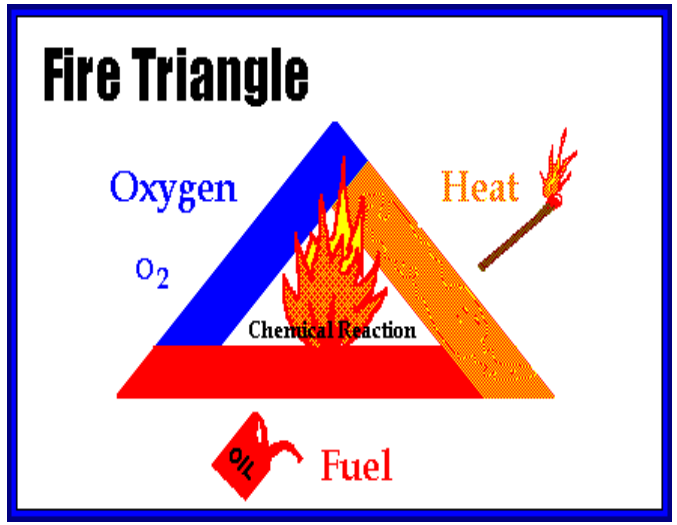
Fire Tetrahedron: Chain Reaction

The fire tetrahedron adds a 4th component:

- chemical chain reaction.

- There must be a chain reaction (chain = continuous) for a fire to sustain and/or propagate.
- In order for there to be a chain reaction, the three elements of heat, fuel and oxygen must be present continuously.
- An on going fire usually provides its own source of heat (hence sustains its self-existence).





Substances Present in Fire (Feed)

- Carbon & Hydrogen => Found in almost every flammable substance.
- Oxygen => Must be present for a fire to occur.
- Synthetic polymers => present in fires involving plastics. Often form toxic fumes when consumed in a fire.

Substances Present in Fire (Product)

Carbon monoxide (CO)

- A side product of combustion, i.e. when carbon reacts with oxygen.
- Produced when there is insufficient oxygen.
- It is colourless, odourless and toxic.

Carbon dioxide (CO_2)

- A product of combustion i.e. when carbon reacts with oxygen.
- A greenhouse gas.
- Could reduce the oxygen concentration in the surrounding air to a dangerously low level.

Substances Present in Fire (Product)

Water vapour

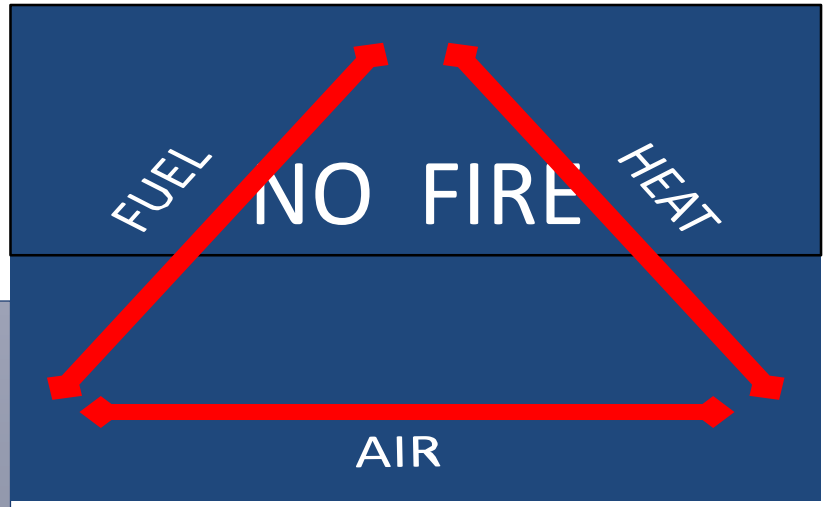
- A product of combustion i.e. when hydrogen reacts with oxygen.

Smoke

- a combination of gases, air and suspended particles (product of incomplete combustion).
- Many of the gases present in smoke are toxic.
- Most fire deaths result from smoke inhalation.

Fire Prevention

- Fire prevention can be characterized by the broken fire triangle.



- Removing the fuel, starving the fire of oxygen or cooling it below the combustion point will put out the fire.

- Fire Prevention is based on eliminating or minimizing one of the components of the “Fire Triangle”.

Fire Prevention

GOOD HOUSEKEEPING

- proper storage of flammable liquids e.g. liquids should be stored in tanks below ground level or on the first floor of multi-story buildings.
- tools and equipment that may produce mechanical or static sparks must be isolated from fuels.

DESIGN FOR SAFETY

- substitute with less flammable materials.
- use catalysts or fire inhibitors.



FIRE DETECTION

- use of systems to warn of the presence of smoke, radiation, elevated temperature or light intensity.

Different Types of Extinguisher

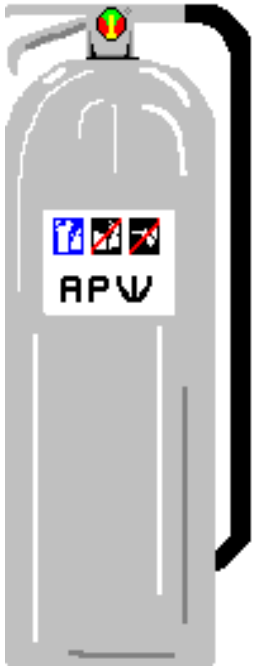
The 4 most common fire extinguishers:

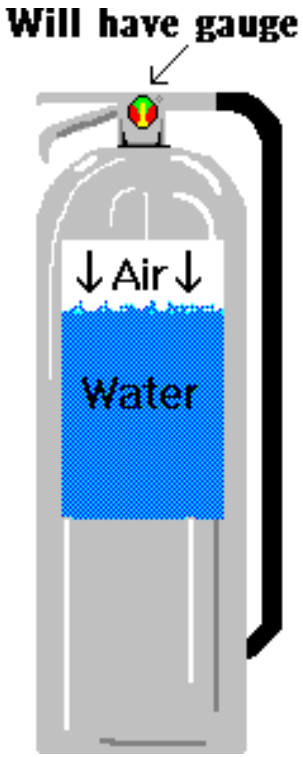
- ⇒ All Purpose Water
- ⇒ Carbon Dioxide
- ⇒ Multi-Purpose Dry Chemical
- ⇒ Dry Powder

Each type of extinguisher has its specific use.



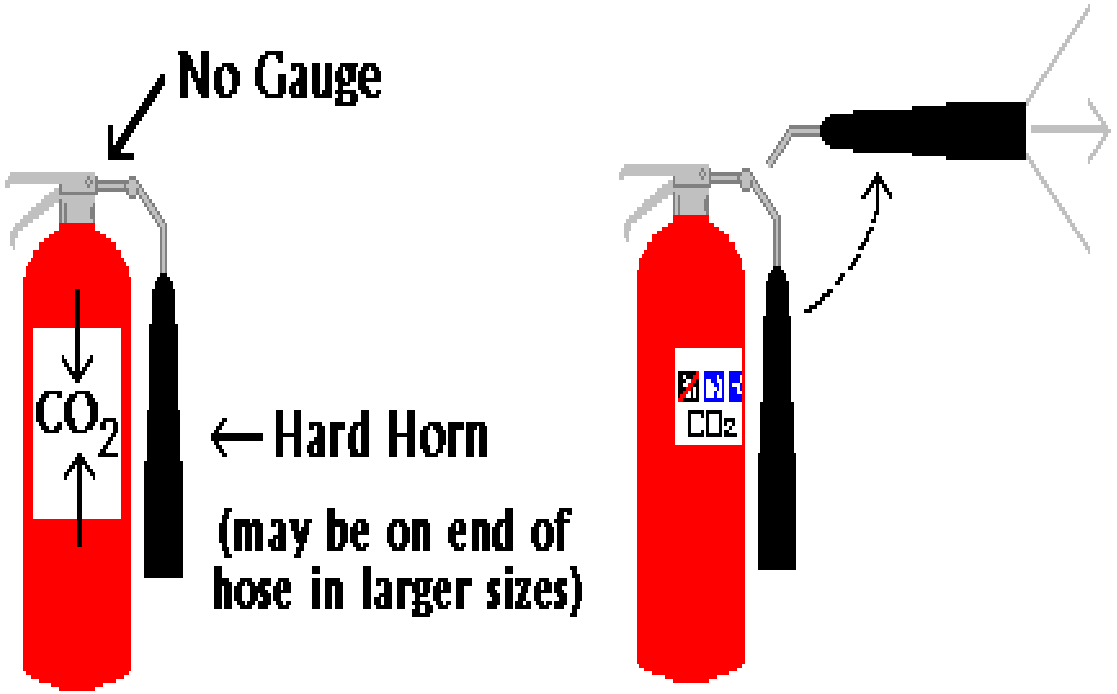
Fire Extinguisher: All Purpose Water





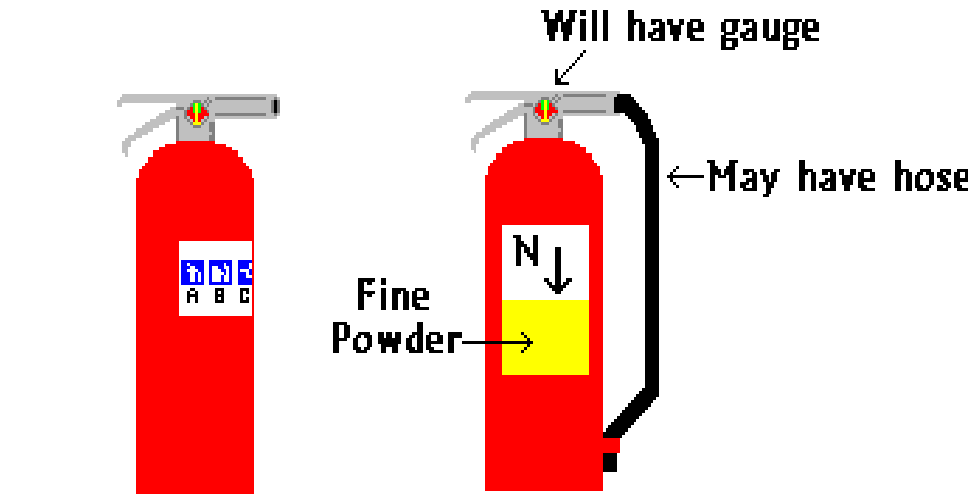
- Use on CLASS A fires.
- Pressurized water.
- Pressure gauge present.
- extinguish the fire by taking away the heat element of the fire triangle

Fire Extinguisher: Carbon Dioxide



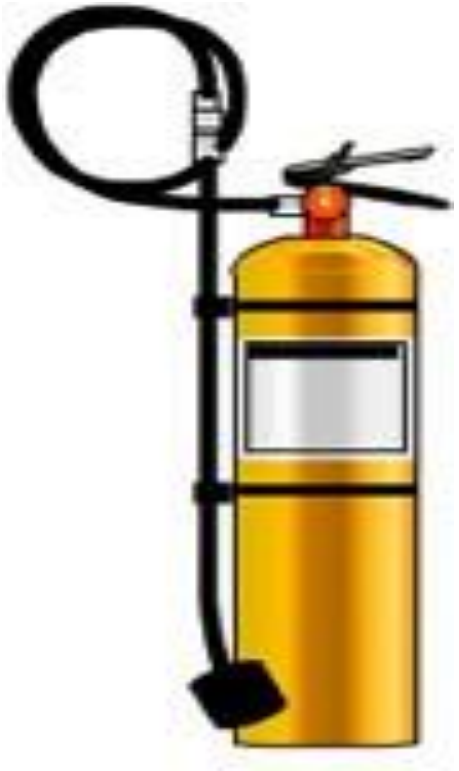
- Use on CLASS B and CLASS C fires.
- Hard, plastic nozzle.
- No pressure gauge.
- extinguish fire by taking away the oxygen element of the fire triangle and also be removing the heat with a very cold discharge

Fire Extinguisher - Multi-Purpose Dry Chemical



- Use on CLASS A, CLASS B, and CLASS C fires
- Fine powder under pressure
- Pressure gauge present
- extinguish the fire primarily by interrupting the chemical reaction of the fire triangle

Fire Extinguisher - Dry Powder

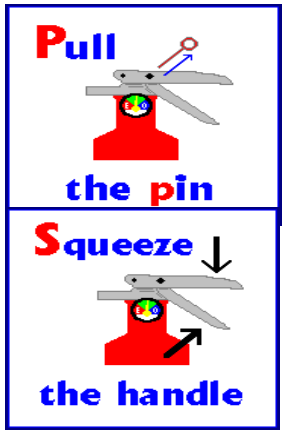


- Use on CLASS D fires
- extinguish the fire by separating the fuel from the oxygen element or by removing the heat element of the fire triangle

How to Use a Fire Extinguisher

Remember this easy acronym when using an extinguisher - P.A.S.S.

Pull the pin. Aim the nozzle.





Squeeze the handle.

Sweep side to side at the base of the fire.



NOTE: If, when using a fire extinguisher, the fire is physically larger than you can safely handle, evacuate the area and notify others by activating the emergency pull station and call TO APPROPRAITE CALL FIRE PROTECTION CENTER.

Remember to RACE during a fire

*R*escue – rescue employees in immediate danger.

*A*lert – yell out “Code Red”/”Fire” (or whatever your facility implementing procedure dictates), pull fire alarm, dial emergency phone number.

*C*ontain – Close all doors and windows.

*E*xtinguish/Evacuate – Extinguish small fires, evacuate employees, if appropriate.





Summary

Fire cause, component, products and movement

Fire prevention, extinguishers and material according to class of fire





THE END



Personal Protective Equipment












Personal Protective Equipment

Personal Protective Equipment

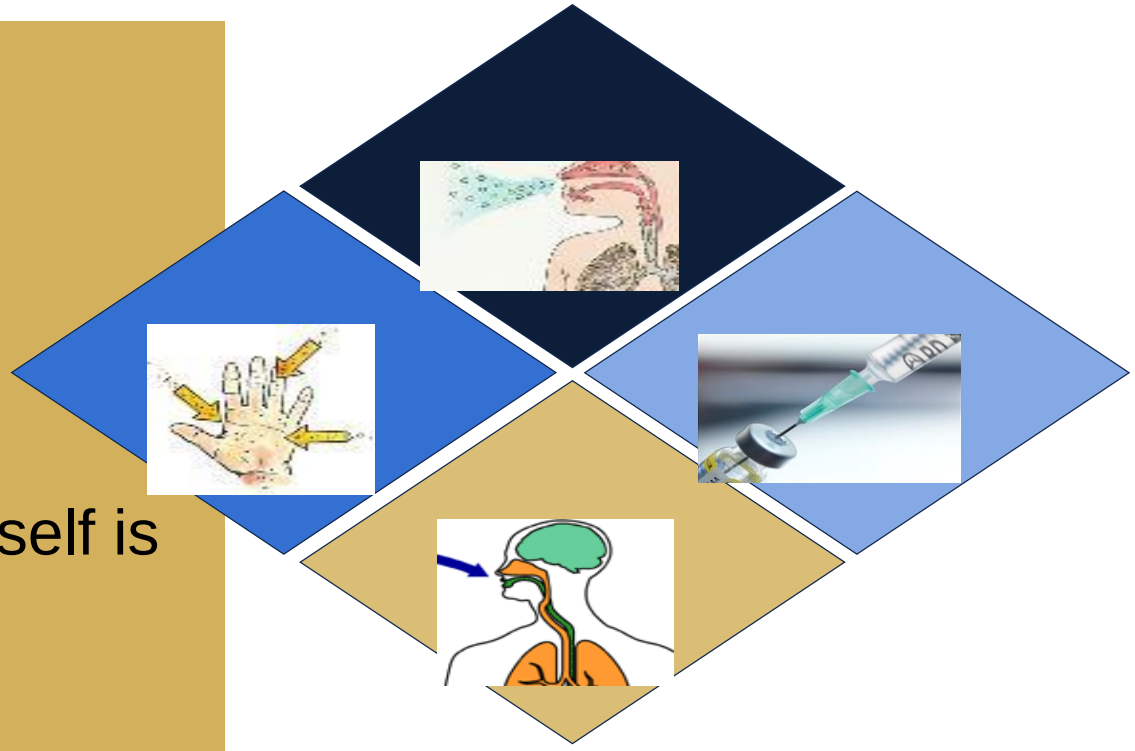
- Personal Protective Equipment (PPE) is any safety equipment that is worn to prevent injury in the workplace.
- PPE creates a barrier between the hazard and worker contact.
- They do not eliminate the hazard, so if the equipment fails then exposure occurs.
- For this reason, they must be worn always to provide protection.

Routes of Exposure

- Inhalation
- Skin Absorption
- Ingestion
- Injection

Knowing the hazards and how to protect yourself is the key to your safety!

Create a barrier using a PPE!

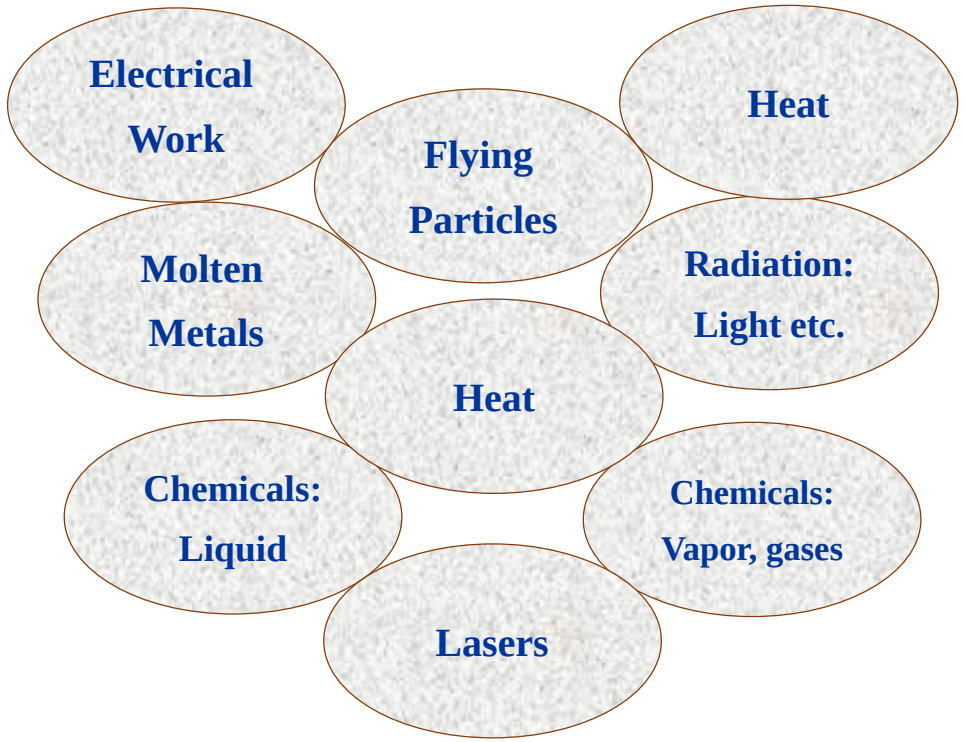


Types of PPE

- Eye & Face Protection
- Respiratory Protection
- Head Protection
- Foot Protection
- Hand Protection
- Hearing Protection
- Body Protection
- Fall Protection

Eye and Face Protection

Required for exposure to eye and face hazards such as:





Eye and Face Protection

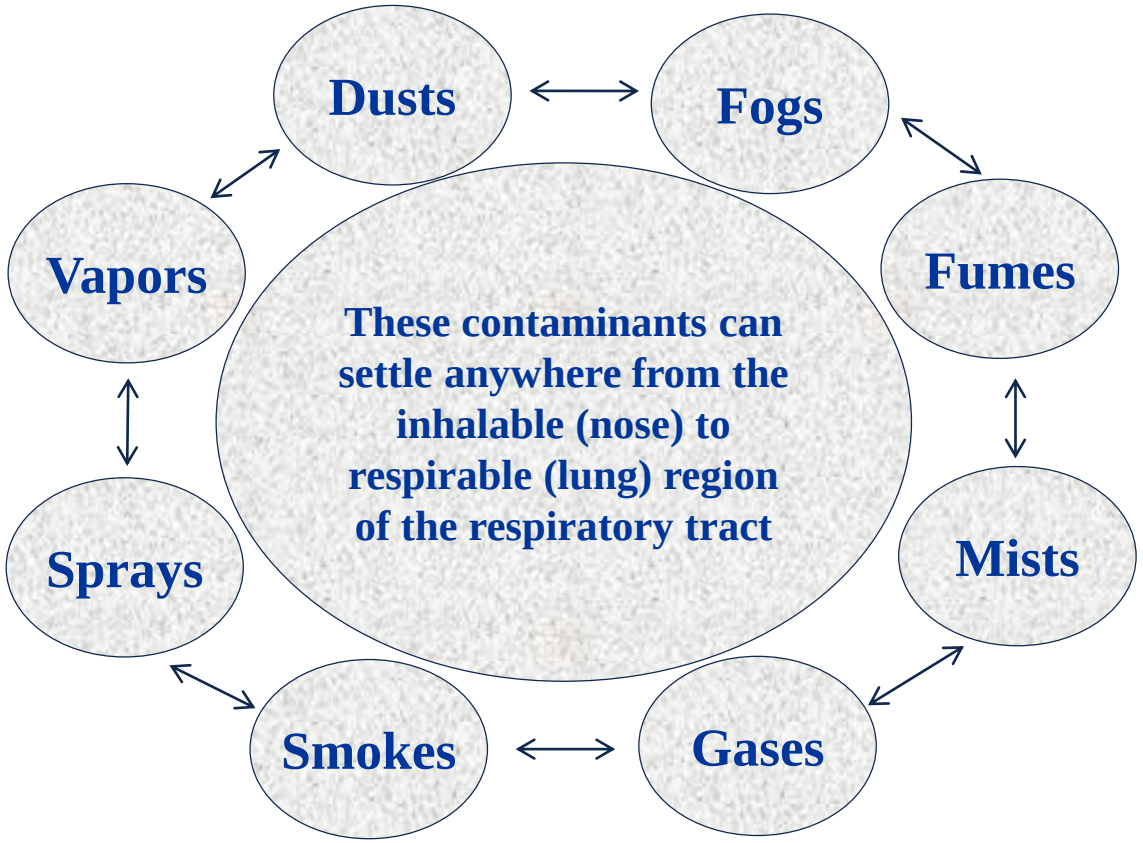
Important requirements:

- Workers/Students exposed to hazard of radiant energy (light radiation) from welding, cutting must contact EH&S for appropriate level of protection, including shaded filter lenses
- All shade numbers for lenses and helmet must conform with standards



Respiratory Protection

Required for protection against hazards such as:

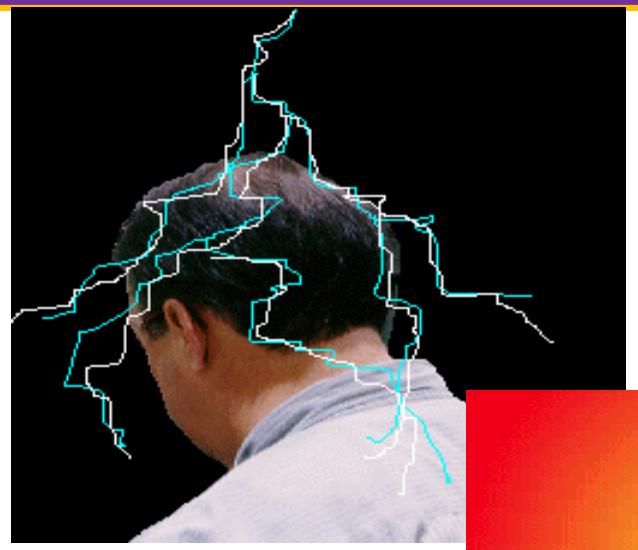




Head Protection

Required when employees are in areas where there is a potential for injury to the head from:

- Falling objects
- Flying objects
- Fixed object
- Protruding material
- High voltage equipment and work involving





Types of Head Protection

Type 1	Type 2	Class G	Class E	Class C
reduce force of impact from a blow to the top of the head	provide protection against both side impact (lateral) and blows to the top of the head	Tested to withstand 2200 volts	Tested to withstand 20,000 volts	No electrical protection



Note: Before each use, inspect for signs of dents, cracks, penetration, and any damage due to impact, rough treatment or wear

Foot Protection

Required when employees are in areas where there is danger of foot injury due to

- falling and rolling objects
- slip hazards or objects piercing the sole, and
- where employees are exposed to electrical hazards





Potential Hazards



Impact Injuries



Spills & Splashes



Compression Injuries



Electrical Shocks



Slipping



Heat/Cold

Hand Protection

Required when employees' hands are exposed to hazards such as

- Skin absorption of harmful substances
- Severe cuts or lacerations
- Severe abrasions
- Punctures
- Chemical burns
- Thermal burns
- Harmful temperature extremes

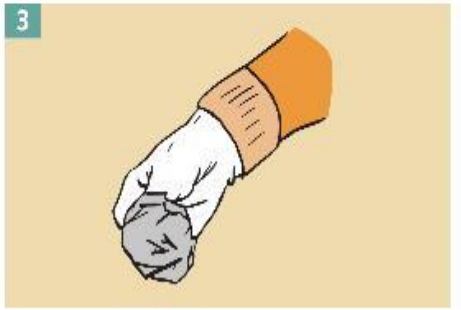
Protection must be compatible with hazard!



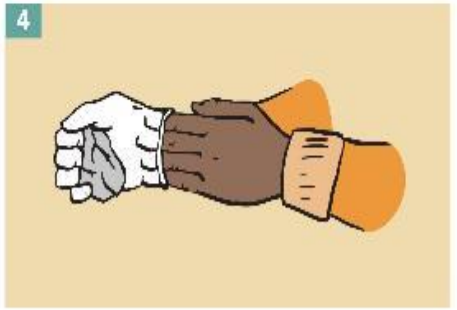
With both hands gloved, grasp the outside of one glove at the top of your wrist, being careful not to touch your bare skin.



Peel off this first glove, peeling away from your body and from wrist to fingertips, turning the glove inside out.



Hold the glove you just removed in your gloved hand.

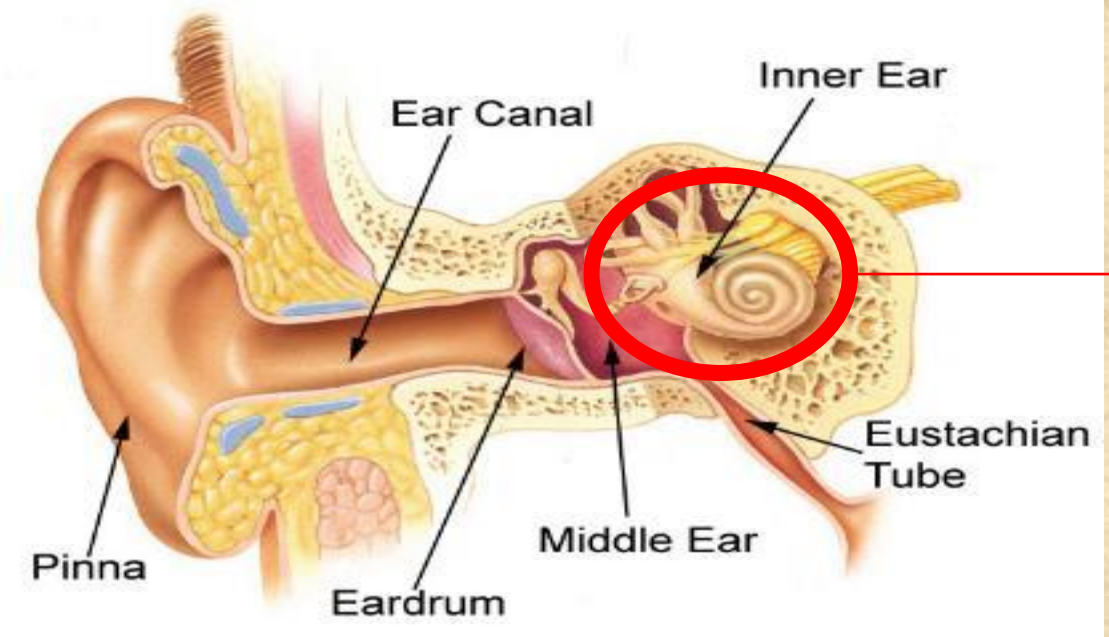


With your ungloved hand, peel off the second glove by inserting your fingers inside the glove at the top of your wrist.

Hearing Protection

Noise is an unwanted sound. Hearing protection is required when exposure to noise level is at or above 85dBA.

Hearing loss occurs as a result of damage to the delicate structures (sensory cells) of the ear – this happens without WORKER's notice.



Region where damage that causes hearing loss occurs

Types of Hearing Protection

There are three types of hearing protection:



Earmuffs



Earplugs



Ear caps or bands

Body Protection

The skin (covering the body) is the largest organ of the body, which also exposes it easily to occupational hazards.

Body parts such as chest, torso, back, arm, legs must be protected from hazards such as:

- Intense heat
- Cuts
- Hazardous chemicals
- Splashes from hot metals and other liquids
- Contact with potentially infectious materials, like blood
- Radiation
- Impacts from tools, machinery and materials etc.

Types of Body Protection

There are different types of body protective clothing which includes:

- Coveralls
- Full body suits
- Sleeves
- Apron
- Coats including – including lab coats, insulated coats a other design



Body Protection

Safe Practice:

- Select and use the right type of protective clothing for the right job
- Protective clothing must fit and be used properly, else they will become a hazard to user
- Inspect protective clothing before use
- Store in clean, cool, dry and ventilated area



Fall Protection

- Required when risk of falling at heights of 6 feet or greater when area is not guarded or protected by other fall protection measures
- Work at any height in aerial lifts, powered platforms and similar equipment
- Include safety belts, lifelines, lanyards



Photo: ASSE

Care of PPE

- Always check PPE for damage before and after use
- Clean PPE before storing
- Dispose of and replace damaged PPE
- Properly store PPE and avoid conditions that could damage them, such as heat, light, moisture, etc.
- Do not fix or repair a damaged PPE





PPE Acquisition and Replacement

- PPE is provided by Supervisor/department concern- not the employee
- If performing activity and you do not have PPE, contact Supervisor for PPE prior to starting activity
- Student may be responsible for lost or damaged PPE
- State Equipment Use Policy must be strictly complied with.



Thank You