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5. Radioactive Pollution:

The spontaneous emission of particles and rays by an unstable nucleus is called Radioactivity and such substances are called Radioactive Substances eg. Radium, Uranium, Thorium. Radioactive pollution can be defined as the release of radioactive substances or high-energy particles into the air water, or earth as a result of human activity, either by accident or by design. Sometimes natural sources of radioactivity, such as radon gas emitted from beneath the ground, are considered pollutants when they become a threat to human health.

5.1 The sources of Radioactive wastes are:

1. **Natural sources:** Solar radiation, Radio nuclides in the earth Crust, Human Internal radiation, environmental Radiations.
2. **Anthropogenic Sources:** The sources of such waste include:
   - **a)** nuclear weapon testing or detonation.
   - **b)** the nuclear fuel cycle, including the mining, separation, and production of nuclear materials for use in nuclear power plants or nuclear bombs.
   - **c)** accidental release of radioactive material from nuclear power plants.

5.2 Effects of radioactive pollution:

The effect of radioactive pollution depends upon:

1. Half –life
2. Energy releasing capacity
3. Rate of diffusion
4. Rate of deposition of the contaminant.
5. Various atmospheric and climatic conditions such as wind, temperature, rainfall also determine their effects.

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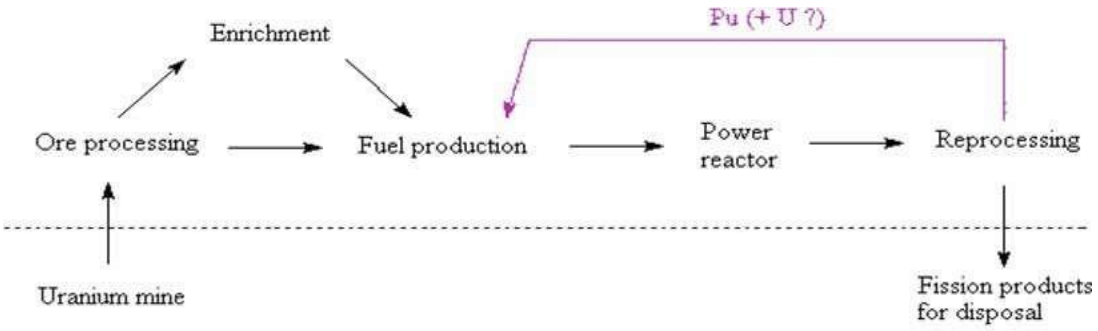
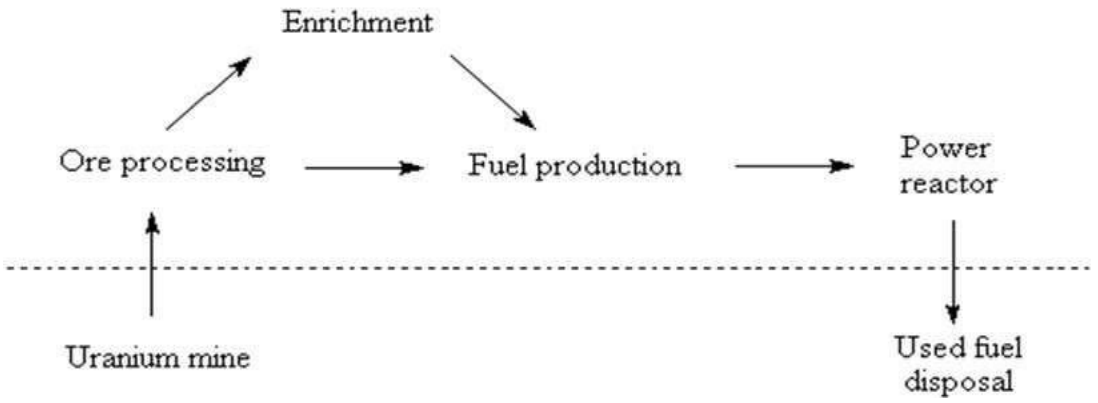
5.3 Effects of industrial effluents

Industries need a wide variety of raw materials and chemicals which are later discharged as effluents. Acids, alkalis, toxic metals, pesticides and other poisonous substances such as cyanide, dyes, oils, detergents, resins, rubbers are a few to mention. Heated effluents that impart thermal loading on receiving waters and effluents containing radioactive materials are also of prime concern. Some of the effluents such as from tanning and meat packing may also contain pathogenic bacteria. The nature and extent of pollution depends on the materials present in the effluent and on the quantity discharged.

5.4 Nuclear Fuel Cycle:

Most nuclear waste comes from the byproducts of the nuclear fuel cycle. The cycle typically is split into three sections: front end, service period, and back end. There can be intermediate stages that include the reprocessing of nuclear waste elements.





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5.5 Classifications of Nuclear Waste:

Nuclear waste is segregated into several classifications.

1. Low level waste is not dangerous but sometimes requires shielding during handling.
2. Intermediate level waste typically is chemical sludge and other products from reactors.
3. High level waste consists of fissionable elements from reactor cores and transuranic wastes.
4. Transuranic waste is any waste with transuranic alpha emitting radionuclides that have half-lives longer than 20 years.

1. **Low Level Waste LLW**:
   - Low level waste is any waste that could be from a high activity area.
   - 90% volume of waste
   - It does not necessarily carry any radioactivity.
   - Split into four categories: A, B, C, and GTCC.

2. **Intermediate Level Waste ILW:**
   - Intermediate level waste requires shielding when being handled.
   - 7% volume of waste
   - Dependent on the amount of activity it can be buried in shallow repositories.
   - Not recognized in the United States.

3. **High Level Waste HLW:**
   - High level waste has a large amount of radioactive activity and is thermally hot.
   - 3% volume of waste
   - 95% of radioactivity

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- Current levels of HLW are increasing about 12,000 metric tons per year.
- Most HLW consists of Pu-238, 239, 240, 241, 242, Np-237, U-236.

4. **Transuranic Waste TRUW**:
   - Transuranic waste consists of all waste that has radionuclides above uranium.
   - TRUWs typically have longer half-lives than other forms of waste.
   - Typically, a byproduct of weapons manufacturing.
   - Only recognized in the United States.

5.6 Creation of Nuclear Waste

- Nuclear waste is generated at all points of the fuel cycle.
- Front end waste consists primarily of low-level alpha emission waste.
- Service period waste typically includes LLW and ILW such as contaminated reactor housings and waste from daily operation.
- Back end waste normally is the most radioactive and includes spent fuel rods and reactor cores.

5.7 Control of Radioactive pollution:

The main objective in managing and disposing of radioactive (or other) waste is to protect people and the environment. This means isolating or diluting the waste so that the rate or concentration of any radionuclides returned to the biosphere is harmless. To achieve this for the more dangerous wastes, the preferred technology to date has been deep and secure burial. Transmutation, long-term retrievable storage, and removal to space have also been suggested.

- Nuclear devices should never be exploded in air. If these activities are extremely necessary, they should be exploded underground.
- In nuclear reactions, closed-cycle coolant system with gaseous coolants of very high purity may be used to prevent extraneous activation products.
- In nuclear and chemical industries, the use of radio-isotopes may be carried under a set of soil or water instead of power or gaseous forms.
- In Nuclear mines, wet drilling may be employed along the underground drainage.
- Nuclear reactors must be enclosed in broad concrete walls to prevent the radiations that emerge out.
- Workers should wear protective garments and glass spectacles should be screened from

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radiation.

- Extreme care should be exercised in the disposal of industrial waste contaminated with radionuclides.

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Industrial Safety

1. Occupational Health and Industrial Safety

It is defined as "science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses arising in or from the work place, which may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community".

1.1. Purposes of Occupational Health and Industrial Safety Program

1. To determine whether the work environment and working conditions of workers are harmful to their health and well-being and prevent such conditions from occurring.
2. To promote the best possible physical, mental and social health of people at work.
3. To prevent occupational diseases caused by physical chemical and biological agents.

1.2. Elements of the work environment

The basic elements in an occupational setting such as a manufacturing plant, industry, or offices are four. These are:

1. The worker
2. The tool
3. The process
4. The work environment

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1.3 Safety Program

Safety Program to Minimize the RISK from "danger, Injury, damage, loss, accidents", and search all hazards at the workplace.

1.3.1 Organization, Management.

OSHMS, SHC, SHO, Policy, Rules and Regulations, SOP, Standard etc.

1.3.2 Assess the potential risk.

Attitude, Awareness and Action (AAA)

1.3.3 Fundamentals of control measures.

Technical knowledge to design/select, construct, operate, maintain etc.

1.3.4 Experience

Learn from past accidents and experience of others

1.3.5 Time

To set up system, do hazard identification, do risk assessment, do documentation, do safety review, training, etc.

1.3.6 You

Everyone (workers and management) should participate/contribute.

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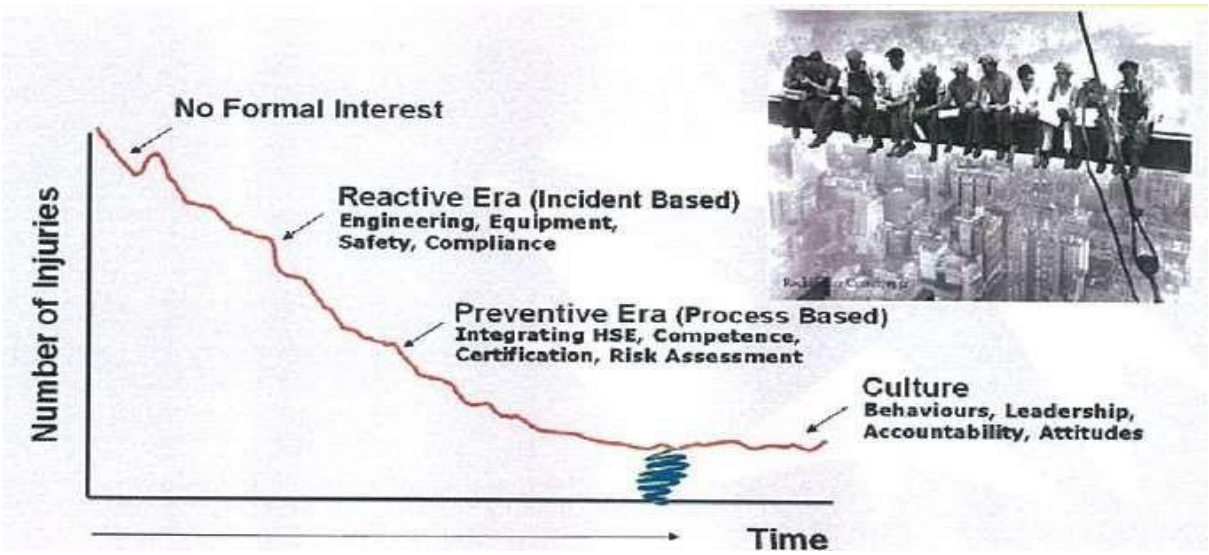
1.4 INDUSTRIAL SAFETY MEANS:

Control of hazards by abidance to best practice, or it is degree of protection of hazards.



1.5 Definitions of Terms: -

1. **Incident:** An event that results in death or injury to person where the injury requires medical attention (including first aid).

Term	Definition
Accident	Undesired event giving rise to death, injury, ill health, damage or other loss
Incident	Event that gave rise to an accident or had potential to lead to an accident (not all incidents propagate into accidents) **Near-miss** is an incident where no injury, damage, ill health, or other loss occurs.

2. **Exposure: -** The measurement of time during which the subject is at risk from a hazard.

3. **Fatality: -** Death due to a work-related incident or illness regardless of the time between injury or illness and death.

4. **Harm: -** Includes death, injury, physical or mental ill health, damage to property, loss of production, or any combination of these.

5. **Hazard: -** A source or a situation with a potential to cause harm, including human injury or ill health, damage to property, damage to the environment, or a combination of these.

6. **Lost Time Injury (LTI): -** Work related injury or illness that renders the injured person unable to perform any of their duties or return to work on a scheduled work shift, on any day immediately following the day of the accident.

7. **Medical Treatment Case (MTC): -** Work related injury or illness requiring more than first aid treatment by a physician, dentist, surgeon or registered medical personnel.

8. **Personal Protective Equipment (PPE): -** All equipment and clothing intended to be utilized, which affords protection against one or more risks to health and safety. This includes protection against adverse weather conditions.

9. **Restricted Work Case: -** Work related injury or illness that renders the injured person unable to perform all assigned work functions during a scheduled work shift or being assigned to another job on a temporary or permanent basis on the day following the injury:

   a. **Risk: -** The likelihood (probability) of a specific hazardous event (e.g. accident) occurring and its consequences.
   b. **Risk Assessment: -** The process of analyzing the level of risk considering those in danger, and evaluating whether hazards are adequately controlled, taking into account any measures already in place.

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c. Risk Management: - The process of identifying hazards, assessing risk, taking action to eliminate or reduce risk, and monitoring and reviewing results.

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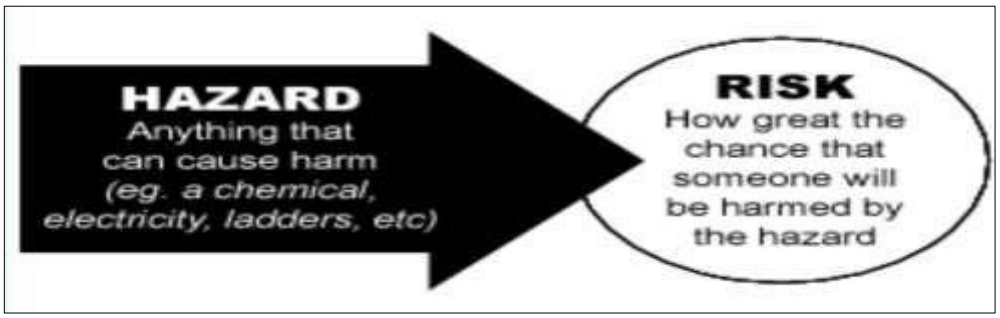
♦ **Difference between Risk & Hazard**

The term "**risk**" is often confused with "hazard". A high voltage power supply, a sample of radioactive material, or a toxic chemical may present a hazard, meaning that they present the potential for harm. Risk indicates probability of hazard causing the harm.



1.6 Environmental Factors or Stresses: -

The various environmental factors or stresses that can cause sickness, impaired health, or significant discomfort in workers can be classified as chemical, physical, biological, or ergonomic.

1.6.1 Chemical hazards:

These arise from excessive airborne concentrations of mists, vapors, gases, or solids in the form of dusts or fumes. In addition to the hazard of inhalation, some of these materials may act as skin irritants or may be toxic by absorption through the skin.

When you work with chemical beware of:

1. Liquids like cleaning products, paints, acids, solvents – ESPECIALLY if chemicals are in an unlabeled container.
2. Vapors and fumes that come from welding or exposure to solvents.
3. Gases like acetylene, propane, carbon monoxide and helium.
4. Flammable materials like gasoline, solvents, and explosive chemicals.
5. Pesticides.

1.6.2 Physical hazards:

Physical hazard has possible cumulative or immediate effects on the health of employees. Therefore, employers and inspectors should be alert to protect the workers from adverse physical hazards. Physical hazard includes:

1. Extremes of temperature.
2. Ionizing radiation.
3. Non ionizing radiation.
4. Excessive noise.

1.6.3 Ergonomic hazards:

These include improperly designed tools, work areas, or work procedures. Improper lifting or reaching, poor visual conditions, or repeated motions in an awkward position can result in accidents or illnesses in the occupational environment. Designing the tools and the job to fit the worker is of prime importance. Engineering and biomechanical principles must be applied to eliminate hazards of this kind. Ergonomic Hazards include:

1. Improperly adjusted workstations and chairs.
2. Frequent lifting.
3. Poor posture.
4. Awkward movements, especially if they are repetitive.
5. Repeating the same movements over and over.
6. Having to use too much force, especially if you have to do it frequently.
7. Vibration.

1.6.4 Biological hazards:

These are any living organism or its properties that can cause an adverse response in humans. They can be part of the total environment or associated with a particular occupation. Work-related illnesses due to biological agents have been widely reported, but in many work- places their presence and resultant illness are not well recognized. It is estimated that the population at risk for occupational biohazards may be several hundred million workers worldwide.

Exposure to many of the harmful stresses or hazards listed can produce an immediate response due to the intensity of the hazard, or the response can result from longer exposure at a lower intensity. In certain occupations, depending on the duration and severity of exposure, the work environment can produce significant subjective responses or strain. The energies and agents responsible for these effects are called environmental stresses. An employee is most often exposed to an intricate interplay of many stresses, not to a single environmental stress.