RADIOACTIVE POLLUTION: IONIZING & NON-IONIZING RADIATION

I. RADIOACTIVE POLLUTION – MEANING

- Increase in natural radiation levels posing threat to life
- Contamination by radioactive substances in solids, liquids, gases, or body tissues
- Defined by the International Atomic Energy Agency (IAEA)

TWO CORE PROBLEMS OF NUCLEAR ENERGY

- Accidental leakage
- Safe disposal of radioactive waste

II. SOURCES OF RADIOACTIVE POLLUTION

A. ARTIFICIAL SOURCES

- Nuclear power plant accidents
- Nuclear weapons testing (fallout)
- Uranium and thorium mining
- Medical uses (X-rays, radiation therapy)
- Nuclear laboratories and reactors

Important radionuclides in fallout:
- Strontium-90
- Caesium-137
- Iodine-131

B. NATURAL SOURCES

- Cosmic rays
- Radionuclides in Earth's crust:

– Uranium-238
– Thorium-232
– Radium-224
– Potassium-40
– Carbon-14

III. RADIOACTIVITY – BASIC CONCEPT

Spontaneous emission of:
- Alpha particles

• Beta particles
• Gamma rays

Due to the disintegration of unstable atomic nuclei.

IV. IONIZING VS NON-IONIZING RADIATION

A. NON-IONIZING RADIATION

DEFINITION

Electromagnetic waves with longer wavelengths.

Examples:
• Near infrared
• Radio waves
• Microwaves
• Higher wavelength ultraviolet

CHARACTERISTICS

• Cannot ionize atoms
• Can excite atoms and molecules
• Low penetration power

EFFECTS

• Sunburn
• Snow blindness
• Eye damage
• Thermal heating (microwave oven)

MOBILE TOWER RADIATION

• Non-ionizing
• Causes thermal and non-thermal effects
• Possible impacts:
– Headache
– Fatigue
– Genetic and reproductive concerns
– Disturbance in birds' navigation

B. IONIZING RADIATION

DEFINITION

Radiation that removes electrons from atoms → forms ions.

TYPES

Electromagnetic:
• Short wavelength ultraviolet
• X-rays
• Gamma rays

Particle radiation:
• Alpha particles
• Beta particles
• Neutrons

CHARACTERISTICS

• High penetration power
• Break chemical bonds
• Damage macromolecules (DNA, proteins)

V. BIOLOGICAL DAMAGE

A. SOMATIC DAMAGE

Affects body cells (non-reproductive)

Examples:
• Radiation sickness
• Hair loss
• Lung fibrosis
• Cataract
• Cancer

B. GENETIC DAMAGE

Affects reproductive cells
• Mutations
• Abnormalities in the next generation
• Heritable defects

VI. RADIATION DOSE

Unit:
• Rem (radiation equivalent in man)

Low dose:
• Cells repair damage

High dose:
• Radiation sickness
• Permanent cell damage
• Cancer

VII. DAMAGE POTENTIAL OF PARTICLES

ALPHA

• Blocked by paper
• Harmful if ingested/inhaled

BETA

• Penetrates skin
• Blocked by glass or thin metal

GAMMA

• Highly penetrating
• Blocked only by thick concrete

VIII. HALF-LIFE

• Time required for half of the radioactive atoms to decay
• Ranges from seconds to thousands of years
• Long half-life radionuclides → major environmental threat

IX. NUCLEAR POWER PLANT ACCIDENTS

Major global accidents:

• Three Mile Island (1979)
• Chernobyl (1986)
• Fukushima Daiichi (2011)

Causes:
• Reactor core overheating
• Fuel rod meltdown
• Release of radioactive materials

X. SAFE DISPOSAL OF NUCLEAR WASTE

TYPES

LOW-LEVEL WASTE

- Medical
- Research
- Protective clothing

HIGH-LEVEL WASTE

- Spent fuel rods
- Nuclear weapons waste

PROPOSED METHODS

- Deep geological burial
- Disposal in space
- Ocean dumping
- Burial under polar ice
- Conversion into harmless isotopes

Current practice:
- Storage ponds
- Reprocessing plants

XI. IMPORTANT POINTS

- Non-ionizing radiation cannot remove electrons
- Ionizing radiation causes DNA breakage
- Gamma rays have the highest penetration
- Alpha most dangerous internally
- Mobile tower radiation is non-ionizing
- Long half-life radionuclides cause persistent pollution