

Energy & Environmental Engineering

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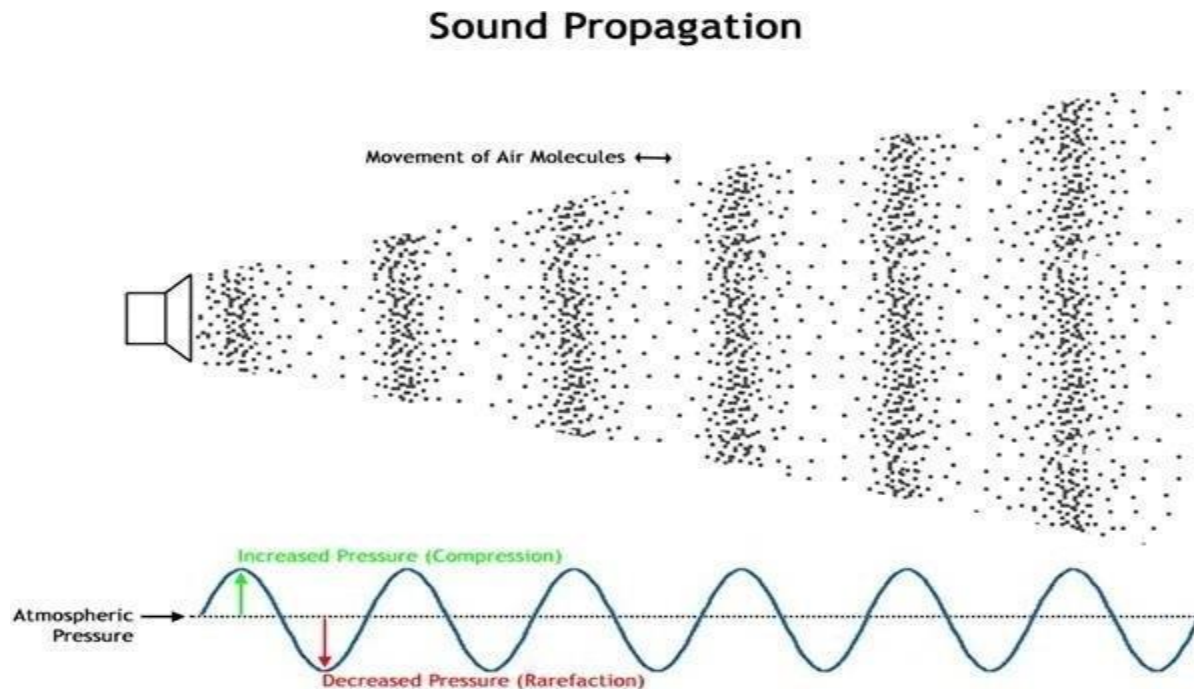
Module 2

- **ENVIRONMENTAL POLLUTION (10 hours)**
- Water, air, soil, noise, thermal and radioactive, marine pollution: sources, effects and engineering control strategies. Drinking water quality and standards, Ambient air and noise quality standards

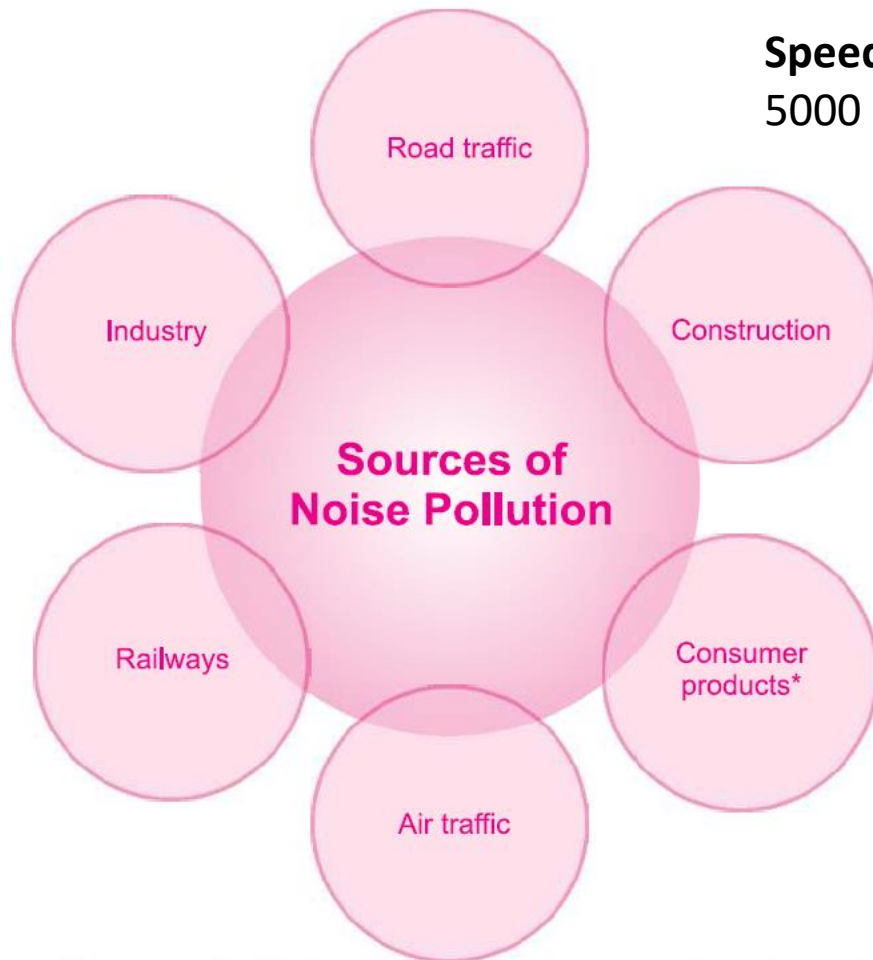


Noise Pollution

- **Noise-** Unwanted Unpleasant sound
- Alternating pressure changes in surrounding air



Sources of Noise Pollution



Speed of Sound- 1500 m/s in water and 5000 m/s in steel, 340 m/s in air

* home appliances, musical instruments, lawn mowers, go carts, motorcycles, air conditioners, etc.

SOUND PRESSURE



100 000 000



1 000 000



100 000



10 000



1 000

Bedroom

100



20

SOUND PRESSURE LEVEL

140 dB

130

Firecrackers

120

Pneumatic
Chipper

110

100

Noisy Workplace

90

80

70

Business Office

60

50

40 Living Room

30

20

Wood

10

0



Noise- Representation

- Audible pressure range – 20 μpa to 200pa
- Minimum pressure to hear –20 μpa – **Threshold of hearing**
- SPL (Sound pressure level) - Pressure that cause a particular sound
- $$\text{SPL} = 20 \log_{10} [P/P_{\text{ref}}] \quad (P_{\text{ref}} = 20 \mu\text{pa})$$

(SPL- dB)
- Intensity of sound is measured in decible (dB)

Noise- Representation- Leq

- Leq: Equivalent noise level at an area

Noise Pollution Control

The Source Path Receiver Concept

- Noise pollution can be controlled by either reducing the noise at the source or by preventing its transmission or by protecting the receiver.

Vehicle Noise levels in India

(1) Noise limits for vehicles applicable at manufacturing stage from year 2003

S. No.	Type of vehicle	Noise Limits from 1 st January, 2003, dB(A)	Date of implementation
(1)	(2)	(3)	(4)
1.	Two wheeler Displacement upto 80 cm ³ Displacement more than 80 cm ³ but upto 175 cm ³ Displacement more than 175 cm ³	75 77 80	Ist January,2003
2.	Three wheeler Displacement upto 175 cm ³ Displacement more than 175 cm ³	77 80	Ist January,2003
3.	Passenger car	75	Ist January,2003
4.	Passenger or commercial vehicle Gross vehicle weight upto 4 tonne Gross vehicle weight more than 4 tonne but upto 12 tonne Gross vehicle weight more than 12 tonne	80 83 85	Ist July,2003

<https://cpcb.nic.in/who-guidelines-for-noise-quality/>

Thermal Pollution

- Thermal pollution increases water temperature, causing a change (lowering) of dissolved oxygen levels. This disrupts the body of water's ecological balance, resulting in the suffocation of some plant and animal species while encouraging the overgrowth of others.
- Human activities can introduce thermal pollution into streams
 - Industries and power plants may use water to cool machinery and then discharge the warmed water into a stream.
 - Water temperature rises when trees and tall vegetation providing shades are cut down.
 - Thermal pollution can also occur through earthquakes.

Effects of thermal Pollution

1. Thermal shock: The sudden change in temperature due to hot wastewater can be of harm to fish and other aquatic animals that have been used to a particular level of water temperature; this invariably can cause fish to migrate to a more suitable environment.

2. Thermal enrichment: This is when heated water from power plants may be used for irrigation purposes to extend plant growing seasons, speed up the growth of fish and other aquatic animals for commercial purposes. However, it has been noted that the harmful effects of thermal pollution outweigh the benefits.

Radioactive Pollution

- The following is a list of major nuclear disasters of the world.
 - Fukushima, Japan - 2011
 - Chernobyl, Russia – 1986
 - Three Mile Island US – 1979
- Radioactive materials are composed of atoms that are unstable.
- An unstable atom gives off its excess energy until it becomes stable. The energy emitted is radiation

Radioactive Pollution

- Radioactive materials are dangerous because of the harmful effect of certain types of radiation on the cells of the body. The longer a person is exposed to radiation, the greater the risk
- People receive some radiation exposure each day from the sun, radioactive elements in the soil and rocks, household appliances like television sets and microwave ovens, and medical and dental X-rays.
- Radiation cannot be detected by sight, smell, or any other sense.

Sources of radiation

UNSCEAR (United States Scientific Committee on the Effects of Atomic Radiation) suggests that the annual dose of radiation, averaged over the population of the Earth, is around 2.8 mSv in total. (*Sv is the unit Sievert – it is a measure of health effect of low levels of radiation on the human body*).

Radiation dose is measured in *rem*. *Rem is a unit of radiation dosage, such as from X-rays, applied to humans*.

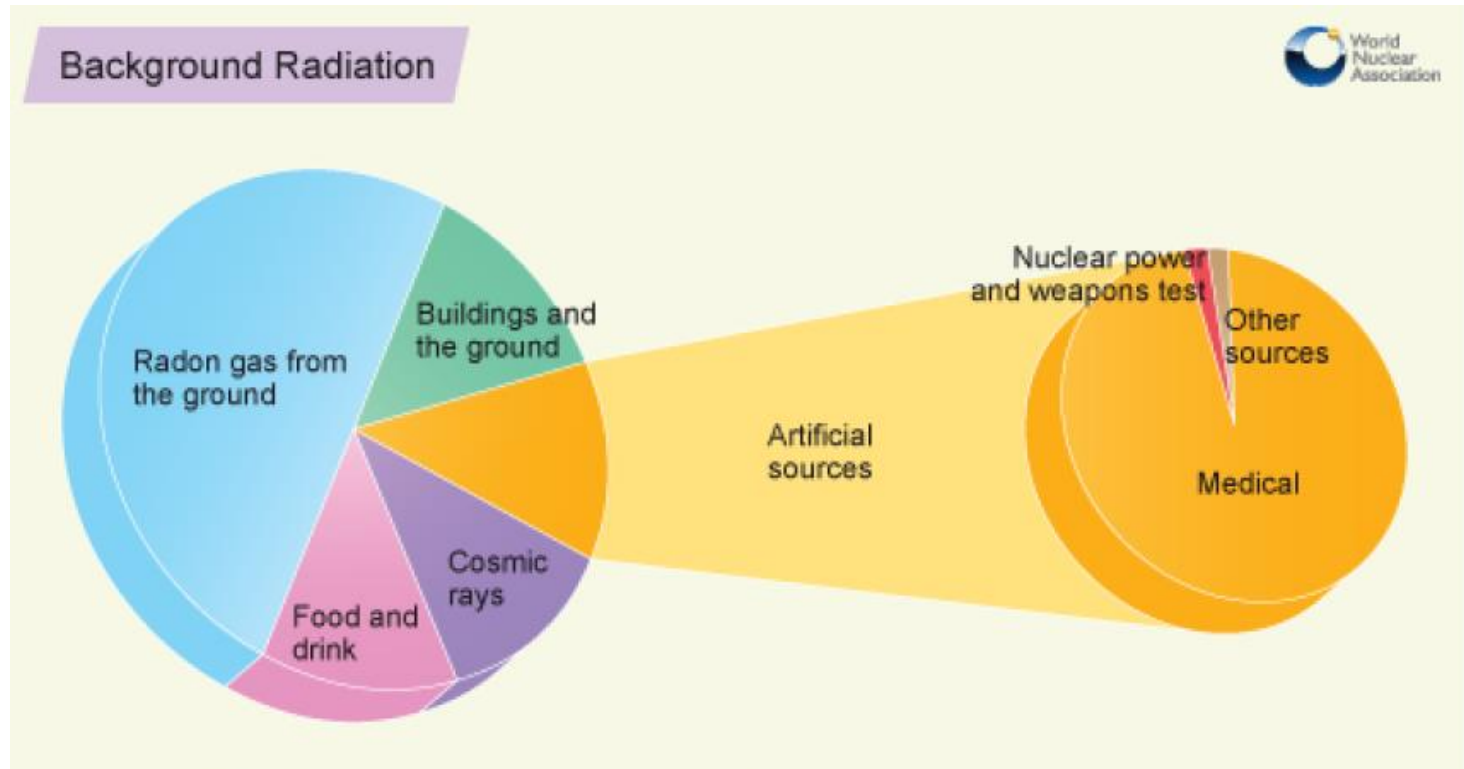
Cosmic rays reaching the earth from outer space are high energy positively charged radiation.

Gamma rays from the Earth and radon decay products in the air all contribute to radiation too.

Our bodies also naturally contain some radioactive materials: Carbon-14, Potassium-40 and Polonium-210.

The Earth itself is radioactive and all materials in the Earth's crust contain radionuclides.

Sources of radiation



Source: Nuclear Energy | Physics for all www.physics4all.com

Category of radioactive waste

There are six general categories

- Exempt waste and very low level radioactive waste. Consists mainly of demolished material (concrete, plaster, bricks, metal, valves, piping)
- High-level radioactive waste :
 - reprocessing of spent nuclear fuel including liquid waste directly produced and solid material derived from the liquid waste that contains fission products in sufficient concentrations, used fuel itself
 - Short-lived and long-lived radionuclides (wastes from operation of nuclear facilities, materials from production and dismantling of nuclear weapons, construction materials from decommissioned reactors and nuclear plants)
 - Plutonium and americium – elements of concern

Category of radioactive waste

There are six general categories

- Low-level radioactive waste
 - This is made up of isotopes having shorter half-lives. Radioactivity level is low.
 - Sources: laboratory research, industrial activities, medicine, contaminated protective clothing
 - Does not require shielding during handling and transport
 - Suitable for shallow land burial
 - Storing the waste for a period of 10-50 years will allow most of the radioactive isotopes to decay
- Uranium mill waste from mining and milling industries
- Fine sandy uranium tailings generated during uranium milling
- Transuranic radioactive waste from manufacture of nuclear weapons
- Naturally occurring radioactive material

Reactor	State	Net MW	Commercial operation
Tarapur 1&2	Maharashtra	150	1969
Kaiga 1&2	Karnataka	202	1999-2000
Kaiga 3&4	Karnataka	202	2007-2012
Kakrapar 1&2	Gujarat	202	1993-95
Madras 1&2	Tamil Nadu	202	1984-86
Narora 1&2	Uttar Pradesh	202	1991-92
Rajasthan 1	Rajasthan	90	1973
Rajasthan 2	Rajasthan	187	1981
Rajasthan 3&4	Rajasthan	202	1999-2000
Rajasthan 5&6	Rajasthan	202	2010
Tarapur 3&4	Maharashtra	490	2005-06
Koodankulam 1	Tamil Nadu	917	2014



Source: World Nuclear Association | www.world-nuclear.org

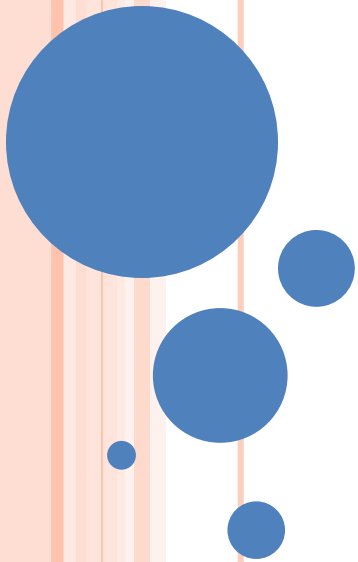
Impact of Radiation

Table 1: Estimated threshold exposures for various non-cancerous side effects

Exposure (rem)	Health Effect	Time to Onset (Without Treatment)
5-10	Changes in blood chemistry	
50	Nausea	Hours
55	Fatigue	
70	Vomitting	
75	Hair loss	2-3 weeks
90	Diarrhea	
100	Hemorrhage	
400	Possible death	Within 2 months
1000	Destruction of intestinal lining, internal bleeding and death	1-2 weeks
2000	Damage to central nervous system, loss of consciousness and death	Minutes/ hours to days

Source: USEPA | Radiation Protection www.epa.gov

Marine pollution



Definition

- A direct or indirect introduction by humans of substances or energy into marine environment
- Resulting in
 - ❖ Harm to living resources,
 - ❖ Hazards to human health,
 - ❖ Hindrances to marine activities including fishing,
 - ❖ Impairment of the quality of sea water and reduction of amenities.

Caused by..

```
graph TD; A[Caused by..] --> B[Marine pollution]; B --> C[Human activities]; B --> D[Nature's activities];
```

Marine pollution

Human activities

Nature's activities

Nature's activities


- Earthquake
- Tsunami
- Oil ground burst
- Volcanoes
- Continental drift

Human Activities



Origin

The diagram consists of two overlapping rounded rectangles. The front rectangle is light orange with a thin orange border. The back rectangle is a darker orange and is slightly offset to the top-left, creating a layered effect.



Land

The diagram consists of two overlapping rounded rectangles. The front rectangle is light blue with a thin blue border. The back rectangle is a darker blue and is slightly offset to the top-left, creating a layered effect.



Sea

The diagram consists of two overlapping rounded rectangles. The front rectangle is light blue with a thin blue border. The back rectangle is a darker blue and is slightly offset to the top-left, creating a layered effect.

Causes and Effects

○ Nutrients

- Oil

○ Sediments

- Plastics

○ Pathogens

- Radioactive substances

○ Alien species

- Thermal

○ Persistent toxins

- Noise

Nutrients

Source

- Sewage
- Runoff from forestry, farming, and other land use.
- Airborne nitrogen oxides from power plants, cars etc.

Effect

- Algal blooms in coastal waters resulting in
 - ❖ Depletion of oxygen in water, killing other marine life .
 - ❖ Release of toxins that can kill fish and poison people.



Sediments

Source

- Erosion from mining, forestry, farming and other land use;
- Coastal dredging and mining

Effect

- Cloudy water resulting in
 - ❖ Impediment to photosynthesis below surface waters.
 - ❖ Clogging of gills of fish.

Pathogens

Source

- Sewage
- Live stock
- Dead bodies

Effect

- Contaminate coastal swimming areas and seafood, spreading cholera, typhoid and other diseases

Alien species

Source

○ Several thousand per day transported in ballast water; also spread through canals linking bodies of water and fishery enhancement projects

Effect

- Out compete native species and reduce biological diversity.
- Introduce new marine diseases.
- Associated with increased incidence of red tides and other algal blooms.
- Problem in major ports

Persistent Toxins (*PCBs Heavy metals, DDT etc.*)

Source

- Industrial discharge
- Wastewater discharge from cities
- Pesticides from farms, forests, home use etc.

Effect

- Poison or cause disease in coastal marine life , especially near major cities or industry.
- Contaminate sea food.
- Fat soluble toxins that bio magnify in predators can cause disease and reproductive failure.

Oil

Source

- From cars, heavy machinery, industry & other land based sources;
- Oil tanker operations and other shipping accidents at sea
- Offshore oil drilling

Effect

- Low level contamination can kill larvae and cause disease in marine life.
- Oil slicks kill marine life, especially in coastal habitats.
- Tar balls from coagulated oil litter beaches and coastal habitat.



Plastics

Source

- Fishing nets
- Cargo and cruise ships
- Beach litter
- Wastes from plastics industry and landfills

Effect

- Discarded fishing gear continues to catch fish
- Other plastic debris entangle marine life or is mistaken for food.
- Plastics litter beaches and coasts and may persist for 200 to 400 years.



Radioactive substances

Source

- Discarded nuclear submarine and military waste
- Atmospheric fallout and industrial wastes

Effect

- Can enter food chain and cause disease in marine life.
- Concentrate in top are predators and shell fish, which are eaten by people

Thermal

Source

○ Cooling water
from power plants
and industrial sites

Effect

- Kill corals and other temperature sensitive sedentary species.
- Displace other marine life.

Marine Pollution Abatement..

- Identify load & type of pollutants and cut it at the source.
- Political commitment and enforce legislation
- Coastal and marine planning & management
- Create less waste

Marine Pollution Abatement

- Reduce/Eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water etc.
- Recycling, incineration
- Pretreatment before disposal to sea
- Use of equipment to reduce water content and volume in the chemical process