

# Noise Pollution

## Introduction

- It is an unpleasant and disturbing sound, which is found to be responsible for several auditory and non-auditory adverse effects on human health and well-being, ranging from simple annoyance to hearing loss.
- The rapid growth of urbanization, industrialization, construction works, increased number of vehicles and deforestation is the major cause of air and noise pollution.
- According to WHO, Noise is considered as a major concerned environmental factor for an unhealthy society (WHO, 2011)
- Noise is a perpetual, significant contributor to occupational diseases in numerous working environments.
- Noise health effects depend on the combination of intensity, frequency and duration of exposure to noise.

## Sources of Noise Pollution

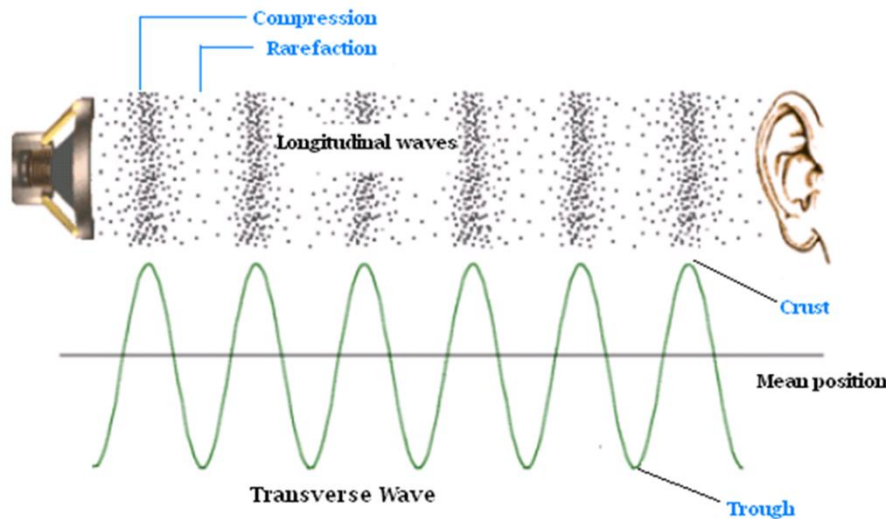
- Industries
- Rail and air traffic
- Road Traffic
- Construction
- Indoor Sources
- Loud Speakers
- Fire Crackers

## Impact on health due to noise pollution

Pathological Effects	Physiological Effects	Psychological Effects
Hearing loss, reduction of speech intelligibility, acoustic traumas, auditory fatigue, etc.	Changes in blood pressure, pulse rate, constriction of blood vessels, dilation of the pupil of eye and changes in blood cholesterol content, etc.	Feelings of discomfort, sleep interference, reduced intellectual performance, fatigue, vexation, irritation, distress, mental or neurological disorders, antisocial behaviour, etc.

Noise above 60dB has a negative effect on increased use of psychotropic medication

## Propagation of sound wave

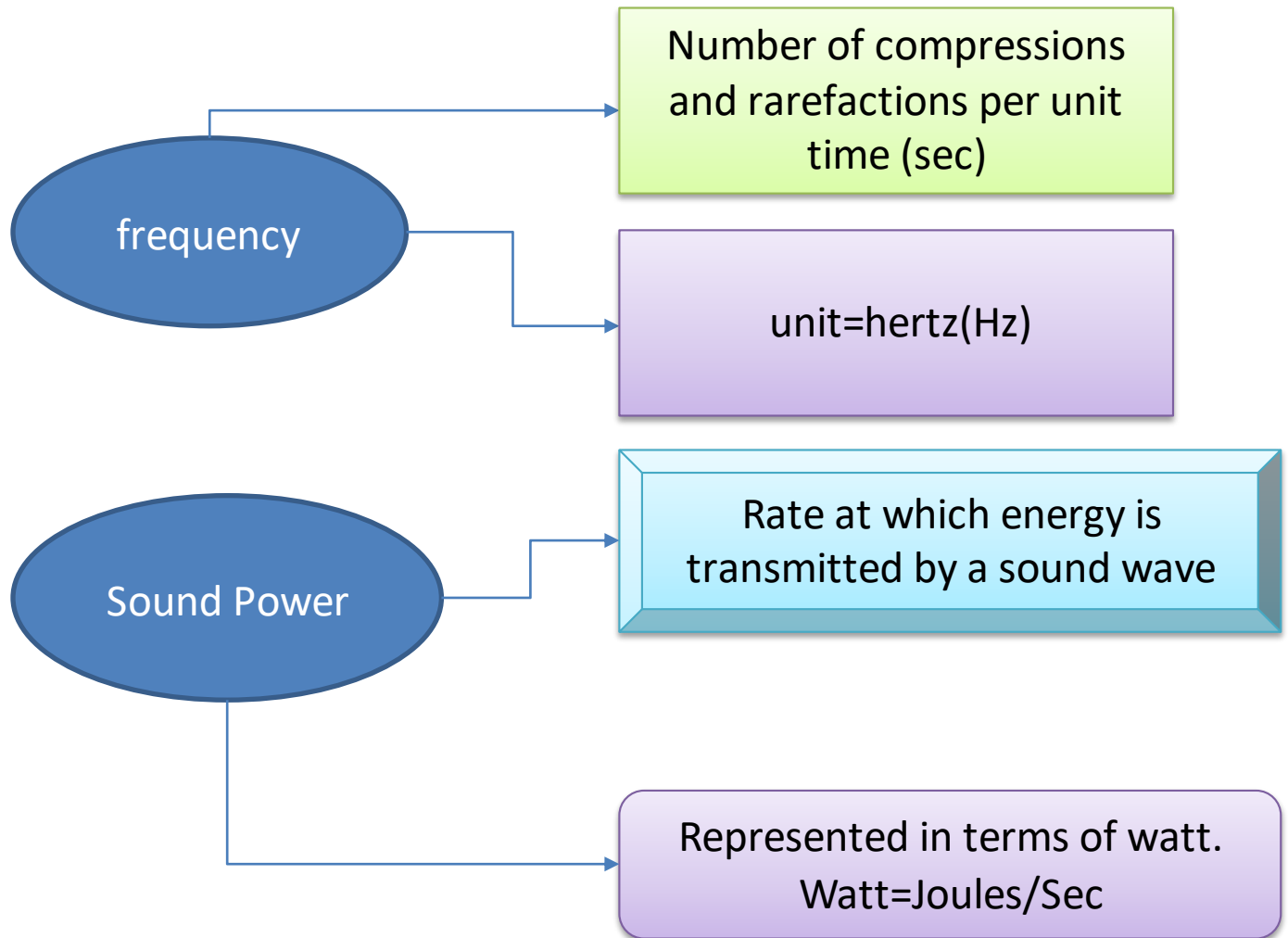


## Properties of Sound

- Physically, Sound is a mechanical disturbance propagated as a wave motion in air and other elastic and mechanical media such as water or, steel.
- Physiologically, Sound is an auditory sensation evoked by this physical phenomenon.(not all sound wave evoke an auditory sensation, e.g., the frequency of ultrasound is too high to excite the sensation of hearing)
- Sound waves involve a succession of compressions and rarefactions of an elastic medium such as air.
- These waves are characterized by the amplitude of pressure changes, their frequency and the velocity of propagation.

$$\text{Wavelength} = \text{speed of Sound} / \text{frequency}.$$

Speed of sound in air(20°C)=344 m/s.  
Sound travels much faster in solids than in air.  
(wood=3,962 m/s, Steel=5,029 m/s)



### Sound Power Level (Lw)

- A scale ten times the logarithm of the ratio of a measured quantity to a specified reference quantity represents sound power level.

$$\text{Sound power level, } L_w = 10 \log_{10} (W/W_0)$$

W = measured Sound power

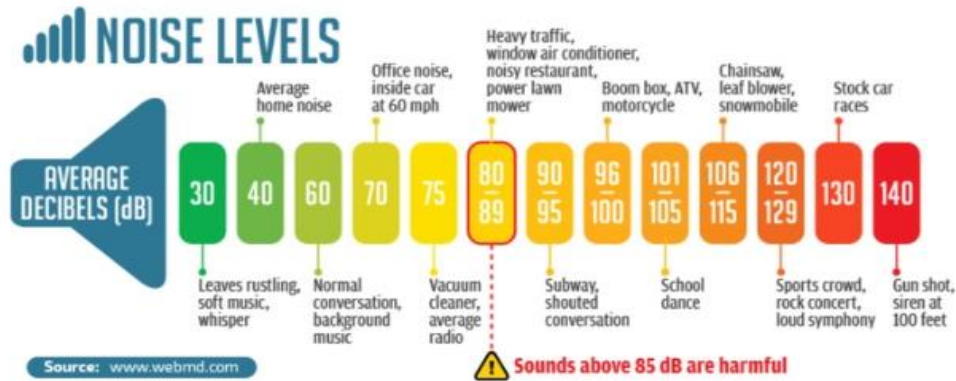
$W_0$  = Reference sound power ( $10^{-12} \text{ W}$ )

1. The sound power generated from a moving tractor is 0.001 watt. What is the Sound Power Level?

As we know,  $L_w = 10 \log_{10} (w/w_0)$

$$= 10 \log (0.001/10^{-12})$$

$$= 90 \text{ dB}$$



## Sound Perception and Measurement

- The magnitude of sound as perceived by human ear is called Loudness.
- Ear is not equally sensitive to all frequencies and amplitudes of sound pressure. For this reason, the sound pressure levels of two different noises may be same. The first may be judged to be louder than the second. If the sound energy of the first is concentrated in a frequency region where the ear is more sensitive.

## Sound pressure level (Lp)

Sound pressure level,  $L_p(\text{dB}) = 10 \log_{10} (P/P_r)^2 \dots (i)$

P = measured Sound Pressure

$P_r$  = Reference sound Pressure (20  $\mu\text{p}$ )

## Combination of noise sources

Combined sound pressure levels

$$\begin{aligned}
 L_{comb} &= 10 \log_{10} (W_1 + W_2 + W_3 + \dots W_n) / W_0 \\
 &= 10 \log_{10} \frac{1}{W_0} [10^{L_{W1}/10} + 10^{L_{W2}/10} + 10^{L_{W3}/10} + \dots 10^{L_{Wn}/10}] \\
 &= 10 \log \sum_{i=1}^n \frac{L_{W_i}}{W_0}
 \end{aligned}$$

Average sound pressure levels

$$\overline{L_p} = 10 \log \frac{1}{N} \sum_{j=1}^N 10^{\left(\frac{L_j}{20}\right)} \dots\dots\dots (ii)$$

$\overline{L_p}$  =Average Sound Pressure Level

$L_j$  =The jth sound pressure level.

$J = 1, 2, 3, \dots, N$

2. Determine the sound power level from combining the four sound levels of 56, 68, 71 and 48 dB.

$$L_W = 10 \log_{10} (W/W_0); W = W_0 \times 10^{L_W/10}$$

$$W_1 = W_0 \times 10^{5.6}$$

$$W_2 = W_0 \times 10^{6.8}$$

$$W_3 = W_0 \times 10^{7.1}$$

$$W_4 = W_0 \times 10^{4.8}$$

$$\text{Resultant } L_W = 10 [\log(10^{5.6} + 10^{6.8} + 10^{7.1} + 10^{4.8})] \approx 73 \text{ dB}$$

3. Compute the mean sound pressure level from the following readings: 38 dB, 54 dB, 68 dB and 77 dB.

## Equivalent Continuous Noise Level

Equivalent continuous noise level ( $L_{Aeq}$ ) of that steady sound which over the same interval of time contains the same total energy as the fluctuating sound.

$$L_{Aeq} = 10 \log_{10} \left( \frac{1}{T} \sum_{i=1}^n 10^{0.1 L_i} \times t_i \right)$$

Where,  $T$  = Total time of operation.

$L_i$  = Noise level of the  $i$ th sample.

$T_i$  = Fraction of total time.

$N$  = number of sample.

4. If an Industrial fan generates a noise level of 65 dB for 10 minutes out of every hour. Compute the LAeq, if the background level is 55dB?

$$L_{Aeq} = 10 \log \left[ \frac{1}{T} (10^{L_1/10} \times T_1 + 10^{L_2/10} \times T_2) \right]$$

$$L_{Aeq} = 10 \log \left[ \frac{1}{T} (10^{6.5} \times 10 + 10^{5.5} \times 50) \right]$$

$$L_{Aeq} = ?$$

5. Calculate LAeq when, Average LD is 67dB (6AM to 10PM) and LN is 43 dB (10PM to 6 AM)?

### **Physical conditions for Noise measurement**

- Noise measurement should be done at location of maximum noise.
- Maximum wind speed should be 5m/sec
- Humidity up to 90%
- Temp 10-50°C

### **Ambient Air quality standards in respect of Noise**

Area Code	Category of Area/Zone	Limits of dB(A) Leq	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

- Day time shall mean from 6:00 AM to 10:00 PM.
- Night time shall mean from 10.00 PM to 6:00 AM.
- Silence Zone is an area comprising not less than 100 meters around hospitals, educational institutions, and Courts Religious places or, any other area which is declared as such by the competent authority.

### **Permissible Noise level standards for house appliances**

Home Appliances	Permissible Noise Level
Refrigerator	60dB(A)

Air Conditioner	68dB (A)
Mixer	75dB(A)
Generator	85-90dB(A)

## **Control of Noise**

### **Noise Reduction at the Source**

- The reduction of the exciting forces e.g., reduction of impacts or, impulsive forces, balancing of moving masses, reduction of frictional forces by proper alignment and lubrication etc.
- Reduction of the response of various components of the system of these exciting forces e.g., by application of vibration dumping materials to the radiating surfaces.
- Changes in operating procedure, e.g., a factory, adjacent to the residential areas, suspend or reduce noise generating operations at night.

### **Noise control of the transmission path**

- Sitting e.g., increasing distance between source and the Receiver.
- Path deflection e.g., by use of barrier.
- Properly designed enclosures.
- Absorption e.g., use of sound absorbing material in a room where both the source and the receiver are present in a room.

### **Protective Measures at the receiver**

- Use of personal protective equipment, e.g., use of earplugs, earmuffs, noise helmets etc.
- Education and public relations.
- Exposure Control. e.g., the rotation of personnel so that work assignments in the intense noise area is for a limited period of time only.

## **Effect of noise**

### **On Humans**

- Chronic exposure to noise may cause noise-induced hearing loss. Older males exposed to significant occupational noise demonstrate significantly reduced hearing sensitivity than their non-exposed peers.

- Unwanted noise can damage physiological and psychological health. Noise pollution can cause annoyance and aggression, hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful effects.
- High noise levels can contribute to cardiovascular effects and exposure to moderately high levels during a single eight hour period causes a statistical rise in blood pressure of five to ten points and an increase in stress and vasoconstriction leading to the increased blood pressure noted above as well as to increased incidence of coronary artery disease.

### **On Animals and Aquatic Life**

- Noise can have a detrimental effect on animals, increasing the risk of death by changing the delicate balance in predator or prey detection and avoidance, and interfering with the use of the sounds in communication in relation to reproduction and navigation.
- An impact of noise on animal life is the reduction of usable habitat that noisy areas may cause, which in the case of endangered species may be part of the path to extinction.
- Noise pollution has caused the death of certain species of whales that beached themselves after being exposed to the loud sound of military sonar.

### **Some other effects on wildlife & aquatic animals**

- Hormone Imbalance
- Chronic Stress
- Panic & Escape behavior
- Abandonment of Offspring
- Injury
- Increase in Loudness of Inter species communication.

### **Effect on plants:**

- The production capacity or growth of plant is affected due to high level noise.

### **Damage to materials:**

- The buildings and other materials may get damaged by over exposure to infrasonic/ultrasonic waves and may even collapse.
- Old architecture may develop cracks and crevices under stress from exploding sounds .