NOISE POLLUTION AND CONTROL

Sound is a form of energy, generated by a vibrating object and requires an elastic medium (solid, liquid or gas) for its propagation. Sound waves are longitudinal waves, because the medium particles have periodic changes in displacement and pressure in the same direction of the waves.

Sounds can be classified into two forms –1.Musical sound 2 Noise. Musical sound consists of a series of harmonic waves following each other at regular interval of time, without sudden change in their amplitude. A musical sound has three main characteristics – loudness, pitch and quality.

A noise consists of a series of waves following each other at irregular interval of time, with sudden change in their amplitude. Noise does not have any characteristic of musical sound.

Noise pollution

Noise pollution is unwanted or excessive sound that can have deleterious effects on human health, wildlife and environmental quality.

Classification of noise

Noise may originate from natural sources as well as through anthropogenic activity.

Natural sources are thunder, cyclone, volcanic eruption, roaring of sea etc.

Anthropogenic sources are classified into i) Transport noise ii) Occupational noise and iii) Neighbourhood noise

TRANSPORT NOISE

Transport noise can be subdivided into a. Road traffic noise b. Rail traffic noise c. Aircraft noise

Road traffic noise ----the main causes of road traffic noise are the number of vehicles and their high speed. Heavy vehicles with high speed create maximum noise on road. All around the world the traffic peak hour is from 10a.m. to 6p.m. The traffic noise is measured on the L_{10}(18 hours) index. The limit of road traffic noise in India is 80 dBA.

Rail traffic noise-----this noise is of lower frequency compared to road and aircraft noise. Introduction of diesel and electric engines, welded tracks and improved coaches has contributed a lot in reducing noise level. Railway tracks running through cities and towns cause

more noise pollution than the tracks running through rural areas, surrounded by open area and trees. Rail traffic noise is measured on L_{eq} scale.

Aircraft noise----aircraft noise is not continuous, but intermittent. The noise is produced during takeoff, landing and flight. The faster and larger aircrafts produce more noise. Supersonic fighter aircrafts create most noise. Among cargo and passenger aircrafts jet engines produce most noise. Aircraft noise level is measured on L_{epn} scale.

OCCUPATIONAL NOISE

Different machines used in industrial operations and domestic purposes are the main sources of occupational noise. It is linked mainly to loud industries such as ship building, mining, railroad work, welding and construction etc. Occupational noise, if experienced repeatedly, at high intensity can cause noise- induced hearing loss.

NEIGHBOURHOOD NOISE

Noise from domestic premises and public places are commonly described as neighbourhood noise. The sources are loud television, music system, building demolition, building construction, loud speakers in public meetings and functions etc.

The permissible limit of noise level for cities, given by Pollution Control Board of India is--------

AREA	DURING DAY (IN dBA)	AT NIGHT (IN dBA)
industrial	75	65
commercial	65	55
residential	50	45
Hospital, educational institutes	50	40

EFFECTS OF NOISE POLLUTION

Excessive noise affects human life adversely. The effects can be discussed under three categories---

1. Audiographic effect---Repeated exposure to noise level of 110 dBA to135 dBA results in temporary hear loss. For long exposure it might lead to permanent hearing loss. Exposure to noise level more than 135 dBA results in damage of tympanic membrane and the sensory cells causing permanent deafness. The frequency of sound at which hearing loss starts is about 4000 Hz.

2. Biological effect---Loud sound can cause increase in secretion of pituitary hormone, increase in blood sugar level, increase in heartbeat rate, headache ,neurological problems, reduced immunity etc.
3. Psychological and Behavioral effect---Noise exposure cause irritability, anxiety, mental fatigue, interferes with sleep and recreation, reduces memory and work efficiency, interferes with personal communication, increases chance of accidents in industries by masking the warning signal etc.

Noise pollution also impacts wildlife. A wide range of animals including insects, frogs, birds and bats, rely on sound for a variety of reasons. Noise pollution can interfere with an animal's ability to communicate, navigate, find food, or avoid predators, attract a mate. Thus noise pollution has become a threat to their existence. The problem of noise pollution is especially serious for marine animals, particularly those that rely on echolocation, such as whales and dolphins.

Psychological and physical effects of noise:

NOISE LEVEL (dBA)	EFFECTS
65	Heard at a distance of 1 meter
80	Annoying
110	Discomforting
135	Painful
150	Significant change in pulse rate
160	Damage of hearing
190	Major damage in a short time

NOISE THRESHOLD LIMIT VALUE

When daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect is considered instead of individual effect of each. When the sum of all fractions is more than one, then the mixed exposure is considered to exceed the threshold limit value.

When,

$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots\ldots \frac{C_n}{T_n} > 1$ then the noise exceeds the permissible limit. Here C_n is the duration of exposure at a particular noise level and T_n is the duration of exposure permitted at that noise level.

The noise threshold limit values are given in the following chart----

NOISE LEVEL (dBA)	PERMISSIBLE HOURS PER DAY
80	16
85	8
90	4
95	2
100	1
105	½
110	1/4

Measurement of Noise Pollution

FREQUENCY

Frequency is the rate at which the source produces sound waves. In other words, frequency is the number of times per second that a vibrating body completes one cycle of motion. The unit for frequency is the hertz (Hz) = 1 cycle per second A healthy, young person can hear sounds with frequencies from roughly 20 to 20,000 Hz. The sound of human speech is mainly in the range 300 to 3,000 Hz.

NOISE PRESSURE

Sound pressure is the amount of air pressure fluctuation a noise source creates. We "hear" or perceive sound pressure as loudness. If a drum is hit very lightly, the surface moves only a very short distance and produces weak pressure fluctuations and a faint sound. If the drum is hit harder, its surface moves farther from its rest position. As a result, the pressure increase is greater. To the listener, the sound is louder.

Sound pressure also depends on the environment in which the source is located and the listener's distance from the source.

INTENSITY

Intensity is the amount of sound energy that flows through unit area. The unit of intensity is decibel. It is not a linear scale, but a logarithmic scale. This kind of scale better represents how changes in sound intensity actually feel to our ears. Using logarithmic decibel scale, if a sound is 80 decibels, and we add another 10 decibels, the sound will be ten times more intense, and will seem about twice as loud to our ears.

Mathematically, decibel is calculated as----

$$dB = 10 \log_{10} \frac{I\ (measured\ intensity)}{I_0\ (reference\ intensity)}$$

The reference intensity I_0 is taken as $1X10^{-12}\ W/m^2$. It is the intensity level just audible to human.

There are practical difficulties to measure intensity accurately, so it is measured in terms of sound pressure.

Intensity is directly proportional to the square of sound pressure, so

$I \alpha P^2$ and $I_0 \alpha P_0^2$

The sound pressure level (SPL) in dB is defined by

$SPL = 20 \log_{10} (\frac{p}{P_0})$ dB

The reference pressure P_0 is usually $2 X 10^{-5}\ Nm^{-2}$.

Measurement of noise level

Noise level in decibel is measured with an instrument called sound level meter. It consists of 3 internationally accepted weighing standards, A, B, C.

In dBA scale the frequencies to which human ears are more sensitive are taken into consideration.

The dBA scale does not take account of peak noise level, duration of noise and its quality. So other scales of measurement of noise levels are introduced.

L_{10} index :

This scale measures peak noise level, fluctuation of noise due to nature of vehicle and traffic density. L_{10}(18hour) is the arithmetic mean of each of the eighteen consecutive hours measured between 6:00am and 12:00 midnight on an average weekday. **The L_{10} has been found to be a useful descriptor of road traffic noise as it correlates quite well with the disturbance people feel when close to busy roads as well as more rural situations. By definition the** L_{10} value is the level just exceeded for 10% of the time **and takes account of any annoying peaks of noise. L_{10} calculated levels are widely used when planning new traffic schemes.**

Equivalent perceived noise (L_{epn}) :

It is a measure of the relative noisiness of an individual aircraft pass-by event. It is used for aircraft noise certification and applies to an individual aircraft, not the noise exposure from an airport. Separate ratings are stated for takeoff, overflight and landing events, and represent the integrated power sum of noisiness during the event. It is measured in dBA scale and the value is taken as, dBA scale value + 13.

Equivalent noise level (L_{eq}):

It is the weighted average sound level over the time of measurement where the time of measurement is specific and for a short duration usually when the noise level is most prominent. It is used for measurement of noise level in the industrial area, residential area as well as traffic.

NOISE CONTROL

The noise generated in the environment can never be eliminated completely, but it can be controlled. An effective model for noise control is the source, path and receiver model by Bolt and Ingard. Noise can be controlled by reducing the noise output at its source, minimizing the noise as it travels along a path to a listener, and providing equipment to the listener or receiver to attenuate the noise.

- Noise control at source:

  The primary consideration of noise control is to reduce noise at its source by introducing quieter working methods and technologies.

  - Transport noise can be reduced at source by limiting speed of vehicles, improving tire design, using silencers, limiting use of horns, designing quieter jet engines, altering flight paths, improving technologies for locomotives etc.
  - Occupational noise can be reduced at source by proper design of machines, proper operation of machines, regular maintenance of machines. Noise produced due to vibration of a machine can be reduced by installing the machine on a thick steel platform isolated from other by a thick block of rubber.
  - Community noise can be easily reduced by limiting the volume of television, music system and loud speaker.

- Noise control at path:

  Controlling the noise along the path involves some kind of modification of the space enclosing both source and receiver.

  - Some common techniques for control of noise in the path are construction of enclosure, vibration isolation, breaking mechanical path, lengthening of transmission path, absorption of sound energy with acoustic treatments, construction of heavy, air –tight enclosures.
  - Acoustic enclosure is done by keeping high noise generating machine in a separate room, at a relatively long distance. The inner walls of the enclosure are made acoustically lined materials, such as glass fiber or fiber wool.
  - Noise barrier is done by constructing walls with hard and dense materials to reflect sound or with porous materials to absorb sound. The barrier should be

placed close to the noise source and there should be no joints or gaps in the barrier.

- Silencers are used to reduce sound transmission mainly in automobiles and vehicles. Generally stainless steel, tin plate, stainless iron coated with fiber glass is used as silencer. The silencer can absorb the sound or reflect the sound or if designed properly can function in both ways.
- Plants are efficient noise absorbers, especially of high frequency noise. Thus plantation along streets, highways and in industrial areas help to reduce noise pollution.

- Noise control at receiver

  It is mainly done at personal level. Commonly used hearing protectors are earplugs, earmuffs etc. In industries workers should be given shift duties to prevent long exposure to noise.

In addition to the above mentioned measures, following steps also reduce noise pollution-----

- Proper planning of cities to separate industrial zone and airport from residential area.
- Making green belt around residential area, industrial area, along streets and railway tracks.
- Raising public awareness about effect of noise pollution.
- Distributing up-to-date information regarding noise pollution.
- Strengthening laws and governmental effort to control noise pollution.
- Establishing networks among environmental professionals, activists and government to help and protect them