SUBJECT:
ENERGY & ENVIRONMENTAL ENGINEERING
B. Tech. I, 1st Semester (B-Division)

TOPIC – "Noise Pollution"

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WHAT IS NOISE POLLUTION?

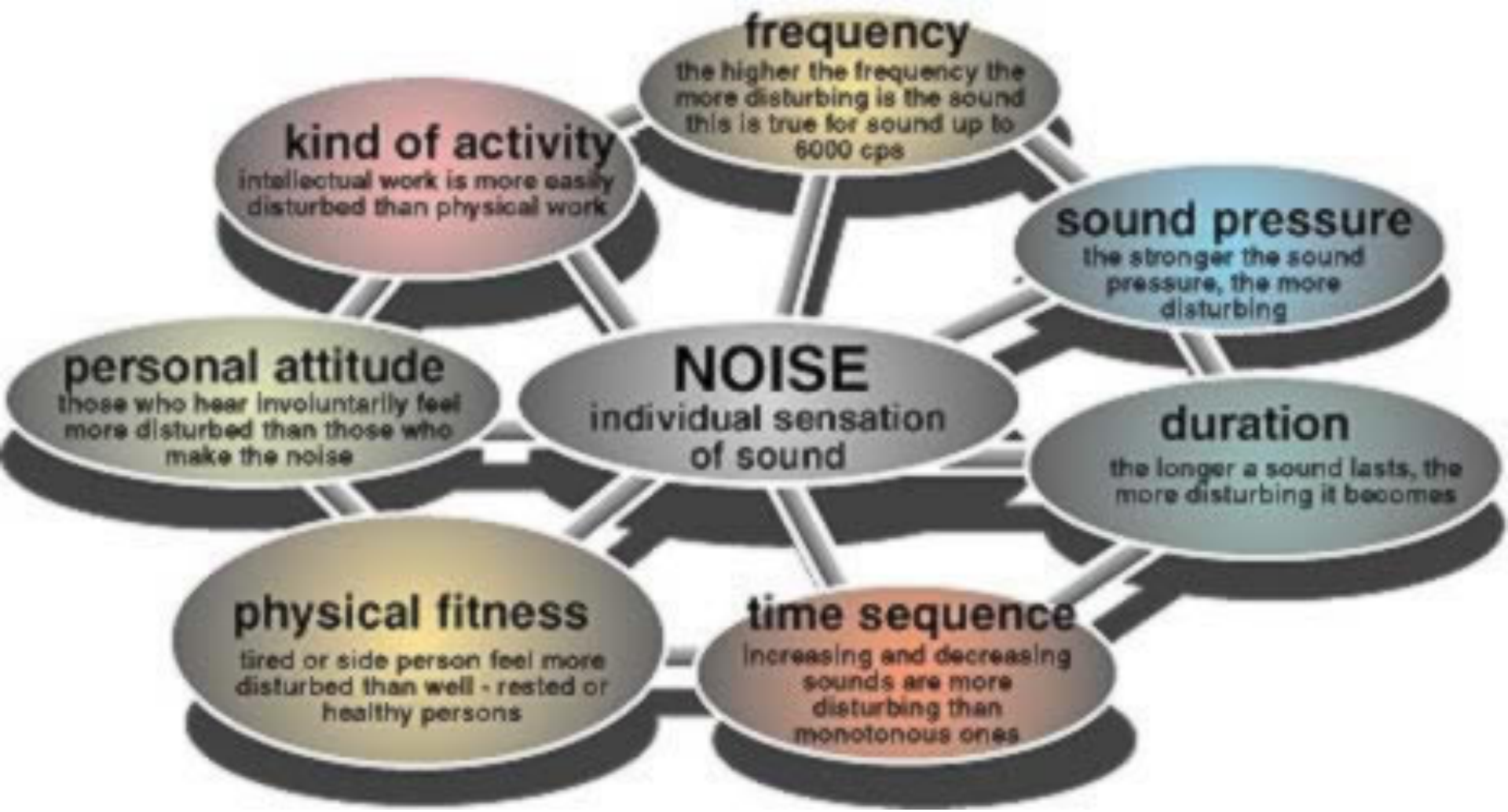
- Sound that is unwanted or disrupts one's quality of life is called as noise. When there is lot of noise in the environment, it is termed as noise pollution.
- Sound becomes undesirable when it disturbs the normal activities such as working, sleeping, and during conversations.
- It is an underrated environmental problem because of the fact that we can't see, smell, or taste it.
- World Health Organization stated that "Noise must be recognized as a major threat to human well-being"

Noise can be defined as an unpleasant and unwanted sound that interferes significantly with the comfort, health or welfare of persons, or with the full use of enjoyment of property.

Noise in itself is a source of pollution.

It has been recognized as a significant health problem related to hearing damage.

Environmental noise may be defined as unwanted sound that is caused by emissions from traffic (roads, air or railways), industrial sites and recreational infrastructures.



Factors Influencing Noise

- The most important change which is evident in most places in this century is the explosion of human population.

- This has exerted pressure on all available resources. One of them is significant rise of noise level.

- Surveys of complaints and physical measurements, all show noise pollution to be one of the major hazards of modern life, especially in areas which are the most industrialized, urbanized and motorized.

- Surveys show that noise is now perceived in many countries to be the major negative factor affecting the quality of life.

- In the United States, for example, *noise is ranked second* only to crime.

- In Germany, a poll indicated that 45% of the population believed that protection against noise is more important than building new roads.

- Oscar Romero, a spokesman for the Copenhagen based EU agency has said that, "Noise has gotten a "late start" compared to other forms of pollution, both in terms of regulation and public opinion"

Noise Environment in Europe

- 450 million (65%) exposed to >55dBA
- 113 million (17%) exposed to >65dBA
- 9.7million (1.4%) exposed to >75dBA
- No systematic differences across Europe
- Eastern European Cities noisier than Western
- Data poor from Central and Eastern Europe

(dBA: A Weighted Decibals)

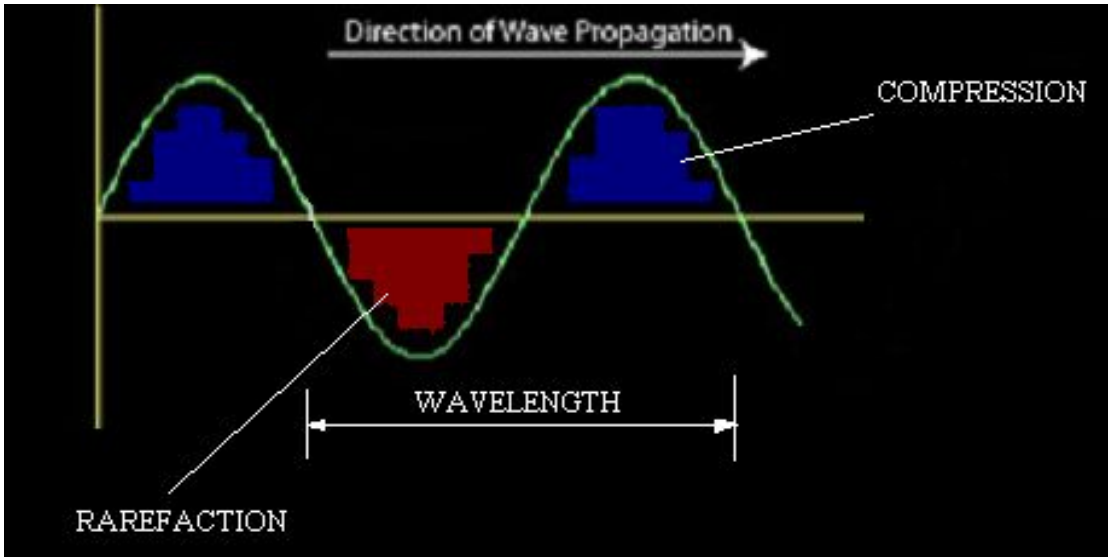
Costs of Noise to Society

- Estimate: 0.2 to 2% GDP

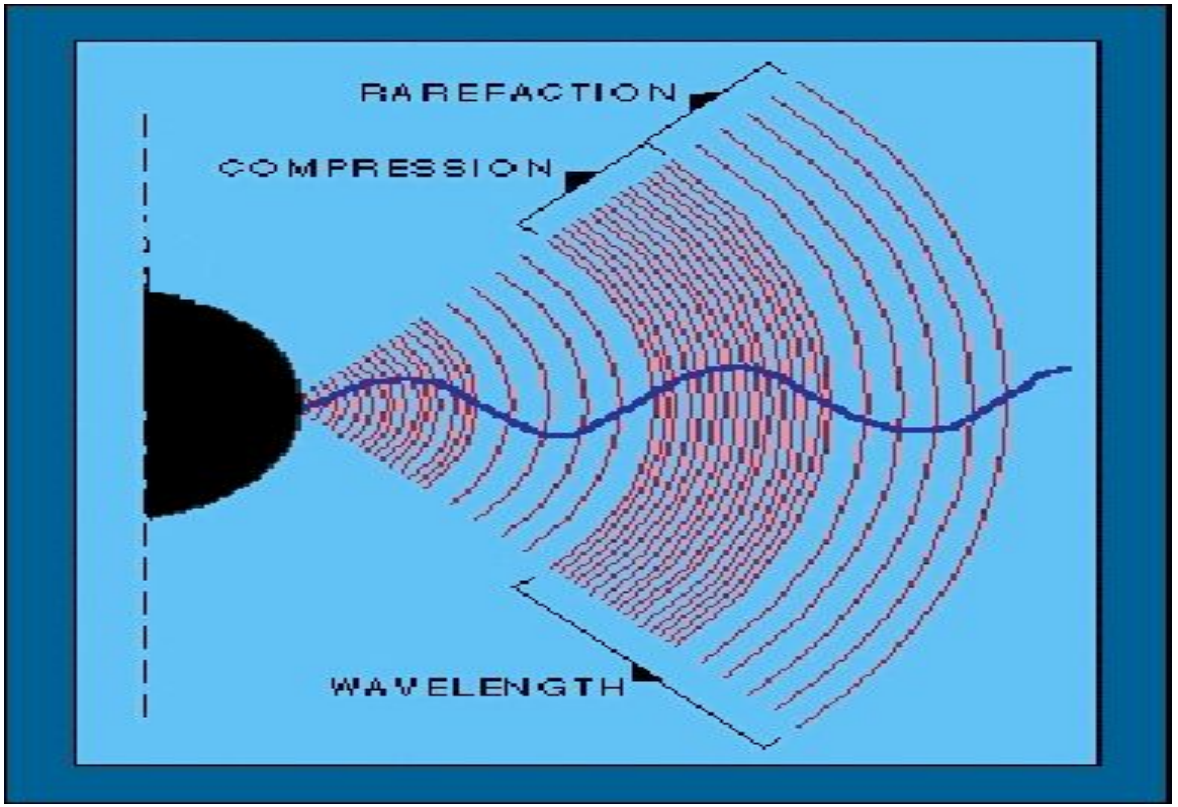
0.2% equates to 12Billion Euros annually

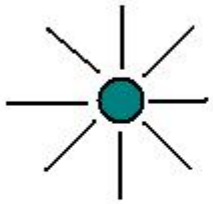
- It will not be untrue to admit that Indians are noisy people. In India, every occasion or sentiment is manifested in a noisy manner – be it a religious occasion, an election or a family celebration.
- If we compare the level of awareness about air quality or greenhouse gas emissions to NOISE, we are still at an early stage.
- Scientists have also been slow to focus on how constant noise levels influence mental and physical health.
- It is high time to realize the importance of protection against noise pollution on global basis.

- Sound is a sensation of acoustic waves i.e. disturbance / pressure fluctuations setup in a medium (air).
- Sound is a disturbance that propagates through a medium having properties of inertia (mass) and elasticity.
- The medium by which the audible waves are transmitted is air.
- Basically sound propagation is simply the molecular transfer of motional energy. Hence it cannot pass through vacuum.

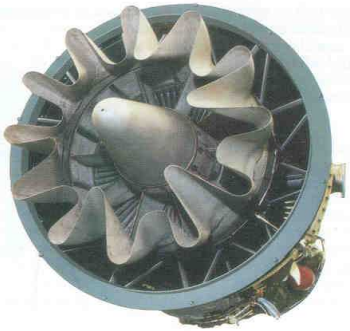


- The disturbance (noise) gradually diminishes as it travels outwards since the initial amount of energy is gradually spreading over a wider area.
- If the disturbance is confined to one dimension (tube / thin rod), it does not diminish as it travels (except loses at the walls of the tube)

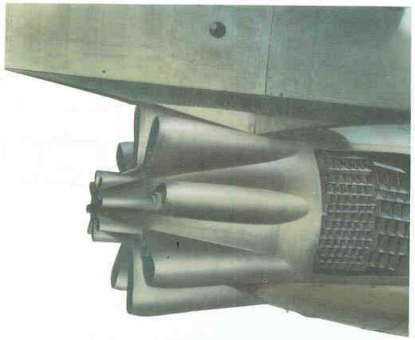




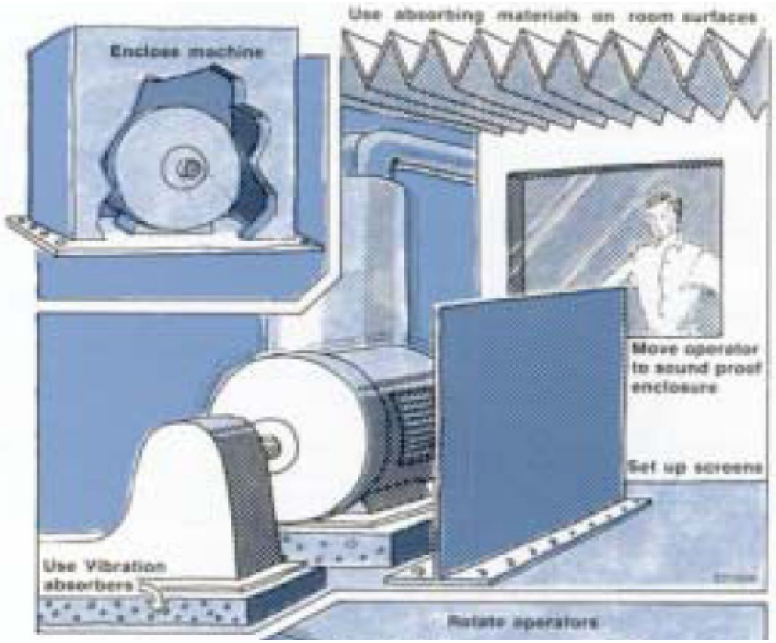
Source **Path** **Reciever**



CORRUGATED INTERNAL MIXER



LOBE-TYPE NOZZLE



Some basic definitions

Sound pressure:
It is the pressure that reaches the timpano (ear drum) of human and animal ears, caused by the oscillating movement of the medium molecules (generally the air). It is given in Pascal (Pa).

Sound pressure level:
It is given by the formula below, where the reference sound pressure is the minimum sound pressure that can be perceived by the human ear. Its value is equivalent to 20 μPa (20×10^{-6} Pa)

$$SPL = 10\log\left(\frac{pres^2}{refpres^2}\right)$$

Where,
pres = sound pressure;
refpres = reference sound pressure.

The unit used is the decibel (dB), submultiple of the bel (B).

Example Problem: Sound Power Levels

A source radiates an acoustic wave with a *sound power level* of 73 watts.

What is the decibel level of the sound when measured at the source (i.e., distance from source 0)?

$$\text{PWL} = 10 \bullet \log_{10}\left(\frac{W}{W_0}\right)$$

where: W = sound power (*watts*)

W_0 = reference power (10^{-12} *watts*)

$\log_{10}$ = a logarithm to the base 10

$$\text{PWL} = 10 \bullet \log_{10}\left(\frac{73}{0.000000000001}\right)$$

$$\text{PWL} = 10 \bullet \log_{10}(73000000000000)$$

$$\text{PWL} = 10 \bullet 13.9$$

$$\text{PWL} = 139$$

Example Problem: Sound Pressure Level

The acoustic wave radiated by a source is measured some distance away from the source and is found to generate a sound pressure level of 156 μPa.

What is the decibel level of the sound wave at the point where it was measured?

$$L_p = 20 \bullet \log_{10}\left(\frac{p}{p_0}\right)$$

where: p = measured Root-Mean-Square (RMS) sound pressure (in μPa)

p_0 = reference RMS sound pressure (20 μPa)

$$L_p = 20 \bullet \log_{10}\left(\frac{156}{20}\right)$$

$$L_p = 20 \bullet \log_{10}(7.8)$$

$$L_p = 20 \bullet 0.89$$

$$L_p = 17.8$$

Example Problem: Sound Intensity Level

A piece of machinery radiates a sound measured at 100 *dB* at a distance of 1 *m* ($r_1 = 1$) from the source.

What would the sound pressure level be at $r_2 = 2$ *m*?

$$L_{P2} = L_{P1} - 20 \cdot \log_{10}\left(\frac{r_2}{r_1}\right)$$

where: L_{P1} = sound pressure level at location of first measurement (in *dB*)

r_1 = location of first measurement (in *meters*)

r_2 = location of second measurement (in *meters*)

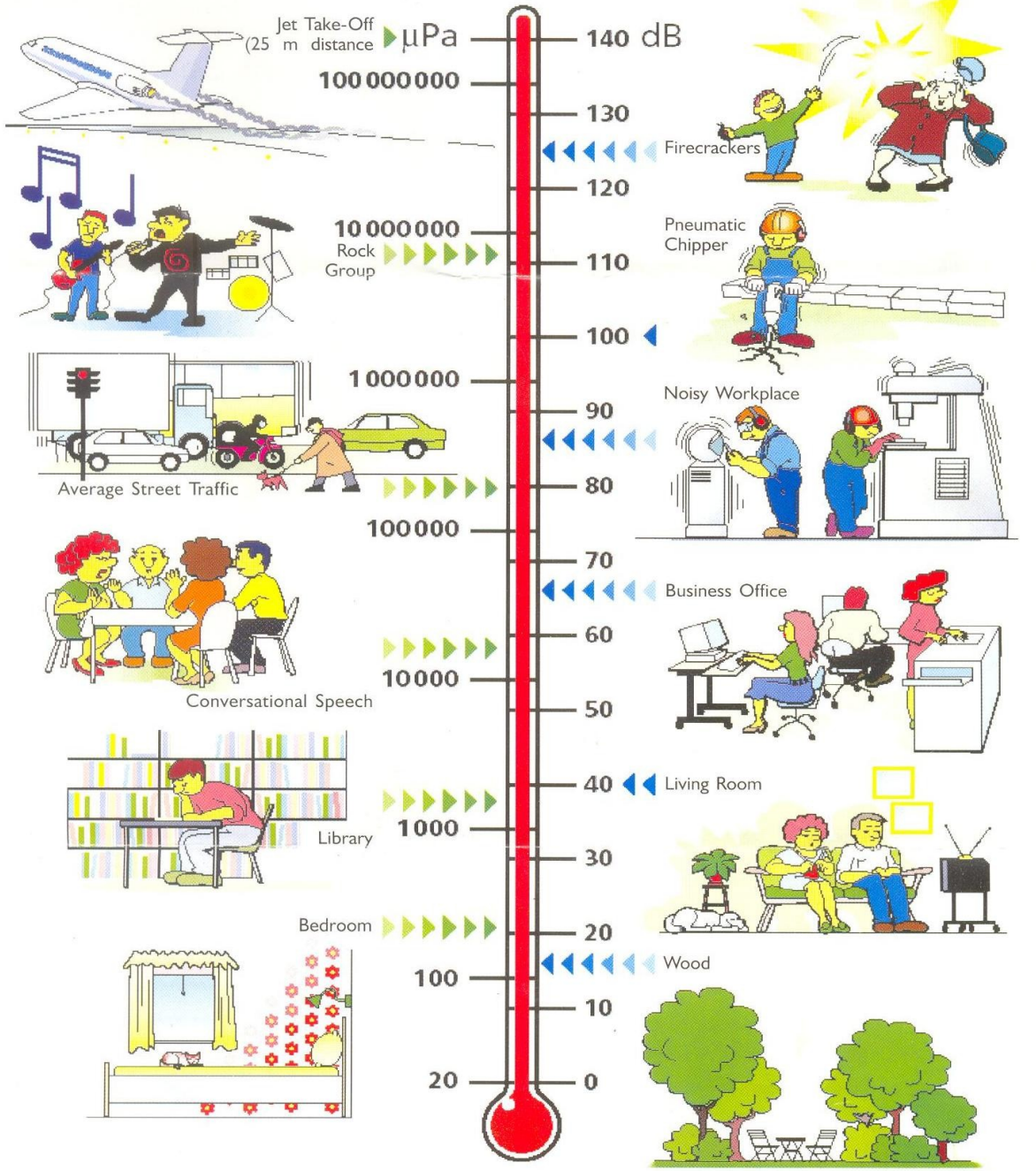
$$L_{P2} = 100 - 20 \cdot \log_{10}\left(\frac{2}{1}\right)$$

$$L_{P2} = 100 - 20 \cdot \log_{10}(2)$$

$$L_{P2} = 100 - 20 \cdot 0.30$$

$$L_{P2} = 100 - 6$$

$$L_{P2} = 94$$


SOUND PRESSURE
SOUND PRESSURE LEVEL
Jet Take-Off (25 m distance
µPa
100 000 000
10 000 000
Rock Group
1 000 000
Average Street Traffic
100 000
Conversational Speech
10 000
Library
1000
Bedroom
100
20
140 dB
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Firecrackers
Pneumatic Chipper
Noisy Workplace
Business Office
Living Room
Wood

Some basic definitions

dB(A):

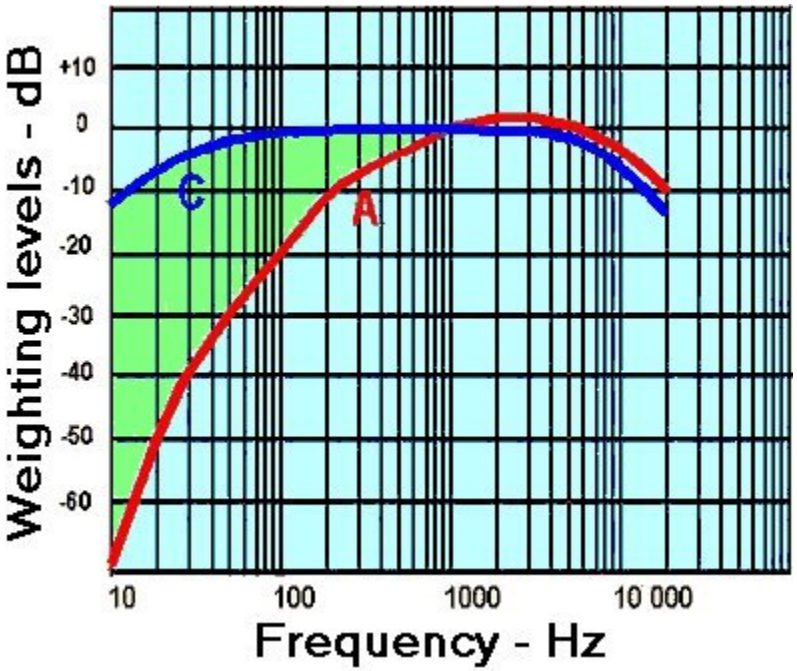
The ear sensitivity to sound is dependent on the frequency of the sound being detected. Frequencies at the extreme of the hearing frequency range are not detected as well as frequencies in the middle of the range.

To account for this, when measuring sound, a weighting curve is used to place more emphasis on frequencies to which humans are more sensible.

The ‘‘A’’ weighting curve is generally used for the purpose of measuring sound levels.

The sound weighted by the ‘‘A’’ curve approaches the perception of the human ear and its value is given by dB(A).

A & C weighted frequencies



- Several different weighting networks have been developed over the years. The one which has been found to best describe the damaging effect of noise is the **A-weighting network.**

- The sound level meter replicates the human response of the ear by using an electronic filter which is called “A” filter.

- The sound pressure level in dB (A) gives a close indication of the subjective loudness of the noise.

dB SCALE

Human ear responds logarithmically to power difference

Alexander Graham Bell invented a unit Bel to measure the ability of people to hear

Power Ratio of 2 = dB of 3

Power Ratio of 10 = dB of 10

Power Ratio of 100 = dB of 20

$$SPL = 10\log\left(\frac{pres^2}{refpres^2}\right)$$

Where,

pres = sound pressure;

refpres = reference sound pressure.

The unit used is the decibel (dB), submultiple of the bel (B).

Some typical values:
35 dB(A)—libraries
65 dB(A)—business offices with normal conversation
75 dB(A)—street with intense traffic measured at the curb
85 dB(A)—street with heavy lorries passing at 6 m of distance

Equivalent level (Leq):

The noise levels are variable along the time, going up and down continuously, making it difficult to evaluate it.

In order to make things easier, the equivalent noise level is defined as a continuous sound level that would produce the same effect on the human ear if compared to the actual noise observed during the measurement, with all the variations.

Therefore, the Leq can substitute by a single value all the variations of the noise level. The equivalent sound level is also given by dB(A).

FREQUENCY

Frequency can be defined as number of pressure cycles / time

It is also known as pitch of sound

Its unit is Hz.

In sound, frequency is as important as its level

<20Hz	20Hz to 20,000Hz	> 20,000Hz
Infrasonic	Audible Range	Ultrasonic

SOURCES: (1) Industrial (2) Non-industrial

(1) Industrial:

Various industries contributing to noise pollution:

- Textile
- Iron and steel
- Pulp & paper
- Chemicals
- Thermal power stations

In industrial cities like Surat, Kolkata, Ludhiana, Kanpur etc. often the industrial zones are not separated from the residential zones of the city, especially in the case of small scale industries.

(2) Non-Industrial:

- Domestic Noise (Household)
- Entertainment devices, musical instruments, air conditioners, kitchen appliances.
- **Loudspeakers** during festivals and religious rituals. (Public Address System)
- Construction & demolition work.
- Transportation noise viz. **road**, rail and air.
- Crowded markets and commercial areas.
- Places near airports-noise due to take off and landing of aircrafts.

Noise Level and Effects

- <55dBA Desirable level outdoor sub-urban neighbourhood
- 55-65dBA Urban “Grey Areas” Annoyance
- >65dBA Black spots

  Stress effects, sleep disturbance, communication, performance deficits
- >75dBA Unfit for Human habitation,

  hearing loss, cardiovascular effects

NOISE POLLUTION: Effects on human beings:

(1) Auditory effects:

Hearing loss

There are two types of hearing loss caused by noise.

(a) Acoustic trauma

It consists of instantaneous damage to the ear from a sharply rising wave front, such as occurs in an explosion and may produce rupture of the ear drum.

(b) Noise induced hearing loss

- It results from long term exposure to intense sound.
- The effect usually occurs slowly.
- Its severity depends on the intensity, frequency and duration of noise exposure.
- The absence of comfort makes noise induced hearing loss especially treacherous since the loss of hearing appears only after significant permanent loss has occurred.

(2) Non-Auditory effects:

(i) Physiological effects:

(a) Headache
(b) Increase in the rate of heart beat
(c) Narrowing of arteries
(d) Pain in the heart beat
(e) Decrease in the rate of colour perception
(f) Lowering of concentration
(g) Muscular strain and nervous breakdown
(h) Digestive spasm
(i) Eye strain
(j) Nausea
(k) Dizziness

The physiological effect of noise upon particular individuals is very variable, and not yet fully understood.

(ii) Psychological effects:

(1) Annoyance.

(2) Psychological or non-pathological noise effects are also variable and very difficult to measure.

(3) The mildest effect is often physical and mental fatigue and lack of concentration.

(4) It results in lowered efficiency, a reduced work rate, increased absenteeism, and a higher potential for accidents and injuries.

(5) Psychological noise effects impinge upon sleep thereby resulting into insomnia.

(6) Noise can also affect verbal communication upon which we all depend, whether in the work, domestic or social environments.

(7) Depression, which reduces the efficiency of a person.

LEGISLATION FOR NOISE POLLUTION:

- In western countries, legislation to deal with noise has existed for a number of years by virtue of noise being considered to be a nuisance.
- Just like laws and acts for various forms of pollution getting introduced in India at a very late stage, example Water (Prevention and Control of pollution) Act came into force from 1974 and Air (Prevention and Control of pollution) Act came into force from 1981,
- Noise Pollution (Regulation And Control) Rules came in as late as February 2000, whereas in UK, Noise Abatement Act came into force from 1960.

Hence, it can be said that scenario for noise pollution control legislation in India, as compared to other developed countries is very slow paced.

CPCB-Standards with respect to noise in ambient air

Area Code	Category of area	Limits in dB	
		Day time	Night time
(A)	Industrial	75	70
(B)	Commercial	65	55
(C)	Residential	55	45
(D)	Silence	50	40

NOTE:

(1) Day time is reckoned in between 6 a.m. to 10 p.m.

(2) Night time is reckoned in between 10 p.m. to 6 a.m.

(3) *Silence zone* is defined as areas up to 100 mts around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the competent authority. **Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these silence zones.**

- NOISE POLLUTION CONTROL

NOISE POLLUTION – CONTROL MEASURES:

- Occupational noise is present in the working environment of many thousands of people for up to 1900 hours per year, and for 30 to 40 years of their lives.
- **Noise should no longer be regarded as inescapable and inevitable**, whether it is hazardous or disturbance noise.
- However, it must be accepted that noise cannot be eliminated entirely from our modern technological environment. While noise cannot of course be totally eliminated, much can be done to reduce it.
- The benefits of noise reduction are very worth while considering.

- The benefits of noise reduction are very worth while considering.

(1) Thousands of people would no longer suffer progressive hearing damage.

(2) Verbal communication between workers would be enhanced.

(3) Improved efficiency.

(4) Reduction of accidents.

(5) General all round improvement in working conditions.

NOISE POLLUTION – CONTROL MEASURES:

- **Control of noise at source**
- **Control during transmission**
- **Use of personal protective equipments (PPEs)**
- **Help of experts in design and monitoring**
- **Green Belt Design (GBD)**
- **Sound absorbing material**
- **Legislation**
- **Education and awareness**

The techniques employed for noise control can be broadly classified as:

- Control at source
- Control in the transmission path
- Control at receivers end

Control at Source

Reducing the noise levels from domestic sectors:

- Buildings can be designed with suitable noise absorbing material for the walls, windows, and ceilings.
- The domestic noise coming from radio, tape recorders, television sets, mixers, washing machines, cooking operations can be minimized by their selective and judicious operation.
- By usage of carpets or any absorbing material, the noise generated from felling of items in house can be minimized.

Maintenance of automobiles:

- Regular servicing and tuning of vehicles will reduce the noise levels.

- Fixing of silencers to automobiles, two wheelers etc., will reduce the noise levels.

Control over vibrations:

- The vibrations of materials may be controlled using proper foundations, rubber padding etc. to reduce the noise levels caused by vibrations.

- **Low voice speaking:** Speaking at low voices enough for communication reduces the excess noise levels.

Prohibition on usage of loud speakers:

- By not permitting the usage of loudspeakers in the habitant zones except for important meetings / functions.

Selection of machinery:

- Optimum selection of machinery tools or equipment reduces excess noise levels.

Maintenance of machines:

- Proper lubrication and maintenance of machines, vehicles etc. will reduce noise levels.

- For example, it is a common experience that, many parts of a vehicle will become loose while on a rugged path of journey.

Control in the transmission path

- The change in the transmission path will increase the length of travel for the wave and get absorbed/refracted/radiated in the surrounding environment.

Barriers

- Buffer zones
- Earth berms/wooden fences/concrete walls
- Vegetation (if dense enough)

Aesthetic noise barrier: Highway in Melbourne, Australia

Design of building:

- The design of the building incorporating the use of suitable noise absorbing material for wall/door/window/ceiling will reduce the noise levels.

Green belt development:

- Planting bushes and trees in and around sound generating sources is an effective solution for noise pollution.

- The degree of attenuation varies with species of greenbelt.

- The statutory regulations direct the industry to develop greenbelt four times the built-up area for attenuation of various atmospheric pollutants, including noise.

Control at receivers end

Use of personal protective equipments (PPEs)

- Protective equipment usage is the *ultimate step in noise control technology, i.e. after noise reduction* at source

- and/or after the diversion or engineered control of transmission path of noise.

- The first step in the technique of using protective equipment is to gauge the intensity of the problem, identification of the sufferer and his exposure to the noise levels.

The usage of protective equipment and the worker's exposure to the high noise levels can be minimized by:

- **Job rotation:** By rotating the job between the workers working at a particular noise source or isolating a person, the adverse impacts can be reduced.

Thank You