# NOISE POLLUTION AND ITS CONTROL

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**Goal:** The goal of this module is to introduce the reader the basic concepts of noise pollution and its control.

**Learning Objectives:** To achieve the goal, the following learning objectives (LO) with selected thrust areas are identified.

**LO-1:** What is noise ? (Definition, theoritical concept)
**LO-2:** How it is measured ? (Concept, mathematical formulae)
**LO-3:** Frequency analysis (Concept)
**LO-4:** Where does noise emanate from? (Concept, application)
**LO-5:** Why bother about noise ? (Concept)
**LO-6:** Control of noise pollution (Concept, technic, application)
**LO-7:** How to document the reports? (Concept)
**LO-8:** What does the Regulatory guidelines prescribe? (Concept, application)

The emphasis of this module is to make the reader understand the basic concepts of noise pollution and its control and co-relate with the happenings at outside world.

By the time you finish reading this module, you can

- Identify the sources of noise pollution
- Grasp the various adverse impacts of noise pollution
- Quantify the noise levels
- Develop methodologies to control noise pollution
- Document the noise levels in a systemmatic approach
- Get familiar with the Statutory limits for both the ambient noise levels and the noise levels at a workspace environment

*Besides*

- Be able to execute assignments in your locality pertaining to noise pollution identification, quantification and control.

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We often hear from people who have returned from shopping in the market that, there is a lot of noise pollution in the city. They often blame the two, three - and four wheelers besides commercial units for increasing ambient noise pollution. On a special day like festivals, marriage functions, birthday parties etc., we can hear loud speakers drilling the common man with severe noise pollution. Let us get familiar with some basic concepts pertaining to noise pollution and its control.

**Towards LO - 1**

## What is noise?

In simple terms, noise is unwanted sound. Sound is a form of energy which is emitted by a vibrating body and on reaching the ear causes the sensation of hearing through nerves. Sounds produced by all vibrating bodies are not audible. The frequency limits of audibility are from 20 HZ to 20,000 HZ.

A noise problem generally consists of three inter-related elements- the source, the receiver and the transmission path. This transmission path is usually the atmosphere through which the sound is propagated, but can include the structural materials of any building containing the receiver (See Fig. 1)

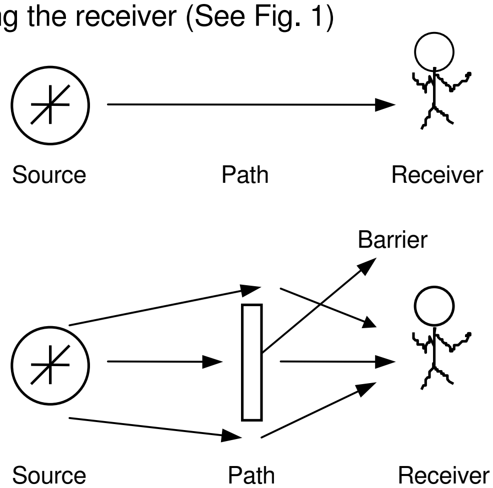


Fig. 1 Inter-relationship between the elements of noise

Noise may be continuous or intermittent. Noise may be of high frequency or of low frequency which is undesired for a normal hearing. For example, the typical cry of a child produces sound, which is mostly unfavorable to normal hearing. Since it is unwanted sound, we call it noise.

The discrimination and differentiation between sound and noise also depends upon the habit and interest of the person/species receiving it, the ambient conditions and impact of the sound generated during that particular duration of time. There could be instances that, excellently rendered musical concert for example, may be felt as noise and exceptional music as well during the course of the concert!

Sounds of frequencies less than 20 HZ are called infrasonics and greater than 20,0000 HZ are called ultrasonics. Since noise is also a sound, the terms noise and sound are synonymously used and are followed in this module.

**Towards LO - 2**

## How it is computed?

The intensity of sound is measured in sound pressure levels (SPL) and common unit of measurement is decibel, dB. The community (ambient) noise levels are measured in the A - weighted SPL, abbreviated dB(A). This scale resembles the audible response of human ear. Sounds of frequencies from 800 to 3000 HZ are covered by the A - weighted scale. If the sound pressure level, $L_1$ in dB is measured at $r_1$ meters, then the sound pressure level, $L_2$ in dB at $r_2$ meters is given by,

$L_2 = L_1 - 20 \log_{10} (r_2/r_1)$ ...... (1)

If the sound levels are measured in terms of pressure, then, sound pressure level, $L_P$ is given by,

$L_P = 20 \text{ Log}_{10} (P/P_o)$ dB(A) ...... (2)

The $L_p$ is measured against a standard reference pressure, $P_o = 2 \times 10^{-5}$ $N/m^2$ which is equivalent to zero decibels. The sound pressure is the pressure exerted at a point due to a sound producing source (see. Fig. 2)

o ) ) ) ) ) * )SPL

Fig. 2 Definition of sound pressure

**Day-night equivalent noise levels (Ldn)**: The day night equivalent noise levels of a community can be expressed as -

Ldn , dB(A) = $10 \times \log_{10} [15/24 (10^{Ld/10}) + 9/24 (10^{(Ln + 10)/10})]$ ............... (3)

where, Ld = day-equivalent noise levels (from 6AM - 9 PM), dB (A)
Ln = night equivalent noise levels (from 9 PM - 6 AM), dB (A)

The day hours in respect to assessment of noise levels, is fixed from 6 AM - 9 PM (i.e., 15 hrs) and night hours from 9 PM - 6 AM (i.e., 9 hrs). A sound level of 10 dB is added to Ln due to the low ambient sound levels during night for assessing the Ldn values.

**Addition of sound levels:** The effective sound levels form two or more sources cannot be simply added algebraically. For example, the effective sound level from two air conditioners 60 dB(A) each, say is not 60 + 60 = 120 dB (A) but 60 + 3 = 63 dB(A). (See table 1). Similarly, the effective sound level of 57 dB, 63 dB, 63 dB, 66 dB and 69 dB is 72 dB. The computation is illustrated below.

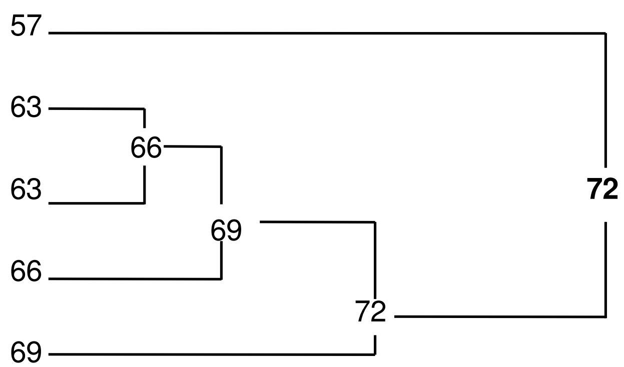


**Table 1 Addition of sound levels, $L_1$ and $L_2$ ($L_1 > L_2$)**

| $L_1$ - $L_2$, dB | Add to $L_1$ |
|---|---|
| 0 or 1 | 3 dB |
| 2 or 3 | 2 dB |
| 4 - 8 | 1 dB |
| 9 or more | 0 dB |

*Source : Ref. (9)*

Towards LO - 3

## Frequency analysis [3,9]

The frequency analysis allow to separate the main components of the signals by dividing the frequency range of interest into smaller frequency bands using a set of filters. We may distinguish between noises that consist of regularly repeated or periodic sounds and those that consist of aperiodic sounds. The simplest periodic sound is a pure tone i.e., a pressure disturbance that fluctuates sinusoidally at a particular frequency. The lower the frequency, the longer is the wave length (wavelength = velocity of sound/frequency).

The noise produced by most sources of community noise, such as automobiles or aircraft engines, are examples of aperiodic sounds. Such sounds cannot be subdivided into sets of harmonically related pure tones but can be described in terms of components extending over finite frequency bands. Such frequency analysis are often done in bands of octaves or 1/3 octaves.

An octave band is a frequency band with upper and lower cutoff frequencies having a ratio of 2. The cut off frequencies of 707 HZ and 1414 HZ define an octave band, whose band centre frequency is 1000 HZ and would be referred to as the 1000 HZ octave band.

Frequency analysers can be divided into two groups viz. constant band width analyser and constant percentage bandwidth analyser. In the constant bandwidth analyser the filter bandwidth is kept constant throughout the frequency range while in the constant percentage bandwidth analyser, the bandwidth is proportional to the centre frequencies. The constant percentage bandwidth analyser is widely used. The nine preferred centre frequencies for noise level measurement are 31.5, 63, 125, 250, 500, 1000, 2000, 4000 and 8000 HZ.[3]

As already mentioned, dB(A) values give emphasis to sounds in the range of about 800 to 3000 HZ. Since the sound generating frequencies are not fully covered under dB(A), for detailed evaluation and engineering design, the multiple-number descriptions provided by frequency analysis are often required.

### Noise measurement instruments[3]

Noise measurement is an important diagnostic tool in noise control technology. The objective of noise measurement is to make accurate measurement which give us a purposeful act of comparing noises under different conditions for assessment of adverse impacts of noise and adopting suitable control techniques for noise reduction. The various equipment used for noise level measurement are summarised at Table 2. The principle and the components of noise measuring instruments is summarised below.

A sound level meter consists basically of a microphone and an electronic circuit including an attenuator, amplifier, weighting networks or filters and a display unit. The microphone converts the sound signal to an equivalent electrical signal. The signal is passed through a weighting network which provides a conversion and gives the sound pressure level in dB. The instructions laid down by the noise level meter manufacturers shall be followed while using the instruments.

The time constants used for the sound level meter standards are [(3)]
S (Slow) = 1 second
F (Fast) = 125 milli seconds

Relatively steady sounds are easily measured using the "fast" response and unsteady sounds using "slow" response. When measuring long-term noise exposure, the noise level is not always steady and may vary considerably, in an irregular way over the measurement period. This uncertainty can be solved by measuring the continuous equivalent level, which is defined as, the constant sound pressure level which would have produced the same total energy as the actual level over the given time. It is denoted as **Leq**. The display of Leq facility is also available in certain models of sound level meters. This is the desired parameter for assessment of ambient noise levels.

**Table 2 Equipment used in the measurement of noise levels**

| S.No. | Equipment | Specification/Area of usage |
|---|---|---|
| 1. | Sound level meter | Type-0 : Laboratory reference standard<br>Type-1: Lab use and field use in specified controlled environment<br>Type-2: General field use (Commonly used)<br>Type-3: Noise survey |
| 2. | Impulse meters | For measurement of impulse noise levels e.g. hammer blows, punch press strokes etc. |
| 3. | Frequency analysers | For detailed design and engineering purpose using a set of filters. |
| 4. | Graphic recorders | Attached to sound level meter. Plots the SPL as a function of time on a moving paper chart. |
| 5. | Noise dosimeters | Used to find out the noise levels in a working environment. Attached to the worker |
| 6. | Calibrators | For checking the accuracy of sound level meters. |

*Source: Ref. (3)*

### Noise Sampling

Bureau of Indian Standards (BIS) has published several code books for sampling and analysis of noise pollution and guidelines for control of noise pollution from domestic and industrial sources. The reader is advised to refer to the BIS code books (table 3) for a better understanding of methods of noise sampling. For sampling of noise levels from industrial sources, noise levels in the different octave bands are measured by a sound level meter in conjunction with octave - band filters at the workers ear level or at about a distance of one meter from the source of noise.

**Table 3 Selected BIS code books on noise pollution**

| BIS Code | Description |
|---|---|
| IS-4954-1968 | Noise abatement in town planning recommendations |
| IS-3098-1980 | Noise emitted by moving road vehicles, measurement |
| IS-10399-1982 | Noise emitted by stationary road vehicles, methods of measurement of |
| IS-6098-1971 | Air borne noise emitted by rotating electrical machinery, method of measurement of |
| IS-4758-1968 | Noise emitted by machines, methods of measurements of |
| IS-3483-1965 | Noise reduction in industrial buildings, code of practice for |
| IS-1950-1962 | Sound insulation of non-industrial buildings, code of practice for |
| IS-9167-1979 | Ear protectors |

*Source Ref. (3 )*

Towards LO - 4

## Sources of noise

**Where does it generate from?** The sources of noise may vary according to daily activities. They sources may be domestic (movement of utensils, cutting and peeling of fruits/vegetables etc.) natural (shores, birds/animal shouts, wind movement, sea tide movement, water falls etc.), commercial (vendor shouts, automobiles, aeroplanes, marriages, laboratory, machinery etc.) industrial (generator sets, boilers, plant operations, trolley movement, transport vehicles, pumps, motors etc.). The noise levels of some of the sources are summarised at table 4.

Typical surveys pertaining to causes of noise pollution, reveal the various sources of noise pollution and frequency variation of their occurrences. The results of a survey conducted in Central London, way back in 1961-62 reveals the presence of noise pollution even in the early ‘60s (Table 5). Road traffic is identified as the major source of noise pollution while at home or outdoors or at work.

**Table 4 Typical noise levels of some point sources**

| Source | Noise level dB(A) | Source | Noise level, dB(A) |
|---|---|---|---|
| Air compressors | 95-104 | Quiet garden | 30 |
| 110 KVA diesel generator | 95 | Ticking clock | 30 |
| Lathe Machine | 87 | Computer rooms | 55-60 |
| Milling machine | 112 | Type institute | 60 |
| Oxy-acetylene cutting | 96 | Printing press | 80 |
| Pulveriser | 92 | Sports car | 80-95 |
| Riveting | 95 | Trains | 96 |
| Power operated portable saw | 108 | Trucks | 90-100 |
| Steam turbine (12,500 kW) | 91 | Car horns | 90-105 |
| Pneumatic Chiseling | 118 | Jet takeoff | 120 |

*Source: Ref. 3,4*

**Table 5 Noise that disturb people- 1961-62 Central London Survey**

| S.No. | Description of noise | No. of people disturbed per 100 questioned | | |
|---|---|---|---|---|
| | | When at home | When outdoors | When at work |
| 1 | Road traffic | 36 | 20 | 7 |
| 2 | Aircraft | 9 | 4 | 1 |
| 3 | Trains | 5 | 1 | 0 |
| 4 | Industry / Construction work | 7 | 3 | 10 |
| 5 | Domestic appliances | 4 | 0 | 4 |
| 6 | Neighbors impact | 6 | 0 | 0 |
| 7 | Children | 9 | 3 | 0 |
| 8 | Adult voices | 10 | 2 | 2 |
| 9 | Radio/TV | 7 | 1 | 1 |
| 10 | Bells/alarms | 3 | 1 | 1 |

*Source: Ref. ( 9)*

The variations in the emission of noise levels in a particular environment can be assessed from the statistical distribution of noise levels in that environment (See Fig 3). To draw a statistical distribution curve, terms like $L_{10}$, $L_{50}$ and $L_{90}$ play an important role.

The Sound levels exceeding 10%, 50% and 90% of the total time intervals during a particular period are designated as $L_{10}$, $L_{50}$ and $L_{90}$ respectively.

From figure, it can be seen that, 90% of the sound levels are about 64 dB(A). Local disturbances increased the sound levels ($L_{10}$) to 76 dB(A), i.e., during 10% of the total time. $L_{90}$ represents the background noise levels.

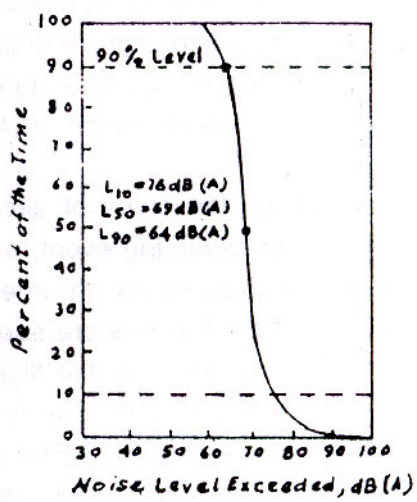


Fig. 3 Statistical distribution of noise levels

The equivalent noise levels, Leq can also be calculated as [5]
$Leq = L_{50} + (L_{10} - L_{90})^2 / 60$

Noise Climate (NC): It is the range over which the sound levels are fluctuating in an interval of time [5]
$NC = L_{10} - L_{90}$

Hence, Leq in the above example is -

$Leq = 69 + (76 - 64)^2 /60 = 71.4$ dB.
and noise climate, NC = 76 - 64 = 12 dB/sampling time.

**Think a bit and do it**

- Observe the activities in your house which produces annoyance to you. Try to record the frequency of their occurrence in a day/week/month etc.
- Identify the noise generating sources in your neighborhood.
- Compute reduction of effective noise levels at your house from your neighborhood using equation (1).
- Tabulate and analyse. what did you find?

**Aircraft Noise**

The noise of aircraft is described in terms of Perceived Noise Levels (PNL), a scale of noisiness, expressed in pNdB. There is no simple relationship between the dB(A) value and pNdB value for all noises. However, a useful statement is that, the pNdB value for a noise is approximately 13 units greater than the dB(A) value for the noise.

A further refinement resulting from the study of aircraft noise is the Effective Noise Level, a scale of noisiness of a time-varying event, expressed in EPNdB. It is used to describe the noise of a single aircraft activity. In order to describe the noise exposure associated with an airport, the EPNdB values are supplemented with such information as the number of flights of each aircraft type, the flight paths that the aircraft use and the time of day at which the operations occur. The resulting picture is often presented in such terms as Noise Exposure Forecast (NEF) contours, which are intended to represent the long-term average noise exposure in communities around airports. More detailed information on the subject is available with Ref. 9.

Towards
LO - 5

## Impacts of noise

**Why bother about noise?** Often neglected, noise induces a severe impact on humans and on living organisms. Some of the adverse effects are summarised below.

- **Annoyance:** It creates annoyance to the receptors due to sound level fluctuations. The aperiodic sound due to its irregular occurrences causes displeasure to hearing and causes annoyance.
- **Physiological effects:** The physiological features like breathing amplitude, blood pressure, heart-beat rate, pulse rate, blood cholesterol are effected.
- **Loss of hearing:** Long exposure to high sound levels cause loss of hearing. This is mostly unnoticed, but has an adverse impact on hearing function.
- **Human performance:** The working performance of workers/human will be affected as they'll be losing their concentration.
- **Nervous system:** It causes pain, ringing in the ears, feeling of tiredness, thereby effecting the functioning of human system.
- **Sleeplessness:** It affects the sleeping there by inducing the people to become restless and loose concentration and presence of mind during their activities
- **Damage to material :** The buildings and materials may get damaged by exposure to infrasonic / ultrasonic waves and even get collapsed.

**Have you observed?**

- Any change in your personal reactions like annoyance, tiredness, loss of concentration while executing your daily activities?
- Any noise polluting source in your surroundings? If so, for how much time, you are exposed to the noise levels?
- Any noise level measurements being taken at your surroundings? What did they say?

Towards LO - 6

## Control of Noise Pollution

Noise generation is associated with most of our daily activities. A healthy human ear responds to a very wide range of SPL from - the threshold of hearing at zero dB, uncomfortable at 100-120 dB and painful at 130-140 dB[3]. Due to the various adverse impacts of noise on humans and environment (See LO-5), noise should be controlled. The technique or the combination of techniques to be employed for noise control depend upon the extent of the noise reduction required, nature of the equipment used and the economy aspects of the available techniques.

The various steps involved in the noise management strategy is illustrated at Fig 4. Reduction in the noise exposure time or isolation of species from the sources form part of the noise control techniques besides providing personal ear protection, engineered control for noise reduction at source and/or diversion in the trajectory of sound waves.

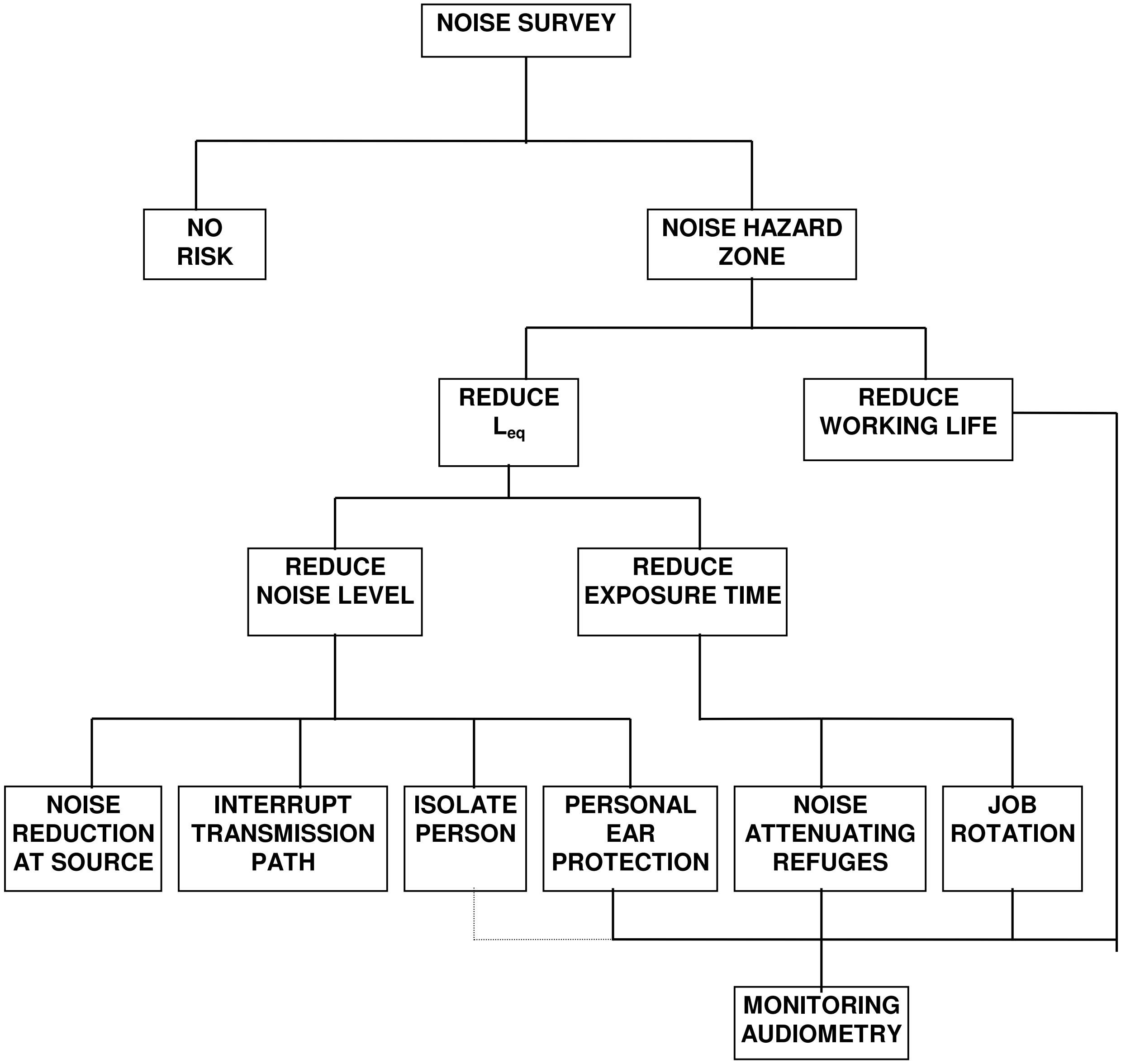


Fig. 4 Noise Management Strategy *(Source : Ref : )*

The techniques employed for noise control can be broadly classified as [4,5,9,10]

- Control at source
- Control in the transmission path
- Using protective equipment.

**Noise Control at Source**

The noise pollution can be controlled at the source of generation itself by employing techniques like-

- **Reducing the noise levels from domestic sectors:** The domestic noise coming from radio, tape recorders, television sets, mixers, washing machines, cooking operations can be minimised 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 minimised.

- **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. Now-a-days, the urban Administration of the metro cities in India, is becoming stringent on usage of loudspeakers.

- **Selection of machinery:** Optimum selection of machinery tools or equipment reduces excess noise levels. For example selection of chairs, or selection of certain machinery/equipment which generate less noise (Sound) due to its superior technology etc. is also an important factor in noise minimisation strategy.

- **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. If these loose parts are not properly fitted, they will generate noise and cause annoyance to the driver/passenger. Similarly is the case of machines. Proper handling and regular maintenance is essential not only for noise control but also to improve the life of machine.

**Control in the transmission path** [9,10]

Please recall the Fig 4 wherein the inter-relationship between elements of noise was represented. The change in the transmission path will increase the length of travel for the wave and get absorbed/refracted/radiated in the surrounding environment. The available techniques are briefly discussed below.

**Installation of barriers:** Installation of barriers between noise source and receiver can attenuate the noise levels. For a barrier to be effective, its lateral width should extend beyond the line-of-sight at least as much as the height (See Fig. 5). It may be noted that, the frequencies, represented on the X-axis of the graph in Fig. 5, are the centre frequencies of the octave band. The barrier may be either close to the source or receiver, subject to the condition that, R <<D or in other words, to increase the traverse length for the sound wave. It should also be noted that, the presence of the barrier itself can reflect sound back towards the source. At very large distances, the barrier becomes less effective because of the possibility of refractive atmospheric effects. Another method, based on the length of traverse path of the sound wave is given at Fig. 6.

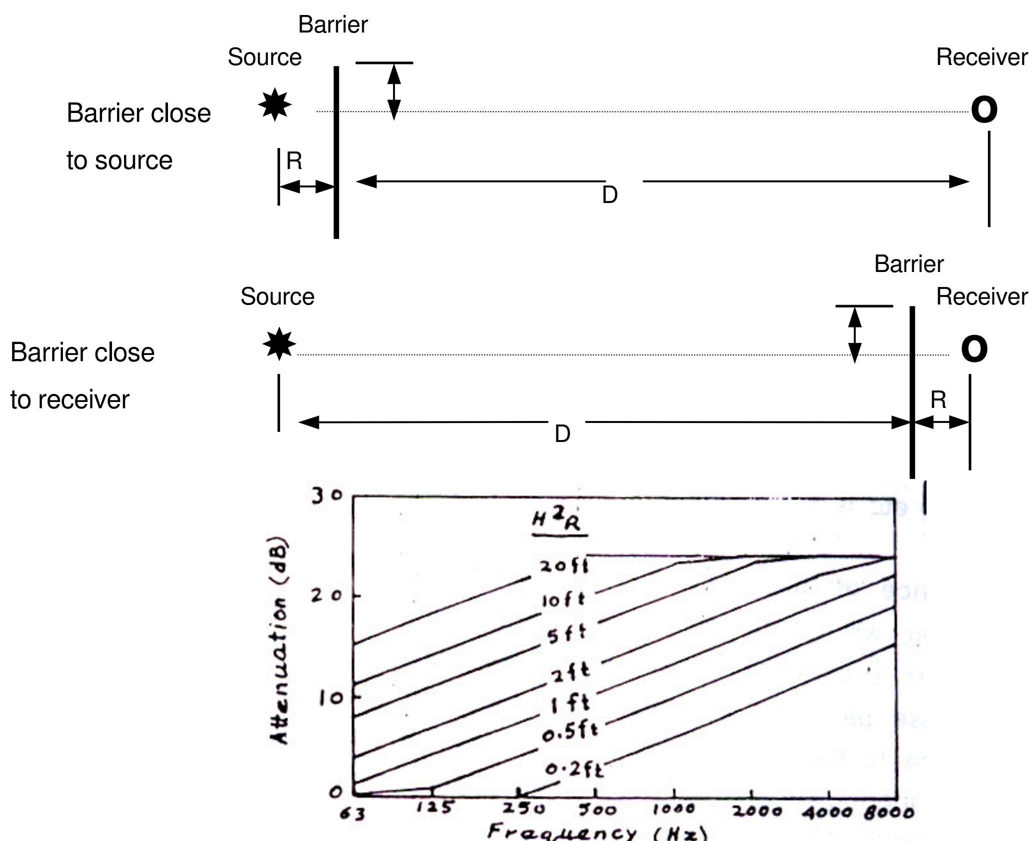

Fig. 5 Attenuation of noise levels using barriers

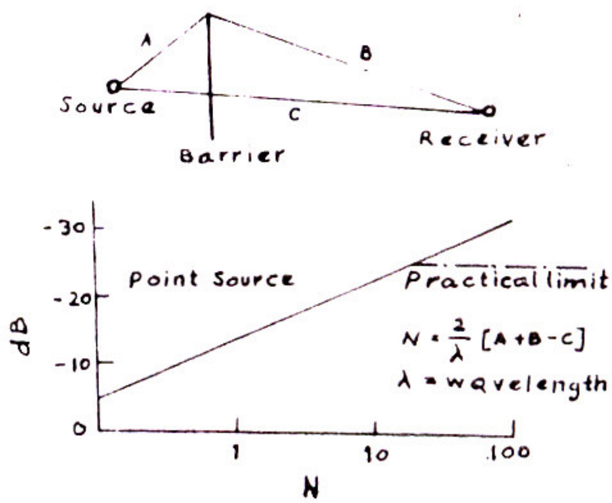

Fig. 6 Attenuation of noise levels using barriers

**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. The approximate reduction of outside noise levels using typical exterior wall construction is given at Table 6. The reduction in noise levels for various frequencies and the A-weighted scale are shown. Variations in spectrum shape may change this A-weighted value by as much as +/- 3 dB.

- **Installation of panels or enclosures:** A sound source may be enclosed within a paneled structure such as room as a means of reducing the noise levels at the receiver. The actual difference between the sound pressure levels inside and outside an enclosure depends not only on the transmission loss of the enclosure panels but also on the acoustic absorption within the enclosure and the details of the panel penetrations which may include windows or doors.

  The product of *frequency of interest and surface weight of the absorbing material* is the key parameter in noise reduction through transmission loss. With conventional construction practices, the high-frequency transmission loss of a panel becomes limited to around 40 dB, owing to the transmission of sound through flanking paths other than the panel itself. Examples of such flanking are structural connections or ducts joining the two spaces on either side of the panel of interest. Procedures for detailed design examples are given at Ref.: 9.

**Table 6 Approximate reduction of outside noise provided by typical exterior wall construction**

| Octave Band Center Frequency (Hz) | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 63 | 0 | 9 | 13 | 19 | 14 | 24 | 32 | 21 |
| 125 | 0 | 10 | 14 | 20 | 20 | 25 | 34 | 25 |
| 250 | 0 | 11 | 15 | 22 | 26 | 27 | 36 | 30 |
| 500 | 0 | 12 | 16 | 24 | 28 | 30 | 38 | 37 |
| 1,000 | 0 | 13 | 17 | 26 | 29 | 33 | 42 | 42 |
| 2,000 | 0 | 14 | 18 | 28 | 30 | 38 | 48 | 44 |
| 4,000 | 0 | 15 | 19 | 30 | 31 | 43 | 53 | 45 |
| 8,000 | 0 | 16 | 20 | 30 | 33 | 48 | 58 | 46 |
| approx. dB(A) | 0 | 12 | 16 | 24 | 27 | 30 | 38 | 33 |

A: No wall; outside conditions.
B: Any typical wall construction, with open windows covering about 5% of exterior wall area.
C: Any typical wall construction, with small open air vents of about 1% of exterior wall area, all windows closed.
D: Any typical wall construction, with closed but operable windows covering about 10-20% of exterior wall area.
E: Sealed glass wall construction, 1/4-in glass thickness over approximately 50% of exterior wall area.
F: Approximately 20 lb./ft$^2$ solid wall construction with no windows and no cracks or openings.
G: Approximately 50 lb/ft$^2$ solid wall construction with no windows and no cracks or openings.
H: Any typical wall construction, with closed double windows (panes at least 3/32" thick, air space at least 4 in.) and solid-core gasketed exterior doors.

*Source : Ref. 9*

- **Green belt development:** Green belt development can attenuate the sound levels. The degree of attenuation varies with species of greenbelt. The typical attenuation of noise levels by shrubs and trees is presented at Fig. 7 (a) and (b).The statutory regulations direct the industry to develop greenbelt four times the built-up area for attenuation of various atmospheric pollutants, including noise.

### Using protection equipment

Before employing the use of protective equipment, please recall the Fig. 4, wherein the various steps involved in the noise management strategy are illustrated. 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.

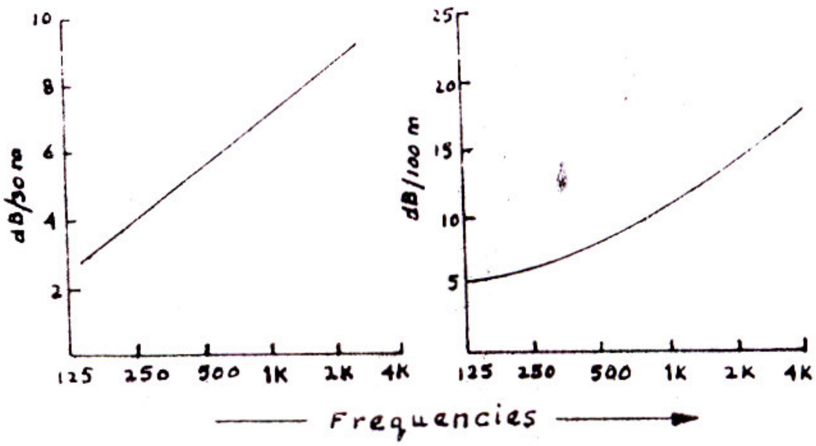


Fig. 7 (a) & (b) Noise level attenuation by shrubs and trees

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. For the Regulatory standards pertaining to time of exposure vs. maximum noise levels permitted in a workspace environment, please refer to LO-8.

The usage of protective equipment and the worker's exposure to the high noise levels can be minimised 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.

- **Exposure reduction:** Regulations prescribe that, noise level of 90 dB (A) for more than 8 hr continuous exposure is prohibited. Persons who are working under such conditions will be exposed to occupational health hazards. The schedule of the workers should be planned in such a way that, they should not be over exposed to the high noise levels.

- **Hearing protection:** Equipment like earmuffs, ear plugs etc. are the commonly used devices for hearing protection. Attenuation provided by ear-muffs vary widely in respect to their size, shape, seal material etc. Literature survey shows that, an average noise attenuation up to 32 dB can be achieved using earmuffs [7]. Details of some of the suppliers of the protective equipment are given in Ref. 3.

Towards
LO - 7

## Documentation of noise measurements

Please recall the Fig. 4, where noise survey is the first step of noise management strategies. By now, the reader might be conversant with the terminology, impacts, significance and control technology of noise pollution. Hence, it is felt to place this section just before the end of the module to avoid any confusion for the reader.

Noise surveys will be conducted in an area (or zone) to find out the ambient noise levels or noise levels at the work environment. The field data will be analysed and documented for decision making. The parameters to calculate however, vary with the objective. But in most cases, Leq, Ldn, NC are the likely deciding parameters (See Table 7 and 8).

For a systematic presentation, the noise survey reports for a typical industrial noise level survey should contain the following information [(3)]

- Reference to individual standard(s)
- Description of the machine and its conditions of installation and operation
- Description of the test environment with respect to its ability to reflect, dissipate or absorb noise and location of the machine.
- Number of workers exposed and duration of exposure
- Description of the measuring apparatus used and method of calibration
- Time constant and weighting network used
- Position of measuring points.
- Results of SPL instruments either A -scale or octave band analysis
- Background noise levels and sound pressure values corrected for background noise, if any.

The same principles can be applied for documentation of community (ambient) noise levels and is left as an exercise to the reader.

Towards LO - 8

## Regulatory guidelines

Statutory Regulatory guidelines were prescribed both for the ambient noise levels (Table 7) and for workspace environment noise levels (table 8). Factories Act, 1948 prescribes the protection of workers against high noise levels (noise level > 90 dB (A)). The State Pollution Control Board and Inspector of Factories have powers to administer the control of noise pollution.

**Table 7 Indian Standards for ambient noise levels** [1]

| Area | Noise Limits, Leq, dB (A) | |
|---|---|---|
| | Day Time [2] | Night Time [3] |
| Silence zone [4] | 50 | 45 |
| Residential area | 55 | 45 |
| Commercial area | 65 | 55 |
| Industrial area | 75 | 65 |

1. Ministry of Environment and Forest (MOEF) Guidelines vide Environment (Protection) Act, 1986 third amendment rules, dated 26/12/89 (Ref. 6)
2. Day time from (600 hrs to 2100 hrs, IST)
3. Night time from (2100 hrs to 600 hrs IST)
4. Silence zone: Up to 100m around hospitals, educational institutions and courts. The zones are to be declared by competent authority. Use of vehicle horns, loud speakers and bursting of crackers shall be banned in these zones.

*Source: Ref. (3,5)*

**Table 8 Damage risk criteria for hearing loss Occupational Safety & Health Administration (OSHA) regulations**

| Maximum allowable duration per day hours | Sound pressure level, dB (A) |
|---|---|
| 8 | 90 |
| 6 | 92 |
| 4 | 95 |
| 3 | 97 |
| 2 | 100 |
| 1.5 | 102 |
| 1 | 105 |
| 0.75 | 107 |
| 0.5 | 110 |
| 0.25 | 115 |

No exposure in excess of 115 dB(A) is permitted.

*Source: Ref. (3,5)*

**Application in Environmental Impact Assessment (EIA) studies**

The **EIA** study will be carried out to evaluate and assess the impacts of any proposed (or existing) activity on the environment. Noise is one of the environmental attributes, on which the likely impacts due to the proposed (or existing) activity need to studied.

The likely steps to be carried out while conducting noise level studies for an EIA project are summarised below. The EIA wiil be carried out for either proposed or existing activities. The sequential steps involved will be same for both the activities.

- The likely activities that generate noise from the proposed activity are to be identified
- The typical sound (noise) levels of the noise generating sources are to be assessed either from literature or from a similar source
- The likely exposure time of a worker at a noise generating source is to be assessed from the plant / utility records
- The workspace environment noise levels are to be checked with OSHA standards (Table 1.8). If the noise exposure levels are higher, suitable noise control measures like personal protective equipment, installation of barriers, enclosures etc., need to be suggested
- The EIA will usually be carried out in an impact circle of radius 3 Km to 25 Km or even more depending on the objective and the likely activities of the proposed project. The representative baseline (or back ground) status of the ambient noise levels need to be collected by monitoring at various stations in the study zone
- The ambient noise levels are to be analysed for the prescribed parameters like, Leq, Ldn etc., and compared with the ambient noise level standards (Table 1.7) for the study region. If these values are higher than the prescribed limits, the likely causes for the high values need to be assessed
- The likely impact of the noise levels from the proposed activity on the local environment keeping in view the baseline status of noise levels need to be predicted
- If the predicted impact is adverse, suitable measures for attenuating the noise levels like, green belt development, in-plant control measures etc., need to be suggested.
- The objective of the EIA study is to make ensure that, the local environment, say noise, will **not** get affected by the noise levels emanated from the proposed activity. If the ambient noise levels are high, then control measures be suggested to the project proponent to ensure that, ambient noise levels will not increase due to the proposed activity

## ***Summary***

*Whether knowingly or unknowingly, everyone of us contribute to noise pollution, because most of our day-to-day activities generate some noise. Often neglected, noise pollution adversely affects the human being leading to irritation, loss of concentration, loss of hearing.*

*identify the sources of noise pollution. Once identified, the reason(s) for increased noise levels to be assessed. Now, efforts shall be made to reduce the undesired noise levels from (unwanted) noise generating sources. This leads to marginal reduction of noise levels. It is still un-bearable scientific methods of noise control shall be employed.*

*The statutory Regulations have prescribed the noise level exposure limits. The public may complain to the statutory Board for violation of noise level limits by any noise generator. Suitable action will be taken to attenuate the noise levels and controlling pollution. It is advisable that suitable noise control measures be taken and reduce the interference of Statutory Board. It is high time that everyone should do this bit in curbing the noise pollution, which is otherwise becoming as effective as SLOW POISONING.*

## Glossary

***Noise***

Noise is unwanted sound.

***Sound***

Sound is a form of energy emitted by a vibrating body and on reaching the ear it causes the sensation of hearing through nerves.

***Infrasonics***

The sound of frequency less than 20HZ.

***Ultrasonics***

The sound of frequency more than 20,000 HZ.

***Decibel, dB***

It is measurement unit of sound, represented by dB.

***Ldn***

The day-night equivalent value of sound level. The day is counted from 6AM to 9PM (15hrs) and night from 9PM- 6AM (9hrs).

***Frequency analysis***

It allows to separate the main components of the signals by dividing the frequency bands using a set of filters.

***A-weighted scale***

It resembles the audible response of human ear. Represented as dB(A).

***Equivalent sound level, Leq***

It is the constant sound pressure level which would have produced the same total energy as the actual sound level over the given time. It is denoted as Leq.

***$L_{10}$, $L_{50}$ and $L_{90}$***

The Sound levels exceeding 10%, 50% and 90% of the total time intervals during a particular period are designated as $L_{10}$, $L_{50}$ and $L_{90}$ respectively.

***Perceived Noise Levels (PNL)***

The noise of aircraft is described in terms of Perceived Noise Levels (PNL), a scale of noisiness, expressed in pNdB.

## Review Questions

1. What is the difference between sound and noise?
2. What is the frequency range of infrasonic and ultrasonics?
3. What is the purpose of frequency analysis?
4. What are the frequencies used for frequency analysis?
5. List out typical sources of noise pollution.
6. What are the impacts of noise?
7. What are the methods to control noise pollution?
8. What are the noise exposure limits in a workspace environment?
9. What are the ambient noise limits?
10. How to document the noise levels ?
11. Write short notes on - (a) aircraft noise (b) application of noise pollution and its control in EIA studies (c) noise reduction at source (d) noise reduction by engineered control of its transmission path
12. Find out the reduction in noise levels if the source is at (i) 2m (ii) 4m, (iii) 6m (iv) 10m (v) 100m from your place (Hint: use equation (1))
13. Find out the noise levels in decibels, if the sound pressure level measured in $N/m^2$ was

$2 \times 10^{-4}$ (ii) $6 \times 10^{-3}$ (iii) $8 \times 10^{-2}$ (iv) $10 \times 10^{-3}$ (v) $3 \times 10^{-1}$.

14. Find out the day-night equivalent noise levels if Ld = 70 dB(A) and Ln = 52 dB(A). If Ldn value were to be in safe limits, which is the best suited habitant zone. Give reasons.
15. Find out the barrier dimensions required for a noise reduction of 15 dB at (a) 500 Hz (b) 1000 Hz (c) 2000 Hz (d) 4000 Hz (e) 8000 Hz
16. Find out the effective noise level from five sources of 50dB, 55 dB, 62 dB, 64 dB and 65 dB noise generation.

### You may try this

- Collect the map of your colony and divide into suitable number of zones. Try to -
  1. Identify the noise sources from each zone
  2. Find out the noise levels of each zone
  3. Compute Ldn values of the colony
  4. Compare with the regulatory standards and find out whether noise levels in your colony are permissible under the respective selected zone or not.
  5. Identify the likely causes of noise from noise sources.
  6. Develop methodologies to solve the problem
  7. Attempt to solve

  *How good are you?*
- Apply the same principles and methodologies and extend the problem area to your municipal ward, panchayat, village, school, club, college etc.
- Keep updating yourself with the latest developments in technology.

**For your information**

The results of a recently conducted study shows that the ambient noise levels in the mining city of Dhanbad are exceeding the statutory regulations ( ). You may also report about your own locality. Aren't you?

## Solved examples

**Ex 1:** If the distance from a noise source is doubled, find out the noise levels.

**Sol:** Given, $r_2 = 2r_1$

We have, $L_2 = L_1 - 20\log_{10} (r_2/r_1)$

Substituting, we get,

$L_2 = L_1 - 20 \log_{10} (2r_1/r_1)$

$= L_1 - 20 \log_{10}(2)$

i.e., $L_2 = L_1 - 20 \times 0.301$

$= L_1 - 6.02$

i.e., the noise level will decrease by 6 dB for doubling of distance from the source.

**Ex 2:** The noise levels at a particular location are 65dB, 70dB and 78dB measured during an hour of the day. Find out the average noise levels at the location.

**Sol:** Given, $L_1$ = 65dB, $L_2$ = 70dB, $L_3$ = 75dB

The noise levels are to be logarithmacally averaged.

Average of $L_1$, $L_2$ & $L_3$ = L (say). Convert the noise levels from decibels to bels.

i.e. $L_1$ = 65dB or 6.5 bels,

$L_2$ = 70dB or 7.0 bels

$L_3$ = 78dB or 7.8 bels

$L = 10 \times \log_{10} ([10^{6.5} + 10^{7.0} + 10^{7.8} ] / 3 )$

$= 10 \times \log_{10} [25419337.37]$

$= 10 \times 7.405 = 74.05$dB.

$\therefore$ Average noise level is 74.05 dB.

**Ex 3:** The sound pressure level is measured at $5 \times 10^{-4}$ N/m$^2$. Find out the noise level in dB.

**Sol:** Given, $P_1 = 5 \times 10^{-4}$ N/m$^2$

We know $P_0 = 2 \times 10^{-5}$ N/m$^2$ (reference pressure)

Noise level in decibels, $L = 10 \log_{10} [P_1/P_0]^2$ dB.

$\therefore L = 10 \log_{10} (5 \times 10^{-4} ) / (2 \times 10^{-5} )$

$= 10 \log_{10} [625] = 10 \times 2.795$

$= 27.95$dB.

**Ex 4:** It is required to find out the day-night equivalent noise levels at a location. The three-hourly day average values in dB are 48, 54, 56, 52, 61 and three-hourly night average values in dB are 36,42,48. Compute Ldn.

**Sol :** (i) Find out day equivalent noise levels.

$$Lde = 10 \times \log_{10} ([10^{4.8} + 10^{5.4} + 10^{5.6} + 10^{5.2} + 10^{6.1}]/5)$$
$$= 56.29 \text{ dB.}$$

(ii) Find out night - equivalent noise levels.

$$Lne = 10 \times \log_{10} ([10^{3.6} + 10^{4.2} + 10^{4.8}]/3)$$
$$= 44.41\text{dB.}$$

(iii) Find out day-night equivalent noise level, Ldn.

$$Ldn = 10 \times \log_{10} [15/24 (10^{Lde/10}) + 9/24 (10^{((Lne+10)/10)})]$$
$$= 10 \times \log_{10} [15/24 \times 10^{5.629} + 9/24 \times 10^{5.441}]$$
$$= 10 \times \log_{10} \{265999 + 103522\}$$
$$= 55.68\text{dB.}$$

**Ex.5.** What barrier dimensions are necessary in order that the barrier provide 20 dB attenuation at 500 HZ.

**Sol**: From fig 1.5, we see that, $H^2/R$ must be atleast 10ft in order to achieve the desired attenuation. This can be accomplished by selecting different values for H and R for example,

H = 5.5 ft, R = 3ft; H = 10 ft, R= 10 ft; H = 17.5 ft, R = 30 ft etc.

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