4. Noise Pollution

4.1 Preamble

Sound may be defined as any pressure variation (in air, water or any medium) that the ear can detect. Pressure variations of air that are caused by the changing weather conditions are far too slow for the human ear to detect. But air pressure changes that occur more rapidly (at least 20 times a second, can be heard) are called sound. A variation of 20 times a second is called 20 Hertz. (Hz.). These are sounds having a single frequency and are called a pure tone.

Sound is such a common part of everyday life that we rarely appreciate all its functions. It provides experiences such as listening to music. It enables us spoken communication, it alerts and warns us. Sound permits us to make quality evaluations and diagnoses - the rattling of a loose bolt, the squeaking of a bad bearing the heart beat, etc.

Yet, too often in our modern society, sound annoys us. Many sounds are unpleasant or unwanted - these are called noise. To a set of rock fans, the thundering sounds of a rock concert are music but it annoys people living close by. Sounds do not necessarily have to be loud to annoy. A creaking floor or a dripping tap is equally annoying as a jet taking off.

What is medically harmful to us is the continued exposure to high levels of noise. This results in annoyance, fatigue, temporary shift of the threshold of hearing, and permanent hearing loss. There is an increasing medical evidence that noise exposure causes physiological disturbances, metabolic disorders, blood circulation changes, etc.

The human ear responds to a very vide range of amplitude of sound. It responds to a very wide range of frequency of 20 Hz to 20,000 Hz. The ear can even detect the weakest sound pressure of 20 millionth of a Pascal (20 U Pa), this pressure is 5 billion times less than the atmospheric pressure. Normally, the sound pressure is the quantity that is used to express the force per unit area (in CGS units as newton per square meter - pascal).

4.2 Environmental Noise

Environmental noise is often called community noise as opposed to occupational noise, but the expression may be somewhat misleading since noise is not a direct result of the activities of a person affected by it, but is produced by external sources and interferes with the different activities of the exposed persons. When dealing with environmental noise, the main objective is to assess annoyance and assessment of noise with respect to community response.

4.3 Noise Pollution Laws

With the increasing ambient noise levels in public places from various sources, inter alia, industrial activity, construction activity, generator sets, loud speakers, public address systems, music systems, vehicular horns and other mechanical devices, which have deleterious effects on human health and the psychological well being of the people, it was considered necessary to regulate and control noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise. For this purpose, as per S.O. 123 (E), dated 14th February, 2000, the Noise Pollution Regulation and Control Rules 2000, were framed under the Environment (Protection) Act, 1986.

An example of calculating dB is shown:

Measured quantity	=	2000 μPa
Reference value	=	20 μPa
20 Log $_{10}$ (2000 μPa/20 μPa)	=	40dB

As we have seen, the human ear is a complex and non-linear device. To have a better environment, and to be able to conform to lay down standards, we must be able to make scientific measurements of sound. These measurements must accurately reflect the "Perceived Level" rather than the absolute value so that it can be decided if this perceived value is detrimental or not. The human ear can give us subjective results. To move from subjectivity to objectivity, we must have instrumentation. Sound level meters are designed to respond in approximately the same way as the human ear to give objective, reproducible measurements of sound pressure level.

4.6 Adverse Effect of Noise

Unwanted noise has several adverse effects. It is not only a nuisance but also a health hazard. Prof. A.K. Sharma, in his presidential address in Indian Science Congress, 1981, had revealed that Calcutta, Bombay and Delhi are amongst the noisiest cities in the world. Prolonged exposure to noise levels of above 90 dB can cause permanent deafness. Miners may show neurological, digestive and neurological disorders under such conditions.

Noise is known to produce various temporary changes in man's physiological state, in particular a construction of the smaller arteries. This can mean a speeded up pulse and respiration rate. Some medical authorities believe that continued exposure to loud noises could cause chronic effects such as hypertension or ulcers. Startling noises elicit involuntary muscular responses. The generation of unreasonable noise within the environment is considered a form of pollution because it lowers the quality of life. The excessive noise can affect people adversely with regard to-

(a) Repeated interference with sleep

(b) Effect on hearing

(c) Effect on communication

(d) Effect on mental and physical health and

(e) Slow down in working efficiency

Continuous exposure of workers to high level noise may result in anatomical disturbances viz. (i) Annoyance, (ii) Fatigue, (iii) Temporary shift of threshold limit of hearing, (iv) Permanent loss of hearing, (v) Change in blood circulation rate, (vi) Change in breathing amplitude, (vii) Change in the rate of saliva and gastric secretion, (viii) Rise in blood cholesterol, (x) Hypertension and (x) Reduced intra-ventricular conductivity.

Some typical Sound Pressure Levels with its generation points are enumerated as follows-

Sr. No 1.	120 B	i) Boiler shop (maximum Levels) ii) Ships engine room (full speed) iii)Underground mines with 3-4 penumatic drills	Intolerable
2.	110 dB	i) Automatic punch press (operators position) ii) Sheet metal shop-hand grinding	Very Noisy
3.	100 dB	i) Automatic lathe shop ii) Printing press room	
4.	90 dB	i) Heavy trucks ii) Construction site with pneumatic drilling	
5.	80 dB	i) Average shop floor ii) Office with tabulating machines iii) Side of busy street	Noisy
6.	70 dB	i) Loud radio in domestic room	
7.	60 dB	i) Restaurant	
8.	50 dB	i) Conversation at 1metre	Quite
9.	40 dB	i) Average suburban area ii) Whispered conversation at night iii) Residential area at night.	

4.7 Factors that Effect the Propagation of Sound

There are many factors, which significantly affect the propagation of sound in the atmosphere. Wind velocity and temperature changes alter the wave directions. Turbulence distorts it and viscosity causes absorption. Absorption by air is far greater for high frequency than for low frequencies and shows a tendency to increase with temperature and to decrease with higher relative humidity. The atmosphere, therefore, attenuates high frequencies and thus distorts the spectrum of noise. It reduces its strength and changes the propagation path.

In addition, most measurements are made at ground level where people live and work and where noise is produced and received. For these reasons, the reflection and absorption of the ground under the path between source and receiver is very important, and must be taken into account as a matter of course when studying the transmission of sound outdoors. The attenuation is higher at higher frequencies and depends on the relative roughness of the surface. The values are low for ordinary grasslands, but vary and rise up to 20 dB per 100 metres for long grass, paddy, shrubs and trees.

Further, when sound waves come into contact with a surface, a part of it is reflected, a part of it is absorbed and a part is transmitted through it depending on the absorption of transmission coefficients. The effect of curved and flat reflecting surfaces on sound is similar to that as on light. Concave surfaces reflect sound and focus it, while convex surfaces disperse sound. The greatest attenuation behind a barrier is when the barrier is as near as possible to either the source or the receiver. When taking measurements of noise sources in the field, unobstructed situations are to be chosen unless the barrier effect is so desired. Whenever a sound wave meets a

interesting to note that when there are two sources emitting sound at 60 dB each the net result is not 120 dB but only 63 dB since dBs are not additive being a Log value.

Noise Intrusions

Noise intrusions are characterised by their transient quality. Typical examples are motor bikes, trucks, aircraft, road drills and sirens. Their noise stands out far above all other sounds, and they interrupt without warning such personal activities as sleep, study, entertainment, relaxation and conversation. Noise intrusions are especially annoying when they are needless, e.g. acceleration of a noisy motorbike or a car operating with a faulty silencer.

Impulsive Noise

Impulsive sounds are greater contributors to human annoyance than slower transient sounds even when both produce the same reading on a Sound Level Meter set to its "F" time weighting. The less elaborate Sound Level Meters with only "F" (Fast) and "S" (Slow) time weighting are not adequate for measuring impulsive noise because their responses are too slow. Some national standards for measuring environmental noise require the user of Sound Level Meter also equipped with an "I" (Impulse) time weighting to evaluate sources such as pile drivers, forge hammers and punch presses all of which emit impulsive noise. In the "I" mode the rise time of the circuitry is about 4 times faster than the "F" mode. This simulates the response time of the human ear. The "I" time weighting is normally used to simulate the loudness response of the human ear to impulsive sounds and is therefore not necessarily the appropriate time weighting for assessing the risk of hearing damage.

Criteria for assessing the risk of hearing loss due to impulsive noise are not broadly standardised. ISO suggests that an approximation of the partial noise dose for a series of impulsive sounds such as for hammering and riveting may be obtained by adding 10 dB to the measured dB(A) "S" value, but it does not cover single impulses such as those from drop hammers and hydraulic presses. Consequently, widely differing supplementary criteria have been adopted in various countries. Some national standards impose impulsive noise limits in terms of dB(A) "I" (Impulse) level. Exposure to impulsive or impact noise should not exceed 140 dB. Because the various exposure criteria for impulsive noise are not uniform, exposed personnel should be given extra attention in the early stages of hearing conversation programmes.

Equivalent Continuous Level

For studying long term trends in environmental noise, it is convenient to use a single number to define an entire periods noise history. This is Leq. It is that continuous dB(A) level which would have produced the same A weighted sound energy in the same time T as the actual noise history.

Measuring Steady Noise

Steady noise measurements may be performed using a Sound Level Meter set to Frequency and Time weightings of 'A' and 'Slow' respectively.

If measurement is made for the purpose of worker safety, noise should be measured at the position of the workers head. It should be noted that in environmental noise measurements, the machine is not the only source of noise, it may not even be the dominant source. Therefore, the microphone should be omni directional to ensure that noise from all sources are accurately

measured. But if the nature of the noise is impulsive or there is a need to do frequency analysis, a precision meter along with a filter set needs to be used.

Discretely Varying Noise Levels

Many workers are exposed to a certain number of discretely varying noise levels. This happens because the noise is either cyclical or varies stepwise at their work station. A worker is also required to move around the plant. Noise codes describe procedures for summing a series of partial doses of noise that such workers receive during the work period. For example an employee is exposed to 90 dB(A) for half the period and 93 dB(A) for the other half. Since full working periods at 90 and 93 represent 100% and 200% doses, for half period, they represent 50% and 100%. Therefore, the employee is being subjected to a 150 % dose.

4.9 Noise Measurement & Survey Report

To assess the adverse effects on noise environment due to mining, following monitoring has to be done:

1. Noise source monitoring,
2. Work zone noise level monitoring, and
3. Ambient noise level monitoring.

To assess the noise exposure at the work-zone as well as to arrive at their impact on the ambient level, it is important that specific noise measurement at source are to be carried for various types of machinery and equipment being used, in accordance with the requirement of international standards. Such measurements will give the operational condition of a particular family of equipment/machinery under use. The noise generated by equipment would affect the individual responsible for operation of the equipment under test and also affect the persons who were in its immediate vicinity. Therefore, the source monitoring has to be done within the cabin of the equipment, which is an integral part of the equipment, where the operator sits and other occupational monitoring to be measured at 5 m distance from the machinery/equipment under operation.

For the source monitoring, all the equipment that are used for the mining activity and the mineral beneficiation are to be monitored for their noise emission. The measurement time interval depends on the type of time exposure. It may be sub-divided into part time intervals, which expose the noise level of the same type. The duration of measurement should therefore be, either for the entire length of an activity or a portion thereof of the several representative activities of sound exposure level. The minimum duration should be 15 sec. If the noise shows a pronounced periodicity, the minimum duration should be at least one cycle of operation. Otherwise, multiples of complete cycles are to be used. Therefore, the noise emitted by the mobile equipment are to be measured at the rate of about 10 to 15 minutes within the cabin of the equipment, where the operator is seated, for one set of complete cycle of operations. Further, multiple of complete cycle of operations, outside the equipment at a distance of 5 m, are to be measured for 20 to 30 minutes duration.

To assess the work zone noise level, monitoring in the mines is to be done, in a portion of the working shift, say for two hours duration, in the morning and in the evening hours, when the temperature inversions are likely to occur. These time intervals of this sample measurement are to be so chosen so that noise exposure would be a characteristic of the working place and would represent for normalising time interval.

spectrum of a machine should also be measured in order to design a noise barrier or enclosure. Frequency analysis is also valuable in proving the effectiveness of noise barriers/enclosures and in trouble shooting during their 'nstallation. In general, Octave band filters are used for these purposes and are, therefore, an essential part of noise control instrumentation.

Noise Insulation

If the source cannot be controlled, then the only alternative is to prevent as much of the noise as possible from reaching the worker. Acoustic barriers and enclosures help only those who work in the shadow of these. They are of no use to people working in close proximity to the noise source. The most effective way of reducing noise is to enclose the noise source. Noise enclosures must be tightly sealed since even small leak reduces their effectiveness.

Ear Protectors

Ear protectors reduce the amount of noise actually entering the ear canal. Some national standards permit their widespread use whereas others limit their use to an interim measure until engineering methods of noise control carried out and in cases where engineering control is not feasible. Standards require their use for employees exposed to a noise dose of 50% and upwards. A noise dose of 50% is equivalent to 87 dB(A) for 8 hours and is referred to as the "action level".

The effectiveness of ear plugs and ear muffs depends upon how well they fit and how carefully they are worn. A loss of attenuation up to 10 dB can occur if the path to the ear canal is not tightly sealed. As with any acoustic barrier, different types of ear protectors have different curves of noise attenuation v/s. frequency. Therefore, ear protectors should be selected by matching their attenuation characteristics to the octave band analysis of the sound field.

Noise Enclosure Design

The first step in designing a noise enclosure is to do an octave band analysis of the noise source. This often requires the machine/noise source to be operated in the absence of all other sources. The second step is to calculate the spectral changes required to reduce the noise to a satisfactory level. The final step is to design an enclosure whose insulation characteristics provide the necessary spectral changes. When the job is complete, another octave analysis can be performed on the noise source and compared with the initial analysis to confirm and prove the effectiveness of the enclosure.

Noise Rating Curves

In cases where noise are steady, noise rating curves are sometimes used alongwith Octave Band analysis to determine the annoyance level of environmental noise. In keeping with characteristics of human hearing, NR Curves put more weight on higher frequencies. When the Octave band spectrogram of a particular noise is superimposed on these curves, the rating number for the noise on whole is obtained by noting where the spectrogram penetrates the highest number curve.

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5. Water Pollution

5.1 Preamble

Most of the human diseases can be attributed to polluted water, either through direct consumption or consumption through food chain. While mining, water pollution occurs because of the following:

a) Mine drainage
b) Mine impoundment
c) Fouling of water sources

Water pollution may be caused by direct discharge of mine water to the water stream and due to erosion and wash off from the mined out area and waste dumps. The water may be acidic, alkaline, charged with dissolved chemicals and toxic substances or suspended solid particles. Water pumped out from the sulphide deposit, halide deposit, fluoride deposit and from any other waste material is generally injurious to biotic life as well as for human consumption. Water bodies severely polluted by acid i.e. mine drainage are not fit for survival of fish and benthic invertebrates.

5.2 Water Pollution Laws

The Water (Prevention and Control of Pollution) Act, 1974 and the Rules made thereunder (1975), as well as the Water (Prevention and Control of Pollution) Cess Act, 1977 and the Rules made thereunder (1978) are the relevant laws of the land to control Water Pollution. Under the Water (Prevention and Control of Pollution) Act, "Pollution" means contamination of water, alteration of the physical, chemical or biological properties of water, discharge of any sewage or trade effluent or any other liquid, gaseous or solid substance into water (whether directly or indirectly), which may, or is likely to, create a nuisance or render such water harmful or injurious to public health or safety, or to domestic, commercial, industrial, agricultural or other legitimate uses, or to the life and health of animals or plants or aquatic organisms.

The objectives of the Water (Prevention and Control of Pollution) Act 1974 are to provide for the Prevention and Control of Water Pollution and the maintenance or restoration of the wholesomeness of water for the establishment, with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.

Before proceeding further, a look into the important provisions of the above laws, as applicable to mining areas, will be quite useful. Under Section 24 of the Water Pollution Act, the discharge of any poisonous, noxious or polluting matter into any stream or well or sewer or on land is prohibited. It also prohibits discharge of any matter into any stream that may impede the proper flow of the water of the stream. Sec. 25 of the Act provides that no person can establish or expand any industry, operation or process etc. which is likely to discharge sewage or trade effluent into a stream or well or sewer or on land without the previous consent of the State Pollution Control Board. The