NOISE LEVEL MONITORING

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Contents

1. Introduction

Human ears perceive certain modulations of the atmospheric pressure as sound. Such modulations result from a propagated vibration of an elastic medium or superposition of such vibrations. These vibrations cause an alteration in pressure, stress, particle displacement, or particle velocity of the medium. Sound propagates through the medium as a wave.

In the absence of acoustic energy in a particular space, air molecules move about in a random thermal motion. There occur frequent collisions amongst the molecules without loss of energy. The net result is an equilibrium condition with characteristic absolute temperature and pressure. On introduction of a vibrating surface, the molecules gain additional momentum by momentum transfer, and the disturbance propagates into the space with a velocity essentially equal to the thermal speed of individual molecules. If the vibrating surface is a pulsating sphere, the sound wave spreads out spherically with a wave of single frequency. The disturbance caused by the vibrating surface spreads through the medium by momentum transfer. The disturbance induces displacement of the individual particles of the medium. The particles attain velocities in the direction of propagation. These bring changes in absolute pressure and temperature. Human ears or microphones detect this pressure change as sound. Whenever the sound is irritating, annoying, unpleasant and unwanted, it is called noise.

Numerous scholars have studied sound as a form of energy since the period of Aristotle (384–322 BC) and recognized noise as a health hazard. In 1713, Ramazzini studied the effects of noise on the workers engaged in hammering copper and other noisy operations. Such workers suffered from loss of hearing and became completely deaf in their old age. Bar conducted similar research in 1886 on the boilermakers. However, it is only in the nineteenth century that acoustics developed as a separate scientific discipline. Chaldni (1756–1824), Helmholtz (1821–1894), Rayleigh (1842–1919), Sabine (1868–1919), etc., were the pioneering scientists contributing to the knowledge and understanding of sound (Malecki, 1969).

During the first half of the twentieth century, studies on acoustics identified the impacts of noise on human beings. Prolonged exposure to disturbing noise may cause several ailments and provide a nuisance. People dwelling near industrial areas or in busy cities are vulnerable to these ill effects of noise. Therefore, noise is considered to be an environmental pollutant and requires a serious effort to develop adequate mitigating measures.

2. Effects of Noise

Excessive exposure to noise has numerous direct and indirect effects on safety and hygiene. It directly affects our sensation of hearing, disrupts sleeping, and causes masking of speech.

Otologists link industrial noise as a source of numerous problems of the ear, such as noise-induced hearing loss, permanent hearing impairment, acoustic trauma, sensorineural hearing loss, tinnitus etc. Exposure to high noise levels can indirectly affect human psychology and physiology, resulting in adverse effects on general performances. A number of ailments have a causal relationship with noise exposure.

Figure 1 illustrates the domain of effects of noise on humans. Medical researchers have recognized noise as an environmental pollutant. A list of many ailments directly or indirectly related to noise may be found in Table 1. Figure 2 shows the factors that determine the effects of noise on people.

However, the epidemiological studies have not yet clearly confirmed links between noise levels and physical ailments. Links have been reported between muscular activity and the variation of sound intensity, and experimental research has shown that noise evokes physiological responses. These responses are characteristic of stress.

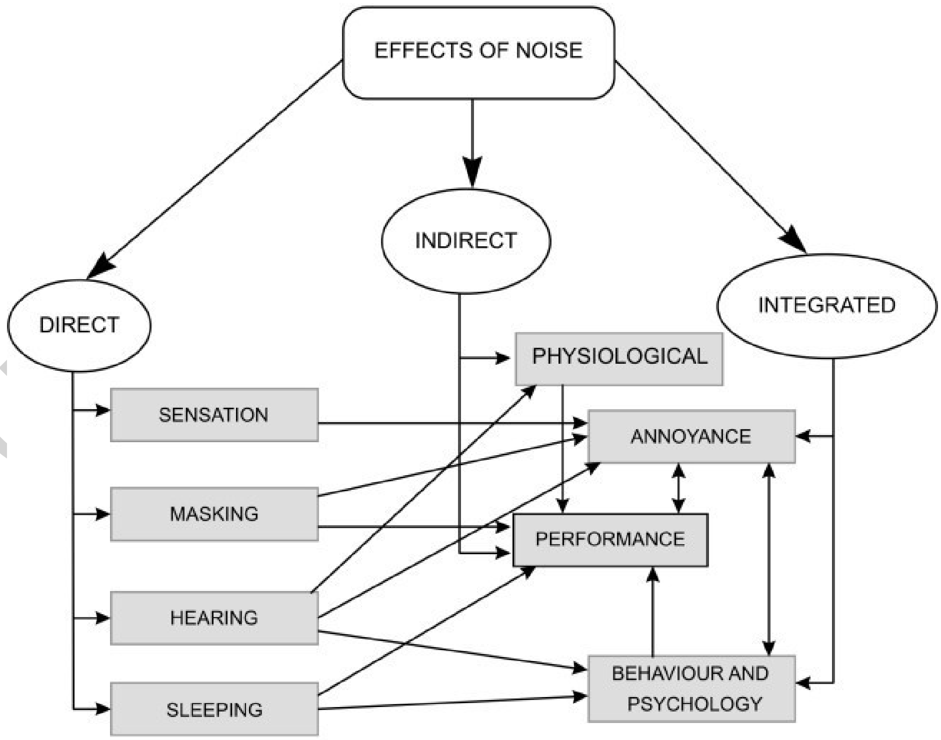

Figure 1. Effects of noise on human beings

	Physiological Effects Related to Noise
1	Frequent blurring of eye sight
2	Frequent strain in eyes
3	Frequent clogging of ears
4	Frequent choking lump in throat
5	Sneezing
6	Constant staffing of nose
7	Troubles due to constant sputum
8	Trouble of constant coughing
9	Heavy chest colds
10	Soaking sweats at night
11	Getting out of breath compared to others
12	Cold hands or feet even in hot weather
13	Stomach upset
14	Nausea of vomiting
15	Feeling of substantial burning or taste sour
16	Cuts in skin staying open for a long time
17	Frequent heavy feeling in the head
18	Having hot or cold spells
19	Dizziness
20	Dizziness just after standing
21	Frequent feeling of faint
22	Trembling of hands or feet
23	Painful menstrual period
24	Loosing control of bladder
25	Getting up tired and exhausted in the morning
26	Difficulty in falling sleep
27	Easily getting awakened from sleep
28	Frequent yawning
29	Thinking get completely mixed up when to do things quickly
30	Wishing somebody to be to advise always
31	Wishing to die
32	Getting easily upset or irritated
33	Getting constantly keyed up and jittery
34	Getting scared at sudden movements or noises at night
35	Becoming suddenly scared for no good reason
36	Difficulty in memorising
37	Difficulty in thinking clearly
38	Difficulty in concentrating

Table 1. List of diseases having relationship with noise exposures
(Source: Yamanaka et al. 1982)

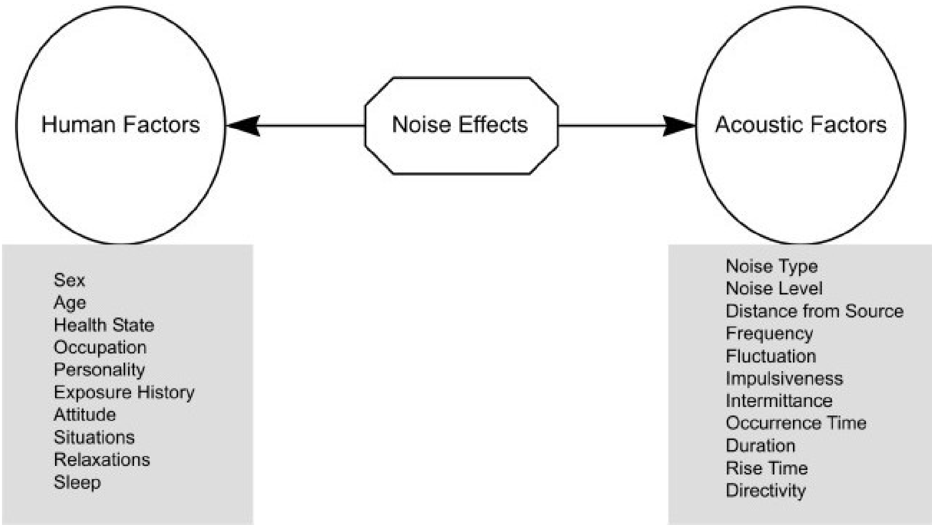

Figure 2. Factors influencing effects of noise on human beings

Tension increases in muscles at a steady state noise level of 90 dBA. It was also reported that long-term exposure to noise contributed to the genesis of cardiovascular diseases. Effects of environmental noise on sleep and health are still an unresolved issue. Of course, medical science has established that higher noise levels can cause circulatory, digestive, and metabolic troubles.

Medical effects of noise have been studied in many research efforts in Japan and Sweden, which were sponsored by various acoustical societies. These societies include the Acoustical Society of Japan, the Architectural Institute of Japan, the Association of Audiology of Japan, the Japanese Society of Public Health, the Japanese Society of Industrial Health, the Nordic Noise Committee (with membership of Denmark, Finland, Iceland, Sweden, and Norway), the Acoustic Society of America, and the Institution of Acoustics of UK. The effect of noise on health is still a primary area of investigation. The degree effect of noise on personal health depends on the amplitude and frequency of occurrences of the noise. It has been found that intermittent drilling noise causes the same impairment of hearing as steady noise of 20 dBA lower. Hazards of noise interrupted 40 times per day are the same as steady noise of 20 dB lower.

On exposure to loud noise for an extended period, the human ear suffers from an effect called "recruitment effect," which causes a raised threshold level and reduced tolerance for loud sounds. Permissible noise exposure is defined as one that increases the risk of hearing handicap by no more than 10% over that attributable to presbycusis (i.e., hearing loss associated with aging). Table 2 gives such permissible exposure for different durations of working hours for various numbers of exposure intervals, which must be fulfilled in an acoustic design of any working system. Industrial noise control measures must maintain the noise levels within a permissible exposure limit to ensure that there is no permanent shift of the threshold of hearing. The US Occupational Safety and Health Administration (OSHA), NIOCH, etc., have carried out extensive studies and prescribed a recommended noise exposure limit for specific sites.

Cumulative exposure	Number of Noise Interval Exposures per 8-h Workday						
	1	**3**	**7**	**15**	**35**	**75**	**150 or more**
8h	90						
6h	91	92	93	94	94	94	94
4h	93	94	95	96	98	99	100
2h	96	98	100	103	106	109	112
1h	99	102	105	109	114	(115)	
30 min	102	106	110	114	(115)		
15 min	105	110	115				
8 min	108	115					
4 min	111						

Table 2. Permissible noise exposure for different interval of exposures

2.1. Effects on Performance

Noise can adversely affect the performance of an industrial worker. Certain facts regarding effects of noise on performance include the following:

- Steady noise without special meaning does not seem to interfere with human performance unless the noise level exceeds ~90 dB(A).
- Irregular bursts are more disruptive than steady noise; irregular bursts of noise of even 50 dB (A) may interfere with the performance.
- High-frequency components of noise, above 2000 Hz, may produce more interference than low-frequency components.
- Noise does not seem to influence the overall rate of work, but high noise levels may increase the variability of the work rate.
- Noise is more likely to reduce the accuracy of the work than to reduce the quantity of work.
- Complex tasks are more likely to be adversely affected than simple tasks.

Considering these facts and the physiological, psychological, and behavioral problems caused by noise exposure, every industry should estimate the possible increase in environmental noise level as a result of the industrial activities at various phases of its operations.

The increased awareness of effects of noise resulted in formulation of standards for the measurement of noise by the national and the international standard organizations. State authorities have also formulated regulations to combat unwanted noise levels.

3. Noise Monitoring

The location of plants, machinery, and their movements, as well as road and traffic patterns in an industrial complex, are planned according to technological and economic requirements. If the acoustic qualities of these are not properly analyzed, the prevailing noise levels in the neighborhood may be adversely affected and the scope for future expansion or modification may be limited. Noisy workings may lead to violation of environmental guidelines, industrial disputes, and compensation claims. The Control of Pollution Act, 1974 authorizes the local authorities to inspect and abate nuisances with the establishment of a "noise abatement zone" and entertain complaints if industrial noise levels exceed the standard background noise level by 10 dBA.

The Social Security (Industrial Injuries—Prescribed Diseases) Amendment No. 4, Regulations 1979 necessitates more measures of noise pollution in industry. The Noise at Work Regulations 1989 (UK) based on the European Economic Community Directive /86/188/EEC have also alerted all sections of industry to the need to measure noise levels at the work place.

International Standards Organization (ISO) standards 1999, 3744, 3746, 3891, and 1996 give procedures and guidelines for noise measurement. However, application of the methods described in the standards to a particular situation requires careful observations of the influences of conditions pertaining to the site.

In any industrial environment, the time of occurrence of the noise-generating activities and the quality of the generated noise, do not follow a simple law. Determination of the exact sound power level of the sources is also very difficult, since the noise sources in the machinery or plant are located at different positions and they work in different cycles.

Therefore, systematic noise monitoring and analysis of results of noise level measurements are necessary to assess the noise levels in terms of the possible combinations of noise sources and influencing parameters.

For noise control purposes, it becomes essential to predict the impact of introduction of new machinery into an existing equipment complex at a particular time and location. In an industry where technological requirements demand continuous changes in the relative positions of machinery, the monitoring of environmental noise levels becomes more critical.

In such cases the noise levels in the industrial complex need to be analyzed not only for proper evaluation of environmental impact but also to incorporate better equipment deployment strategy.

Noise level monitoring involves determination of the values of different acoustic variables in order to study their relationships. The following section describes briefly the important variables that are important for noise level monitoring.

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Bibliography

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Biographical Sketch

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