11
Sound and Noise

11.1. Objectives

1. Understand the nature of sound and the basis of sound measurement, the decibel (dB).
2. Be able to compare different environmental sounds.
3. Understand how humans are affected by noise.
4. Become familiar with noise exposure standards and protection from excessive noise.

11.2. Introduction

Humans live in a world of sound. Many sounds are quite pleasant and persons who are not hearing impaired enjoy hearing voices, music, and many sounds of nature. People often listen for sounds that could warn of danger or the malfunctioning of equipment. Individuals have differing abilities to detect sound of varying intensities and frequencies, and differ as well in their personal tolerance of and appreciation of sound.

Sound that is harsh and unpleasant (or unhealthy) commonly is referred to as noise. In recent years, the subject of noise has been given considerable attention, especially as it affects human health and behavior. The federal government, through OSHA (Occupational Safety and Health Administration), has established noise exposure limits to prevent worker hearing loss and/or psychological stress due to excessive exposure to noise. OSHA does not have enough inspectors to insure all work environments meet standards. It is up to individuals to understand the nature of sound and noise so they know when unhealthy environments may exist due to undesirable or unwanted sound.

11.3. What Sound Is

The sound that people hear is due to vibrations in air or substances that are transmitted to the hearing organs. What are perceived as sounds are sonic pressure waves.
that travel through the air (or different substances) and interact with the eardrum by entering the ear canal or by passing through the body. Thus the eardrum responds to "sound pressure." There is a very, very large change in sound pressure (perhaps as much as 10,000,000 times) as sounds vary from the "threshold of hearing" (the intensity of sound just barely detected by an average human ear) to the sound pressure created by a large jet engine operating nearby. People can "feel" sound when they touch a vibrating body and the vibrations pass through the body to the eardrum.

The sense of hearing also responds to sound frequency (or pitch), that is, the number of vibrations or cycles per second—Hertz (Hz). The range of sound frequencies that can be heard varies from about 20 to 20,000 Hz, depending on the individual. As the intensity of sound is increased to an appropriately high level for a given frequency, the hearing sensation becomes painful, and the "threshold of pain" is reached.

Human hearing also can distinguish between sounds that differ in quality, those combinations of frequencies and intensities that produce squealing, grating, grinding, or rasping sounds. When the frequencies and intensities are combined in suitable proportions, pleasant musical or vocal sounds result. Thus, the sounds that are heard can be quite complex, but their effects on humans are well established.

In this chapter, our concern is with that part of sound called noise and how it may affect workers and their work. Generally, excessive noise can lead to hearing impairment, fatigue, annoyance, and interference with performance. Noise also can serve as a warning of equipment malfunction or a signal of needed maintenance. We frequently rely on sounds (or no sound) to tell us that equipment is performing satisfactorily.

11.4. How Sound Is Measured

The intensity of sound is measured in units of decibels (dB). The unit decibel is a ratio of any two components of sound, power, sound pressure, intensity, etc. The human ear has the capability of distinguishing a wide range of sound intensity and frequencies. The range of sound pressure that an individual might be able to distinguish from the threshold of hearing to causing damage to the ears is over a million. Because the decibel scale is a ratio, to measure a single source of sound a base line called a filter is used. Three standard filters are used. They are identified as A, B, and C. Filter A is less sensitive to very high and very low frequencies. The C filter is commonly used for high frequencies. The B filter falls in between the A and C. It is seldom used. When using a sound meter it is important to identify which filter is used. This is commonly done by using the units of dBA or dBC after the reading.

To simplify the measurement of sound, decibel readings are based on an exponential scale of sound pressure levels. Remember that the decibel is not an absolute measure of the sound pressure, but rather is a ratio of a measured sound pressure to a reference sound pressure. Also, because this sound scale is exponential, a sound