Chapter 6

Introduction to Sound

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Purpose

To introduce the major concepts associated with sound

Chapter Topics

- The Nature of Sound
- What is Sound?
- The Characteristics of Sound
- How Sound Affects Hearing
- Measurement of Sound

The Nature of Sound

Understanding sound is important to understanding the total work environment. The general nature and characteristics of sound and how we measure and characterize sound are important when discussing **noise-induced hearing loss** (NIHL).

The *Oxford English Dictionary* defines noise as "a sound, especially one that is loud or unpleasant or that causes disturbance." The difference between sound and noise is that noise is unwanted, regardless of how loud. Some people perceive certain sounds as noise, while others don't. People perform these subjective "measurements" of sound all the time just by listening.

All sound must be considered for its potential to damage hearing—unwanted or not. Sound may be hazardous if you have to shout at someone an arm's length away to have a conversation (ie, the Three-Foot Rule). However, engineers, audiologists and hearing scientists use quantitative calculations to precisely determine when sound may be damaging.

What is Sound?

Pressure variations from a vibrating source transmitted in any elastic (movable) medium (eg, air, water, solids) cause sound.

Sound Waves

These pressure changes, whether from a thunderclap, a ringing bell, vocal cord movement or an explosion, all result in sound if there is a medium. For example, when you strike a tuning fork, molecules begin to vibrate (**Figure 6-1**).

In one cycle of this vibration, the molecules push or bump against each other. Then the molecules move back, or expand, to fill the empty space created by the movement of the tuning fork in the opposite direction. Finally, the molecules return to their original places. The molecules that were bumped move on to bump adjacent molecules, which move on to bump others, and so forth as the sound wave moves, or **propagates**, outward. This continues as long as the tuning fork vibrates.

The technical term for the higher-pressure phase in which pushing or bumping molecules move closer together is **compression**. The term for the lower-pressure phase in which molecules move further apart is **rarefaction**. Remember, the air molecules themselves do not travel very far. It is the pressure *wave* that travels sometimes for long distances, as with a thunderclap. Sound travels 1,128 feet per second through air on a standard day (normal barometric pressure and about 70°F). In water, sound travels four times faster than in air, while it travels faster still through solids (eg, 16,600 feet per second through steel).

Sound can travel through any medium with particles to be vibrated. However, sound cannot travel in a vacuum, such as outer space, because it has no particles to vibrate. Just as your hand feels differently as it travels through air than through water, sound behaves differently in air than in water. Characteristics such as absorption and speed change as the medium changes. The path of the sound changes as these characteristics change. The sound can curve around or even travel through obstacles. Sound changes depending on size, weight and construction of the various materials that make up the obstacles. As sound travels, the energy of the sound wave dissipates, or dampens, over distance. All characteristics of the environment need to be considered, when trying to determine the path or propogation of sound.

Without a receiver, the impact of sound is minimal. A receiver in an occupational setting is most often a worker; without workers, there can be no noise exposure.