Learning Objectives

Upon completion of this unit, students should be able to:

1. Describe the structures and functions of the eye and ear.
2. Discuss measurements of illumination and luminance.
3. Discuss the effects of the auditory and thermal environments.
4. Discuss measurement of noise levels.
5. Discuss the methods of controlling thermal conditions.
6. Explain the effects of vibration and techniques of controlling the effects.

Unit Lesson

This unit focuses on senses of the human body and measurement of environmental factors. It deals with the human senses and techniques to evaluate the environment as it relates to the senses.

The first section of the unit describes the primary senses in ergonomic study which include vision, audition, tactation, olfaction, and gustation. It explains the structure (Figure 3.1) and function of the eye and visual fatigue. Techniques for controlling direct and indirect glare are also discussed. The ear consists of three components: the outer ear, the middle ear, and inner ear. The structure of the ear is discussed and shown in Figure 3.2. Speech intensity and noise effects on performance are summarized in Tables 3.3 and 3.4 respectively.

Noise-induced hearing loss (NIHL) is discussed, and the guidelines to protect hearing are provided in Table 3.5. Olfaction, gustation, and tactation are also briefly explained.

It is important to study the environmental factors affecting the task performance of workers. The factors are classified as visual, auditory, and thermal. Illumination and luminance as well as their measurements and engineering procedures in the design are discussed. Contrast is the difference between the luminance of an object and the luminance of surrounding surfaces. Contrast can be calculated using the formula shown on page 72 in the textbook. Direct and indirect glare as well as light sources are also discussed.

The auditory factor, specifically noise or unwanted sound in workplaces, is also important to review. While some sounds are needed to warn or advise personnel, noise is described as having a negative impact and being an environmental stressor. Industrial noise is a phenomenon that requires understanding of both the physics of wave energy and the way in which noise is heard and affects human hearing. Measurement of noise levels is explained and measuring devices such as sound level meters (SLM), integrated sound level meters (ISLM), and noise dosimeters are introduced. A noise dosimeter, which is a portable measuring device, is useful for a worker who changes locations frequently. Guidelines for instrument selection are also provided in Table 3.9. It is important to be familiar with the guidelines for acceptable noise levels published by OSHA listed in Table 13.10. A chart for environmental noise comparison is also given in Table 3.11.
The next section deals with thermal factors: temperature and humidity. Body heat balance, which is a function of personal, environmental, and administrative conditions, is explained in Table 3.12. The heat balance equation for the body is also summarized on page 81 in the textbook. The Eastman Kodak Company (1983) provides a guideline for exposure time in certain humidity levels, ambient temperatures, and workloads, as shown in Table 3.13. This guideline is very useful because a worker's exposure time can be obtained from the work conditions.

Web bulb globe temperature (WBGT), which combines temperature, humidity, and solar radiation, is useful to estimate the environmental effects on workers. The WBGT is determined by dry bulb temperature, relative humidity, mean radiant temperature, and air velocity. WBGT correction factors for clothing types are also summarized in Table 3.14. Engineering controls to reduce heat stress include general ventilation, air treatment, air conditioning, local air cooling, and shielding. Administrative controls and work practices are also discussed. Factors affecting the occurrence of heat stress are summarized in Table 3.17.

The subject of vibration is discussed in the next section. The topics include physiological effects, such as whole-body and hand-arm vibrations, as well as performance effects. Techniques to mitigate the effects of vibration include source control, path control, and receiver control.

It would be beneficial to study further in the area of controls by visiting the OSHA or NIOSH website.

References


Supplemental Reading


Learning Activities (Non-Graded)

Apply What You Have Learned

Complete exercises 3.2, 3.6, and 3.10 on pages 95-96 of your textbook.
1. (3.2) Explain how to minimize overloading of the visual system in a visual inspection task in a manufacturing facility.
2. (3.6) Identify a national or international standard (or guideline) for each occupational design in vision, audition, and vibration.
3. (3.10) Describe a task that relies largely on the sense of tactation.

*Non-graded Learning Activities are provided to aid students in their course of study. You do not have to submit them. If you have questions, contact your instructor for further guidance and information.