

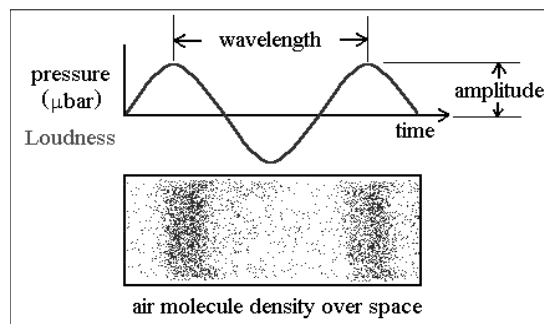
# Human Factors Engineering

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## Lecture 5 (NOISE)

### Sound

- ❑ Sound: sensed variations in air pressure
- ❑ The number of cycles per second is called the frequency of the sound
  - Expressed in hertz (Hz) or cycles per second



## Intensity of Sound

- ☐ Associated with the human sensation of loudness
- ☐ Defined in terms of power per unit area
  - Example: watts per square meter (W/m<sup>2</sup>)
- ☐ Because the range of power values for common sounds is so tremendous it is convenient to use a logarithmic scale to characterize sound intensity
- ☐ The bel (B), is the basic unit of measurement
  - 1dB=0.1B
- ☐ Sound power is directly proportional to the square of the sound pressure, hence sound-pressure level (SPL), in decibels (dB), is defined as

$$\text{SPL (dB)} = 20 \log \left( \frac{P_1}{P_0} \right)$$

## Inverse Square Law

- ☐ The intensity of the sound (sound power) is inversely proportional to the square of the distance

$$I \propto 1/D^2$$

- ☐ According to Inverse Square Law the level of sound decreases by 6 decibels every time the distance from the sound source doubles

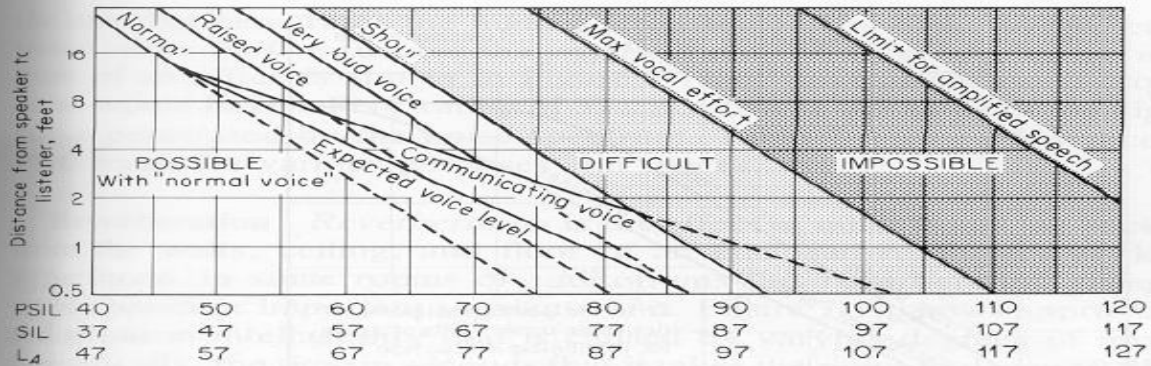
# Effect of Noise on Speech Communications

- ❑ Different indices have been developed to evaluate the effects of noise on speech communications
  - AI: Articulation Index
  - PSIL: Preferred-octave Speech Interference Level
  - PNC: Preferred Noise Criteria curves

## Preferred-octave Speech Interference Level (PSIL)

- ❑ Used as a rough estimate of the effects of noise on speech reception
- ❑ It is simply the numeric average of the decibel levels of noise in three octave bands centered at 500, 1000, and 2000 Hz
- ❑ Thus, if the decibel levels of the noise were 70, 80, and 75 dB, respectively, the PSIL would be 75 dB
- ❑ The PSIL loses some of its utility if the noise:
  - Has intense components outside the ranges included in the PSIL
  - Has an irregular spectrum
  - Consists primarily of pure tones

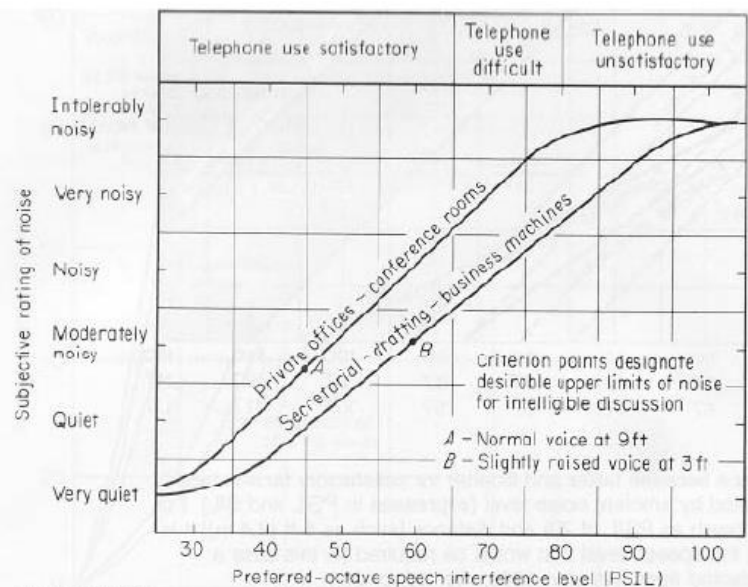
# Preferred-octave Speech Interference Level (PSIL)



**FIGURE 7-9**

Voice level and distance between talker and listener for satisfactory face-to-face communication as limited by ambient noise level (expressed in PSIL and SIL). For any given noise level (such as PSIL of 70) and distance [such as 8 ft (2.4 m)] it is possible to determine the speech level that would be required (in this case a "shout"). (Source: Adapted from Webster, 1969, Fig. 19, p. 69.)

## PSIL



**FIGURE 7-10**

Rating chart for office noises. (Source: Beranek and Newman, 1950, as modified by Peterson and Gross, 1978, to reflect the current practice of using octave bands with centers at 500, 1000, and 2000 Hz.)

# PSIL

**TABLE 7-2**
**MAXIMUM PERMISSIBLE PSIL FOR CERTAIN TYPES OF ROOMS AND SPACES**

Type of room	Maximum permissible PSIL (measured when room is not in use)
Secretarial offices, typing	60
Coliseum for sports only (amplification)	55
Small private office	45
Conference room for 20	35
Movie theater	35
Conference room for 50	30
Theaters for drama, 500 seats (no amplification)	30
Homes, sleeping areas	30
Assembly halls (no amplification)	30
Schoolrooms	30
Concert halls (no amplification)	25

Source: Peterson and Gross, 1978, Table 3-5, p. 39.

## Problem

*Part A.* Compute the preferred-octave speech interference level (PSIL) for the three hypothetical situations given below.

Midpoint of Octave Band (Hz)	Intensity (dB) in Hypothetical Situations		
	A	B	C
500	69	37	23
1,000	81	86	30
2,000	75	42	37
Total	_____	_____	_____
Total ÷ 3 = PSIL =	_____	_____	_____

*Part B.* Are any of the “assumptions” regarding the accuracy of the PSIL violated in any situation listed above? If so, what?

*Part C.* Using Figure 7-9, on page 209 of the text, answer the following questions.

1. In situation A, above, what approximately is the maximum distance people can be apart and have a reliable conversation if they are shouting?

\_\_\_\_\_ feet apart

2. If two people are working eight (8) feet apart in situation A, would it be possible, difficult, or impossible to communicate?

\_\_\_\_\_

3. In situation B, if two people are ten feet apart, what level of voice will they have to use in order to have a reliable conversation?

\_\_\_\_\_ level of voice

*Part D.* Using Figure 7-10 on page 210 of the text, answer the following questions.

1. If the three situations were private offices, what approximately would be the subjective rating of the noise by people in each situation?

Situation A \_\_\_\_\_

Situation B \_\_\_\_\_

Situation C \_\_\_\_\_

2. In which situation(s) A and/or B, would you recommend a telephone operator be located?

Situation \_\_\_\_\_

*Part E.* Using Table 7-2, page 210 of the text, answer the following questions.

1. What would be two possible uses for Situation B?

Use 1: \_\_\_\_\_

Use 2: \_\_\_\_\_

2. Would it be permissible to use Situation C as a:

Movie theater? \_\_\_\_\_

Theater for drama? \_\_\_\_\_

Concert hall? \_\_\_\_\_

*Part F.* What do you see as the advantages and disadvantages of using PSIL as a measure of the speech interference of noise?

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