not noticed until losses at the speech frequencies, 500, 1000 and 2000 Hz are 15 dB (ASA 1951) or 25 dB (ISO 1964) Substantial losses may occur at frequencies from 3000 to 6000 Hz without producing any subjective awareness of changes in hearing The production of noise-induced hearing loss is a slow insidious process and years of exposure may elapse before any significant noticeable loss of hearing occurs (Fig 45–5)

- Second, the deleterious effects of noise-exposure cannot be directly equated to the energy content of the noise That is, doubling the energy content in the noise does not produce twice the hearing loss It is logical that the larger the total energy content of the noise is the smaller will be the time of exposure required to produce the same amount of hearing loss, but the exact relation between time and energy is not known

- Third, the total amount of hearing loss produced by noise-exposure depends on many more variables than was thought originally Hearing loss varies with the type of exposure and its degree of intermittency, with the individual exposed, the total duration of the exposure, and with the degree of consistency of use of ear protection

Noise-exposure and permanent hearing loss. This discussion has referred to hearing loss produced by noise-exposure, not by noise The concept of exposure, of the need for time of development of hearing loss is important Brief exposures to most industrial noises will produce no illness or damage to the ear Whenever the causal relations of hearing loss to noise are considered, one should consider each of the four factors bearing on noise-exposure

1 The overall noise level to which the man was exposed
2 The frequency composition or spectrum of this noise, probably as expressed in octave band sound pressure levels
3 The duration and time distribution of noise during a typical "work-day"
4 The total duration of the noise-exposure during the "work-life"

(A-scale measurements may be substituted for 1 and 2)

To elucidate these last two factors consider the following

Frequently, one is confronted by persons who work in high level noises, perhaps as high as 110 or 120 dB Before drawing any conclusions about the effects of exposure to these noises, one must inquire carefully about the length of time spent in the noise Brief exposures to these noise levels will not produce severe hearing loss and in most cases, not even *significant* hearing loss On the other hand, one also encounters persons who work in lower noise levels, perhaps 100 dB, and again exposure time looms important The possible effects of extended exposure to these lower levels must not be minimized In many instances persons who are exposed to the 100 dB noise have much longer total duration of exposure than do the men who work in excessively high noise levels If the noise level is approximately 100 dB and the exposure has been long, existing hearing loss may be directly related to the noise-exposure

Some industrial noises will produce significant hearing loss only if the exposure continues over 15 to 20 years Many operations that are associated with these industrial noises, however, are characterized by rapid job turnover The total duration of exposure for any man's ears may not be more than two or three years One must remember, however, that men who work in noisy jobs at one location will generally transfer to a noisy job in another location Exposure to the average industrial noise for two or three years usually produces only minor changes in hearing

These previous statements are based on long experience with continuous noises There is insufficient experience about the auditory effects of impulse-type noises, such as blasts, rifle fire, or drop hammer sounds

Hearing Conservation and Noise Exposure

Two questions must be considered before setting the limit beyond which noise exposures are judged to be severe enough to warrant organizing a hearing conservation program First, can a realistic hearing conservation program provide complete protection for all ears? And second, what do we know about the effectiveness of the different