

and 1500 Hz are now available on some instruments

Clinical measurements of hearing are made to determine the presence of abnormal function of the ear. Before behavior can be described as abnormal, a reference point, or normal value, must be designated. The standard values of average normal threshold for pure tones are expressed in decibels of sound pressure level re 0.0002 dyne per square centimeter. The quantity that is of interest, however, is not the sound pressure level of the normal threshold but rather the magnitude of departure from this threshold. To simplify the calculation of these departures, audiometers are now calibrated to read "zero" when the sound pressure level of the output signal is equal to the sound pressure level of the reference standard. Departures from reference can then be read directly from the setting of the audiometer attenuator dial. Departures from reference threshold may be expressed as "x dB above audiometer zero" or simply as "x dB hearing level." In clinical records any change from reference threshold is expressed as "hearing level in decibels re audiometer zero."

Pure tone audiometry may be subdivided into two classes: threshold audiometry and screening audiometry. Each may be done by manual or automatic equipment.

**Threshold audiometry** Threshold audiometry, as its name implies, is used to determine the auditory threshold for a given stimulus. There are three sources of variability which may affect the results of pure tone threshold tests, namely, *variability in the test environment, in the subject's performance and in the tester's performance*.

Variability in the test environment is caused mainly by changing ambient noise levels in the testing area. Unless test areas are specially treated to reduce ambient noise levels below certain specified values, the measured thresholds of persons with normal hearing may be masked. The usual ambient noises in test environments are predominantly low frequency sounds, and most of the masking at 1000 Hz and below. It is usually easy to detect masked low frequency thresholds on audiograms made in poorly sound-treated environments. These audiograms show normal or near normal hearing at 1000 Hz

and hearing losses as large as 10 dB at 250 Hz and at 500 Hz. Thresholds at 1000 Hz may show the effect of masking if the ambient levels are moderately high. Unless hearing tests are made under extremely bad conditions there is very little, if any, masking effect seen at 2000 Hz and higher frequencies.

Ambient noise in the testing environment is perhaps the most frequent environmental cause of variations in audiograms, but it is by no means the only cause. The subject must be comfortable so that he will not become restless and squirm or fidget. Humidity, temperature, barometric pressure, and the size and décor of the test room are all factors that influence comfort and it is important to pay attention to these details in order to provide optimum conditions for producing good audiograms.

- Variability caused directly by the subject may be caused by his past experience with hearing tests, to intelligence, education, and physiological conditions, or to his hearing and attitude towards the test. In this latter category for example, subjective tinnitus (a purely subjective sensation of noise, such as ringing in the ears) is sometimes loud enough to mask the signal tone and produce spurious records. The attitude of the subject toward the test is of extreme importance.

- Variability caused by the tester is dependent to a large extent upon his motivation. A tester may be extremely well trained, but if he is careless, the test results may be completely invalid. A minimum amount of training in giving hearing tests is absolutely essential, especially actual practice training with an audiometer. Careful testing is important also.

**Screening audiometry** Screening audiometry has only limited use in industry. It can be used successfully for follow-up audiometry since only a change in hearing status is sought. Usually screening is accomplished by testing at several frequencies with a level of 15-20 dB. The subject is passed if he hears the tone and failed if not. Those who fail are retested with threshold audiometry.

**Automatic audiometry.** The need for testing the hearing of large numbers of persons