Valid audiometric screening tests are a prerequisite to evaluate the effectiveness of a Hearing Conservation Program (HCP).

A procedure based on hearing thresholds levels (HTLs) has been developed to validate the audiometric screening tests used in a HCP. Two different aspects must be considered: statistical procedures and other possible causes.

The proposed approaches apply to groups as well as to a single individual.

When assessing the validity of the audiometric screening test in a HCP, the following aspects must be considered:

1. **STATISTICAL PROCEDURES**
   - Audiometric Technique
   - Technical Procedures
   - Threshold Variations by Frequency on the Vertical Axis
   - Floating Average

2. **OTHER POSSIBLE CAUSES**
   - Intrinsic/Extrinsic Causes
   - Employee Being Tested

**AUDIOMETRIC TECHNIQUE**

Audiometric testing uses 5 dB steps. A hearing threshold change of 5 dB infers a measurement error. As a criterion of acceptability, a 10 dB variation is tolerated. However, a difference of more than 10 dB cannot simply be attributed to the audiometric technique.

**TECHNICAL PROCEDURES**

Screening audiometric tests done in industry are subject to specific procedures and legislations. Among the required elements, the following play an important role:

- The locale;
- The audiometer;
- The personnel.
In many situations, erroneous thresholds in the low frequencies may be due to an inadequate locale. A typical example is shown below:

**Fig. 1:** In this company, the locale did not meet the required standards. It resulted in abnormal thresholds for both the right and left ears for the first test. Since the first test was invalid, the second test was used as the baseline.

![Hearing Thresholds](image)

**Fig. 2:** Shown above is the average HTL per frequency for two consecutive years (534 employees). The overall evaluation of the group shows an improvement at all frequencies. There is an important variation of thresholds, especially in the lower frequencies due to what proved to be an inadequate locale.

**Fig. 3:** A sub-standard locale often shows worse HTLs in the low frequencies (0.5 and 1 kHz) in both ears.

**Fig. 4:** Averaged HTL at .5, 1 and 2 kHz in a company (800 employees) from 1962 to 1985. From year 1975 to 1979 there was an increase in case reviews due to an audiometer problem.

**Fig. 5:** Variations of a subject’s HTL (Y axis) between an untrained technician (Tech A) and a certified audiologist (Aud B), as well as with themselves.

A variation due to audiometer problem would have been noted immediately through either the floating average and/or the vertical frequency analyses.

**PERSONNEL**

Variation of thresholds between different testers can be a cause of abnormal results. It can be present in situations where there are different testers from year to year. As shown on Fig. 5, audiomeric tests done manually can result in a wide discrepancy between different technicians or health professionals.

The figure shows, that the repeatability of the hearing screening done by the technician and the audiologist is similar. However, when the tests are compared between a trained person (audiologist) and an untrained technician there is a great variability.
Employees being tested may have personal reasons for abnormal test results, such as malingering, use of drugs or alcohol before the test, inadequate rest period from noise exposure, etc. If no reason is indicated on the pre-test questionnaire, the employee should be further questioned.

The variation criteria (circled in red) can be modified by the user. The following abnormal variations are automatically indicated as the end of the test:

CONCLUSION

PERSONAL FACTORS
1. Genetic
2. Otological disease
3. Systemic disease
4. Presbycusis*

EXTRANEOUS FACTORS
1. Exposure to noise
2. Trauma
3. Ototoxic agents
4. Physical agents

*Based on Tables F1 and F2 of OSHA or ISO 7029.

The observed thresholds may be valid and the noted variations may be due to causes not related to the HCP. The questionnaire of each individual with highlighted changes in their audiogram needs to be reviewed.

The proposed software offers these advantages:
- Timesaving
- Prevents possible errors from manual review.
- Automatic identification of problem cases allowing immediate action (retest, question the employee, and/or referral)
- Ensures valid screening tests
- Validates screening tests to evaluate HCPs and analyze Standard Threshold Shifts (STS).