

# The standard shift of the auditory threshold due to exposure to occupational noise

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## Basics

In the context of occupational hearing assessment, within the Hearing Conservation Plan, the need for two types of audiometry, namely: base audiometry and annual control audiometry, is established according to the regulations of the Occupational Safety and Health Administration of the United States of America (OSHA). Any worker who works exposed to a level equal to or greater than 85 dB (A) during an 8-hour working day, must be included in the Hearing Conservation Plan (PCA).

## Baseline audiometry versus annual audiometry

Basic audiometry is the first audiometry performed on the worker, ideally at the time of hiring and prior to any exposure to occupational noise in the contracting company. If baseline audiometry is not performed prior to the worker's entry, OSHA allows the employer to provide the audiometry service for the first six months after the contract.

The basic audiogram must be performed with 14 hours of auditory rest, that is, without the individual having met sounds above 85 decibels (A), in case this requirement cannot be met due to having entered work, the regulations allow the audiogram to be taken if the worker has used the appropriate hearing protection during the working day.

Adequate hearing protection is one that keeps the worker at a safe level of exposure, below ninety decibels during their workday and is checked with OSHA's formula for calculating the effectiveness of hearing protection, known as reduced NRR (NRR-7/2).

If the employer provides audiometry services by contracting these on an outpatient basis with a provider who uses a van with a soundproof cab, OSHA allows the audiogram to be taken even up to one year after admission. In this exceptional case, even if the worker is exposed to average levels of 85 dB (A) TWA, he must use adequate protection on a mandatory basis.

The annual audiometry or occupational hearing screening is the auditory evaluation that is performed annually to all workers who are exposed to a noise level equal to or greater than 85 dB (A) TWA during their eight-hour workday.

The noise levels allowed in the enclosure to perform the base audiometry and the annual audiometry, should never exceed 40 dB (A), it is recommended to use an audiometric booth that meets the specifications of the American Institute of Standards (ANSI), although audiometry can be performed in a silent common environment, if it is guaranteed with monitoring by ANSI type 2 sound level meter, that the established background noise level is not exceeded to obtain reliable audiometries, that is, 40 decibels. Audiometry must be done by certified personnel, it can be in this case a technician, a nurse, an audiologist, or a doctor, duly accredited by the Occupational Hearing Conservation Council of the United States (CAOHC).

Audiometry in the occupational field is performed in both ears separately, only by air, that is, taking the auditory threshold (minimum level at which the individual can respond to 50% of the sound stimuli) through headphones placed on the pinna or inserted into the external auditory

canal. OSHA sets up the sound frequencies (in Hertz or Hertz) at which the auditory sensitivity of the collaborator is evaluated: 500 Hertz, 1000 Hertz, 2000 Hertz, 3000 Hertz, 4000 Hertz, 6000 Hertz and 8000 Hertz, the latter is optional, but recommended. The audiometer must follow the ANSI regulations, it must be calibrated once a year or if it does not pass the daily visual, auditory and biological inspection, prior to performing the audiometric tests.

#### The objective of audiometry in the occupational field

Within the Hearing Conservation Plan, audiometry plays a leading role, since it allows measuring the situation of the hearing health of workers, both those who enter, and those who are regular employees of the company. To achieve this, OSHA proposes the method of comparison between the auditory threshold of the base audiometry, versus the auditory threshold of the annual audiometries. With this method, different scenarios can be found:

- A. The worker's hearing threshold has not changed
- B. The auditory threshold has varied slightly
- C. The auditory threshold has varied significantly

When there is a variation of the auditory threshold, which is identified by comparing the auditory thresholds of the base audiogram, versus the annual audiogram, it must be determined whether the nature of the variation is related to exposure to occupational noise or due to other diseases or factors, additionally, different entities can be distinguished:

1. Temporary deviation of the auditory threshold (TTS)
2. Standard Deviation of Hearing Threshold (STS)
3. Permanent deviation of the auditory threshold (PTS)

If the worker does not present any variation between the base audiogram and the annual audiogram, annual audiometric surveillance is kept. If the worker presents a slight or non-significant variation between the thresholds (of +/- 5 decibels of auditory level), this is considered an irrelevant factor due to the subjectivity of the test.

If the worker presents a significant variation between the thresholds of the base audiometry and the annual audiometry, a differential analysis should be conducted initially. Most researchers agree that there is a classic pattern of noise-induced hearing loss, this occurs at high frequencies, initially at 4000 cycles per second and then extends to surrounding regions of the cochlear base, affecting 3000 and 6000 cycles per second, subsequently advances to the frequencies of the speech area and is distinguished from other types of hearing loss, originated by other pathologies, by its classic recovery in the frequency of 8000 cycles per second, in its first stages mainly. The differential analysis is not performed by the hearing conservationist who does the audiometry, this task is done by the professional supervisor, who must be a doctor, or an audiologist certified as such by the Occupational Hearing Conservation Council (CAOHC).

All occupational hearing evaluations must follow a procedure: brief interrogation, otoscopy, taking of auditory thresholds, recording of results, reporting and analysis of results. If during data collection or otoscopy, the hearing conservationist detects information useful for further analysis, he must record it in the report, for example, if the worker indicates that he had exposure to noise unrelated to his work or if he has pain or hearing loss of sudden onset; presence of visible pathology in the ear canal or in the tympanic membrane, such as impacted earwax, acuous, purulent or bloody secretion, in which case the evaluation must be stopped and the professional supervisor informed. Hearing loss in severe or medium frequencies or flat

profile, do not correlate with hearing loss of work origin and should be referred to the professional supervisor for study and treatment.

OSHA establishes the criteria necessary to record a deviation from the auditory threshold as suspected of occupational hearing loss, which are:

1. Hearing loss is of occupational origin
2. The auditory threshold is below the line of 25 dB HL
3. There is a deviation in the average of the auditory threshold of the frequencies of 2000, 3000 and 4000 cycles per second, equal to or greater than ten decibels HL, in one or both ears

Noise-induced hearing loss is initially temporary. During a day with exposure to loud noise, auditory fatigue may occur, and the worker will feel a reduction in their hearing ability, which is called a temporary threshold drop (TTS). During the period of hours of rest, since the individual leaves work and enters again, the lapse allows the auditory organ to recover from fatigue and the subject returns to its first auditory state. After a period of days, weeks, months, or years of exposure, finally the temporary threshold drop becomes permanent (PTS). Ideally, the hearing conservationist detects the temporal variations of the threshold to prevent these from becoming permanent lesions, it is for this reason that the annual auditory screening is conducted without a previous rest of 14 hours.

#### The standard threshold shift (STS)

It is defined as a change in the auditory threshold equal to or greater than 10 decibels (dB HL), in one or both ears, average of the frequencies of 2000, 3000 and 4000 cycles per second (Hz) between the base audiogram and the annual audiogram.

The identification of the standard threshold drop (STS) is the most important reason audiometry is performed in the occupational context.

When a change of this nature is detected, OSHA states that actions should be taken to protect the hearing of the worker(s) who present a positive STS (probable carriers of occupational noise-induced hearing loss). Actions may include conducting a noise study of the area where the employee works, audiodosimetry, making reductions in working hours or changes in shifts, establishing rest periods, maintaining, or replacing machinery and studying the suitability of the personal hearing protection used by the worker. The worker with positive STS must be referred to the insurance company for the corresponding compensation to be made.

OSHA allows corrections to be made for the patient's age, as it is considered possible that there is a hearing impairment attributable to age. Although OSHA allows age-corrected calculation, this practice is not recommended as it does not protect the worker or the employer. The use of age correction is a masker of the patient's hearing situation. The best practice is not to apply age correction.

To calculate the standard decrease of the threshold, the auditory thresholds of the base audiogram are added in the frequencies of 2000, 3000 and 4000 cycles per second, the result is divided by three and an average is obtained, this is done in both ears separately, after, the comparison with the current thresholds is made. If, by subtracting the current average from the average of the base audiogram, it is found that there is a deviation equal to or greater than 10 decibels, in one or both ears, a standard decrease in the threshold will be documented. The best practice is to perform a verification audiometry, with auditory rest of 14 hours, within a period not exceeding 30 days, in case of persisting the STS descent, it is reported as positive, and the current audiogram becomes the new base audiogram.

**Ejemplo de Standard Threshold Shift (STS)  
(Desviación estándar del umbral auditivo)**

<b>Izquierdo</b>							
Frecuencia (Hz)	500	1000	2000	3000	4000	6000	8000
Actual	5	0	10	10	10	5	5
Base	0	0	0	0	0	0	0
Cambio	0	0	10	10	10	0	0
Desviación	0	0	10.0				

### Conclusions

The OSHA – CAOHC Temporary Threshold Shift Method ensures that prompt actions can be taken to prevent noise from causing irreversible damage to the hearing of workers who are exposed to noise levels above 85 decibels (A) in an eight-hour workday.

### Bibliography

- Danielson, R. (2017). Understanding Audiograms. In T. Hutchinson, & T. Schulz, *Hearing Conservation Manual* (p. 71). Milwaukee, Wisconsin, Estados Unidos de América: CAOHC.
- Rawool, V. (2012). *Hearing Conservation, in occupational, recreational, educational and home settings*. Morgantown, West Virginia: Thieme.
- Stach, B. A. (2003). *Comprehensive Dictionary of Audiology Illustrated*. St. Louis, Missouri: Delmar Cengage Learning.