

# EFFECTIVENESS OF A HEARING CONSERVATION PROGRAM

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## ABSTRACT

Hearing Conservation Programs (HCPs) are used in a multitude of companies to prevent or reduce occupational noise induced hearing loss. What is not easily obtained from the accumulated data in various HCPs is their effectiveness.

## INTRODUCTION

The effectiveness of a Hearing Conservation Program (HCP) can be verified using one of three approaches:

- Audiometric Trend Analysis
- Statistical relation to presbycusis *ISO 7029 – Annex A and OSHA presbycusis Tables F1 and F2*
- Audiometric Database Analysis, according to ANSI S12.12 *Evaluation of Hearing Conservation Programs*

This presentation is limited to the first two procedures.

## AUDIOMETRIC TREND ANALYSIS (ATA) <sup>1</sup>

ATA is an approach developed for administrative evaluation of the effectiveness of a Hearing Conservation Program.

### Advantages

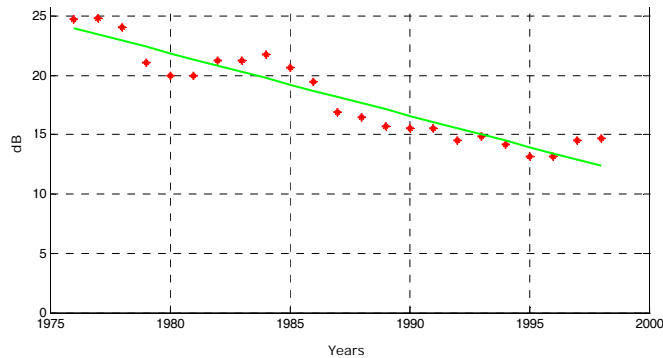
- Easy to understand and interpret
- Can be applied to any jurisdiction
- Allows follow-up of HTLs over the years
- Allows identification of % of compensation cases based on the standards of the chosen jurisdiction
- Allows comparative evaluation of costs
- Allows prediction of potential future costs

Audiometric Trend Analysis can be evaluated for the entire workforce of employees.

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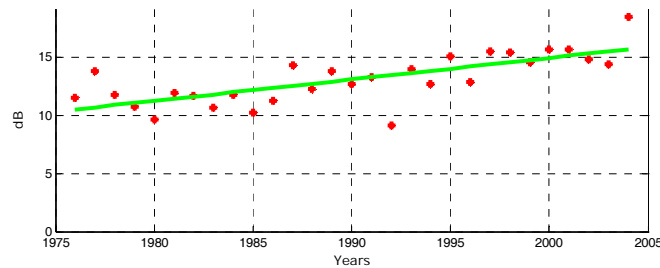
<sup>1</sup> Ref.: Bertrand, R.A. and Zeidan, J. A new approach to evaluate the effectiveness of a hearing conservation program. 1995 Industrial Hearing Conservation Conference. University of Kentucky, Lexington, Kentucky 40506-0108, April 5-7, 1995.

### Mining company – Global Trend – Average hearing loss at .5 1 2 3 kHz



*Evolution of average hearing loss at 500, 1000, 2000 and 3000 Hz frequencies using linear regression. We note a favorable trend proving the efficiency of the program for the entire workforce*

### Manufacturing company – Trend analysis



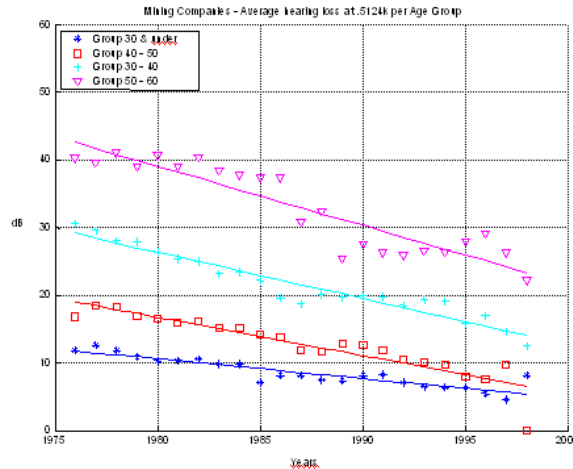
*Evolution of average hearing loss at 500, 1000, 2000 and 3000 Hz frequencies. A progression of HTLs indicates an inadequate program.*

### **TREND ANALYSIS ACCORDING TO AGE GROUP**

The Audiometric Trend Analysis can also be performed according to age group. This approach is very useful considering the following aspects:

- It is a well-known fact that the acquisition of NIHL occurs mainly in the first 10 to 15 years of exposure;
- For older workers, the evolution of HTLs is mainly related to presbycusis;
- For all workers, the presbycusis factor is much more pronounced for older than for younger workers.

This is well demonstrated in a study done over a 15 years period after the inauguration of a Hearing Conservation Program in 29 mining companies based on 135,363 audiograms performed for 16,977 employees.



*A graphic representation of an audiometric trend according to age groups for 16,977 employees, based on 135,363 audiograms.*

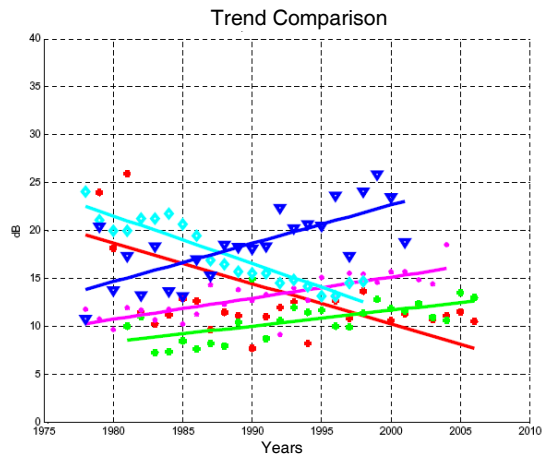
It is interesting to note that with a proactive HCP, as used in the Quebec Mining Association, no employees in the 20 to 30 year age group hired after the program was started had a compensable hearing loss. Compared to the presbycusis predictions of ISO 7029, the average HTLs of this group were at the .46 percentile.

For the youngest age group (20 to 30), who were all hired when the HCP had already been implemented and for the 30 to 40 age group, 50% of whom were hired after implementation of the HCP, there is greater improvement of HTLs as compared to the older age groups. This is a constant finding in a well-maintained HCP.

### **COMPARATIVE EVALUATION**

A trend analysis can be done for a variety of groups based on criteria determined by the industry:

- The entire workforce of a company
- The entire workforce of a company by age groups
- For specifically selected groups of employees in relation to particular criteria, such as:
  - Noise level exposure
  - Workstations
  - Departments
  - Tasks, etc.



*An example of global trends for 5 different companies.  
We note favorable trends for certain  
companies and unfavorable ones for others.*

## **COMPENSATION**

Compensation standards in various jurisdictions vary according to the selection of frequencies as well as the levels at which compensation is awarded.

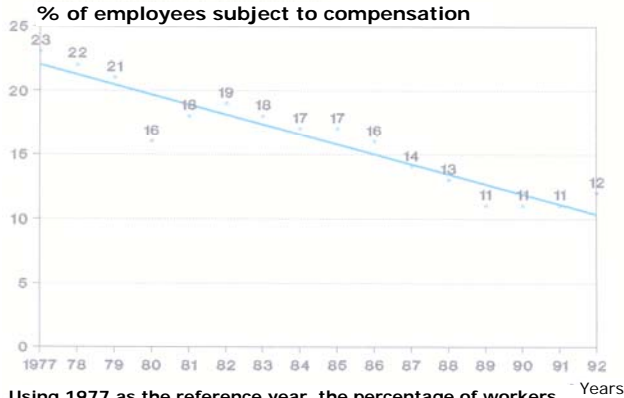
Standards for all jurisdictions in both the United States and Canada have been pre-programmed into the software.

Based on the average HTLs of frequencies used for compensation in a specified jurisdiction, the number of potentially compensable cases can be determined.

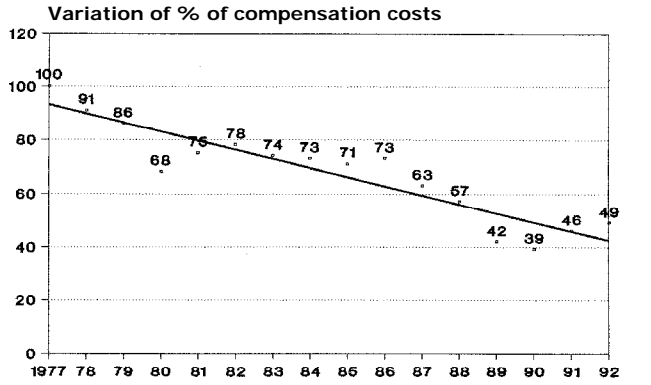
Using a reference date, potential costs, based on HTLs and the number of compensable cases, can also be estimated.

Actual costs can be evaluated if the data is available. For each jurisdiction, we must consider:

1. Standards
2. Amounts awarded
3. Annual variation of costs
4. Special considerations specific to a jurisdiction



Using 1977 as the reference year, the percentage of workers subject to compensation was evaluated using the standards in effect in 1992.



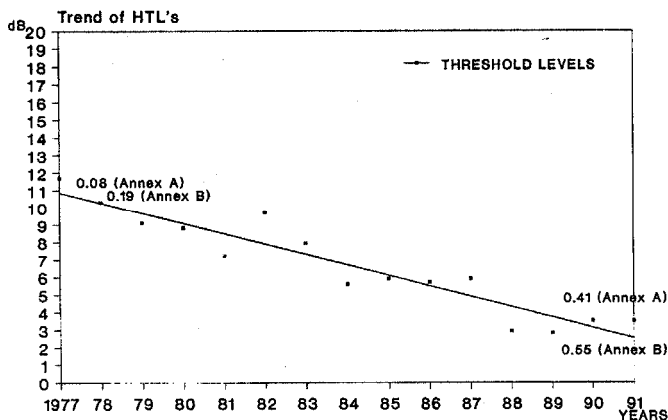
Using 1977 as the reference year, the percentage of compensation costs was evaluated for the period from 1977 to 1992.

### RELATION TO PRESBYCUSIS (MEDIAN HTL ANALYSIS)

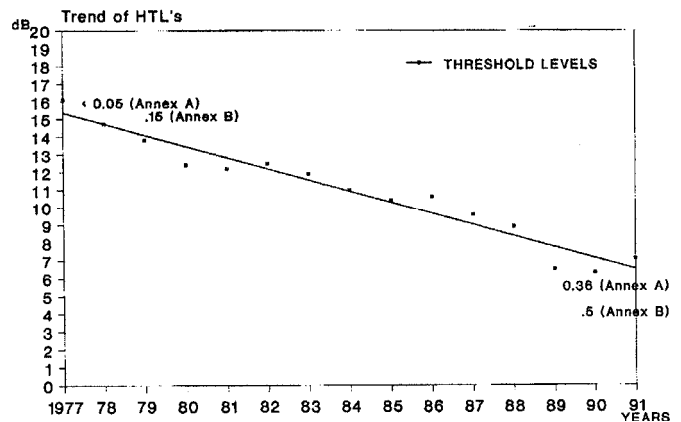
Evolution of HTLs for groups of employees can also be compared to the prediction of hearing loss according to the presbycusis aspect for various age groups.

The aim should be to have average HTLs similar to the prediction of hearing loss according to the presbycusis factor based on ISO 7029 – Annex A (ANSI S3.44-1996 – Annex A and B).

The evolution of HTLs for the 20-30 and 30-40 age groups compared to the evolution of HTLs based on ISO 7029 (ANSI S3.44-1996-Annex A and B).



For the age group 20 to 30, the average hearing loss went from a presbycusis relationship of 0.08 to 0.41 over a 15-year period. This is very close to the optimal goal of 0.5, the median for presbycusis factor.



For the age group of 30 to 40, we must retain the fact that some of the older workers of that group were hired before the inception of the hearing conservative program.

While there is a marked improvement in the 30-40 age groups, it is not as pronounced as that noted for the younger age group of 20-30

years old; group in which groups all the employees were hired after the inception of the hearing conservation program.

In the absence of intrinsic causes, such as pathologies, or extrinsic causes, such as exposure to noise or cranial trauma, normal evolution of HTLs is similar to the predictions of ISO 7029 or Annex A of ANSI S3.44 (1996). The results can also be presented using OSHA's Table F1 and F2 for presbycusis.

The utopian goal for a HCP is to have an evolution of HTLs similar to the median of ISO 7029 predictions for presbycusis.

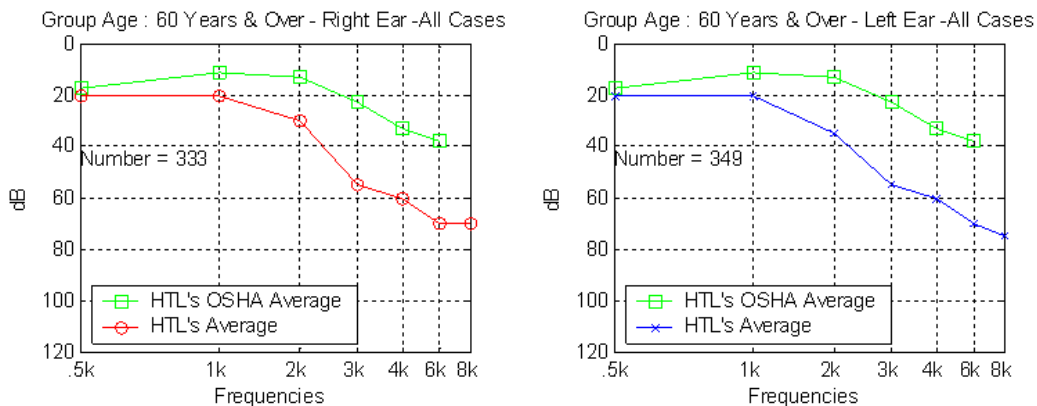
This analysis is made according to age groups separated by 5-year intervals considering the fact that, with age, there is a greater increase of hearing loss in the high frequencies.

The observed HTLs can be compared to the median predictions of HTLs for various age groups.

Two approaches can be used:

1. HTLs median average in relation to ANSI S3.44 Annex A (ISO 7029);
2. Using OSHA's Table F1 and F2 for presbycusis.

Examples for an age group are presented using the OSHA approach.



**Examples using the OSHA F1 and F2 tables.**

We can compare this approach to a trend analysis with various age groups. It is a good indication of how the evolution of subjects' hearing compares, both collectively and individually, to existing predictions.

This approach allows the company to identify subjects in the lower percentile in order to determine the cause of the observed hearing loss and introduce measures to prevent any future loss.

## EVALUATION OF INDIVIDUAL CASES

The overall trend analysis is based on the evaluation of HTLs of either the entire work force or by selected groups, such as age group, workstation, jobs, noise exposure levels, etc.

The question arises: Can we identify the non-performing subject?

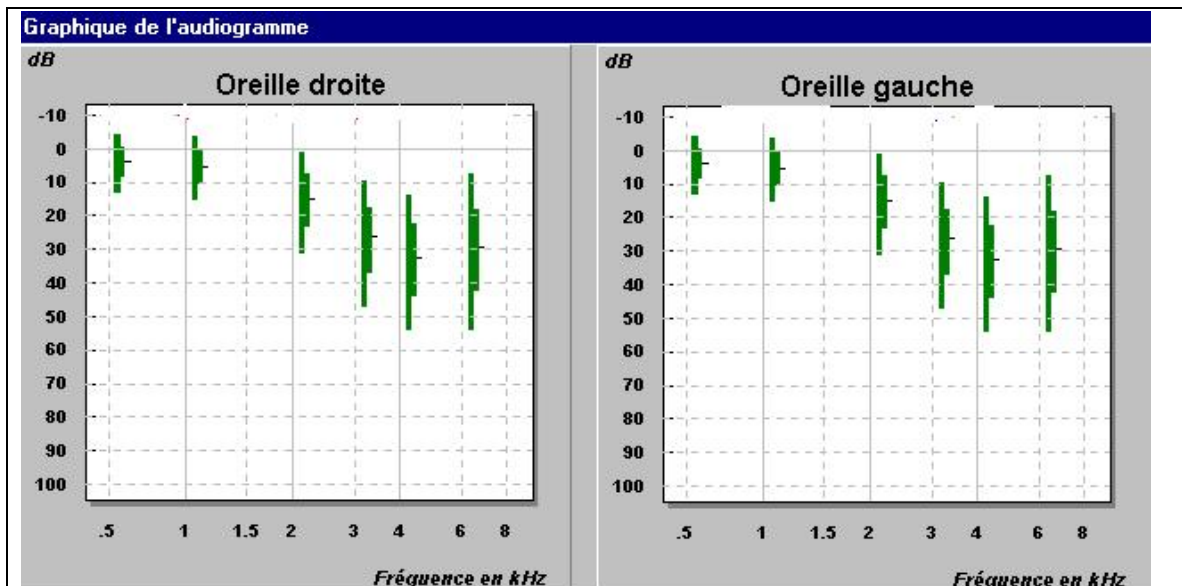
At present, there are no audiometric tests that may allow the evaluation of sensitivity of the effect of noise on hearing.

Indirect methods can be used, such as:

- Relation of HTLs to the prediction of ISO 1999 (1990)-(ANSI S3.44);
- Relation of observed HTLs to presbycusis using either ISO 7029 or OSHA's tables F1 and F2;
- NITTS taking into consideration the use or non-use of HPDs.

## ISO 1999 (1990)/ANSI S3.44(1996) PREDICTIONS

Based on the age, gender, level of exposure and duration of exposure, it is possible to predict using ISO 1999 or the ANSI S3.44 the probable HTLs from a group of employees.



50 year old male exosed to 92 dBA for 30 years.

In this figure, we represent the predictions of HTL's from the .9 to the .1 percentile, that is for the least sensible to the most sensible effect of noise upon hearing. It is to be noted that these predictions are without the use of HPD's.

**Probability of HTL's including exposure and presbycusis**

	.5K	1K	2K	3K	4K	6K	.5-1-2-4K
90%	-4.3	-3.4	1.4	9.8	13.8	7.7	1.9
75%	-0.6	0.6	7.7	17.5	22.7	18.1	7.6
50%	3.6	4.9	14.6	25.8	32.3	29.2	13.9
25%	8.8	10.6	23.7	37.4	44.1	42.7	21.8
10%	13.5	15.6	31.5	47.3	54.1	54.3	28.7
5%	16.3	18.6	36.1	52.9	59.9	60.9	32.7

The same graph can be presented with the following figures and calculations of HTLs according to the standard used in a given jurisdiction. Any combination of frequencies can be used.

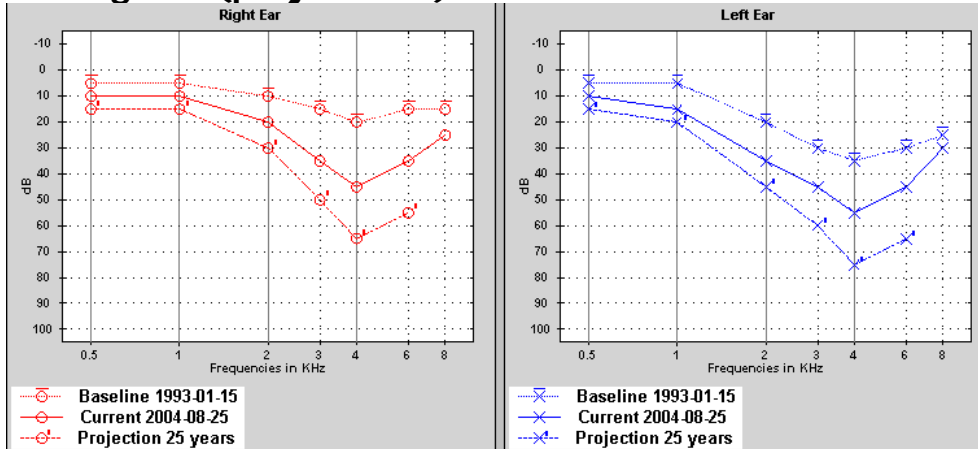
The occupational history should be based on the noise level of exposure of the worker at his workstation and the duration that he has worked at a given workstation.

As a rule, at least since the last 20-25 years, noise levels have been measured on a regular basis and are available for workers in a specific company.

It can however be more difficult to obtain the detail occupational history of noise exposure with previous employers or when, if applicable, he was in the armed forces.

The overall exposure of an employee can be shown using a logarithmic average:

**Audiogram (projections)**



Projection of the HTLs in 25 years based on the baseline to the last audiogram (All rights reserved Corti© software).

## Applications

- This approach allows us to better target subjects for education and training in the adequate use of HPDs.
- The entire work force of a company can be compared with groups of the same age, sex, noise exposure and number of years of exposure. The percentile relationship for each employee to his specific group can be obtained.

Classification	Low	High
H1/P1		15
H2/P2	15	20
H3/P3	20	30
H4/P4	30	

- All the compensation formulas for the US and Canadian jurisdictions have been incorporated in the Corti© software.
- The user may choose the standards in a specific jurisdiction to calculate whether a subject is eligible for evaluation in order to receive compensation.

It is usually not recommended to apply statistical on a single individual. On the other hand, the statistical results are based on analysis of single individual. The recommended approach allows identifying the percentile relation of each individual used for the overall statistical analysis.

It helps to identify problem cases to introduce proper measures to prevent continued worsening of HTLs.

From the ISO 1999 formula<sup>2</sup>, Bertrand and Zeidan developed an approach to estimate the noise levels that would have resulted in the observed HTLs of a subject.

Based on this retrospective analysis of the evolution of HTLs, projections of HTLs at a future date can be determined assuming that the evolution of HTLs continues at the same rate.

## **DISCUSSION**

When we proceeded to the analysis of this database in the year 2000, it became evident that the absence of an adequate HCP resulted in many subjects to an important hearing loss. For the 2 examples shown above, we applied our projections of HTLs approach.

For example, after 10 years of exposure, we would have been able to project the HTLs noted at the last audiogram.

## **RELATION OF HTLS TO PRESBYCUSIS**

For each employee, the relation of his HTLs can be correlated to ISO 7029 or OSHA's tables F1 and F2.

## **NITTS**

This is a pro-active approach that helps identify subject with NITTS. It is used for problem cases such as those subjects in the lower percentiles of ISO 1999.

## **CONCLUSION**

From an administrative aspect, the approach used is an easy to understand, qualitative and quantitative procedure to evaluate the effectiveness of HCPs.

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<sup>2</sup> Bertrand, R.A., Zeidan, J., A new Approach to Evaluate the Effectiveness of a Hearing Conservation Program. 1995 Industrial Hearing Conservation Conference, University of Kentucky, Lexington, Kentucky 40506-0108, April 5-7, 1995.