

## NOISE EXPOSURE SURVEYS - 10 YEARS OF EXPERIENCE

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### ABSTRACT

The procedure for the assessment of "Noise Exposed Worker" as outlined in the Ontario Hydro Corporate Noise Control and Hearing Conservation Program requires that a noise exposure survey be performed following the CSA Standard Z107.56. This paper outlines practical aspects of the survey, resulting from 10 years of experience. It describes steps to be taken starting from the planning aspects, through the actual survey, and the handling of the numerical results.

### RÉSUMÉ

Le processus d'évaluation du "travailleur exposé au bruit" décrit dans le programme d'Ontario Hydro de lutte contre le bruit et de préservation de l'ouïe exige qu'un sondage sur l'exposition au bruit conforme à la norme CSA Z107.56 soit effectué. Le présent article décrit certains aspects pratiques d'un tel sondage, après dix ans d'expérience. Il explique l'étape de planification, le sondage lui-même et l'interprétation des résultats numériques obtenus.

## 1.0 INTRODUCTION

For the last 10 years, noise exposure surveys have been conducted in Ontario Hydro. Results from these surveys are used for hearing conservation purposes and to provide data needed for Workers Compensation Board claims.

As per the Corporate Noise Control and Hearing Conservation Program, Ontario Hydro employees are classified as "Noise Exposed Workers" (NEW), when their average long term noise exposure exceeds 85 dBA. Because of the cost involved, individual noise exposures are rarely determined. Instead, the noise exposure of a trade (defined as a group of employees working in the same noise environment) is calculated using results from measurements performed on statistically significant samples of workers within the trade. The procedure used is the one in the CSA Standard Z107.56<sup>(1)</sup>. The average noise exposure of the group is calculated at the 95% confidence level ( $L_{Trade,95\%}$ ) using the mean value of the sample's noise exposures and their standard deviation. Members of the entire trade are declared NEW when their  $L_{Trade,95\%}$  exceeds 85 dBA.

## 2.0 BASES FOR THE METHOD

### 2.1 Distribution of the samples

It has been shown that statistical distributions of weekly average noise exposures of workers from several trades within Ontario Hydro follow a normal distribution. This could be explained by the fact that:

- a) the theorem of the central tendency predicts normal distribution of the means, and
- b) since the quantity that is measured (sound pressure) is logarithmically related to the units used (sound pressure level, dB), then if pressures are log-normally distributed, the sound pressure levels will be normally distributed. The normal distribution simplifies the statistical treatment of the data and the required calculations. The data that have to be calculated are:
  - a) the average mean noise exposure level ( $L_{Trade}$ ), defined as the arithmetical average of the measurements, and

- b) the standard deviation of the samples.

## 2.2 Variances Within and Between Samples

Analysis of variance was performed on several databases of noise exposure levels of workers from different trades, all collected for four consecutive days. It was found that for most of the databases the variance of noise exposure levels within workers (i.e., between noise exposures of the same worker day after day) are much smaller than variances between workers (i.e., between noise exposures collected from the workers on the same day).

The consequence of the above is that if work is performed approximately in the same way, there is no need for sampling several days in a row: one day is enough, provided that there are no changes in the noise environment.

This statement was also tested, by calculating  $L_{Trade}$  of several trades using data from 1, 2, 3 and 4 consecutive days of sampling and obtaining approximately the same result.

## 3.0 PREPARATION OF THE SURVEY

### 3.1 Planning Meeting

Line management requesting the noise exposure survey are seldom knowledgeable of how it has to be performed. On the other hand, the surveyor needs to know the operations conducted at the site, trades and subtrades involved, nature of the activities that they are performing and the number of workers in each trade/subtrade. This interchange of information is best achieved at a formal meeting involving local line management, Joint Health and Safety committee representative and local safety contacts.

Only a careful preliminary planning work can insure a successful survey.

### 3.2 Determination of the Trades/Subtrades

Easy as it may appear, determining the groups that have to be tested is a difficult task. Questions regarding the existence of subgroups, shifts, supervisors (if they are or are not part of the trade) have to be answered. There is no straight forward procedure that will assist in determining the groups. Consultation with line supervisors and common sense are still the most direct way.

On the other hand it may appear that there are two trades (e.g., day and night shifts). Therefore a sampling strategy will be conducted on that premise. However, at the end of the survey, a student's T-test between the resulting  $L_{Trade}$  may show that there is no statistically significant difference. The two trades are in fact one for the purpose of the noise exposure survey. In that case, results from both tests have to be pooled and  $L_{Trade}$  calculated again to get a single  $L_{Trade}$  number.

## 3.3 Determination of the Sample Size

Two situations may occur when deciding on the number of employees to be sampled:

- i) The Standard deviation of the sample is known from previous measurements, or
- ii) The Standard deviation is unknown.

In the first case, Table B2 from the Standard should be used. It shows the sample size used to determine  $L_{Trade}$  95% for different standard deviations.

If the standard deviation is not known (in the case of a measurement done for the first time), the sample size can be determined using any of the Tables A-1 through A-4 in reference.

Table 1, reproduced from Table A-4, Ref 2, is currently used in Ontario Hydro. In most cases it provides a sample size equal to or larger than that in Table B2 from the Standard and is, therefore, a helpful starting point.

Table 1: Sample Size for Different Populations

	7-8	9-11	12-14	15-18	19-26	27-43	44-50	> 50
Sample Size	6	7	8	9	10	11	12	14

### 3.4 Sampling Duration

The duration of the sampling depends of the activities performed in the workplace. As mentioned in 2.2, one-day sampling should provide sufficient data.

However, a two-day survey allows the surveyor to ensure the reliability of the test results. For the same reason, surveys done for the first time should not be performed less than two, and preferably three days.

## 4.0 PERFORMING THE SURVEY

### 4.1 Data Required

Before starting the survey, the following data should be collected:

- a) Names of the trades to be surveyed
- b) Number of workers in each trade (population size)
- c) Number of workers in each trade to be tested (sample size)
- d) Names of the workers to be tested. They should be volunteers, selected on a random basis.

### 4.2 Presurvey Meeting

Before starting the survey, workers from the sample should be assembled for an informal meeting. Detailed explanation of the objectives of the survey should then be provided. The workers should also be shown the dosimeters and explained how they operate to avoid misunderstandings and suspicions that the device is a tape recorder to spy on them.

At the same meeting, the details of the survey are explained, and the forms that they have to filled are shown.

### 4.3 The Survey

The daily routine starts with the calibration and the checking of the dosimeters' batteries, performed by the technician in charge.

Then, the portion of the Noise Exposure Survey form (Figure 1) regarding time "on", # of the dosimeter and the name of the worker are filled in. Dosimeters are then given to each worker, with the microphone, pointing up, attached to the collar, and the cables secured to avoid any safety hazard.

Workers are instructed that the dosimeter should be worn all the time, including the lunch time. They are then sent off to their duties.

During the day, the technician in charge of the survey, follows the workers taking notes of the tasks performed by the workers and of the ambient noise levels.

### 4.4 At the End of the Day

At the end of the day/measuring period workers return with their dosimeters. They are required to fill out the Activity form, that contains details of the tasks they were performing during the day.

Dosimeters are checked for changes in the calibration and for the state of their batteries, prior to taking the reading of the  $L_{eq}$ .

The ambient noise level measurements and the activity information is used to validate the noise exposure results (the individuals'  $L_{eq}$ ): this is the only way of ensuring that there was no foul play with the dosimeters.

## 5.0 DATA MANIPULATION

The CSA Z107.56 Standard provides all the formulas needed for the calculation of  $L_{Trade(95\%)}$ .

As per the Standard, the first step is to calculate the mean noise exposure and the standard deviation of the sample.

Then, the sample size has to be validated using the data from Table B.2 from the Standard. If the number of data gathered are sufficient, then the next step is to calculate  $L_{Trade}(95\%)$ .

The resulting average noise exposure of the trade at the 95% confidence level is the one to be used for the classification of the trade as "noise exposed" and also to provide the noise exposure level requested by the Workers Compensation Board (WCB).

**References**

1. CSA-Z107.56-M86 "Procedures for the Measurement of Occupational Noise Exposure". Canadian Standards Association, 1986.
2. Technical Appendix A (Calculation of Sample Size for a Maximum Risk Subgroup from a Homogeneous High Risk Subgroup) - Leidel et Al: Occupational Exposure Sampling Strategy Manual, NIOSH, 1977.

FIGURE 1

**DAILY ACTIVITY SHEET**

(thank you for your cooperation)

NAME: \_\_\_\_\_

DOSIMETER NO.: \_\_\_\_\_

TRADE: \_\_\_\_\_

DATE: \_\_\_\_\_

Time Period	Location/Elevation	Work Activity (e.g., grinding, walking, steam leaks, noisy sources)
I-Shift Start--Coffee Break		
II-Coffee--Lunch		
III-Lunch--Coffee		
IV-Coffee--Shift End		

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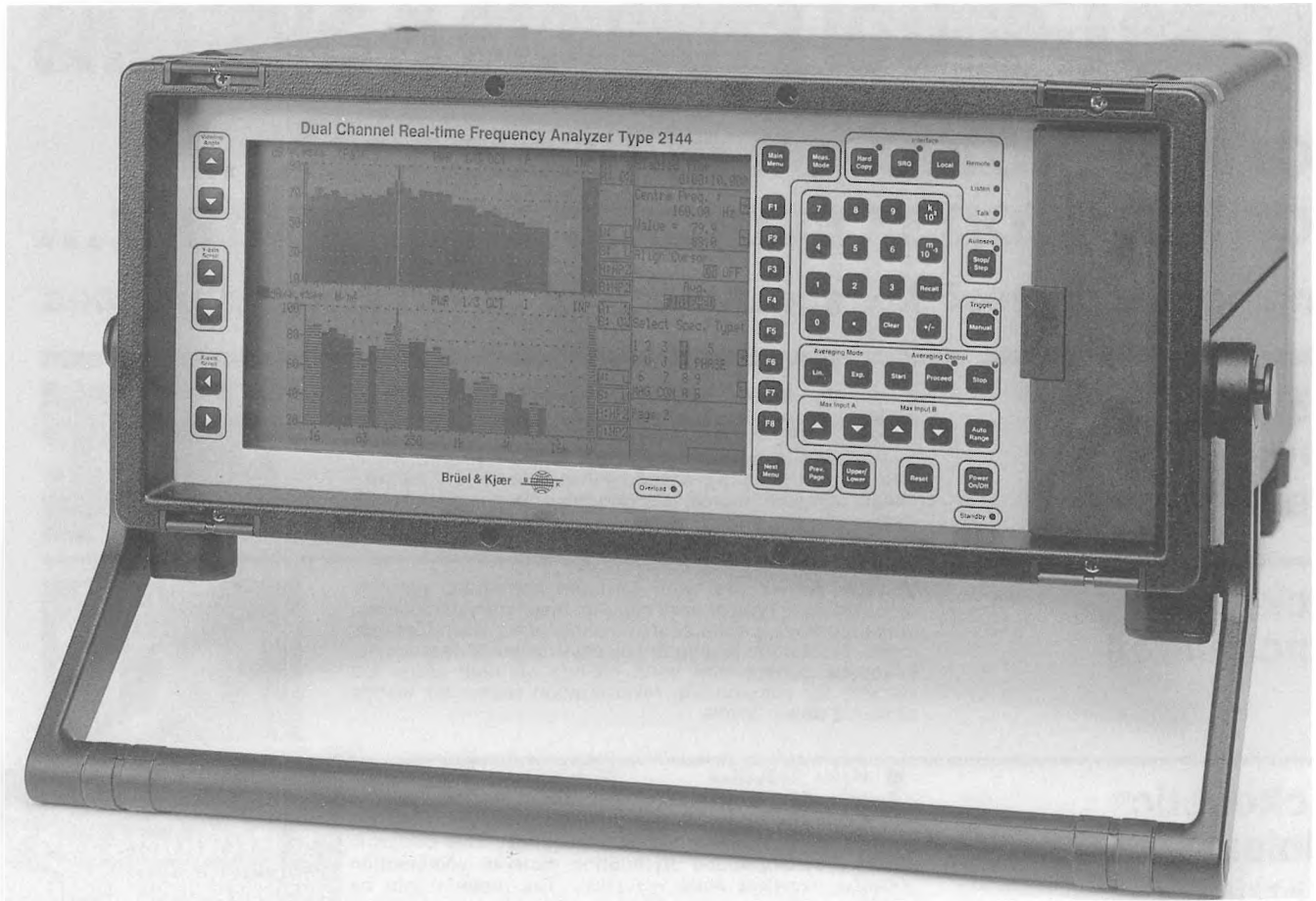
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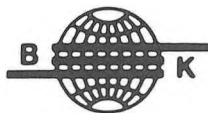
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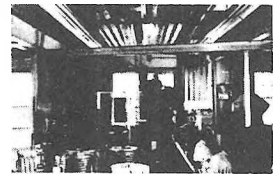
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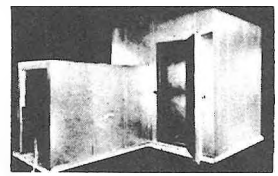
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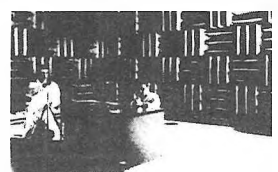
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