Noise Exposure Group Surveys - Number Of Days To Sample

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ABSTRACT

A study to determine the number of noise exposure measurements days required to be performed on a group of workers, so as to obtain reliable results was conducted. In all 13 groups from two different sites were involved, with sample sizes ranging from 3 to 24 employees (average 12.5). Surveys were performed for four consecutive days. The reports from the surveys included the results from each one of the four days of testing ($L_{Trade,8}$) and of the corresponding $L_{Trade,32}$. The daily $L_{Trade,8}$ were compared with the corresponding $L_{Trade,32}$ using the Student's t-Test. Results show that for the samples being tested, there were no significant differences in 88.5% of the cases. It was concluded that one day of testing is probably sufficient. However, because of the difficulty in determining a "typical" day, it is recommended that testing be performed for two days.

SOMMAIRE

Cette étude a été conduite afin de determiner combien de jours sont nécessaires pour obtenir des résultats fiables lors de la mesure à l'exposition au bruit d'un groupe de travailleurs. En tout, 13 groupes provenant de deux différents sites ont été étudiés. L'échantillonnage variait entre trois et 24 employés avec une moyenne de 12.5 employés. On a mesuré l'exposition au bruit pendant quatre jours consécutifs. Le rapport inclus les résultats quotidiens obtenus ($L_{Trade,8}$) et le $L_{Trade,32}$ correspondant, en utilisant le Student's t-Test. Les résultats obtenus avec l'échantillonnage testé ont démontré qu'il n'existait pas de différences significatives dans 88,5% des cas. On a donc conclu qu'une journée de test est suffisant. Par contre, puisqu'il est difficile d'identifier une « journée-type », il est recommandé d'effectuer des mesures pendant deux jours.

1. INTRODUCTION

The CSA Z107.56-94 Standard: "Procedures for the Measurement of Occupational Noise Exposure" (1) provides all the information needed for measuring and calculating the occupational noise exposure level $L_{eq,T}$ of employees exposed to potentially harmful noise levels. A new edition of the standard was to have been released in 2004. From the $L_{eq,T}$ the normalized $L_{Ex,T}$ can also be calculated. The main body of the Standard deals with testing on individuals. However, there are situations, where many employees work in the same acoustical environment and the measurement of each individual's noise exposure may not be economical, or feasible. In such cases, recourse may be made to determining the exposure of employees in a group.

A group is defined as employees who work in similar acoustical environments and are assumed to experience similar noise exposures. The number of employees to be tested (sample size, **n**) depends on the total number of employees in the group (population size, **N**), the standard deviation of the measurement results and on the desired precision of the results.

Appendix B "Noise Exposure of Groups" provides procedures to be followed to determine L_{Trade}, the arithmetic noise exposure level of the group, for the prescribed time period T. The procedure of Appendix B allow for determination of whether the group is over-exposed or not, using the results of daily noise exposures $L_{Ex,T}$. An individual is defined as overexposed when his $L_{Ex,8} > 85$ dBA. The calculation is done taking into account the required precision.

Specifically, the following is determined:

a) sample size, for a given precision
b) $L_{Trade,}$ and
c) Precision of the calculated L_{Trade}

Five tables in the Appendix B of the Standard show the sample number **n** for a given situation. For example, for a precision of +/- 2, a standard deviation of 8 and a population of 50, the number of employees to be tested will be 24. For the same **N** = 50, a precision of +/- 6 and a standard deviation of 2, this number (**n**) drops to only 3.

No specification on the required number of samples for each individual (for how many days should he be tested) are contained in the Standard, nor for how long (how many hours) the samples should be taken.

This paper describes a study performed in the former Ontario Hydro several years ago. It was designed to determine the required number of days the noise exposures should be tested, so as to obtain reliable results. Noise exposure surveys were performed for a week, (5 consecutive days), for a whole-shift noise exposure (L_{eq40}). Later on, a study was done to find if L_{eq32} (4 days average) survey is as representative as the

L_{eq40}. For that purpose, the Student t-test was applied to L_{eq40} and L_{eq32} calculated from results from several noise exposure surveys. No statistically significant differences were found between both results. Consequently, it was decided that surveys should be performed for four consecutive days and the resulting L_{eq32} should be used to calculate the L_{Trade}.

After several years of practice, a question was raised, if one-day exposure (L_{eq8}) could be used for the same purpose. If that proved to be true, the length and the cost of a noise exposure survey would be greatly reduced. To test this hypothesis, results from several noise exposure surveys were analyzed. This paper presents the results and conclusions from the study.

2. MATERIALS AND METHOD

Results from two noise exposure surveys were used for this study. They were performed at a large construction site (during the construction of Darlington Nuclear Generation Plant) and at an existing large nuclear plant (Bruce "A"). All together, 13 groups were involved, with sample sizes ranging from 3 to 24 employees (average 12.5). Surveys were performed for 4 consecutive days. The reports from the surveys included the results from each one of the 4 days (the $L_{Trade,8}$) of testing and of the corresponding $L_{Trade,32}$.

The L_{Trade} for each of the four days was calculated, as the average of the L_{eq8} of the members of the sample population. Therefore, there were four L_{Trade} calculated one for each day and one $L_{Trade,\ 32}$ calculated over the four days. All L_{Trade} were calculated at the 95 Upper Confidence Level.

The method used here, consisted of testing the significance of differences between the $L_{Trade,\ 32}$ (L_{Trade} calculated over the four days) with each of the four the $L_{Trade'8}$ (L_{Trade} calculated from only one day) for each trade. The significance was tested using the Students t-test.

If the outcome of the study showed that the differences were statistically not significant, then one-day testing will be equivalent to that of a complete week and the four-days testing will be replaced by only one-day of testing.

3. RESULTS

Tables 1 and 2 (Darlington and Bruce "A", respectively) contain details from the surveyed groups as well of the results.

The first column in each table lists the names of the groups (trades) being tested. The next contains the sample sizes of the group that was tested during each of the four days.

Following are the results for each of the four days of

TABLE 1
RESULTS FROM DARLINGTON NGS CONSTRUCTION

TRADE	NUMBER TESTED		DAY1	DAY 2	DAY 3	DAY 4	4-DAY AVERAGE
Electrician	14	LTrade	87.0	86.8	86.4	84.4	88.2
		Std Dev	7.9	4.2	7.8	4.7	6.3
		UCL95%	90.8	88.8	90.4	87.2	91.1
		Signif	N	N	N	N	
Boiler-makers	14	LTrade	90.0	88.5	88.1	88.5	89.9
		Std Dev	5.9	5.0	7.3	6.6	6.0
		UCL95%	92.9	91.1	91.7	91.7	92.6
		Signif	N	N	N	N	
Painters	14	LTrade	91.3	90.2	90.8	92.6	91.9
		Std Dev	7.0	9.9	6.3	7.6	7.3
		UCL95%	95.0	95.9	89.7	91.9	94.9
		Signif	N	N	N	N	
Pipefitters	13	LTrade	91.3	90.2	90.2	92.6	91.9
		Std Dev	3.8	5.2	4.5	4.2	3.6
		UCL95%	93.1	92.9	93.0	94.7	93.6
		Signif	N	N	N	N	
Mech.Instrum.	14	LTrade	83.4	86.0	86.5	86.4	86.7
		Std Dev	2.7	3.3	3.2	4.2	1.9
		UCL95%	84.7	87.6	88.0	88.4	87.7
		Signif	Y	N	N	N	
Pre Fab Shop	5	LTrade	90.1	89.3	88.6	89.0	89.4
		Std Dev	4.8	3.7	2.9	2.5	3.3
		UCL95%	92.9	89.3	88.6	89.0	89.4
		Signif	N	N	N	N	

TABLE 2
RESULTS FROM BRUCE NGS-A

TRADE	NUMBER TESTED		DAY1	DAY 2	DAY 3	DAY 4	4-DAY AVERAGE
Control Maintenance	20	LTrade	83.2	83.1	83.2	80.6	84.2
		Std Dev	6.8	5.1	5.8	5.1	4.8
		UCL95%	85.7	85.1	85.4	82.4	86.0
		Signif	N	N	N	Y	
Mechanical Maintenance	24	LTrade	86.7	88.5	87.2	89.4	89.0
		Std Dev	4.8	5.1	3.8	5.4	4.1
		UCL95%	88.2	90.1	88.4	91.6	90.4
		Signif	N	N	N	N	
Building Mechanics	8	LTrade	85.6	87.9	87.4	89.5	87.9
		Std Dev	4.6	2.8	4.2	5.9	3.2
		UCL95%	87.6	89.1	89.5	95.4	90.0
		Signif	N	N	N	Y	
Service Maintenance	6	LTrade	88.1	89.1	86.3	88.0	88.5
		Std Dev	4.8	6.0	2.6	4.3	4.4
		UCL95%	90.5	92.1	87.6	90.8	92.1
		Signif	N	N	N	N	
Chemical Technician	3	LTrade	86.3	82.0	84.1	86.4	86.5
		Std Dev	5.1	1.7	9.4	2.6	1.3
		UCL95%	86.3	82.0	84.1	86.5	87.7
		Signif	Y	Y	N	N	
Assistant Operator and 2nd Operator	14	LTrade	85.8	84.9	87.3	88.5	88.6
		Std Dev	8.2	6.8	5.8	4.5	4.3
		UCL95%	89.6	88.1	90.1	90.6	90.6
		Signif	N	N	N	N	
Handyperson	14	LTrade	86.4	85.4	85.9	84.1	87.0
		Std Dev	2.9	3.5	8.6	3.3	6.5
		UCL95%	87.6	86.9	89.5	85.8	90.1
		Signif	N	N	N	Y	

testing (DAY 1, 2, 3, 4) and for the 4 days average. For each trade, the tables shows the calculated $L_{Trade,8}$, the Standard Deviation ("Std Dev"), the 95% Upper Confidence Level of L_{Trade} ("UCL95") and the result from the Students t-Test ("Signif") as "Y" (yes) or "N" (not). All data were calculated using all $L_{eq,8}$ for each one of the 4 days of testing. The $L_{Trade,32}$ (4-DAY AVERAGE) was obtained as the arithmetic average of the four $L_{Trade,8}$. The significance of the difference between a given $L_{Trade,8}$ and the $L_{trade,32\ as}$ was tested using the UCL95 of the corresponding $L_{Trade.}$

4. DISCUSSION

Using a limited measurement time duration (one day or one week) to assess yearly exposures level implies the following assumptions:

a) Noise levels workers are exposed to are more or less steady, and
b) They do not change significantly over the year.

This, of course, is an assumption very difficult to prove. However, on the other hand, to prove it one way or other is a very costly and practically impossible task to be performed. Consequently, a successful noise exposure survey requires a great deal of common sense and knowledge of the tasks performed by the workers, provided in general by workers supervisors. In essence, surveys should be performed in representative working conditions. This may require more than one day of testing, to assure that the day was really "typical."

One limiting factor in this study is that it was performed for trades from only two activities: electrical generation and construction. A follow-up study using different workgroups will be extremely useful to confirm or reject the hypothesis.

Results from Darlington indicate that with one exception (Mechanical Instrumentation, Day 1) there is no statistically significant difference between L_{Trade} calculated using daily and weekly averages. (Rate of success 96%).

This was not the case in Bruce "A", where the rate of success was 86%, with statistically significant differences in the case of Control Maintenance, Day 4; Building Mechanics,

Day 4; Chemical Technician, Day 2; and Handyperson, Day 4). No satisfactory explanation was found for the above discrepancies.

5. CONCLUSIONS

No statistically significant differences were found between L_{Trade} calculated using one day and four days calculations in 96 % of the cases in Darlington and 86 % in Bruce "A". Therefore, it appears that there is no additional benefit in testing for 4 days, instead of one.

However, testing for two days, may allow for a control of how representative a "typical" day is, especially, when the survey is done on a trade that has not been previously tested.

ACKNOWLEDGMENTS

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REFERENCES:

1) CSA Z107.56-94 Standard: "Procedures for the Measurement of Occupational Noise Exposure", Canadian Standard Association, 1994.

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