LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND

ISSN 0111-6711

REPORT

Vol. 16 No. 12 1991

EFFECTIVENESS OF HEARING PROTECTORS OVERTIME

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ABSTRACT

A study measuring the ability of new Peltor Grade 4 helmet mounted earmuffs to reduce the noise levels reaching the wearers' ears was undertaken over a one year period. The objective was to establish effective replacement guidelines for earmuffs.

The results showed that the earmuffs provided effective hearing protection for the operator. There were no statistically significant changes in field attenuation levels during the first nine months. While the following three month period did experience a significant decrease, mean inner ear noise level measured at the twelve month stage was 78.8 dB(A). This level is well under the damage risk criterion of 85 dB(A) over an eight hour day. It was noted during this study though, that operators would normally have replaced the cushions by this stage due to cushion deterioration.

Results suggest that Peltor grade 4 helmet mounted earmuffs used for this trial can be safely used for a maximum period of twelve months before cushion replacement.

INTRODUCTION

Studies have been undertaken which looked at the effects of excessive noise levels within the logging industry and how these could be reduced with the aid of hearing protection devices (HPD's) such as earmuffs (Davis,1978; Lloyd,1986; McFarland,1989a). While many of these studies recorded hearing damage levels to workers and the causes of damage, none of these studies have looked at the rate at which an earmuffs effectiveness decreases over time.

The measure of effectiveness is expressed in terms of attenuation and is measured in decibels dB(A). Attenuation is the difference between the outside noise level and the noise level recorded inside the earmuff.

LIRO undertook a study in August 1990 to look at the effectiveness of 15 sets of Peltor Grade 4 helmet mounted earmuffs. Each set was issued to a full time logger and used continually in his normal working environment for twelve months. The earmuffs attenuation levels were measured on the day of issue and subsequently at three monthly intervals throughout the year.

The aim of this study was to record the rate of earmuff deterioration so that effective guidelines on earmuff replacement could be formulated.

ACKNOWLEDGEMENTS

LIRO gratefully acknowledges the Accident Compensation Corporation for assisting with funding for this project, CHH Forests Limited staff, contractors Phil Hansen, Grant Ashby, Graham McCardle, Colin Sunnex and their crews.

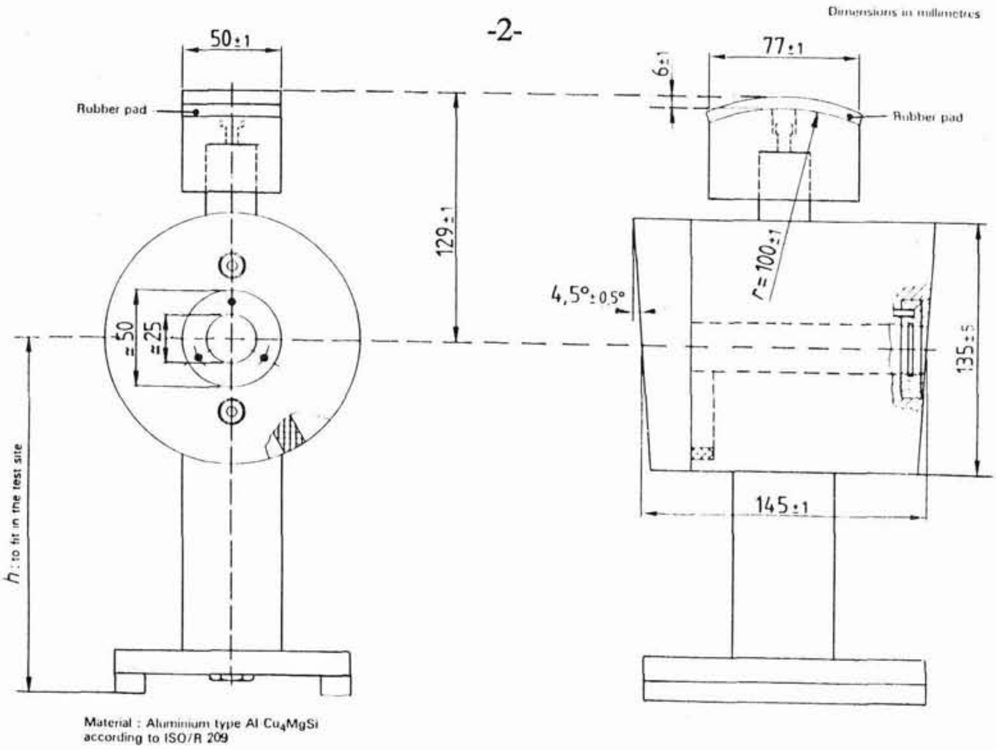

Figure 1 - Acoustic Test Heads

DAMAGE RISK CRITERION

The damage risk criterion relevant to this study is that the worker's daily exposure should not exceed 85 dB(A) for eight continuous hours. This risk criterion is based upon information gathered from related studies (Lloyd,1986; McFarland,1989b). In both these studies it was stated that noise induced hearing loss (NIHL) will occur if there is a continuous exposure over an eight hour day to a noise level in excess of 85 dB(A).

PROCEDURE

Fifteen loggers working in Woodhill, Riverhead, Topuni and Mangawhai Forests of Northland were selected for this study. All were full time loggers and had a stable work history. These areas were chosen because of their close proximity to the testing laboratory in Auckland.

Each operator was issued with a new helmet equipped with Peltor Protection (Grade 4) earmuffs. Grade 4 earmuffs are the highest protection grade helmet mounted earmuff currently available on the New Zealand market.

Two methods were used to measure hearing protector attenuation:

- Laboratory testing was carried out using an artificial head in accordance with British Standard 6344: Part 1 (1984) (Figure 1). The pairs of earmuffs were taken from the operators in the field every three months to the laboratory for testing. Once testing was completed, the helmets and earmuffs were returned to their specific wearers in the field.

- Field testing was carried out on each earmuff by measuring and comparing noise levels recorded by two microphones; one microphone was located inside and the other outside the earmuff, while the logger operated a chainsaw for approximately 15 minutes (Figure 2). This procedure was repeated on the same operator, wearing the same pair of earmuffs, every three months.

DATA ANALYSIS

Laboratory

The data analysis from laboratory test results was analysed in two ways.

Firstly, a mean attenuation level was obtained by averaging the attenuation levels for each set over a range of increasing octave frequencies. This gave a mean attenuation level for each individual pair of

Figure 2 - Field Testing Equipment

earmuffs (set) which was used as a comparison against the field test results.

Secondly, the sets were grouped together and a mean attenuation level gained for the sets as a whole, over the same frequency range as before. This form of analysis gave an overall measure of attenuation for the sets which could be compared after each test for signs of any significant changes.

Field

The field data analysis consisted of measuring each set's attenuation level then subtracting it from the previous test result. This gave the degree of attenuation change that had occurred within the three month period. Any significant fluctuations were examined to see if there were any obvious external explanations (i.e. long hair/glasses/bad fit) and this was recorded accordingly.

The inside microphone reading for each set was recorded to gauge what level of noise reached the ear through the earmuff. Besides being an essential element in the attenuation calculation, this measurement enabled a quick check to see if the earmuff was operating effectively.

RESULTS

Laboratory Testing

The initial laboratory testing revealed that the 15 sets of earmuffs selected for the trial

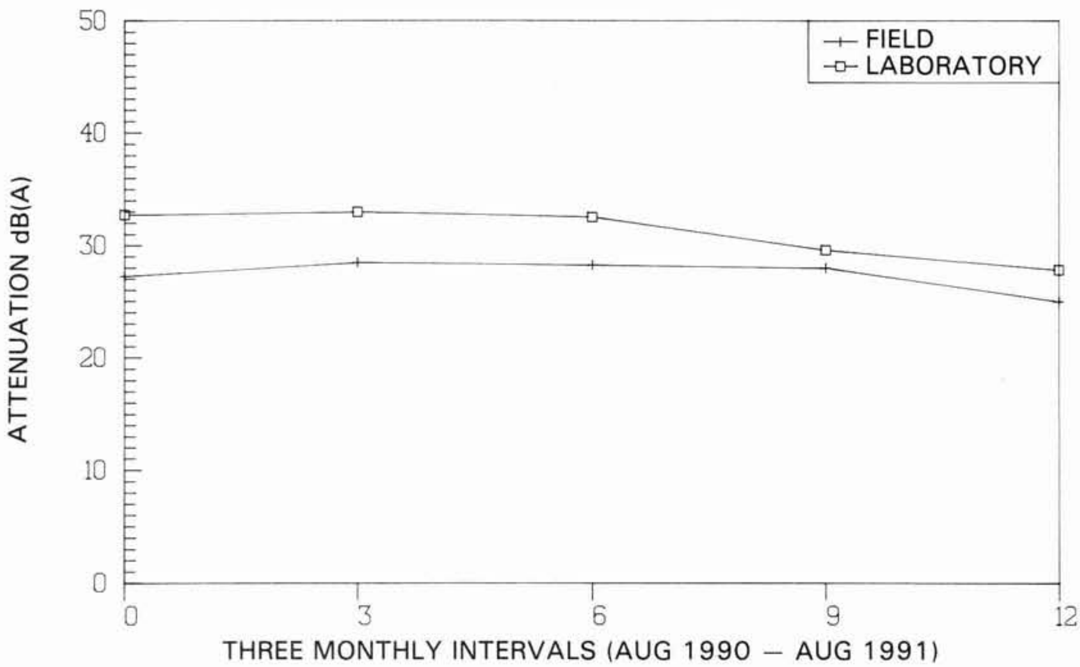

Figure 3 - Mean HPD Attenuation Levels

were very uniform. They had a mean attenuation of 32.7 dB(A) and a low standard deviation 0.4 dB(A) indicating little variation among the sets.

There was no significant decrease in attenuation levels for the 0 to 6 month period. The third three month period did however experience a significant 2.9 dB(A) decrease at the 95% confidence level, reducing the mean attenuation level to 29.6 $\pm$ 2.4 dB(A) (Figure 3).

This decrease after 6 - 9 months in the laboratory test was the result of a change in the interaction between the artificial test head and the earmuff cushions. Having hard flush metal surfaces, the test head did not effectively seal the individual indents that had formed in many earmuff cushions. This enabled sound waves to enter through these gaps and adversely effect the test results.

Several of the cushions' vinyl covers had perished and split (Figure 4). This seriously reduced their ability to effectively seal against the artificial head.

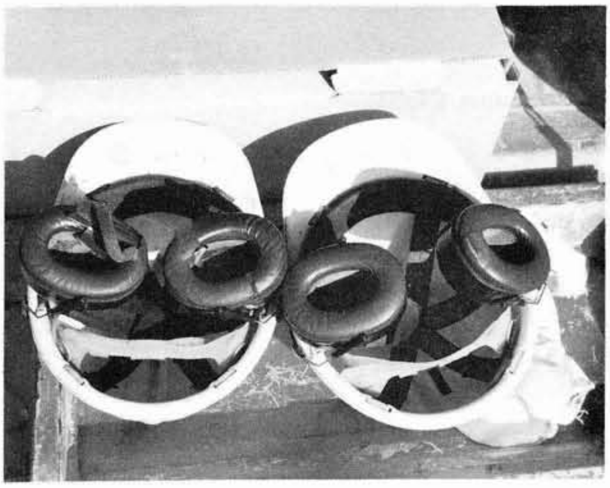

Figure 4 - Earmuff Cushion at Nine Months

The final three month period (9 - 12 months) also experienced a further decrease in mean attenuation levels. This decrease was found not to be statistically significant from the previous laboratory results. However, analysis of the results for the full 12 month period showed a significant 5.0 dB(A) decrease. Laboratory attenuation levels had decreased from 32.7 $\pm$ 0.4 dB(A) to 27.8 $\pm$ 4.8 dB(A) over the one year trial.

Field Testing

The field testing overcame the problems of the laboratory tests, giving a better representation of the true performance of the HPD's in the field.

Since each set of earmuffs were user specific, the cushion indentations matched the operators features when worn in the field. This provided a much more effective seal against noise than in the laboratory tests. Also the field testing took place while the operator was performing his normal job. Therefore the noise levels recorded inside and outside the earmuff were what would normally be experienced during an eight hour working day.

Field attenuation levels showed no statistically significant decrease for the first nine months, remaining around 28 $\pm$ 3.0 dB(A). Field attenuation actually increased by 1.2 dB(A) from test 1 (new) to test 2 (3 months), due to the earmuff cushions moulding to the operator's head. This resulted in a more secure seal which in turn increased the earmuffs' effectiveness.

While the final three month period did experience a statistically significant 3.0 dB(A) decrease in attenuation at the 95% confidence level, mean inner ear noise level measured at the twelve month stage was 78.9 $\pm$ 3.0 dB(A) (Figure 5).

This level is 6.1 dB(A) below the damage risk criterion of 85 dB(A) over an eight hour period relevant to this study. Considering that an earmuff's protective rating spans a range of 6 dB(A), this is an important result.

A Student's t-Test comparison between field test 1 (new) and test 5 (12 months old) shows no significant decrease in field attenuation. Mean field test attenuation had only fallen 2.3 dB(A) in total over the twelve month period.

Further analysis of the results showed that laboratory testing alone could not be used as a guide for earmuff replacement.

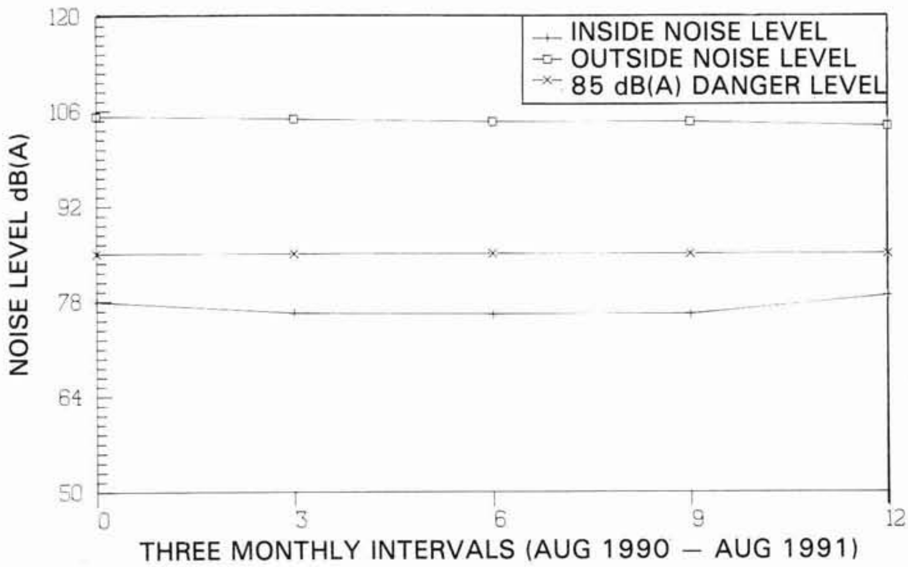

Figure 5 - Mean HPD Noise Levels

A simple correlation showed little relationship between the field and laboratory results, with a coefficient of 0.34.

DISCUSSION

It was apparent that relatively few operators were aware of earmuff hygiene kits. These kits contain a set of new cushion seals that can be easily fitted to the earmuff cups once the old cushions have been removed. The cost of these kits is approximately $20.00 and one kit contains cushions for both cups. As the condition of the cushions plays a very key role in maintaining effective levels of protection, the use of these kits should be encouraged.

Rough and/or careless handling does reduce the effective lifespan of the earmuff by as much as six months.

Earmuffs should not be swapped around between operators as the cushions become very operator specific. If swapped with another operator, the earmuffs effectiveness is significantly reduced.

Long and/or bushy hair can dramatically reduce the earmuff cushion's ability to achieve an effective seal with the operators head. This inability to seal makes the earmuff virtually useless in terms of providing effective hearing protection. Simply moving the hair out of the way when positioning the earmuff can greatly enhance the earmuff's effectiveness.

Outside chainsaw noise levels experienced no statistically significant changes throughout the one year test period, remaining between 103dB(A) and 104 dB(A).

CONCLUSIONS

Inner ear noise levels experienced no statistically significant increases during the one year test period, increasing from 76 dB(A) to 78 dB(A).

Field testing gave a more accurate representation of the earmuff's effective noise protection. Laboratory testing alone cannot be used to measure the true level of an earmuff's effectiveness.

A comparative test between the first and last field tests showed no significant decrease in attenuation for the twelve month period. The reason being that field attenuation actually increased over the first three month period as the earmuffs became moulded to the operator's head.

The earmuff cushion condition is a key earmuff component in maintaining effective levels of noise protection. Rough and/or careless handling does reduce the effective lifespan of the earmuff by as much as six months.

The results show that over the twelve month period the earmuffs provided effective protection for the operator. There were no statistically significant changes in field attenuation levels for the 0 to 9 month period. While the following three month period did experience a significant 3 dB(A) decrease at the 95% confidence level, mean inner ear noise level measured at the twelve month stage was 78.8 dB(A). This level is well within the damage risk criterion of 85 dB(A) over an eight hour period relevant to this study.

While the results of this trial cannot be applied to all earmuff brands currently available on the New Zealand market, study results suggest that Peltor Grade 4 helmet mounted earmuffs can in most cases be safely used for a maximum period of twelve months before cushion replacement.

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