Proceedings of The Institute of Acoustics

# 'ANNOYANCE DUE TO IMPULSE NOISE'

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## INTRODUCTION

A joint laboratory study of reported annoyance to impulsive sound compared with traffic noise was initiated and partially funded by the Commission of the European Communities, Directorate-General for Research, Science and Education, under the Environment and Raw Materials Research Programme. Four laboratories took part (ISVR, Southampton University, England; The Acoustic Laboratory, Technical University of Denmark at Lyngby; Institute for Perception TNO, Soesterberg, Netherlands; and Institut fur Larmschutz, Dusseldorf, Germany). The study was carried out in accordance with a protocol devised by team leaders at a series of meetings of the Directorate-General for Research, Science and Education of the CEC. Each laboratory has prepared its own reports on the study; this paper presents a combined analysis of the results.

## MATERIALS AND METHODS

Four master tape recordings were prepared and identical copies distributed to each of the participating laboratories. The tapes were, with their designation and original source: Gunfire (G) - Soesterberg; Pile driving (P) - Lyngby; Synthetic impulses (S) - Soesterberg; and for comparison purposes, Traffic (T)- Southampton. Each of these noises was presented for five minute periods at four different $L_{Aeq}$ levels (49, 56, 63 and 70 dB) to sixteen subjects in each of the four participating laboratories according to a pre-determined experimental design sequence. Normally hearing (< 15 dB re ISO R389 from 250 Hz - 8000 Hz) male subjects between 20 and 30 years of age listened to the sounds presented through loudspeakers one at a time, whilst seated in a simulated indoor listening environment. Subjects were briefed on their role in the study and asked to record their reactions to the noises on specially prepared response sheets. The complete test procedure, including a hearing test at the beginning and a coffee break halfway through, took approximately 2 hours for each subject.

## RESULTS

In the analyses a fixed effects model for laboratories and subjects has been used, principally because neither factor can be regarded as a random sample. Differences between sounds and levels are therefore compared with the overall estimate of error provided by the residual mean square.

It should also be borne in mind that the impulse sounds were chosen as satisfying the CEC criterion for the detection of noise of an impulsive character, in that the difference between the impulsive and root mean square values in time of the sound pressure levels measured with an appropriate sound level meter is greater than or equal to 4 dB. The impulse sounds measured in the laboratory situation produced differences in the range 6-10 dB, whereas for the traffic noise differences were 2-3 dB.

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## SUMMARY OF FINDINGS

Although laboratories judged the individual sounds differently (Figures 1-4), on average the impulse and traffic sounds were significantly different from each other.

The relationships between $L_{Aeq}$ and reported annoyance were best represented by linear relationships.

The most important difference between annoyance ratings of the three impulse and the traffic sounds is expressed in the slopes of the regression lines relating $L_{Aeq}$ and reported annoyance.

The results obtained by each laboratory were not of comparable precision. TNO subjects were less able to discriminate between the various sounds. A detailed analysis of the combined results of three laboratories (Dusseldorf, ISVR and Lyngby) showed similar results (Figure 5).

The sounds fall into three groups. The impulse sounds having the same slope, with the synthetic sound (S) being significantly more annoying than the gunfire (G) and pile-driving (P), and the traffic noise which is less annoying but with steeper slope (Figure 5).

Inclusion of the data from TNO does not materially change these findings.

At the higher indoor $L_{Aeq}$ levels impulse and traffic sounds are equally annoying, whereas annoyance decreases more rapidly with decreasing $L_{Aeq}$ for traffic than for impulsive sounds (Figures 5 and 6).

The value of the correction for the increased annoyance due to impulse sounds most appropriate to these data would be level dependent, and vary between 0 for an indoor level of 65 $L_{Aeq}$ to about 10 for a level of 40 $L_{Aeq}$ (Figure 7).

Comparison of the 'very much' annoyed data with the 'highly' annoyed data obtained by Schultz in his synthesis of social surveys, showed that the home projection showed close correspondence (Figure 6).

## CONCLUSIONS

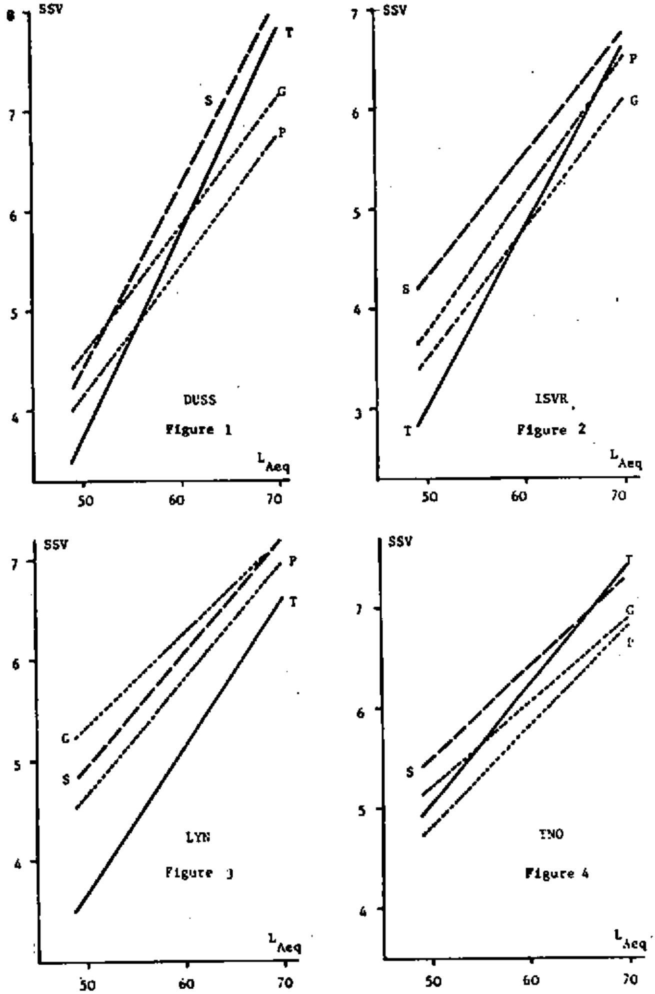
The techniques used in this pilot study have shown that laboratory experiments can be designed to distinguish significant differences between the relative reported annoyance of impulse and other sounds. Furthermore the results show that comparisons with field data can be meaningful.

In general, the impulse sounds were more annoying than the traffic noise at the same $L_{Aeq}$ indoor level, although their rate of growth of annoyance was less. Were an impulse noise annoyance correction to be derived from these data, it would vary from 0 to 10 dB over the range of indoor average noise levels of 65-40 $L_{Aeq}$.

It may be observed that the commonly used correction of 5 dB for noises of impulsive character is certainly of the right order of magnitude.

## ACKNOWLEDGEMENT

The work reported here was partially funded by the EEC. Acknowledgement is also given to Dr. J.A. John of the Department of Mathematics, University of Southampton who assisted with the experimental design and statistical analysis aspect of the research programme.




Figures 1,2,3,4. Reported annoyance in laboratory (Sound × Level)

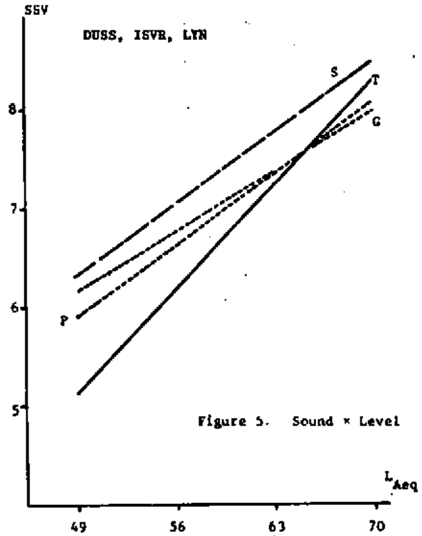



Figure 5. Sound × Level

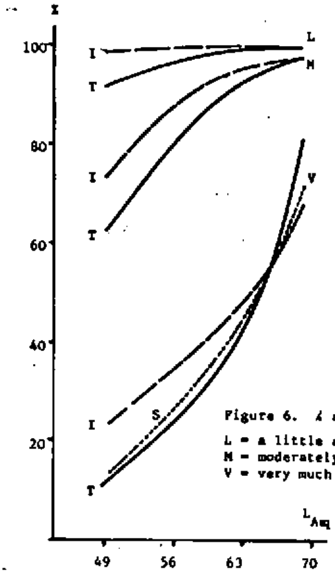



Figure 6. % annoyed.

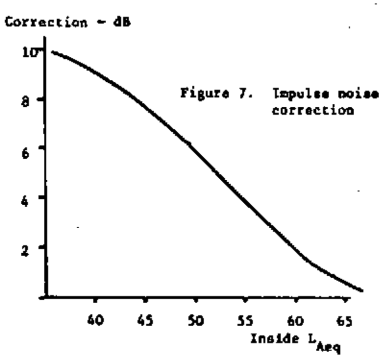



Figure 7. Impulse noise correction