# BRITISH ACOUSTICAL SOCIETY.

Meeting at the University of Salford, Oaklands Road, Salford.5. Lancs. on Thursday 25th/26th October, 1973.

## "NOISE AND LOUDNESS EVALUATION".

### THOUGHTS ON A GENERAL MODEL FOR PREDICTING COMMUNITY REACTION TO NOISE

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As the need for noise control and its legislation grows, so too does the idea of a unified noise rating procedure. This is an objective measure of noise which may be used to predict or estimate human response to that noise and, of most importance, is applicable to all kinds of sound; from factories, from road vehicles, from aircraft, over long and short time periods and at high and low intensities. This is not a new idea but support for it is steadily increasing amid the confusion of a multitude of specialised noise rating scales.

Certainly there is no shortage of possible contenders for the title, with scales like $L_{NP}$, $L_{eq}$ and $L_{10}$ in close competition. There is substantial agreement upon the factors which contribute to noise nuisance; intensity, frequency distribution, duration, intermittency, background noise, time of day and so on. The difficulty is to correlate a suitable combination of these attributes with human response in a normal, everyday environment.

The single factor which obscures the result we seek is that people are very non-uniform. Although we may predict the average response of a large group of people to a particular noise, some members may respond very differently from the average. In many areas of noise planning it is usual to ignore the variation and to set some maximum mean response as a suitable target. The net result of such action may be strong protest from a significant fraction of residents who are highly aggravated by their noise climate. The purpose of this paper is to inject a plea for the recognition of the variability factor in the development of a unified scaling technique.

The importance of the factor is illustrated in Figure 1. This is a graph showing the percentage of people finding noise unacceptable as a function noise level. Precise definitions of noise acceptability and noise level are immaterial to the present argument. Curve A, which has a 100% discontinuity at a critical noise level L would be the environmental planner's ideal. It tells him that provided he exposes people to levels no greater than L, the noise will be completely acceptable. However implicit in Curve A is that all people respond to noise in an identical manner. This is not the case and what some people consider acceptable, others will consider unacceptable.

If we assume that acceptability of noise is an attribute which has a continuous dimension and that individual estimates of the acceptability of any particular noise climate are normally distributed along this dimension, then Curve B in Figure 1 represents a more realistic situation. With this curve the planner faces the dilemma that all levels of noise are unacceptable to some people. Accepting that some noise is unavoidable, how many dissatisfied people may be considered justifiable? The answer to this question is well beyond the scope of this paper, if indeed it exists at all. In Figure 1 the critical level L is arbitrarily chosen as the point at which 33% of exposed people consider the noise to be unacceptable.

The main point is that such a decision has to be made. Obviously the selection of a critical noise level becomes easier as the slope of the acceptability curve increases, i.e. as it asymptotes to the ideal curve A. On Curve C, for example, a small change of noise level about L corresponds to a much larger change in the number of affected people than it would on Curve B. The search for a scale of noise which has a high correlation with response is an attempt to increase this sensitivity and hence to make the choice of acceptability limits easier.

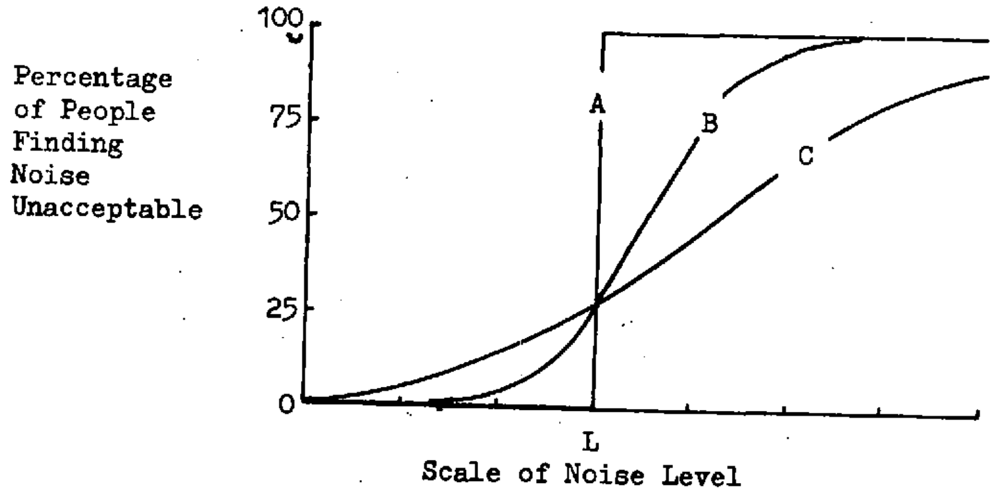
Figure 2 shows a series of such curves derived by comparing results from a number of surveys of the effects of aircraft noise on people living around airports (Ref. 1). The different curves give the percentage of people who respond at various levels of annoyance, increasing scores representing increased annoyance. The noise scale in this case is Noise and Number Index NNI, one of many suitable scales which might have been used, and which might be expected to give similar results. The most significant feature of Figure 2 is the low slope of the curves which reflects high individual differences. The curves are in fact cumulative normal distributions with standard deviations of 20NNI, (equivalent to a noise level deviation of 20dB). One interpretation of this diagram is there would be as much variation of annoyance amongst real people exposed to a fixed amount of noise as there would be amongst identically behaved people normally distributed over a range of noise levels with a standard deviation of 20NNI. Clearly the variability appears to be very large leading one to wonder whether there is not a better index of noise than NNI, i.e. one which will steepen the slopes in Figure 2. If there is, it has yet to be discovered.

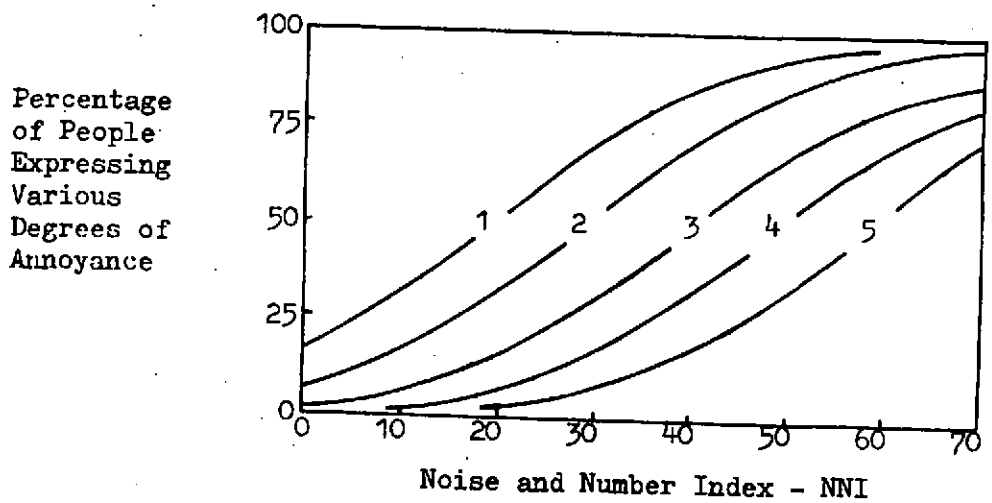
A second problem stemming from the nature of the annoyance value in Figure 2 is that there is no clearly defined dichotomy which would allow us to select a single curve for planning purposes. Indeed the same is undoubtedly true of the acceptability attribute, there being no clear boundary between regions of acceptability and unacceptability. Instead there will be a transition zone where a decision is difficult to make. This is illustrated in Figure 3 which has been derived from Figure 2 as a suitable planning chart. The response has been divided into three categories "unaffected", "affected" and "seriously affected", where the middle category represents the transition zone.

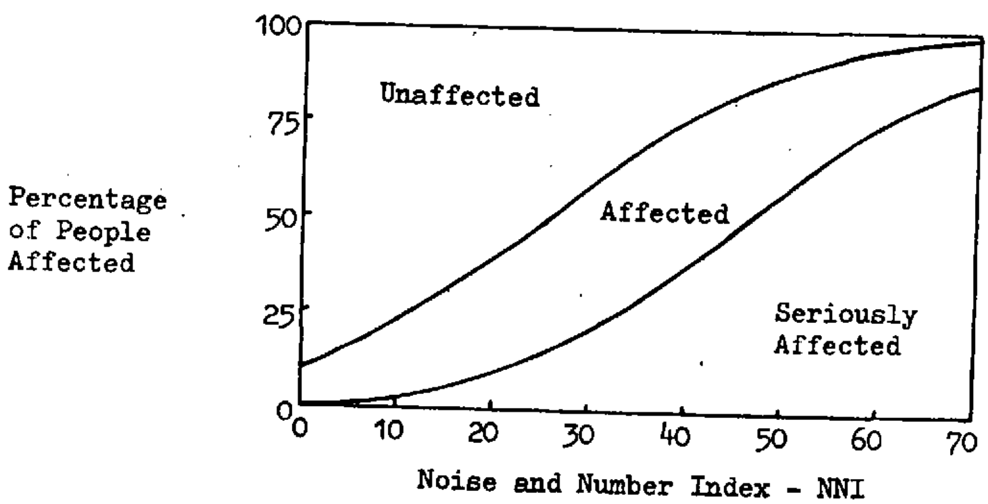
Figure 3 of course has restricted appreciability in that it may be used to estimate the impact of aircraft noise upon people in residential areas around major international airports. In principle however, it should be a relatively straight forward matter to develop a generalised version or versions of Figure 3 which would be appropriate for residential, commercial or industrial locations, at different periods of the day and for various sources of noise.

Reference

1. J.B. Ollerhead "Estimating Community Annoyance due to Airport Noise" Loughborough University Report TT 7203, March 1972.


Percentage of People Finding Noise Unacceptable
100
75
50
25
0
A
B
C
L
Scale of Noise Level


Percentage of People Expressing Various Degrees of Annoyance
100
75
50
25
0
1
2
3
4
5
0
10
20
30
40
50
60
70
Noise and Number Index - NNI


Percentage of People Affected
100
75
50
25
0
Unaffected
Affected
Seriously Affected
0
10
20
30
40
50
60
70
Noise and Number Index - NNI