University of Southampton
Southampton S09 5NH

Tel (0703) 559122
Telex 47661

INSTITUTE OF SOUND AND VIBRATION RESEARCH

Department of Social Statistics

CEC JOINT RESEARCH PROJECT

COMMUNITY REACTIONS TO AIRCRAFT NOISE

FINAL REPORT

by

I.D. DIAMOND and J.G. WALKER
(Project Coordinators)

Submitted to:

Dr. P. Guillot
CEC DGXII

March 1986

1. INTRODUCTION

Aircraft noise indices have historically been developed on a national basis usually through an integrated programme of social surveys and noise measurements in the vicinity of major airports. As might be expected there have been international differences in the focus of these studies: in the questionnaire design, in details of noise measurement, and in the analysis of the results. These differences have led both to different measures of disturbance and noise levels.

This study originates from an initiative by the Commission of European Communities (CEC) through DGXII to establish common methods for collecting data around airports to allow comparison of results between surveys for:

(a) the questions expressing the community reactions to noise of overflying aircraft and to the environment noise in general,

(b) the assessment of noise exposure in the zones selected for interviews,

(c) the methods of selecting the zones and the persons to be interviewed,

(d) the data to be analysed,

(e) the methods of establishing correlations between noise exposure and the community reactions to noise.

The subsequent sections of this report describe first the approaches used to achieve successfully the objectives listed above and then examines some substantive results found in the study.

2. DESIGN

The participant countries were France, The Netherlands and the United Kingdom (Appendix I) and surveys took place at Paris-Orly, Amsterdam-Schipol and Glasgow Airports. To achieve the first objective of the study, extensive discussions took place on the methods used to prosecute noise studies in each country. This enabled a common method to be proposed.

The basic design of the study was that each team identified a number of common noise areas (CNAs) within which the social survey and noise measurement programmes would be conducted. These were defined as areas within which noise levels from a particular aircraft varied by no more than (about) 3 dB. Within each CNA two residual noise zones (RNZs) were identified, one expressing high levels of residual noise and the other low. In every case the main source of residual noise was road traffic.

In each zone the programme of social survey and noise measurements was carried out concurrently so as (a) not to influence responses to the surveys, and (b) to maximise the correlation between the measurement and the actual noise exposure at the time of the survey. The social survey used a common core questionnaire in each country and identical sampling strategies. Additional questions of particular national interest were included near the end of the questionnaire so as to ensure that the core questions would be delivered similarly in each country.

The core questionnaire was introduced as a study of the local environment and respondents were given the opportunity of mentioning aircraft noise spontaneously as a reason for disliking the area. Subsequent questions asked for their reactions to aircraft noise at different times of the day and week. Questions were designed to determine annoyance directly as well as to allow activity disturbance to be assessed.

Noise measurements were gathered for aircraft by taking noise levels for individual events together with a complete listing of numbers and types over the measurement period. Residual noise measurements were obtained using hourly measurements over a seven day period at a number of sites.

A major success of this study was that careful design led to the fieldwork programmes being completed in each country such that the data were comparable. Thus it is fair to consider this as one large international study rather than three similar national studies.

3. RESULTS

Table 1 contains 24 hour L_{eq} values for aircraft and for residual noise in each zone and demonstrates the success of the study in obtaining a suitably wide range of noise exposures.

The second panel of Table 1 gives the reasons most commonly mentioned in each zone for disliking an area. It is immediately obvious that aircraft noise is perceived as important by many

respondents in all countries. However, this is tempered by the fact that very few respondents wished to move from their area whilst most liked their environment on the whole.

In the main, annoyance due to aircraft noise increased with the level of aircraft noise. An exception was found in the UK where respondents in the medium CNA were more annoyed than their counterparts in the high CNA. This type of effect has been observed previously and can be interpreted as being due to respondents in the high CNA accepting the noise as part of their environment, whereas in the medium CNA, aircraft were much more of an intrusion. In Glasgow there were also socio-economic effects which contributed to this result as respondents in the high CNA were predominantly in low socio-economic classes, who are less inclined to complain typically. It is possible to adjust the results to take account for differences in response due to some individual characteristic such as socio-economic status. This is done by calculating the level of disturbance which would be expected if all the zones had identical population characteristics. At Glasgow such an adjustment demonstrated that the observed results were not out of line with those elsewhere in the study.

The results also confirm that the data from the 3 separate national studies are comparable. The dose-response relationships for each country are similar and thus can be merged to provide a single large data set.

With regard to source specific noise, the respondents were asked initially about their reactions to all noise in their area. Later in the questionnaire they were asked about specific sources. Table 2 contains the latter question from the core questionnaire. In Question 24, respondents were asked to rate their annoyance on a scale of 1-10, where 10 meant they were very much annoyed, and 1 indicated that they were not at all annoyed. Figures 1-3 give the proportions (for all zones in the study) who replied between 8-10 to questions about specific noise sources in each zone, by the level of aircraft noise in that zone. They also contain regression lines and confidence bands for these data.

The regression lines are as follows:

AIRCRAFT Annoyance = -146.1 + 2.94* ALEQ + 0.02 RLEQ
ROAD Annoyance = -58.4 - 0.27 ALEQ + 1.62* RLEQ
OVERALL Annoyance = -135.6 + 1.84* ALEQ + 0.83* RLEQ

* Significant at 1% level

It is clear from these results that residual noise has very little influence on annoyance due to aircraft noise across all three countries in the study. Levels of annoyance increase

steadily as aircraft noise increases. An interpretation of these regression coefficients is that an increase of around 10 dB in levels of aircraft noise - in the range of aircraft noise levels observed in this study - will lead to an increase of around 30% in the proportion annoyed in a particular zone.

As might be expected, annoyance from road traffic is related to level of road traffic noise but there is no evidence at all that individuals experiencing high levels of aircraft noise will be less annoyed by road traffic than their counterparts in low CNAs.

The final regression concerns annoyance as a result of overall levels of noise. It is clear that both aircraft and residual noise contribute significantly to this annoyance. However, the influence of aircraft noise is over twice that of residual noise. This linear additive model is rather simple and a number of experiments were undertaken to amalgamate noise from the two sources. A good discussion of the possibilities in this area is found in Rice (1985). Figures 4-6 present the same proportions as Figures 1-3, but this time plotted against Total L_{Aeq}, defined as the log sum of the two noise sources.

The use of Total L_{Aeq} as a noise index increases the slope of the regressions of annoyance from overall levels of noise as high residual noise in low CNAs will play an increasingly important role. This regression line is

$$\text{Overall Annoyance} = -140.54 + 0.896^{*}\ \text{TOTLEQ}$$

*Significant at 1% level

indicating that an increase in total L_{Aeq} of around 10 dB will lead to an increase in the proportion annoyed in a zone of around 9%.

A final result relates to question ordering. Respondents asked early in the questionnaire about their disturbance from noise in general were more likely to reply positively than when they were asked later. It is possible that these respondents felt they had, by the end of the questionnaire, expressed their annoyance sufficiently and were less likely to complain further about the noise. This has implications for further questionnaire design in studies of this type.

4. CONCLUSIONS

1. The study has demonstrated very successfully the potential for international cooperation in aircraft noise annoyance studies. Informed policy making on environmental noise internationally requires the scientific understanding of the relationship between individuals' disturbance from noise and their exposure. Thus, international standards require comparability in the design, execution and analysis of national studies as achieved here.

2. There is no clear consistent effect of residual noise on annoyance due to aircraft noise. The proportions reporting annoyance from aircraft noise could be predicted adequately using levels of aircraft noise while levels of residual noise do not influence annoyance due to aircraft noise. With regard to annoyance from *all* noise, the best noise index in this case was the Total LEQ which sums both aircraft and residual noise, thus giving weight to high residual noise in low CNAs.

ACKNOWLEDGEMENTS

The authors would like to express their thanks to members of the teams in each country, most notably Dr. R. de Jong and M. Vallet. Thanks are particularly due also to Dr. P. Guillot of DGXII, CEC.

REFERENCES

COOPER, P.J., DIAMOND, I.D., WALKER, J.G. and RICE, C.G. 1984 *Proc. Institute of Acoustics*, Acoustics 84, 301-308. The modelling of source specific and total noise annoyance using source specific noise measurements.

RICE, C.G. 1985 *Inter-Noise 85* CEC Joint Project on Impulse Noise: Effect of road traffic noise level on judged annoyance.

Table 1: Characteristics of Zones in International Study

	Common Noise Area (CNA) / Residual Noise Zone (RNZ)	High		Medium		Low	
		High	Low	High	Low	High	Low
France	Aircraft 24 h L_{eq}	69.4	69.4	57.9	54.4	45.2	45.2
	Residual 24 h L_{eq}	70.5	66.2	66.0	55.0	66.8	56.6
	Survey sample size	115.0	84.0	50.0	100.0	90.0	112.0
United Kingdom	Aircraft 24 h L_{eq}	68.2	68.2	66.7	66.7	55.7	55.7
	Residual 24 h L_{eq}	63.6	53.9	67.5	52.4	68.8	51.2
	Survey sample size	77.0	126.0	86.0	109.0	105.0	104.0
France	Reasons for disliking an area	aircraft traffic	aircraft	aircraft traffic no parks	aircraft shopping	traffic no parks	
UK	Reasons for disliking an area	aircraft	aircraft crime	aircraft traffic		traffic	

Netherlands	CNA	1	2		3		4		5	
	RNZ		High	Low	High	Low	High	Low	High	Low
	Aircraft 24 h L_{eq}	50	59	59	62	62	62	62	66	66
	Residual 24 h L_{eq}	48	63	46	59	46	64	53	64	52
	Survey sample size	100	70	53	50	51	48	49	58	102
	Reasons for disliking an area	shopping smell	aircraft traffic neighbours	aircraft	aircraft traffic	aircraft		aircraft	aircraft traffic	air-craft

Table 2: Format of Question on Source Specific Noise.

Question 24. How do you feel about

(a) the noise from aircraft

(b) the noise from traffic

(c) other noise than aircraft or traffic

(d) the overall level of noise around here

Answers on a scale of 0-10 where 10 indicates very much annoyed and 1 indicates not at all annoyed.

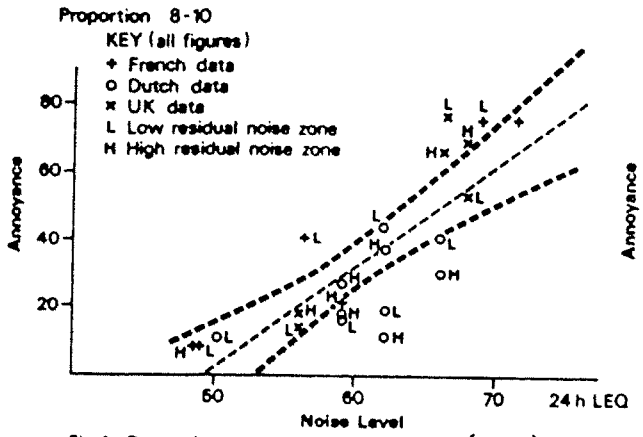

Fig 1. Proportion expressing high annoyance (≥8/10) with aircraft noise by level of noise from aircraft

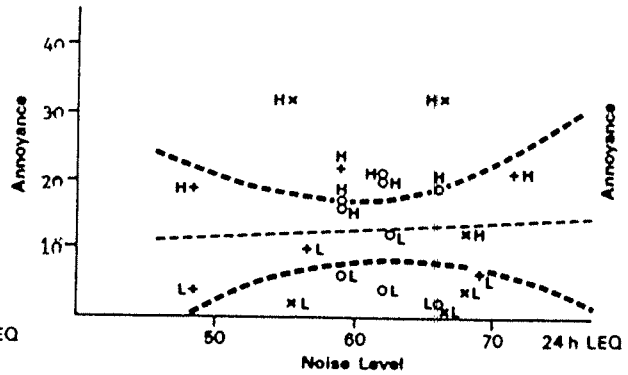

Fig 2. Proportion expressing high annoyance (≥8/10) with road traffic noise by level of noise from aircraft

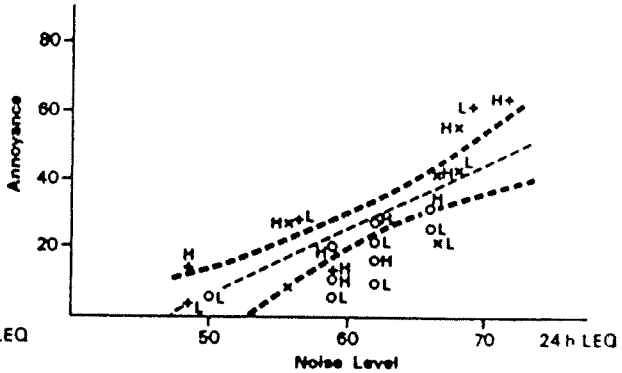

Fig 3. Proportion expressing high annoyance (≥8/10) with overall noise by level of noise from aircraft

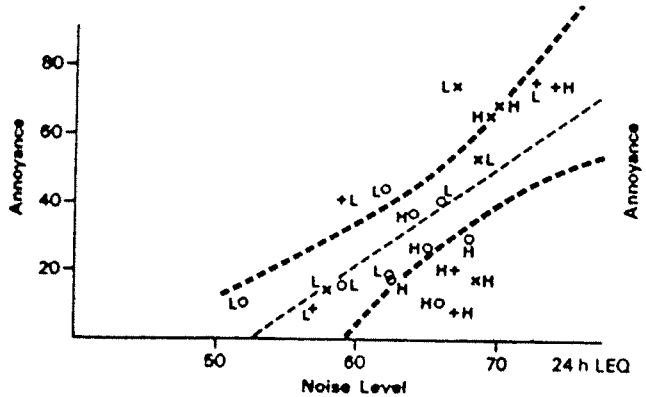

Fig 4 Proportion expressing high annoyance (≥8/10) with aircraft noise by total noise level

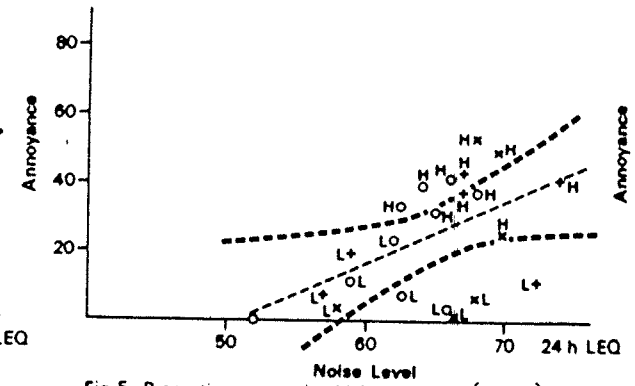

Fig 5. Proportion expressing high annoyance (≥8/10) with road traffic noise by total noise level

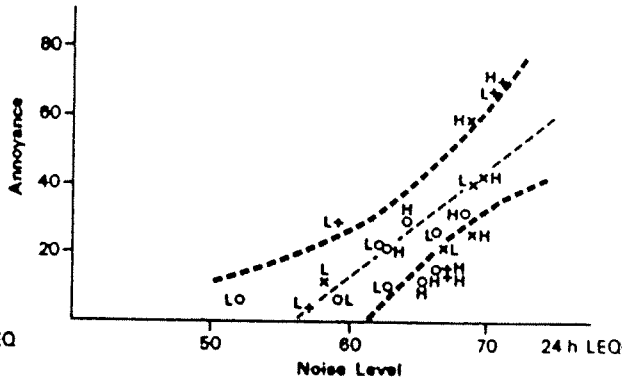

Fig 6. Proportion expressing high annoyance (≥8/10) with overall noise by total noise level

APPENDIX I

Participating Teams and Advisors

United Kingdom	**I.D. Diamond**, Department of Social Statistics, University of Southampton **J.G. Walker**, Institute of Sound and Vibration, Research, University of Southamton **J.B. Critchley**, Civil Aviation Authority, London **G.C. Richmond**, Civil Aviation Authority, London
The Netherlands	**R.G. de Jong**, TNO Leiden (formerly TNO Delft) **F.H. van Tol**, TNO Delft
France	**M. Vallet**, IRT, Bron **G. Pachiaudi**, IRT, Bron **Y. Tanguy**, STNA **F. Terzan**, STBA **A. Depitre**, DGAC **J. Francois**, IFOP, Paris
CEC	**P. Guillot**, DGXII
Advisors	**F. Ingerslev**, Technical University, Lyngby **R.R. de Josselin de Jong**, Ministry of the Environment, Netherlands