inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 6.6

STUDIES OF THE ANNOYANCE OF LOW FREQUENCY AIRCRAFT NOISE AT TWO CIVIL AIRPORTS

L. Silvati, S. Fidell, K. Pearsons, R. Howe, M. Sneddon

BBN Technologies, 21128 Vanowen Street, 91303, Canoga Park, CA, United States Of America

Tel.: 818-610-8212 / Fax: 818-716-8377 / Email: fidell@bbn.com

Keywords:
LOW FREQUENCY NOISE, ANNOYANCE, AIRCRAFT NOISE

ABSTRACT
Two field studies of the annoyance of aircraft-induced rattle and vibration in the homes of airport neighborhood residents have yielded information about relationships between noise levels in the one-third octave bands from 25 to 80 Hz and the prevalence of a consequential degree of annoyance among respondents. The findings of the two studies are quite similar with respect to the prevalence of annoyance due to vibration and rattle, as well as the frequency of notice of rattle and the household objects identified as rattling.

1 - INTRODUCTION

Neighborhoods near runway ends have received the greatest attention in airport noise impact analyses, since the very high noise levels of direct overflights in these areas are associated with the highest levels of noise-induced annoyance. The noise exposure gradient (change in noise level with distance) is much steeper to the side than along the extended centerline of a runway because areas to the sides of runways are not directly overflown. Thus, (A-weighted) noise exposure is not as great in an area at a comparable distance from the side of a runway as from a runway end. Jet engines can nonetheless create enough low frequency energy to induce perceptible vibration and audible rattling of objects inside structures to the sides of runways. In August of 1997 a social survey of the annoyance of low frequency runway sideline noise was conducted near Los Angeles International Airport (Fidell, Silvati, Pearsons, Lind, and Howe, 1999). In June of 1999 a second very similar social survey was conducted in Minneapolis, MN. These two studies produced comparable results with respect to the prevalence of annoyance due to aircraft noise-induced rattle, frequencies of notice of rattle, and the types of objects cited as sources of annoying rattle in homes.

2 - METHOD

2.1 - Characterization of low frequency noise levels

In Study 1 simultaneous outdoor measurements were made at several locations within the interviewing area near Los Angeles International Airport (LAX). These wide-bandwidth recordings were analyzed using software which identified the maximum sound level observed in each of the one-third octave bands centered at 25 to 80 Hz in the 30 seconds prior to and following the (unweighted) maximum noise level of each aircraft noise event recorded. A spatial interpolation algorithm was applied to measured low frequency noise levels to generate a set of contours from which low frequency noise levels could be estimated at each respondent's street address. The algorithm treated the low frequency noise measurements as elevation information to fit a surface through the field measurement points.

In Study 2, FAA's Integrated Noise Model (INM) v6.0 was exercised to produce maximum C-weighted aircraft noise contours. The noise level gradients of this contour set served as a basis for estimating low-frequency sound levels from aircraft noise events recorded in the field throughout the interviewing area near Minneapolis-St. Paul International Airport (MSP). These estimates were checked against field measurements made at six points within the interviewing area.

2.2 - Survey design and questionnaire

A sampling frame of residential telephone numbers was assembled from several sources, including digital reverse directories. All residences located in an area 1000 to 5000 feet south of the runway complex at LAX were included in the sampling frame of Study 1. In the second study, homes that had received acoustic insulation through the sound insulation program at MSP comprised one interviewing group, while homes that had not received acoustic insulation comprised a second group.

A basic questionnaire of 13 closed response category items was administered by telephone in both studies. The questionnaire was introduced as a study of neighborhood living conditions. Respondents were asked preliminary questions about duration of residence and about the most favored and least favored aspects of neighborhood living conditions. Respondents were next asked about the annoyance of street traffic noise and aircraft noise, and whether airplanes made vibrations or rattling sounds in their homes. Respondents who had noticed rattling sounds were asked five additional questions: how annoyed they were with the rattling sounds, how often they noticed the rattling sounds, what sorts of things rattled in their homes, whether they had tried to do anything to reduce the rattling in their homes, and whether they had ever complained to the airport about the rattling.

All respondents were asked if they had ever complained to the airport about aircraft noise in general. In Study 2, respondents were asked whether their home had been acoustically insulated, and (for those whose homes had been insulated) whether they were pleased with the reduction in noise levels inside their homes since the acoustic treatment had been completed.

2.3 - Calling procedures

In both surveys, twelve centrally-supervised telephone interviewers made ten contact attempts: an initial attempt followed by nine callbacks at different times of day. The opinions of one English-speaking, adult household member were sought from each selected household. All interviewers read a training manual and underwent half an hour of training, including practice interviews, prior to conducting interviews. Potential respondents were randomly selected from the sampling frame at the time of conduct of the survey.

3 - RESULTS

In Study 1, 644 interviews were conducted at a completion rate of 87%. Twenty-nine percent of all respondents described themselves as highly annoyed (high annoyance is the sum of "very" and "extremely" annoyed responses) by aircraft noise in general, while 21% described themselves as highly annoyed by aircraft-induced vibration or rattle sounds in their homes.

In Study 2, 495 interviews were conducted at a completion rate of 81%. Thirty-eight percent of all respondents described themselves as highly annoyed by aircraft noise in general, while 26% described themselves as highly annoyed by aircraft-induced vibration or rattle sounds in their homes.

All respondents who reported noticing vibrations or rattling sounds in their homes were asked (1) whether they were annoyed by the vibrations or rattling sounds in their homes, (2) to describe how often they noticed vibrations or rattling sounds in their homes, and (3) to cite the types of objects which rattled in their homes. Responses to these questionnaire items are compared in the following subsections.

3.1 - Prevalence of annoyance due to aircraft noise-induced rattle

Of the respondents who noticed rattle, 40% (in Study 1) and 42% (in Study 2) were highly annoyed by vibrations or rattling sounds in their homes. Figure 1 shows the distribution of the degree to which these respondents were bothered or annoyed by aircraft noise-induced vibrations or rattling sounds in their homes. The distributions of degree of annoyance due to rattling sounds in the two surveys are generally similar.

3.2 - Frequency of occurrence of vibrations in homes

Figure 2 shows the frequency of occurrence of rattle in homes of respondents who reported noticing vibrations or rattling sounds in their homes. Half of the respondents in Study 1 and 44% of the respondents in Study 2 who had noticed vibrations or rattling sounds in their homes reported that they noticed them several times a day.

3.3 - Sources of rattle in homes

Figure 3 shows the objects which rattled or vibrated due to aircraft noise in respondents' homes. A majority or plurality of respondents cited windows as the objects in their homes which rattled or vibrated, whereas items on shelves were reported by a minority of respondents.

The percentages of respondents who had tried to alleviate the vibrations and rattling sounds due to aircraft noise in their homes was 32% in Study 1 and 33% in Study 2. Further, 25% of the respondents

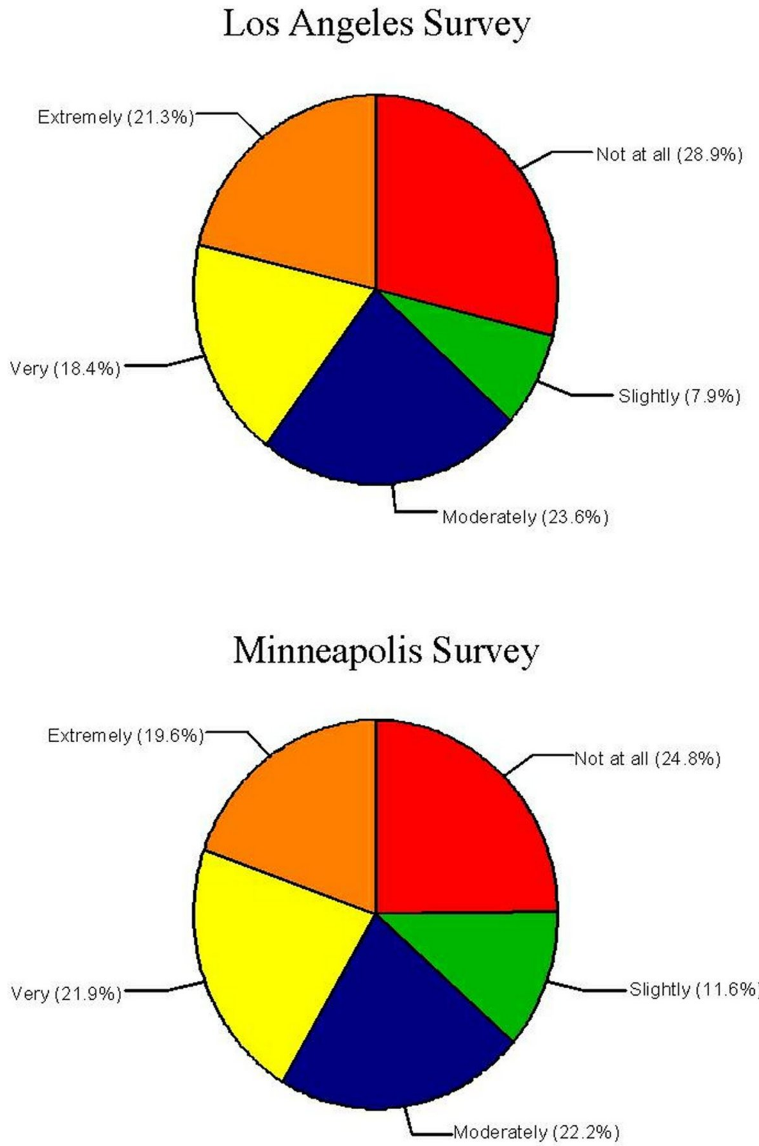

Figure 1: Degree of annoyance due to aircraft noise-induced vibrations or rattling sounds of respondents in both studies who had noticed rattling sounds.

who had noticed rattling sounds in Study 1 had complained to the airport about the rattling, whereas 30% of those respondents in Study 2 had made such complaints.

4 - DISCUSSION

Findings from these two studies have established the existence of annoyance due to low frequency aircraft noise exposure. This annoyance induced by secondary emissions is not completely subsumed by annoyance due to aircraft noise in general. The Spearman rho correlation coefficient between annoyance (in any degree) due to aircraft noise-induced rattle and annoyance due to aircraft noise in general,.70, accounts for about half of the variance. Further, the Spearman rho correlation coefficient (these correlations are based on the annoyance ratings of respondents who reported noticing aircraft noise-induced vibrations or rattling sounds in their homes) between high annoyance due to aircraft noise-induced rattle and high annoyance due to aircraft noise in general,.60, accounts for only 36% of the common variance. Annoyance due to rattle is thus distinguishable from annoyance due to aircraft noise in general.

ACKNOWLEDGEMENTS

These studies were sponsored by the City of Richfield, Minneapolis.

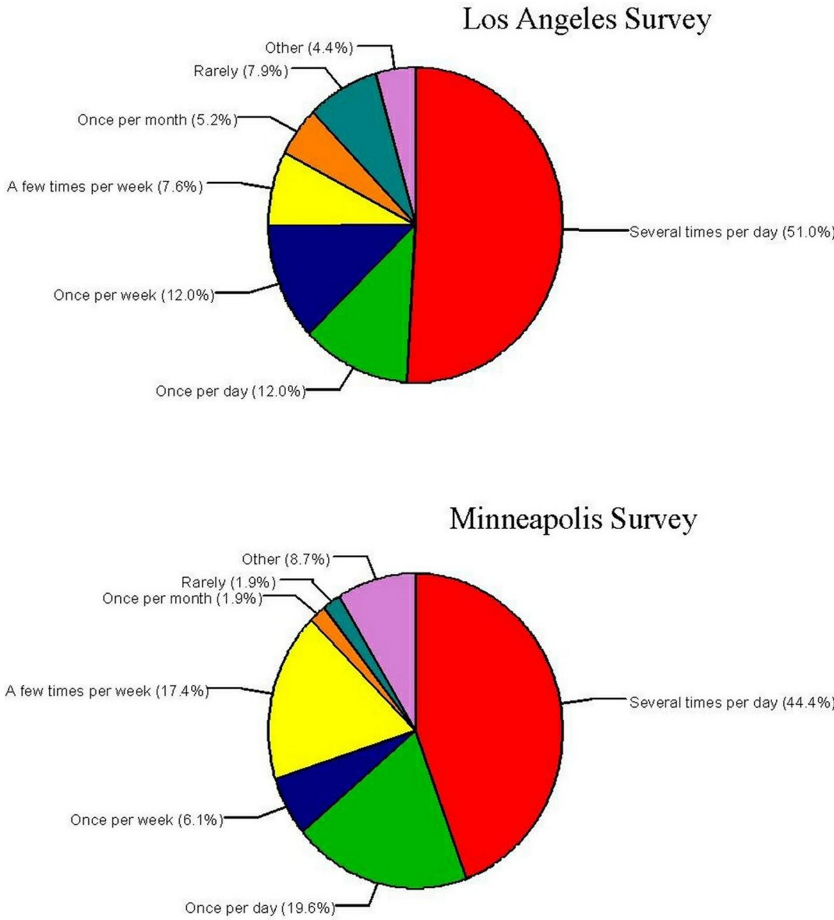

Figure 2: Frequency of occurrence of aircraft noise-induced vibrations or rattling sounds of respondents in both studies who had noticed rattling sounds.

REFERENCES

1. **Fidell, S., Silvati, L., Pearsons, K., Lind, S., and Howe, R.**, Field study of the annoyance of low frequency runway sideline noise, *J. Acoust. Soc. Am.*, Vol. 106(3), Pt.1, pp. 1408-1415, 1999

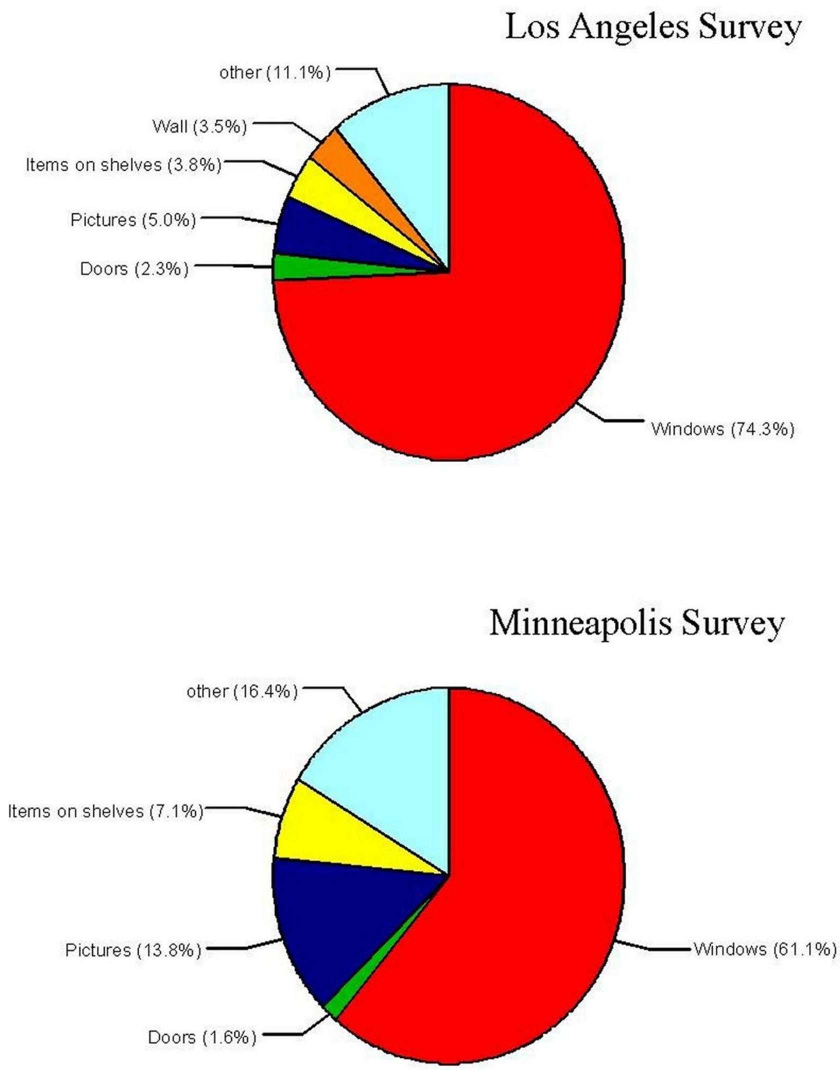

Figure 3: Objects in respondents' homes which vibrate or rattle due to aircraft noise.