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LONG RANGE PROPAGATION OF AIRPORT GROUND NOISE

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INTRODUCTION

In the vicinity of an airport, noise from overflying aircraft is normally the most significant source of noise and has thus dominated regulatory and administrative attention. However, recent laboratory [1,2] and field [3] studies have suggested that continuous type noises, such as airport ground noise or road traffic noise, play a significant rôle in determining overall noise annoyance. Thus, these types of noise may be worthy of greater consideration than they have been given in the past, and, in particular, should be considered when airport developments are planned. However, the assessment of the impact of future community noise exposures requires reliable noise prediction techniques. Unfortunately the prediction of noise levels at long range by analytical methods is extremely unreliable because the combined effects of ground impedance, topography, screening and meteorological conditions create considerable uncertainty. The only practical alternative to analytical methods in the generalized case is to base predictions on source-to-receiver distance and source characteristics only, although this can lead to errors at specific sites [4]. However, if sufficient empirical data were to be obtained for a representative range of topographical and meteorological conditions then the special characteristics at specific locations might be cancelled out by averaging and it may be possible to derive a single meaningful "grand mean attenuation rate" for the particular source in question. Such a relationship would provide a reasonable prediction model notwithstanding the likelihood of small errors at specific locations. These errors would almost certainly be no worse than those obtained using analytical techniques.

This paper reports an investigation which was based on measurements of airport ground noise levels at four different airports at distances of up to 3 km. The data were grouped together to determine whether it was possible to derive a single "grand mean attenuation rate" or whether the peculiarities at specific locations made a single relationship unrealistic.

DATA COLLECTION

The data were obtained on a number of separate occasions at Gatwick, Stansted, Prestwick and Glasgow airports. They comprise full-thrust engine test running and take-off roll noise.

(a) Engine test running. Full-thrust engine test running was used as a noise source at Gatwick and Stansted airports. Noise levels from a number of different Boeing B707 and McDonnell-Douglas DC-10 type aircraft were measured. Some measurements were made using exhaust mufflers at the tailpipes of B707 engines. Normally only one engine at a time would be run up to full thrust during engine testing although other engines are operated to provide balancing thrust and auxiliary power.

(b) Take-off roll. Take-off roll was used as a noise source at Prestwick and Glasgow airports. A number of commercial operations of Boeing B747, B737 and B727, Lockheed L1011, McDonnell-Douglas DC-10 and DC-9 and BAe 1-11 aircraft were measured. Measurement locations were within the airport perimeter at these airports and thus the propagation was always at shorter ranges over cropped grassland and runways, taxiways and aprons. All engines are run at or near full-thrust settings during take-off roll, but the difference between these data and the engine test running data, involving one engine at full-thrust and one or more at lower thrust settings, would be less than 5 dB(A).

All data used were obtained under moderate or calm wind conditions and no special note was taken of other meteorological conditions. It is considered that a reasonable sample of different aircraft types, terrain and weather conditions was obtained.

DISCUSSION

An earlier report [5], based on the engine test running noise levels alone, concluded that an attenuation rate of 12 dB per doubling of distance adequately represented the data. A high correlation ($r = -0.958$) was observed between peak dB(A) noise level and log distance, ignoring source directivity, rural vs urban terrain, aircraft type, screening by hangars, use of exhaust mufflers and weather conditions. This result implied that meaningful predictions of airport ground noise could be obtained using these data alone, without recourse to complex analytical methods. There appeared to be small, nonsystematic deviations from the regression line at specific locations but the comments in the introduction concerning error cancellation still apply.

When the take-off roll data are incorporated in the analysis (shown in Figure 1) the grand mean attenuation rate reduces to 11.3 dB per doubling of distance and the correlation coefficient is brought down to -0.896. Uncertainty about the distance from source-to-receiver at maximum noise level during take-off roll (because the source is moving and engine thrust settings change rapidly during start-of-roll) may be one reason for these changes.

There appears to be no systematic effect on noise levels due to aircraft type and operation, airport topography, meteorology or intervening terrain. Either the effects of these variables have coincidentally cancelled out in our data set, or they are unimportant.

The apparent ineffectiveness of airport buildings as noise screens is supported by measurements at Gatwick of the excess attenuation of a 10 m high earth bank partially surrounding a holding area at the western end of the runway. A *maximum* excess attenuation of 4.5 dB(A) on take-off roll noise was observed at a receiver distance of 1 km (in the nearest community). The *mean* excess attenuation for several aircraft was less than 3 dB(A).

CONCLUSIONS

Given the present state-of-knowledge there appears to be no advantage to taking account of any factors other than source-to-receiver distance and probably engine type and thrust setting, when predicting airport ground noise levels in nearby communities. Long range propagation from ground sources to ground receivers appears to be adequately represented by a grand mean attenuation rate of 11-12 dB per doubling of distance. Screening by airport buildings and housing developments, and the use of simple exhaust mufflers appear to have no systematic effects at long range.

Airport ground noise typically drops to about 50 dB(A) or less at distances in excess of 3 km. Thus no significant community effects would be expected at any greater distance, although exceptional weather or topographical conditions may result in unusual propagation to greater distances.

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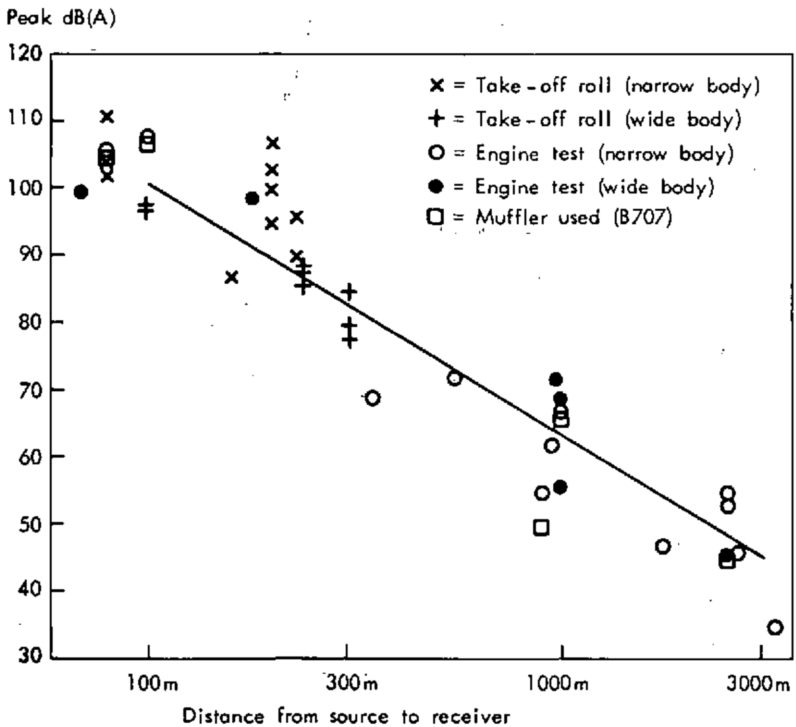

Fig. 1 Relationship between take-off roll and engine test noise and distance from the source.