AIRCRAFT ENGINE GROUND RUNNING NOISE

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INTRODUCTION

Possible community annoyance due to aircraft engine ground running noise can become a significant factor when considering the development of aircraft and aeroengine manufacturing, maintenance, and research and development facilities. This is because modern jet and fanjet aeroengines produce high sound power outputs which can be audible over relatively large distances for significant time periods. There has been little research into the effects of meteorological and topographical variation on the propagation of aircraft engine ground running noise over large distances. In addition there has been little research into the establishment of an appropriate exposure/response relationship for aircraft engine ground running noise, and therefore, any assessment scheme must involve reasonable assumptions as to the comparability of aircraft engine ground running noise to other noise sources for which more data is available.

Noise level predictions

A previous synthesis of a collection of airport ground noise levels at four different airports at distances of up to 3 km (Walker and Flindell 1983) concluded that average attenuation over these distances can be adequately represented by a grand mean attenuation rate of between 11 and 12 dB per doubling of distance. It was not possible to separate out the effects of screening by substantial and continuous aircraft hangars, workshops and offices (Flindell, Walker and Large 1985).

Of course, actual attenuation in any specific case is affected by meteorological and topographical conditions and by the frequency spectrum of the source. Recent measurements at Filton Airport, Bristol show the effects of these factors quite clearly. Measurements were made on two occasions at various distances and angles to USAF F111 twin engined aircraft being run at various thrust settings from idle to maximum afterburner thrust whilst tied down onto a concrete apron. Noise levels were predicted at the various measurement sites for each thrust setting using USAF source noise level data for a distance of 75m (USAF 1973) and the 11 dB per doubling of distance attenuation rate. The differences between measured and predicted noise levels as averaged across all thrust settings tested are given in the following table. The aircraft heading was 244° on both occasions (see Figure 1).

Distance	Angle to the nose	Wind from 350° 8 knots	Wind from 225° 5 knots
450 m	45°	-15.3 dB	-5.3 dB
550 m	52°	- 1.5 dB	-9.2 dB
900 m	112°	8.9 dB	
1650 m	119°	7.4 dB	

The USAF source noise level data was verified by measurements at the 75 m reference distance which were found to be in close agreement. Therefore, the differences as outlined in the table must be assumed to be due to the residual error implicit in applying a grand mean attenuation rate to any particular situation.

Considering first the differences at 900 m and 1650 m. The measured noise levels were higher than predicted because of a combination of three factors. There was a following vector wind component of 6 knots. The propagation path was over flat unobstructed ground with a slight rise up to both measurement locations. The noise spectrum produced at these angles to the aircraft nose is predominately lower in frequency than the noise spectrum from much smaller angles to the aircraft nose and is therefore attenuated less by distance.

The 450 m and 550 m measurement locations were at approximately the same angle either side of the aircraft nose, picking up a significant amount of higher frequency intake noise. The propagation path to the 550 m measurement location was across flat unobstructed ground, whereas the propagation path to the 450 m measurement location was across a complex natural bank and valley with additional (unrelated) earthworks (see Figure 2). The measured noise levels at the 450 m measurement location were 15 dB lower than predicted with an adverse vector wind component of 4 knots and 5 dB lower than predicted with an adverse vector wind component of approximately 1 knot. The measured noise levels at the 550 m measurement location were 9 dB lower than predicted with an adverse vector wind component of nearly 5 knots and 1.5 dB lower than predicted with a following vector wind component of nearly 8 knots. Thus the differences between measured and predicted noise levels at the 450 m and 550 m measurement locations were due to greater than average attenuation in the forward arc, together with substantial effects of moderate winds and an unexpected effect of the complex topography underlying the propagation path to the 450 m measurement location.

Noise level assessments

Aircraft engine ground running operations at Filton Airport occur intermittently, each complete test procedure taking up to an hour or more. During an aircraft engine test procedure, engines would normally be run for a large proportion of the total testing time at idle thrust with occasional bursts of high power thrust lasting for minutes at a time. There is no directly relevant social survey data and therefore an assessment of likely community annoyance was made by assuming that community annoyance to aircraft engine ground running noise would be the same as community annoyance to road traffic noise at the same 12 hour L_{Aeq}, during an 0800 to 2000 hrs working day. This assumption is likely to give an underestimate of community annoyance to aircraft engine ground running noise at the time that it occurs, but is a reasonable way of making an overall estimate of community annoyance as averaged throughout the day.

In this particular case the assessment was made in respect of possible residential development on parcels of land near to the ground running base. A 12 hour L_{Aeq} of 65 dB(A) was proposed as a criterion limit of acceptable noise exposure for further residential development, drawing on the noise Insulation

Regulations 1975 equivalent criterion of 68 dB(A) L_{10} for the purpose of determining compensation for increased road traffic noise. Eight per cent of the population of England are exposed to road traffic noise levels outside their homes of 65 L_{Aeq} and above (averaged over 12 hours) (Harland and Abbott 1977). Approximately 20 per cent of these people describe themselves as "quite a lot" or "very much" bothered by the noise of road traffic when indoors at home (Morton Williams et al 1978). The mean dissatisfaction score on a 7 point dissatisfaction scale of those 8 per cent would be about 4.5 which is above the mid-point of the scale (Langdon 1977).

There are at Filton Airport a small number of existing residents within a predicted average attenuation conditions 12 hour 65 L_{Aeq} contour for aircraft engine ground running noise (on those days that ground running occurs). This criterion limit is supported by the fact that airport management receive written complaints from some of these existing residents, whilst some other exposed residents do not complain.

Finally, the proposal of a 12 hour 65 L_{Aeq} criterion limit of acceptable noise exposure for residential development does not necessarily imply acceptability at lower noise levels, as there are many individuals who would be annoyed at lower average noise levels, particularly in the context of the very high noise levels that would be permissible for short durations under any 12 hour L_{Aeq} criterion.

CONCLUSIONS

Differences between measured noise levels and predicted noise levels using reliable source reference noise levels and the 11 dB per doubling of distance attenuation rate as proposed by the authors elsehwere (Large, Walker, Flindell 1984) can be attributed to meteorological, topographical and source frequency spectrum differences occurring in real situations as compared to under average attenuation conditions. Nevertheless, the assumption of average attenuation conditions is a necessary compromise when making global predictions of long term average noise exposure for planning and control purposes.

A 12 hour 65 L_{Aeq} criterion has been proposed as an appropriate noise level limit for acceptability for residential development, on the basis of comparisons with community response to road traffic noise. This criterion assumes that possibly high levels of community annoyance occurring during high power test running for relatively short periods can be traded for lower or zero levels of community annoyance occurring throughout the rest of the day, on those days that aircraft engine ground running occurs.

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Figure 1 Aircraft engine ground running tests at Filton Airport Bristol

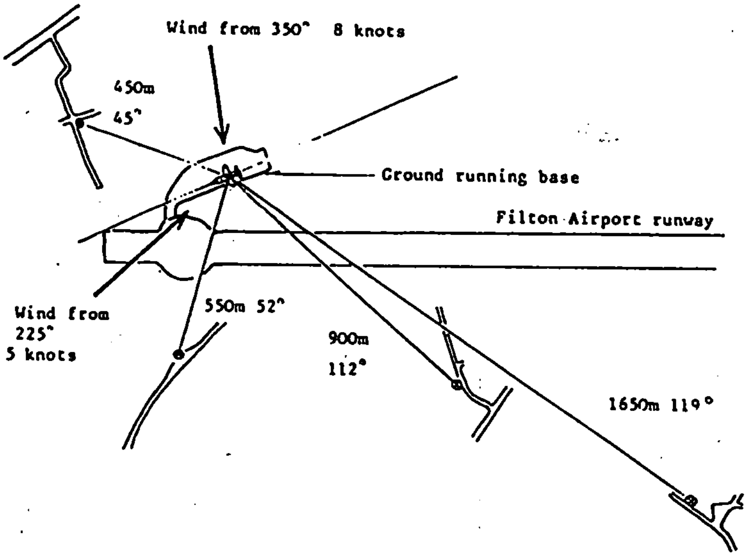

Figure 2 Complex topography to NW of Ground running base