# Proceedings



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Barriers for Noise Control

# Proceedings

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Barriers for Noise Control

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BARRIERS FOR AIRPORT GROUND NOISE CONTROL

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#### INTRODUCTION

Recent expansion at London's Heathrow and Gatwick airports has brought airport ground noise sources nearer to existing housing areas adjacent to the airport boundaries. This has resulted in the construction of noise control barriers at the western end of the Gatwick runway, around the new Gatwick North Terminal, and around the new Heathrow Pourth Terminal in an attempt to protect the nearby communities from increased airport ground noise levels. However, there are considerable doubts as to the effectiveness of such barriers, particularly where their height might be only a few percent of the source-to-receiver distances. There is very little theoretical and empirical information available on which to base reliable attenuation predictions. This paper reports the authors' current philosophy in respect of attenuation prediction techniques as based on the limited amount of experimental evidence obtained in the last few years.

#### LONG DISTANCE ATTENUATION

Airport ground noise is subject to attenuation due to spherical spreading, atmospheric absorption, ground scattering and absorption and diffraction by screens and barriers. The authors have previously reported [1,2] a synthesis of a collection of noise measurement data obtained at distances of up to 3 km from the sources. The data can be collapsed onto a single attenuation curve represented by an attenuation rate of 12 dB per doubling of distance (12 dB/dd). This grand mean attenuation rate appears to be capable of predicting noise levels at long ranges as well as any other more sophisticated methods. It does not distinguish between screened and unscreened propagation paths.

Plainly, the 12 dB/dd attenuation rate will not apply at relatively short source—to—receiver distances (up to about 300 m) where large barriers provide effective attenuation. In addition, excess attenuation introduced by a large barrier will be partly offset by a loss of attenuation due to ground absorption and scattering (ground effect), because the direct ray path will be lifted above the ground. These effects were examined by making measurements of the earth berm at the western end of the Gatwick runway. Barrier attenuation was measured first at short source—to—receiver distances using both a loudspeaker noise source and actual aircraft taxing noise and second at a distance of 750 m from the berm using only aircraft taxing noise. In all cases predictions of actual barrier attenuation were compared with predictions using the Maekawa/Tatge [3,4] formula of 10 log(3+ 20 N)dB, where  $N=28/\lambda$ . 8 is the path difference between the direct ray paths with and without the barrier and  $\lambda$  is the wavelength.

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#### LOUDSPEAKER MEASUREMENTS

Figure 1 shows the layout of the berm in relation to the taxiway and loudspeaker and microphone positions. The loudspeaker was mounted at a typical aircraft engine height of 3 m. The loudspeaker and amplifier produced approximately 90 dB SPL on axis at 13 m in each one—third octave band separately from 125 Hz to 4 kHz. The data in Table 1 represents the A-weighted SPLs that would result from simultaneous excitation in all one—third octave bands (i.e., pink noise) a situation that, in practice, would have destroyed the loudspeaker.

Table 1. Loudspeaker measurements

	Open G	round	Screened by Berm		
. Distance from source	142 m	203 m	197 m	257 m	
. Measured level, dB(A)	76.5	72.8	58.5	57.7	
. Predicted level, 8 dB/dd	76.5	72.4	72.7	69.7	
. Predicted level, 6 dB/dd	_	_	80.6	78.3	
3. Predicted barrier access	-	-	23.8	23.1	

The attenuation from 13 m to 142 m and 203 m over open ground is well represented by an attenuation rate of 8 dB/dd (spherical spreading plus ground effect). The measured noise levels, as screened by the berm, are best represented by subtracting the predicted barrier excess from the predicted levels using an attenuation rate of 6 dB/dd (i.e., assuming no ground effect, giving errors of 2 dB at 197 m and 2.5 dB at 257 m).

#### ATRICAPT TAXIING NEASUREMENTS

Aircraft taxiing measurements were made at 164 m from the taxiway at two positions; shielded and not shielded (Figure 2). Barrier attenuation was determined as the difference between the A-weighted SPLs at the two positions as at Table 2.

Table 2. Aircraft taxiing measurements at 164 m

	 8737	Coronado	DC-8	BAC1-11	Tristar	BAC1-1
Measured barrier atten.	23.0	12.0	22.0	22.5	17.6	14.3
Predicted barrier atten.	22	24	24	23	21	23
Predicted barrier atten.	14	16	16	15	13	15

Part of the variability in the data is due to engine thrust setting changes during taxiing and part is due to spectral variations between aircraft types being affected differently by ground absorption and scattering. Predicted barrier attenuation 1 uses the Maekawa/Tatge formula and assumes no loss of ground effect. Predicted barrier attenuation 2 again uses the Maekawa/Tatge formula and also assumes an 8 dB loss of ground effect as appears to have occurred with the loudspeaker measurements. Clearly the berm gives good attenuation but agreement with predictions is subject to uncertainty.

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Additional aircraft taxiing measurements were made using a microphone at Charlwood, 750 m from the berm. An observer on the top of the berm reported precise aircraft positions by a radio link. The maximum observed barrier attenuations are given at Table 3, together with predictions using the Maekawa/Tatge formula. The predictions assume no loss of ground effect, since at long ranges the direct ray path over the barrier is very nearly at grazing incidence to the receiver.

Table 3. Aircraft taxiing measurements at 860 m.

Measured max. atten. 1.5 Predicted excess atten. 18			4.5	Caravelle 2.5 18	Caravelle 2.5 18
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On average, the berm gave negligible attenuation. The predictions are clearly inappropriate.

#### ADDITIONAL DATA

The data used to derive the 12 dB/dd attenuation rate referred to above [1,2] provides additional evidence for the ineffectiveness of barriers at long range. Engine test runs at London Gatwick and Stansted airports were measured both close to (around 100 m) the sources and simultaneously at distances of up to 3 km. Data covered wide and narrow bodied aircraft with high and low mounted engines, in some cases using tail-pipe mufflers. The data is plotted at Pigure 3 in terms of A-weighted SPL and log distance. Appropriate allowance is made for differences in source noise level by normalizing on the basis of the data obtained for each aircraft type at relatively short range. Part of the data was obtained using engine test runs in the Gatwick south maintenance area which is shielded to the south by substantial and continuous aircraft hangers, workshops, and offices. The remainder of the data was obtained for propagation across similar terrain without substantial screening. No effect of the screening could be distinguished.

#### CONCLUSIONS

Noise barriers appear to offer effective attenuation of airport ground noise at propagation distances up to approximately 300 m. Attenuation at these distances can be predicted reasonably well using the  $10 \log(3 + 20 \text{ N})$  dB formula whilst allowing for an associated loss of ground absorption and scattering. However, barriers appear to offer negligible benefit at greater distances although extrapolation of the  $10 \log(3 + 20 \text{ N})$  dB formula would imply some effect.

#### ACIONOWLEDGEMENT

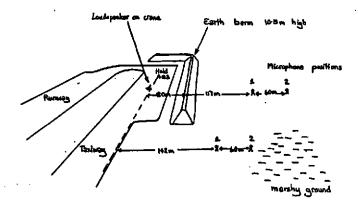
The authors wish to acknowledge the assistance of the British Airports Authority in arranging access for measurements, and providing a crane for raising the loudspeaker.

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Figure 1. Loudspeaker measurements



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Figure 2. Aircraft taxiing measurements

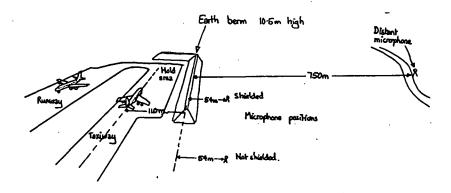


Figure 3 Effect of shielding at long range

