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PREDICTION AND MEASUREMENT OF GROUND NOISE FROM TAXIING AIRCRAFT AT HEATHROW TERMINAL 4

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1. INTRODUCTION

Following the original Terminal 4 (T4) planning inquiry held in 1979 the Secretary of State imposed a number of planning conditions (condition 10a-d) relating to the use of T4 which he considered necessary in order to protect the residential community surrounding the terminal area from the noise created at night by aircraft taxiing and ground running.

In summary the conditions prohibited aircraft movement to, or running aircraft at, the terminal site between 2330 and 0630 hours unless the aircraft had already landed. He further prohibited taxiing aircraft on the taxi way to the east of the terminal which connects runway 27 left and the terminal for an additional half an hour on the above times.

In April 1985, a report was published by the inspector following a second planning inquiry held to consider giving permission for the relaxation of the above restrictions. (1)

The Inspector, having been presented with conflicting technical evidence by the British Airports Authority (BAA), the appellants, and the local authorities, recommended that temporary planning permission be granted to the appellant for a period of three years from the date Terminal 4 became operational, to permit the taxiing of aircraft to and from the T apron of Terminal 4 at any time. The T apron faces north west away from the nearby community in Hounslow whilst the restrictions relating to the use of the S and V aprons orientated to the south east were to remain.

He further recommended that within this period of temporary permission the noise levels within the nearby residential areas should be extensively monitored by the appellant, in collaboration with the responsible planning authorities, to the satisfaction of the Secretary of State. At the end of this temporary permission the Secretary of State should decide, on the evidence of the noise monitoring test, whether to reinstate, delete or amend the previously imposed subcondition 10a of the 1979 planning permission.

2. REFERENCE NOISE LEVELS

The basic noise emission from an aircraft is usually stated for a standard linear distance. Usually to define aircraft as a noise source relatively short distances are used to avoid the effects of ground and air attenuation.

In the UK the source level (in NNI calculations) is quoted at 152 metres (500 feet).

For the purpose of prediction of ground noise at T4 the local authorities used data acquired from a field survey of taxiing aircraft under normal operating conditions. The predictions were based on a survey carried out in 1978 by the then Greater London Council.

At a distance of 78 metres sideline noise was measured, a mean $L_{A}max$ freefield value of 94.5 dB(A) was recorded for seven taxiing 747's. This value was corrected to obtain the 25 metre Source Noise Levels (SNL) shown in Table 1 below, which also indicates the level used by the BAA's Noise Consultants at the Inquiry and the extrapolated results of some recent unpublished work carried out by Flindell and Walker (4). The large variations shown in the table could not be fully explained at the Inquiry and was a major factor for the divergence of the predicted receptor noise levels.

TABLE 1

SNL's at 25m			
	BAA	LAs	Flindell
B747	94 (72)	108 (91)	- (87)
L1011	102 (80)	109 (92)	-

() indicate SNL's at 100m normalized using the measured/modelled attenuation rates used by each author.

3. ATTENUATION RATES

The above SNL's obtained at a distance of 78 metres by the local authorities were then used to calculate the predicted noise levels likely to be generated within the community by the taxiing aircraft using Terminal 4.

The reference noise data L_AMAX at each octave band were corrected for the effect of barriers by using the semi-infinite barrier method due to Maekawa with additional attenuation due to ground and air absorption.

These corrections rendered an attenuation rate of 8.2dB per doubling of distance (dd). The combined A weighted sound pressure level was then calculated for given receptor distances, barrier heights etc for the two main types of aircraft, B747 and Tristar L1011, likely to be in operation at the terminal.

A similar attenuation rate prediction was used by the BAA's consultants at the first T4 Planning Inquiry, however, at the condition 10 (2nd) T4 Inquiry a simplified 'global' attenuation rate of 11dB per dd was quoted in varience to the above.

This rate was based on work done by Walker and Flindell (1983)(3) where test data were obtained at Gatwick, Stansted, Prestwick and Glasgow Airports. The conclusions from these trials were that there appeared to be no advantage in allowing for any factors other than source to receiver distances plus possibly engine types and thrust settings in predicting noise levels generated in the community by taxiing aircraft.

4. NOISE SURVEYS

Ten noise monitoring surveys were carried out jointly by a team of observers from London Scientific Services, the London Borough of Hounslow and Spelthorne Borough Council from mid 1986 until 1988. Five sites were selected, four of which were close to sites originally chosen to predict the receptor noise level. The same four sites were used by the CAA, who were commissioned by Heathrow Airport Limited (HAL) to carry out a similar exercise. While attended measurements were carried out between 0400 and 0630 hours typically one or two days per month, an observer positioned 'airside' gave a commentary of the taxiing and APU operations so that noise level data could be related to specific aircraft events. Measurements were recorded onto tape and simultaneously displayed graphically on a level recorder. Each person at the monitoring sites was informed of the landing of aircraft and subsequent taxiing over block numbers with the aid of two

GROUND NOISE FROM TAXIING AIRCRAFT AT T4

way radios to enable the chart recordings to be suitably anotated for later identification together with a subjective description of the taxiing noise. Measurements were carried out 4 metres above ground (1st floor bedroom height) to compare with results obtained at 1.2 metre height. A comparison showed the $L_A$max of taxiing aircraft events to be typically 2dB(A) higher at the 4 metre height.

Simultaneously, at five minute intervals the environmental parameters $L_A$eq, L90, L50 and $L_A$max were also measured.

The meteorological conditions were noted from meteorological broadcasts received via an airband radio. Data recorded during windspeeds greater than 5 m/s were rejected. The typical range of results from the local authority survey, the CAA survey, are tabulated with the predicted data and shown in Table 2.

TABLE 2

LA_{max} Noise Predictions and Measurements — Taxiing Noise Terminal 4

Inquiry Site Number	Local Authority Prediction		Large et al Predictions Worst case aircraft	Local Authority Measurements*		CAA measurements*	
	B747	L1011		B747	L1011	B747	L1011
1	63 [69]	64 [69]	45	55—67†	—66†	62—68	55—65
2	59 [66]	60 [67]	47	48-66	51—65	58—64	53—66
3	58 [65]	58 [65]	49	49-65	50—65	57—61	58—65
4	68	69	48	59—69	57—66	52—68	53—64

* some events not measurable above the background noise level or not heard

[ ] 6dB per doubling of distance + Maekawa

† limited measurements

GROUND NOISE FROM TAXIING AIRCRAFT AT T4

5. DISCUSSION OF RESULTS

There was general agreement between the consultants at the Inquiry on the criteria that should be applied in the assessment of night-time noise.

i. The $L_A$max should not exceed 65dB(A), external
ii. The $L_A$eq should not exceed 50dB(A), external.

The results of the local authority monitoring showed that there were 8 events which equalled or exceeded the 65dB(A) external peak noise. Whilst this vindicated the predictions of the local authority experts it was not thought sufficient evidence to object to the continued use of the T apron of Terminal 4 provided that only aircraft producing similar or less noise emission than the 747s and L1011 monitored to date, are allowed to use the T apron facilities at night.

Clearly there was a large range in the measured noise levels with general agreement between the Local Authority and CAA results. The range is likely to be due to a combination of variables such as meteorological conditions, barrier effects, aircraft operations and directivity of the aircraft with respect to the receptor point.

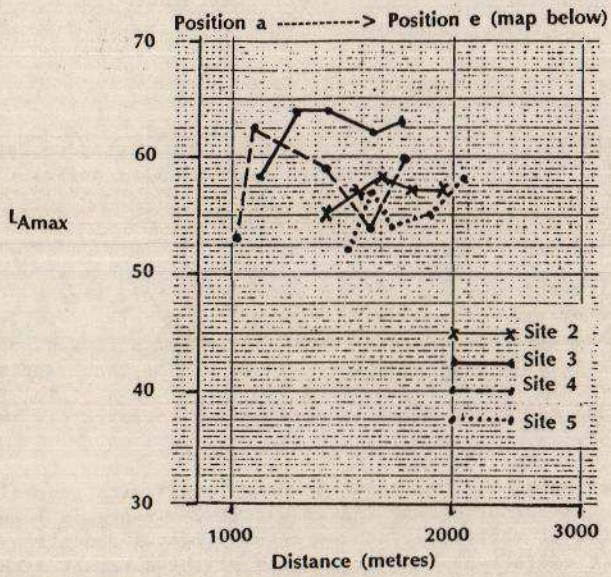
The comparison of the predicted and measured data given in Table 2 shows that the Local Authority method tended to predict levels within the upper range of the measured results. Conversely, the BAA's predictions more closely represented the levels not measurable above the background noise.

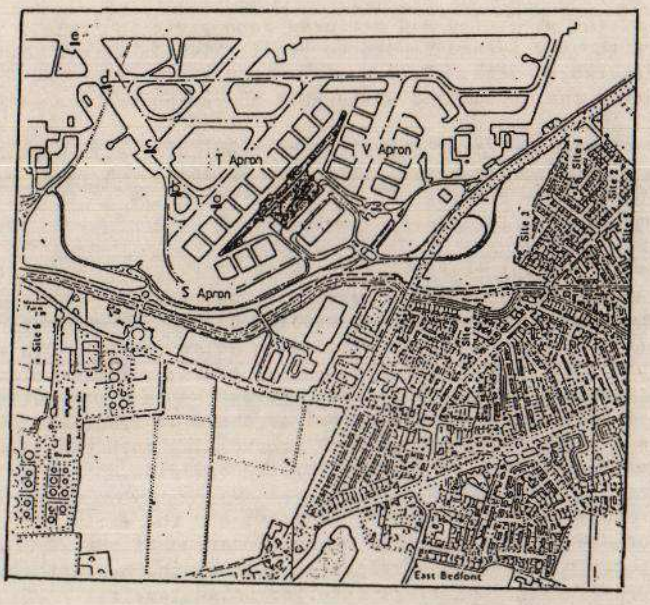
One of the major factors in predicting receptor noise levels is that of SNL's for respective aircraft types. The more recent unpublished work (4) would tend to support the findings of the Local Authority SNL's for B747's used for the Condition 10 T4 Inquiry (Table 1).

The results show an initial regression analysis of the local authorities. $L_A$max with distance data has found to give poor correlation. This was mainly due to the varying meterological conditions and in particular the effect of Terminal 4 (some 14 metres high) as a noise barrier. This effect is shown in figure 1 which displays the typical taxing noise levels at four community sites as a B747 aircraft taxied towards the terminal building. A sharp reduction in noise level was recorded as the B747 manoeuvred from the taxiway onto the T apron threshold (before progressing onto the stand) showing the degree of attenuation offered by the building.

A more detailed study of the data is in progress and the early indications show the need for useful consideration of the location of the aircraft source with respect to potential barriers as well as the overall distance automation when predicting long range receptor noise levels.

Figure 1 L_{Amax} with Distance for taxiing aircraft





REFERENCES

1. 'London Heathrow Airport Terminal 4 Public Inquiry Inspectors Report': G D Slade (1985)

2. R E Cadour, B J Atkinson, E Devine, C A A monitoring of 'The Noise Impact at Night of Heathrow Terminal 4 Operation' DORA Report 8717, Civil Aviation Authority (1988)

3. I H Findall, J G Walker, 'Long Range Propagation of Airport Ground Noise', Institute of Sound & Vibration Research (1989)

4. I H Findall, J G Walker, British Airports Authority - Unpublished Research (1989)

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