The Quiet Con

'A' Weighted Leqs as the Index of Aircraft Noise Annoyance

Produced for HACAN ClearSkies with the assistance of
FANG (the Federation of Aircraft Noise Groups).

CONTENTS

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Introduction

> Heathrow has seen a record of continuous long-term improvement in the noise climate with the number of people within its noise 'footprint' reducing from two million to about 300,000 over the past 25 years. This is despite a 70 per cent increase in the number of aircraft taking off and landing.
> *British Airways' High Life Magazine, November 2002*

> Nobody hearing evidence from people living around Heathrow as I have done could fail to appreciate the profound feeling that noise generated by aircraft using the airport has not been controlled in any effective manner.
> *Roy Vandermeer, QC, Terminal Five Inspector's Report*

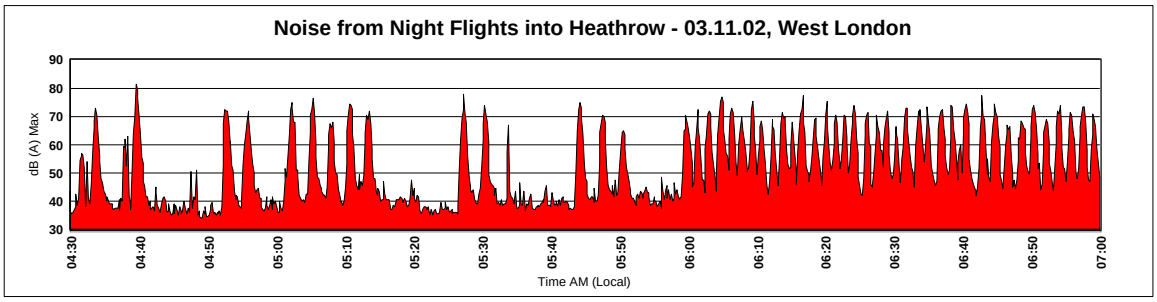
> The evidence confirms the Department's view that the contours are not faultless, and that other factors can and must be taken into account.
> *Roy Vandermeer, QC, Terminal Five Inspector's Report*

These three statements above refer to the same environmental problem, the aircraft noise currently endured by residents across London and the Thames Valley due to the position of Heathrow airport. The difference is that the first statement, written by a company who hope to persuade the Government to approve a third, and then a fourth runway at Heathrow, draws upon the measurement the Government itself currently relies upon, an 'A' weighted Leq. The second statement, on the other hand, is the testament of people actually subjected to that aircraft noise, as summarised by the independent T5 Planning Inspector. This is not a comparison of like with like: a 'profound feeling' is something to be wary of, because it relies on a subjective notion, whereas an Leq is an objective scientific measurement. The third statement, however, recounts an admittance by the Government that the way it currently assesses aircraft noise is faulty.

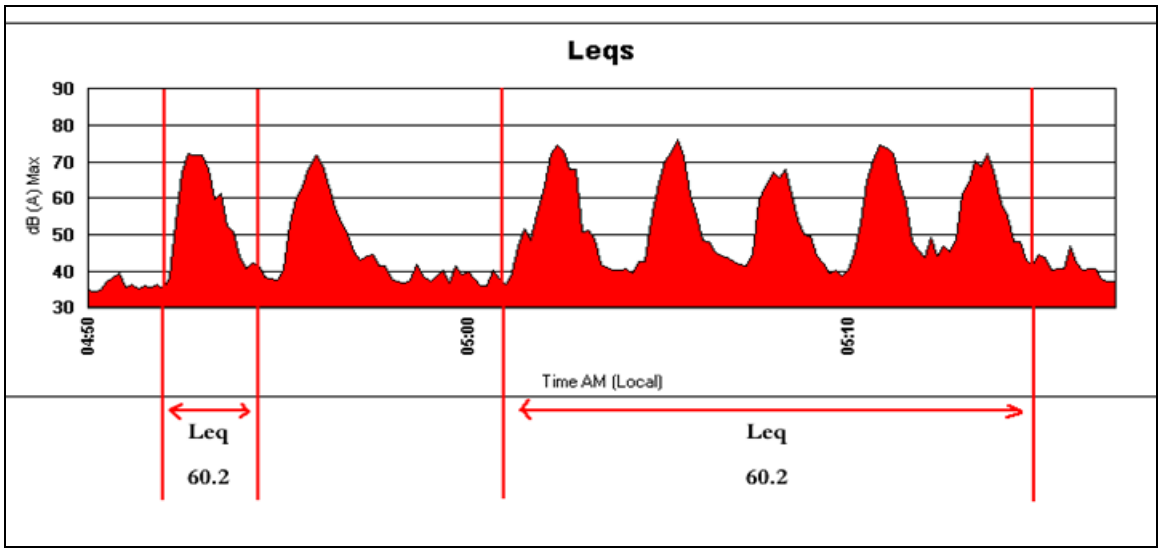
This paper is in two parts. The first part outlines what an Leq is, and looks at the way the Government uses Leq to measure the noise exposure dose of those subjected to aircraft noise. The second part focuses on the significance of the fact that the Leqs used are themselves 'A' weighted. Those already familiar with sound measurement and the arguments over the Government's continued use of Leqs may wish to go straight to Part II, which contains the original material of this paper. It should be noted that this paper has been produced with limited resources, and its limited aim is to persuade those responsible for assessing aircraft noise to use their resources to produce additional indices to 'A' weighted Leqs, sole reliance on which is likely to be distorting the truth.

Part 1: Sound Level Equivalent, Leq

L stands for sound Level, and eq stands for equivalent, and Leq is an average Decibel measurement of sound over time, called a Sound Level Equivalent. The graph below shows how the sound level, L, varies with time as aircraft fly overhead[1].

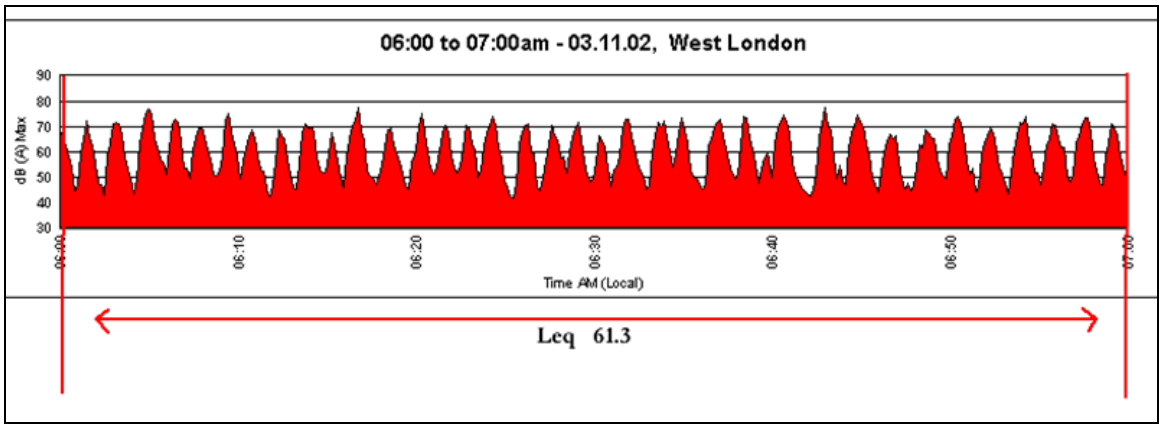


The background noise level is a little under 40 dB, and each time an aircraft flies overhead the sound level rises to around 70 dB. Leq averages out the sound to produce a single dB figure, equivalent to an unvarying level of sound over the same time period. This figure is then used as a measure of noise exposure.



In the above graph, for instance, the sound level starts below 40 dBs, increases to over 70 dBs, then dies away again: the Leq for a single aircraft movement is only 60.2 dB, despite the fact that for 20 seconds the aircraft is producing over 70 dBs. Similarly the Leq for the five aircraft (shown on the right) arriving at Heathrow between 05:00am and 05:20am is also only 60.2 dB, although four out of the five actually produce more than 70 dBs.

[1] All noise measurements in this paper are taken from approaching aircraft approximately 6 miles from the runway threshold, at which point aircraft are descending through 2000ft.

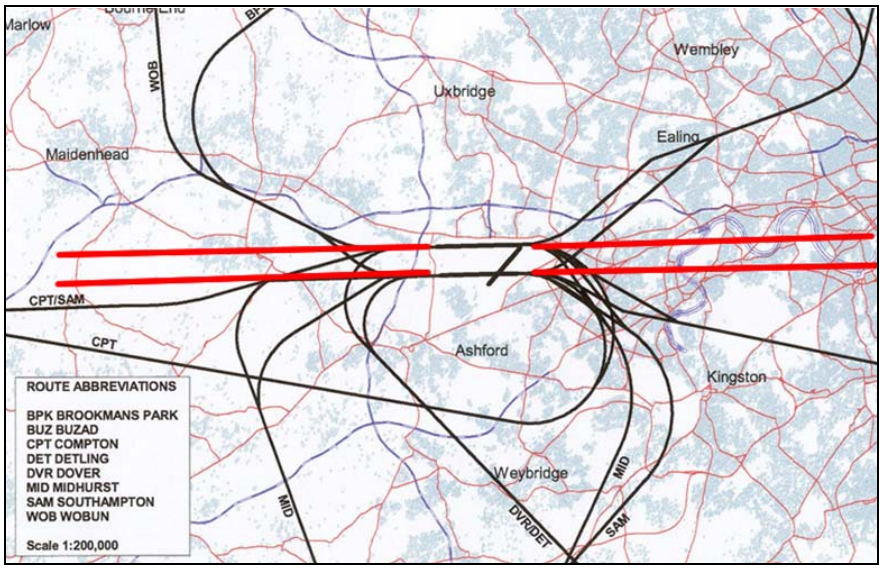


Similarly in the graph above the Leq between 06:00am and 07:00am at Heathrow is 61.3 dB, produced by a background sound level of 40dBs, and 36 peaks of aircraft noise, most of which exceed 70dB. This pattern is reproduced throughout the 16 hour day, the period the Government uses to produce the daytime Leq figures for Heathrow. It is true, as the Government argue, that Leq is a universally recognised metric of noise dosage for near continuous sound over a given time period. However, Leq it is not well-suited to measuring aircraft noise, because, as the above graphs illustrate, aircraft noise is made up of a series of distinct events. These limitations of Leqs when applied to this type of noise hazard are recognised internationally, for instance by the World Health Organisation:

> Where there are no clear reasons for using other measures, it is recommended that LAeq,T be used to evaluate more-or-less continuous environmental noises. However, when there are distinct events to the noise, as with aircraft or railway noise, measures of individual events such as the maximum noise level (LA Max) or the weighted sound exposure level (SEL) should also be obtained in addition to LAeq,T.
> *WHO Guidelines for Community Noise, Executive Summary, p2*

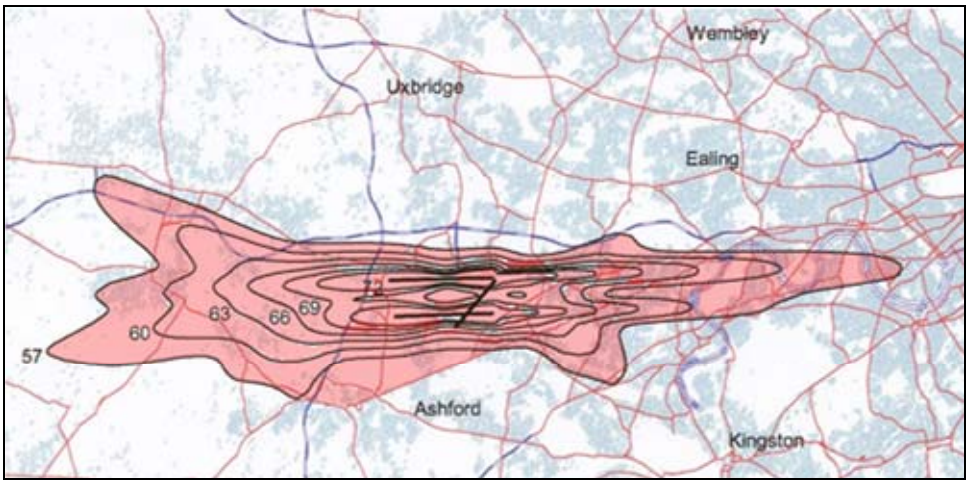
Leq Noise Contours

The approach and departure routes at Heathrow are given in the map below:



Departure (in black) Routes, and Straight-in Approach Paths (in red) for Heathrow

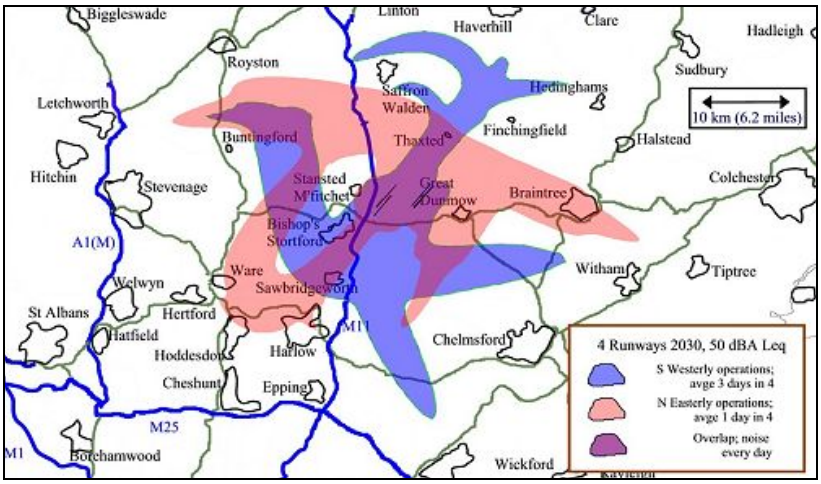
By feeding these routes into a computer and using information about the noisiness of individual aircraft generated by monitors, the Government uses the 16 hour LAeq to produce daytime noise contour maps out to a level of 57 dB.



16 hour Heathrow Noise Contours out to 57dB LAeq, for 2002.

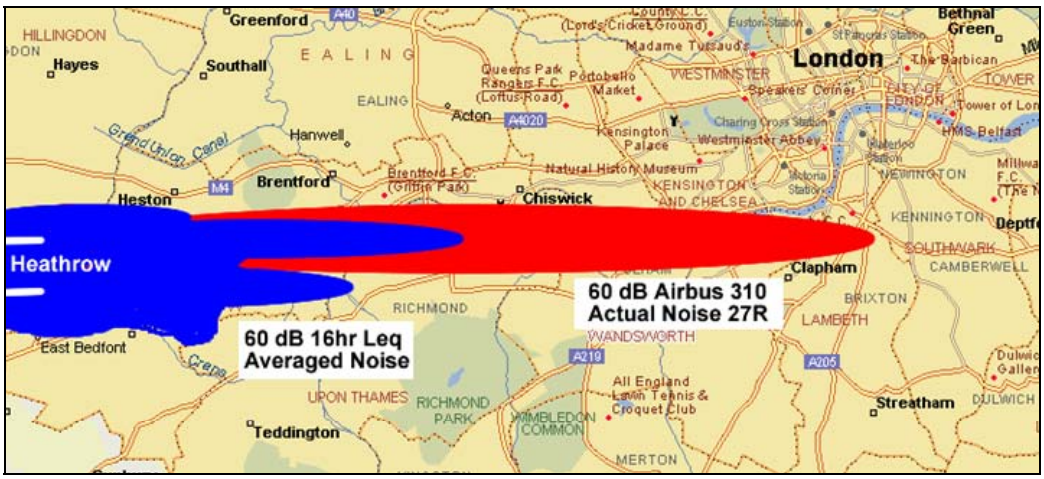
Aircraft need to take off and land into the wind, so westerly winds mean that they approach Heathrow to land over London, heading west, and take off over Windsor, also heading west. This is known as 'westerly operations' or 'westerlies' for short. When the wind is from the east the pattern is reversed, and aircraft approach over Windsor, and take off over west London, heading east. The ratio between westerly and easterly operations at Heathrow is know as the 'modal split'. The prevailing wind over the United Kingdom is from the west, as a result of which for approximately 75% of the time Heathrow is on westerly operations. On easterly operations aircraft turn sharply soon after take off, to avoid the built-up areas straight ahead, instead flying over Ealing to the north, or Twickenham and Wimbledon to the south, giving rise to bumps in the noise contours out towards Ealing and Kingston. On westerly operations the turns are not so tight, spreading the contours over Slough to the North, and to the south east of Windsor to the south. This is partially why, to the east of Heathrow over west London, the contours produce a longer, narrower shape than over Windsor.

There is another reason for the asymmetry in the noise contours, however, which is the way the modal split is incorporated. The approach paths over Windsor are only used 25% of the time, and thus feature less strongly. So not only is the Government using ALeq in a non-standard way because aircraft noise is a series of high noise events rather than near continuous sound, but the resultant inaccuracy is then magnified by including the periods of relief experienced due to altering wind direction. This shrinks the contours and gives a false picture of the extent of aircraft noise. For instance, when Heathrow is on Westerly Operations, which occurs approximately 273 days of the year, a lot more people are living within the 57dB Leq than is suggested by the Government's noise contours. What is needed are separate sets of contours for westerly and easterly operations, together with an indication of the proportional split between the two. An example of this for Stansted with four runways, produced not by the Government but by local individuals, is given overleaf:



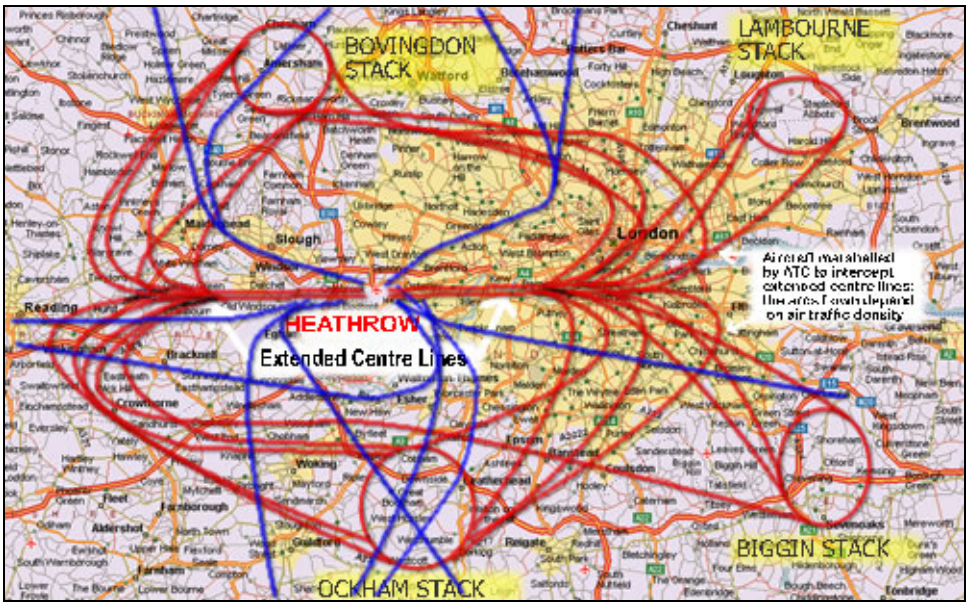
Stansted SERAS projection: Noise Contours showing modal split

The above map uses Leqs as its basic index, but there are other ways in which the extent of noise disturbance can be assessed. The map below, for instance, compares the 60dB LAeq noise contour (in blue, only going as far as north Richmond) with the actual 60dBA noise footprint of an Airbus 310 (in red, stretching out to north Brixton). The red contour shows the extent of people subjected to actual noise above 60dBA whenever an Airbus A310 lands at Heathrow on Westerly Operations. The map assumes a straight in approach, and an Airbus 310 is a short haul QC1 rated (relatively less noisy) aircraft.



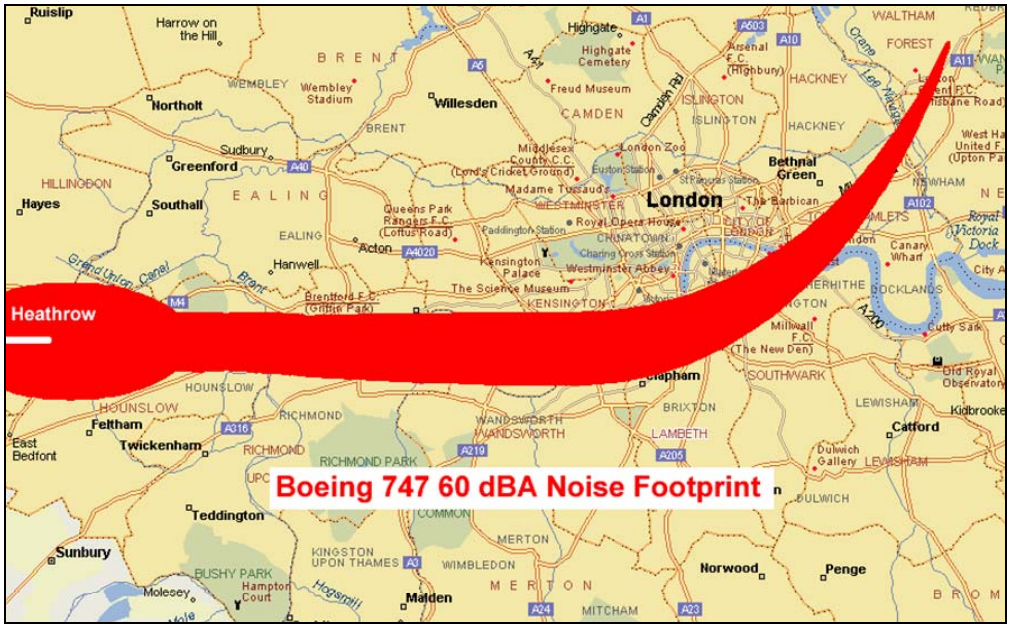
60dB LAeq v. 60db LA Max Noise Footprint for an Airbus 310

The production of noise contours assumes a straight in approach by all aircraft, but this is not what happens in practice. Heathrow is fed with approaching aircraft from four stacks: the overall picture of both arrival and departure tracks, is illustrated in the map below.



London Heathrow - arrival (red) and departure (blue) routes. (The red arrival routes show the variety of flight paths aircraft may take, depending on the volume of traffic. The blue departure routes are fixed - aircraft may not deviate from them below 4000ft unless directed to do so by air traffic control for operational reasons.)

The map below approximates the area of noise produced by a Boeing 747 - 400 coming off the Lambourne stack and turning over Stockwell to line up on Heathrow's northern runway. (Although the Government do not use Leqs to measure night noise exposure, 60dBA, it should be noted, is the level which the WHO experts on the subject agree should not be exceeded at night. A high proportion of the 14-16 aircraft which currently arrive at Heathrow between 04:00 and 06:00 am are Boeing 747s.)



Boeing 747 arrival noise footprint 60dBA (from Lambourne stack) - approximation

To use ALeqs as the sole index of aircraft noise is unsatisfactory not only for the reasons given above, but also because it fails to give adequate weight to the large increase in the numbers of aircraft now using Heathrow. The way sound is perceived in a human mind does not correspond in a linear way to its energy level: to double the amount of energy in a sound wave is not to make the sound twice as loud. The relationship between what is heard and the energy present in the sound wave corresponds instead to a logarithmic scale - thus the Decibel scale is logarithmic. To double the number of aircraft is to increase the Leq by approximately 3 (10 log 2), or, to put it another way, to decrease the average sound of each aircraft by 3 dB enables a doubling of the number of aircraft without increasing the Leq. To understand the mechanism requires mathematical skill, but the effect can be clearly expressed:

> Or again, given that the current number of ATMs at Heathrow (427,000) is roughly equal to the numbers at Gatwick, Stansted and Luton combined, according to the Leq model the population around Heathrow would hardly notice if all the latter flights were transferred to Heathrow. This seems so patently absurd that it calls into question the whole concept of Leq as a tool for quantifying changes in the response of the population over time.
> *Dr Hugh Jones, Imperial College, Proof of Evidence presented to T5 Inquiry*

Another way of illustrating the point is to examine the way Leq is misleading and look at the effect of runway alternation, as was also raised at the T5 Inquiry:

> Suppose that the Government decided that runway 27L would always be used for landing, and runway 27R always for take-off, as indeed was the threat when a third parallel runway was considered at Heathrow. That means that for half the population the numbers [of aircraft] would be roughly doubled, whereas some would have the numbers greatly reduced. Thus at a stroke roughly half the population would be removed from the 57 Leq contour, so that one could claim that "the number of people affected by aircraft noise" had been drastically reduced.
> *Dr Hugh Jones, Imperial College, Proof of Evidence presented to T5 Inquiry*

The way in which the Leq index fails adequately to reflect the distress caused by the increase in number of aircraft using Heathrow is summed up by the T5 Inspector as follows:

> I do not believe that the increase in the number of movements has been adequately reflected in the LAeq 16 hour measure
> *Terminal Five Report, 21.3.52*

This point becomes particularly significant with the retirement of Concorde. With respect to departures, Concorde's contribution to the LAeq was almost the equivalent to that of the rest of the entire fleet put together. Overall Concorde produces as much sound energy as 120 Boeing 757s, so if the Leq scale alone is used as a 'noise cap' (as both British Airways and BAA plc are calling for) Concorde's demise would let in a further 120 Boeing 757s. This is a direct illustration of the inadequacy of Leqs, because four hours worth of non-stop noise from Boeing 757s at a rate of one every two minutes, is very much worse to have to endure than two minutes of one extremely loud Concorde, followed by 3 hours 58 minutes relief. Unfortunately, however, the Government have chosen to use noise contours which include Concorde as a base from which to measure any deterioration in the noise climate should a third runway be built at Heathrow. With regard to Terminal Five, the Inspector warned against this:

> I have grave doubts as to the validity of using the potential benefits of phasing out Concorde as a justification for permitting Terminal Five.
> *T5 Summary Document, 88, p16*

Using such an index the number of noise events over 70dBA, as used by Sydney International Airport (see Appendix III), overcomes the way Leqs mask the number of aircraft involved.

There is also the fundamental point that the figure of 57dBLAeq, chosen by the Government to be the 'onset of community annoyance', is two decibels higher than the international figure used by the WHO, which acknowledges that serious annoyance commences at 55 dBLAeq. The Government's rationale for adding two decibels to the figure is as follows:

> Because most aircraft noise originates from above, contours include the effect of ground reflection (see Note 2)
>
> Note 2: Aircraft noise: daytime values accord with the contour values adopted by the DfT which relate to levels measured 1.2m above open ground. For the same amount of noise energy, contour values can be up to 2dBA higher than those of other sources because of reflection levels.
> *Planning Policy Guidance (PPG24): Planning and Noise, June 1997*

There is no scientific justification for this: what needs to be measured is what actually affects people, and this includes any inevitable ground reflection. A person comparing 57dB's worth of experienced car noise with 57dB's worth of experienced aircraft noise, is going to be subjected to the same level of noise, and is not going conclude that the aircraft is in fact 2 Decibels less noisy because the noise comes from above and is more prone to ground reflection - but that is how the DfT attempt to justify their reduction of the threshold. It has been claimed that there is a statistical correlation of the onset of annoyance with the 57 dBAleq contour, but the scientist called on behalf of the Government at the T5 inquiry was forced to admit that the Government's own press release on the subject was misleading, and that this correlation is in fact statistically weak.

> The expert witness for the Department did not attempt to hide the deficiencies of LAeq measures in general and the LAeq 16hour in particular. He accepted that the relationship between LAeq and community annoyance was statistically weak and that the ANIS report had not found a rapid increase in disturbance at 57dB LAeq as the press notice issued at the time had suggested.
> *Terminal Five Inquiry Report, 21.3.32*

It should also be noted that even 55 dB LAeq may be too high a figure, because the World Health Organisation figure for the onset of annoyance (as opposed to serious annoyance) is a full five decibels lower, at 50 dB LAeq. To use the example of Stansted again, if the 50 dB contour is plotted against the official 57 dB contour, its area is almost 2.5 times larger.

Stansted: WHO compared with D/T

Factors such as these (although he did not have access to the Stansted produced contour maps) all contributed to the highly critical way in which the Terminal Five Inspector, after listening not only to the Government, but also to independent witnesses, came to regard Leq.

> I do not, however, believe that it is right to rely entirely upon the single measure of LAeq 16hour. As I have already pointed out this suffers from a number of deficiencies which, in my judgement, limits its value as a true and complete reflection of the impact of aircraft noise on those living around Heathrow.
> *Terminal Five Inquiry Report, 21.3.38*

To appreciate the full weight of the Terminal Five Inspector's criticisms please see Appendix II.

Even the Secretary of State for Transport was forced to take notice of these independent criticisms of the Leq, although his mentality as revealed by his use of the word 'adequacy' when the topic to be addressed is clearly inadequacy.

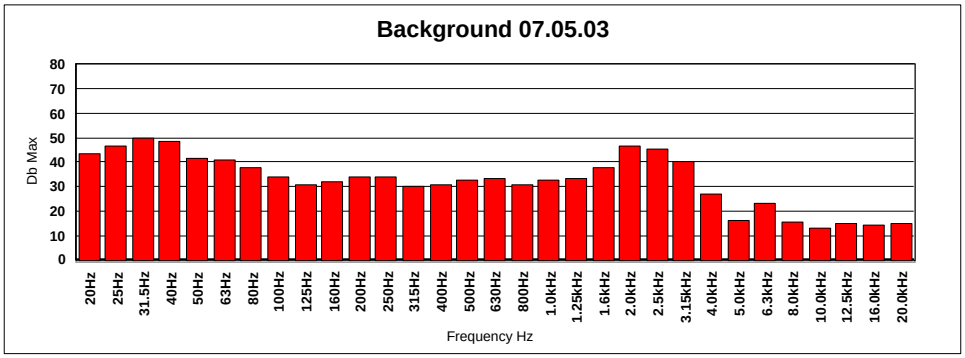
> 60. In the light of the Inspector's views on the adequacy of the Leq index, the Secretary of State thinks it right to adopt a precautionary approach.
> *T5 Acceptance Letter, 20th November 2001*

The Government themselves, therefore, when for the first time really put under the pressure of an independent examination, agreed that Leq fails to provide a robust measurement of aircraft noise exposure. However, the inadequacies referred to above all come into play before any consideration is given to whether 'A' or 'C' weighting used.

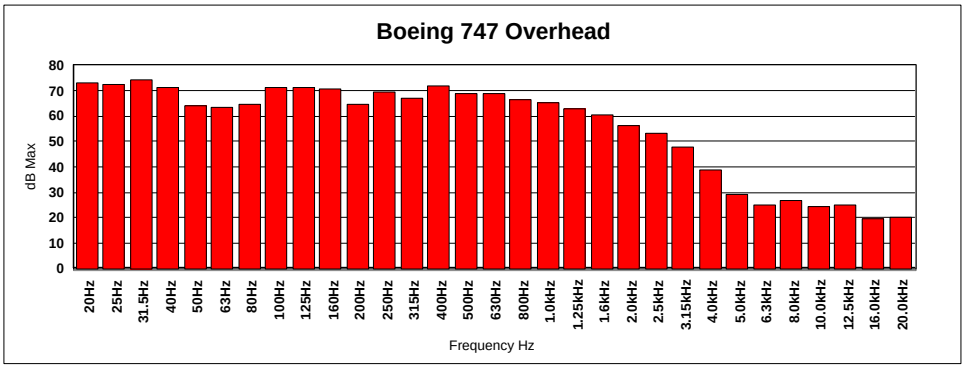
Part II: The Use of 'A' and 'C' Weighting

The next time you hear a bird singing, try blocking your ears, and you'll find that you can hardly hear the bird. Try the same thing when an aircraft flies overhead, and you'll find that despite blocking your ears a lot of the noise still gets through. This is partially because the aircraft is louder, but also because, unlike the bird song, a lot of the aircraft's noise occurs at low frequency. Low frequency sound travels further and has greater penetrative power than medium or high frequency sound, to the extent that when you hear the aircraft noise with your ears blocked, much of the sound is being transmitted by your skull.

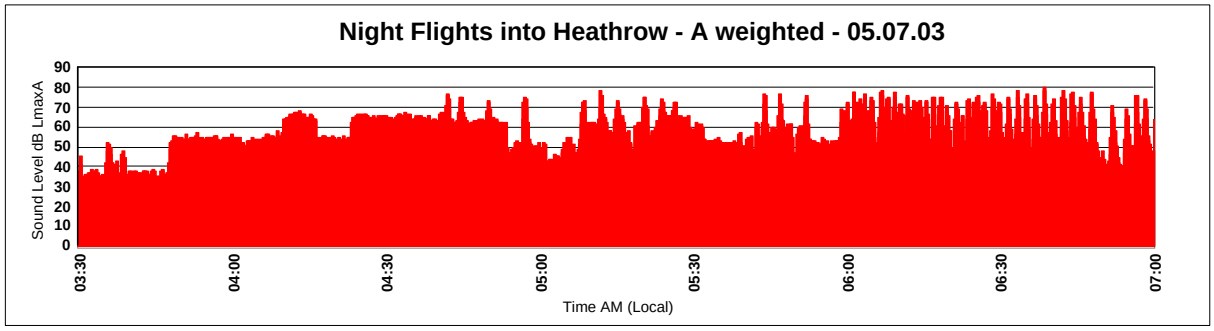
The human mind does not hear sound in a uniform way: it is more sensitive to sound at medium and high frequencies than to low frequencies. To reflect this fact in a way which allows sound to be measured 'as heard' an 'A' weighting filter can be applied to the level of sound as measured by a meter. 'A' weighting largely discounts sound below 200 Hz, and at low and medium volumes of sound this gives an accurate picture of the way sound is perceived. In the graph below, which breaks down sound into its different frequencies, the peak at 2.0kHz is a nearby blackbird singing. The rest of the sound is the kind of background hum to be heard in a city back garden - mainly distant road traffic, a rumble which does have a relatively large low frequency component. At low overall levels of sound, generally speaking the low frequency component is not distressing.



In the next graph a Boeing 747 passes overhead: the blackbird is drowned out by the whine of the turbines, and the characteristic low frequency roar takes over, as indicated by the large amount of high readings at and below 200 Hz. This graph goes down to 20 Hz, which is roughly the lowest note which a human ear hears. However, if an 'A' weighting is applied to the sound level measurement most of the noise between 200Hz and 20Hz, a large proportion of the total noise caused by aircraft is discounted.

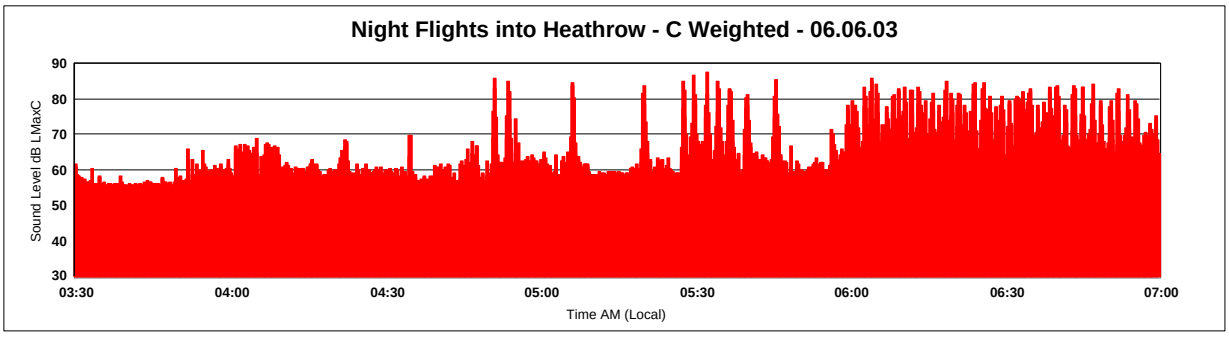


The effect of this when measuring aircraft noise can be illustrated by a direct comparison of early morning night flights into Heathrow.



5th July 2003 was a clear morning, and the increase in background sound level, starting a little before 04:00am and peaking just after, is the dawn chorus. The sound level initially begins below 50dBA, and then increases when the birds start singing to reach a level in the high 60s from just before 04:30am. At around 04:40am the first aircraft arrives, peaking at 78dBA. What is significant, however, is that using 'A' weighting, the noise of the first aircraft appears to be only slightly louder than the bird song. This runs contrary to the way the noise from the aircraft drowns out the bird song: experientially, the bird song and the aircraft noise are very different categories.

'A' weighting is not the only weighting that can be applied to a sound measurement to ensure that it accurately reflects what it heard. 'C' weighting is used when the noise is loud, and especially when there is a large low frequency component. If we now take a look at another morning when the birds sang and night flights came in, a different picture emerges.



The background sound level (the rumble of distant traffic) has increased from around 40 dBs to the high 50s. The dawn chorus is much less marked and peaks at below 70 dB (the same as with the 'A' weighted measurement, because birds cannot physically produce low level sound) and then the first aircraft comes in, just before 05:00am, at 86 'C' weighted decibels. This gives an accurate indication of the full spectrum of noise produced by a modern airliner, something which is particularly important when considering sleep disturbance (as in the above graph, at around 5am in the morning).

The World Health Organisation acknowledge the significance of low frequency sound:

> Special attention should also be given to: noise sources in an environment with low background sound levels; combinations of noise and vibrations; and to noises with low-frequency components.
> *Guidelines for Community Noise, Exec Summary 3.10 - World Health Organisation [WHO]*

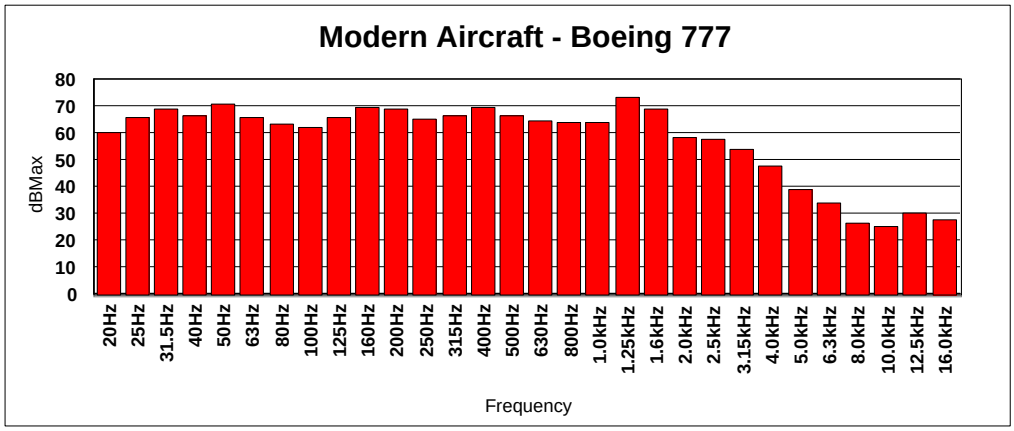
The European directive on the assessment and management of environmental noise also refers to the low-frequency component:

> 3. Supplementary noise indicators
> In some cases, in addition to Lden and Lnight and where appropriate Lday and Levening, it may be advantageous to use special noise indicators and related limit values. Some examples are given below:
> - the low-frequency content of the noise is strong.
> *EC Directive 2002/49/EC Annex 1.3*

Unfortunately, the UK Government continues to refuse to acknowledge the significance of the large low frequency component of aircraft noise:

> On the question of aircraft noise measurement weighting, there are no plans to depart from the use of A weighted decibels...
> *Written Response from the DfT, 27th March 2003*

There is much talk of 'sustainability' in the run up to the forthcoming White Paper on aviation, and how it will be possible to manage aircraft noise to achieve this. However, massaging the way the noise is assessed is not an honest start to managing it. It is true that aircraft have become quieter, but a lot of the improvements have been in the mid to higher frequencies (the characteristic whine of a jet engine). A large aircraft needs to generate a lot of power to remain airborne, even in the landing phase, giving rise to the characteristic highly penetrative roar/rumble (not unlike hearing thunder in the distance). Even the most modern large 'quiet' aircraft, the Boeing 777, puts out a lot of low frequency sound. This aircraft is classified QC1 or even, depending on the engines fitted, QC 0.5 for approaches (ratings which under the current regime allow a large number of these aircraft to land at Heathrow between 23:30 and 06:00), but the graph below indicates that despite these ratings there is a large output of noise below 200 Hz, the part of the noise spectrum discounted by the use of 'A' weighting.



Conclusion

The continued sole reliance on 'A' weighted Leq as the index of aircraft noise annoyance by the UK Government is masking the true extent of the aircraft noise. The Government needs to acknowledge that aircraft noise consists of a series of discreet loud events, and has a large low frequency component, and should therefore be assessed using additional parameters, as recommended by both the World Health Organisation and the European Union. The Government's continued sole reliance on 'A' weighting may partially explain the discrepancy between objective 'scientific' claims that the number of people affected by aircraft noise has diminished considerably, and the subjective observations of those who actually have to endure the noise, particularly those living outside the official noise contours.

The UK Government, which has already agreed that the way it currently measures aircraft noise is flawed, is about to publish a White Paper on the future of aviation in the UK over the next thirty years. This is likely to propose that new runways are necessary despite the environmental problems they cause. The way the Government currently assesses aircraft noise, however, fails to provide an adequate picture of the problem of aircraft noise. Instead, the parameters used by the Government are likely to underestimate significantly the levels of noise residents living up to 20 miles away from major airports are forced to endure. The public's confidence in the forthcoming White Paper, and possibly also its legal standing, are likely to be compromised unless the Government can demonstrate that, in order to assess accurately and honestly the true extent of the environmental degradation caused by aircraft noise, it is prepared to adopt more objective indices of aircraft noise measurement than 'A' weighted Leq.

References

WHO Guidelines for Community Noise, Executive Summary

Directive 2002/49/EC

Status of Low-Frequency Aircraft Noise Research and Mitigation - Wyle Report WR 01-21

Validity of Leq, Proof of Evidence, T5 Inquiry, Dr Hugh Jones

Terminal Five Report, Roy Vandermeer QC

D/T Noise Contours

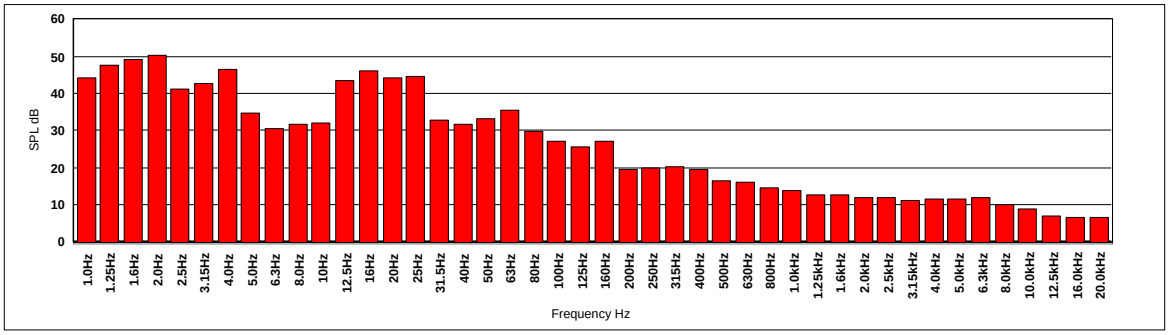
Stansted Noise Contours - Stop Stansted Expansion

Appendix I

Infra-Noise

In addition to the problem of low frequency noise (200 Hz down to 20 Hz), there is also the problem of 'infra-sound'. This is caused by very low frequency 'sound' waves below the hearing threshold of most human beings. They can however be felt (typically in the chest, or through the feet) and at high levels they are liable to cause vibration inside houses (because their penetrative power is very great) - loose fittings, cups and glasses, etc. may rattle. A graph showing the whole frequency range output of a modern jet liner indicates a large infra-sound component:

Complete Frequency Spectrum of an Aircraft Overhead



It should be noted that all the above measurements relate to approaching aircraft, using lower throttle settings. On take off, with much higher throttle settings, the low frequency problem is more acute, with those people behind the aircraft most susceptible. In the United States this problem is caused 'back blast', and the Wyle Report WR 01-21 (see bibliography) is largely dedicated to it.

Appendix II

Extract from the Terminal Five Inquiry - The Inspector's criticisms of Leq

My Conclusions

21.3.29 In assessing the effect of Terminal 5 on the overall noise climate I must first consider the manner in which that climate is measured. I accept the Department's view that any noise index must be reliable, robust, realistic and sensitive. However, I am not convinced that the LAeq 16hour index used by the Department meets all of those criteria. It was criticized by all the main parties opposing Terminal 5 as failing to reflect the actual experience of those living around Heathrow. To some degree such criticisms would be inevitable whatever the form of index adopted. The evidence of those individuals who appeared at the inquiry or made written representations confirms responses to noise vary widely. Consequently any index which attempts to translate this into an average representation of annoyance across the community as a whole must by definition fail to reflect the extremes at either end.

21.3.30 The criticisms of LAeq 16hour go further and deeper than this, however. Although the ANCOM 1 model which is used to generate the LAeq 16hour contours attempts to reflect actual experience in that it uses noise measurements taken from aircraft operating at the London airports, it cannot take into account the

effect of different weather conditions. More significantly it was accepted that it does not reflect the use of runway alternation. Since it is based on average conditions, those affected by runway alternation experience noise levels some 3dB higher while the flight path they live under is in use and 3dB lower when it is not. This is such a fundamental feature of operations at Heathrow that I believe any index which fails to reflect it must be open to question.

21.3.31 Equally LAeq 16hour does not indicate the maximum noise of individual events so that it cannot indicate how many times conversation is interrupted in a particular location whether it be a school, a major public space such as Kew Gardens or a private house or garden. Since these are the very factors which cause annoyance, I can understand why many argued that LAeq 16hour failed to reflect the concerns felt by local residents. I shall consider the impact of Terminal 5 on noise at night in the next part of this Chapter but I should note at this point that the LAeq 16hour measure by definition excludes the night period. Although the Department and BAA argued that it was a good proxy for a 24 hour LAeq, the Department also accepted that this could change if there were a substantial shift in the balance of traffic between night and day.

21.3.32 The expert witness for the Department did not attempt to hide the deficiencies of LAeq measures in general and the LAeq 16hour in particular. He accepted that the relationship between LAeq and community annoyance was statistically weak and that the ANIS report had not found a rapid increase in disturbance at 57dB LAeq as the press notice issued at the time had suggested. I am in no position to investigate the events which took place in 1982 but, on the evidence placed before me, it does seem likely that the weight attached to the 57dB LAeq by the Department as the measure of the overall noise climate is greater than the original research would support. 21.3.33 The greatest single criticism of the LAeq approach was that it failed to give adequate weight to the number of aircraft movements. As the Department accepted, the addition of a further 400 movements by light Chapter 3 aircraft would increase the LAeq 16hour by only 1dB. As the Department acknowledged even a difference of half a decibel could be significant and the area enclosed by a contour would increase by 15-20% for each 1dB increase in the LAeq level. To this extent the LAeq is influenced by the number of events. The issue is whether that influence is sufficient to reflect the experience of those affected. In this context I am concerned by the evidence that for departures, Concorde's contribution to the LAeq 16hour was almost equivalent to that of the rest of the fleet put together. This reflects the claim that Concorde produces as much noise energy as 120 Boeing 757's or 35 Boeing 747-400's.

21.3.34 In fact, many of those appearing at the inquiry told me that the noise climate had deteriorated and that this was largely due to the increase in the number of movements. They were unconvinced by claims based on LAeq 16hour that the noise climate had improved. While I recognise that the sample of people canvassed by HACAN might not be representative I do accept that many of those living around the airport believe that the noise climate has got worse over the last 5-10 years. A substantial number genuinely find the existing noise levels distressing and unacceptable. Since there is no dispute that individual aircraft have become quieter in that period (by a factor of 3.3 according to BAA) I am satisfied that their perceptions must be based on the substantial increase in the number of movements. I also conclude that this is not truly reflected in the LAeq 16hour index.

21.3.35 This brings me on to another criticism of LAeq. It was pointed out that the original study which led to its adoption had taken place in 1982 at a time when Heathrow had been handling some 220,000 movements a year. It is now handling over 440,000 movements (para 8.2.56) and people's perceptions of noise may well have changed in the 18 years since the ANIS report was produced. The Department recognised that it was very difficult to establish the true underlying relationship between the noise of individual events and their number and accepted that it would have been useful if further social surveys had been carried out. I strongly endorse this view. If parties are to have confidence on the indices used to measure the noise climate they need to be founded on a sound basis of up-to-date research. Unfortunately the Department 's own evidence suggests that this does not apply to the use of LAeq, in spite of their argument that research had guided the choice of noise indices since 1967.

21.3.36 Having identified and accepted many of the criticisms of the LAeq system in general and the LAeq 16hour index in particular, it is fair to record that it was presented to the inquiry only as a means of indicating those areas in which various levels of annoyance were likely to occur. There was no suggestion either that everybody within the 57dB LAeq 16hour contour would be annoyed or that nobody outside it would be annoyed by aircraft noise. Indeed the Department accepted that many complaints came from people living outside the area exposed to 55 dB.

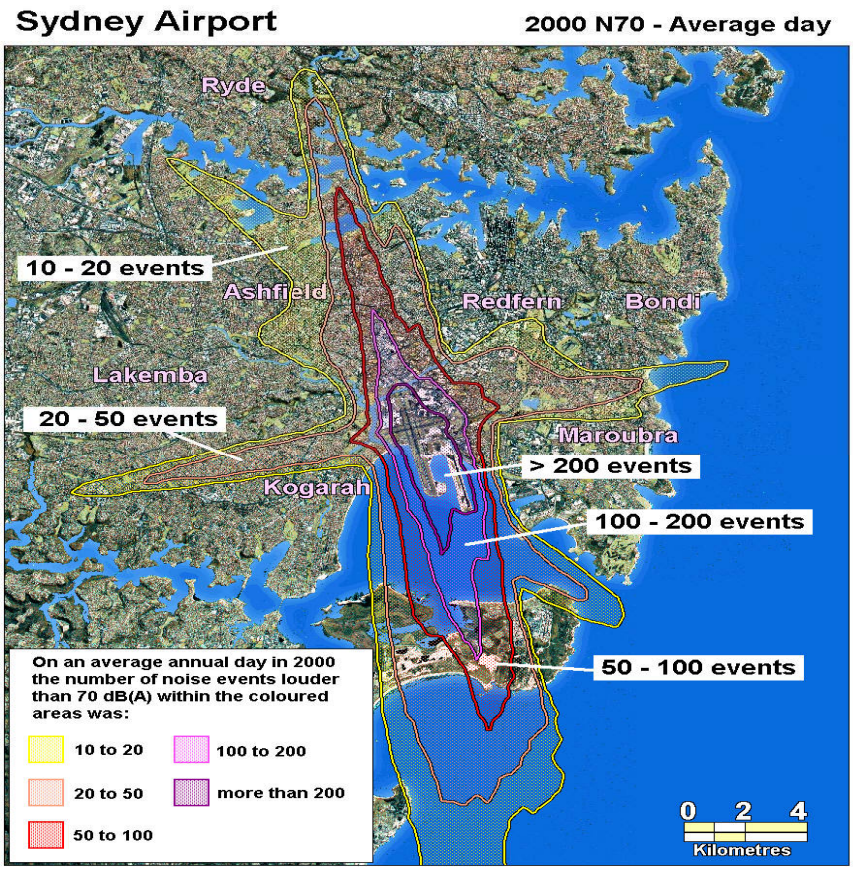
21.3.37 With all its limitations the LAeq system remains the means adopted by the Department to measure changes in noise exposures and to forecast the degree of community annoyance likely to result. It is used throughout PPG 24 the most recent policy advice on the subject and is specifically applied to aircraft noise in that guidance. On that basis, it should be applied as part of the test of the effects to Terminal 5 although not in the form of the noise exposure categories in PPG 24 since these do not apply to new noise sources such as Terminal 5.

21.3.38 I do not, however, believe that it is right to rely entirely upon the single measure of LAeq 16hour. As I have already pointed out this suffers from a number of deficiencies which, in my judgement, limit its value as a true and complete reflection of the impact of aircraft noise on those living around Heathrow. Consequently, I have some sympathy with the approach adopted by LAHT5 and Hillingdon in examining the impact of Terminal 5 on particular locations and under different headings. I believe that this work illustrates the importance of a more detailed assessment than that provided simply by the LAeq 16hour contours. I have recorded the Department's view that it would be wrong of me to judge the effects of Terminal 5 solely by use of the LAeq 16hour contour alone (para 21.3.4). That is a view to which I would have come in any event on the basis of the evidence I heard. I am, however, grateful that the Department made such a concession particularly against the background of a number of assertions by Government that the noise climate around Heathrow was improving based purely on the LAeq 16hour contour. The evidence confirms the Department's view that the contours are not faultless, and that other factors can and must be taken into account.

Appendix III

An Alternative to Leq

Sydney airport, similar to Heathrow because it is cited so that approaching aircraft overfly the city, does not rely on Leqs to indicate the extent of the noise problem. Instead, maps are produced showing the density of air traffic, and also maps giving information such as the number of noise events above 70 dB A on an average day, as below:



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