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## NOISE IMPACT OF AIRPORT DEVELOPMENTS

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### 1. INTRODUCTION

In the early days after World War II, Heathrow Airport was developed as London's major International Airport and its increase in size to a three terminal airport in the 1960's was not significantly impeded by planning restrictions. The introduction of jet aircraft in 1958 had caused a marked rise in the number of noise complaints and the Wilson Committee [1] in 1963 considered the noise problem at Heathrow as "acute".

### 2. THE NOISE AND NUMBER INDEX (NNI)

The Wilson Committee instituted the social survey which lead to the production of NNI, relating measured noise level and number of aircraft to annoyance. Their investigations were concerned with ways of dealing with an existing noise problem and concentrated on reducing noise levels of aircraft and improving the sound insulation of houses around the airport by a grant scheme for double glazing. The planning of future airport developments was not considered; the position of Heathrow as the major London airport was already established and the Wilson Committee could not believe that Heathrow could cease to be a major airport. NNI was subsequently used in all Airport Inquiries for the next 20 years for evaluating aircraft noise. The relationship was  $NNI = 15 \log N + \text{Average peak noise level} - 80$ . Where N is the number of aircraft above 80 PNdB between 0600 and 1800 GMT on an average day between June and September. The average noise level is in Perceived Noise decibels (PNdB). The Wilson Committee found that between 50 and 60 NNI aircraft noise becomes "intolerable". Subsequently the following degrees of "annoyance" have been used at most Public Inquiries:

- 35 NNI - low annoyance
- 45 NNI - moderate annoyance
- 55 NNI - high annoyance

### 3. GROUND NOISE

Noise from aircraft on the ground was briefly considered by the Wilson Committee - they appreciated that running of engines on the ground caused

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problems especially when testing at full power after maintenance. No recommendations were made for establishing a system for rating ground noise; it is excluded from the NNI assessment. We are more or less in the same position today. In the 1960's and 1970's, ground noise was much less of a problem than noise from aircraft taking off and landing. Now that these noise levels are gradually decreasing due to the introduction of quieter aircraft, attention is being drawn to ground noise. There is no agreed procedure for the assessment of noise from ground sources at airports. Various different methods have been attempted and conflicting procedures have caused considerable confusion at inquiries. It has been considered in depth at recent Airport Inquiries.

## 4. THE PLANNING PROCEDURE

In the United Kingdom, permission must be obtained from the Local Planning Authority to carry out developments. For a major airport development the planning application will normally be "called in" by the Department of the Environment for determination; a Planning Inquiry will be held at which each interested party will put their case. In effect, everyone will be carrying out their own individual Environmental Impact Assessment. The developer will present evidence to show that his proposal will have a minimal impact on the surrounding community. The local objectors will present evidence to show that the development will have serious adverse effects on their area, while the Local Authority will normally be caught in between the two. Airports generate considerable prosperity in the surrounding areas, and not everyone is bothered by noise. Policy decisions are determined by Local Councillors - elected both by those whose livelihood depends upon the airport, and also by those affected by noise. It is usual for the Local Authority to object to airport developments; perhaps to test the evidence of the developer but sometimes the objection seems to be a "token" objection, lodged to satisfy one section of the community and not too forcefully carried out - to satisfy another section of the community. An Inspector, appointed by the Department of the Environment, listens to evidence from all interested parties and produces a report with a recommendation to the Secretary of State. Then the Secretary of State makes his own decision, taking political factors into account. It has been suggested that marginal seats surrounding the airport can effect his decision.

## 5. CIRCULAR 10/73 "PLANNING AND NOISE" [2]

This Circular, issued in 1973 and still current, from the Department of the Environment to Local Planning Authorities, gives guidance on dealing with airport developments. It is open to the authorities themselves to adopt local policies, but when an application is referred to a Public Inquiry, the Inquiry Inspector must take account of the National policy in Circular 10/73. This gives "ground rules" for the Inquiry and refers to assessment of airborne aircraft noise in NNI values.

Circular 10/73 recommends that minimum noise routes should be firmly established around airports so that Local Authorities can take account of areas affected by aircraft noise in their long term planning. In areas above 40 NNI sound insulation is recommended for residential development while schools can

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require sound insulation above 35 NNI. More stringent criteria are recommended in rural areas, presumably because of the lower background noise levels. Aircraft noise exposures at the time of the planning application should be assessed as well as those for 15 years ahead. The emphasis in Circular 10/73 is on the planning of noise sensitive development around airports, although the same criteria are recommended to be used for the establishment of new airports and the extension of existing airports.

## 6. CASE HISTORIES

### 6.1 Heathrow, Terminal 4

The three terminals in the central area of Heathrow Airport have a capacity to deal with 30 million passengers per year (30 mppa). The opening of Terminal 4 on the south east perimeter of the airport in 1986 followed a Public Inquiry held between May and December 1978. Air noise was assessed in NNI values by both sides; the proposer, the British Airports Authority (BAA) [3] and the objectors - the Greater London Council [4] and Surrey County Council [5]. The number of flights necessary to deal with the annual passenger capacity is always a subject of argument at Airport Inquiries; assumption of large numbers of future jumbos with seating capacities of 800 have sometimes been made, which minimises the number of flights. Assuming that the increase in airport capacity from 30 mppa to 38 mppa is reflected in a direct increase in flights with the same passengers per aircraft, the NNI values around the airport will increase by  $15 \log 38$ , ie, 1.5 units - an insignificant amount. Assuming that

future trends for the introduction of quieter aircraft continues, the opening of Terminal 4 will not bring about increased noise levels from airborne aircraft. Future NNI levels will only be slightly higher than they might have been. The Inquiry Inspector was nevertheless concerned with the total number of flights and recommended an annual restriction of 260,000 Air Transport Movements (ATMS). The Secretary of State imposed a restriction of 275,000 ATMS, but this was subsequently removed following the Terminal 5 Inquiry in 1985.

A major concern at the Terminal 4 Inquiry was the impact of ground noise on the nearby communities of Bedfont and Stanwell. The location of Terminal 4 on the edge of the airport means that the local community does not have the same protection of the distance to Terminals 1-3 in the centre of the airport. The Inspector realised the problem and recommended an extensive noise barrier 7 m in height, no running of engines after maintenance, and no movements between 23.30 and 06.30. These restrictions were imposed by the Secretary of State, but following an appeal by BAA, the night-time aircraft movements were allowed on the terminal apron farthest from the community.

In their technical evidence to the Inquiry, Surrey County Council [5] drew attention to Planning Circular 10/73 "Planning and Noise" which emphasises the need to avoid "a creeping growth of the ambient noise level". The background noise level  $L_{90}$  was a fundamental concept in considering the impact of ground noise.

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The Greater London Council [4] drew attention to additional noise from Terminal 4 by saying that "many of the relatively quiet periods existing at present will disappear although the  $L_{10}$  or  $L_{eq}$  level may only increase by a relatively small amount".

The BAA [3] took account of the existing environmental noise in terms of  $L_{90}$ ,  $L_{50}$  and  $L_{10}$  as compared with the new noise levels in terms of  $L_{eq}$  and peak noise levels. The Inspector's report drew attention to difficulties in assessing ground noise impact, particularly for taxiing noise. For APU noise he stated "At night, if even a single APU were operated, it would often produce, I find, a level so far above the likely background as to annoy many people".

For taxiing, the Inspector stated "there is no accepted yardstick for the measurement or evaluation of noise from this source". The Inspector assessed the impact of taxiing noise by comparing peak taxiing noise levels from individual aircraft with existing  $L_{10}$  levels after advice from BAA. The effect of a number of aircraft taxiing was not considered even though BAA produced estimates of future likely aircraft movements.

Terminal 4 has been described as "the terminal that nobody wanted", because of problems of taxiing aircraft having to cross the southern runway. The ideal site between the two runways at the western end of the airport was thought to have been ruled out because it is occupied by Perry Oaks Sewage Works. This site subsequently came under consideration for Heathrow Terminal 5, discussed later.

### 6.2 Gatwick, Terminal 2

Gatwick Airport has one runway, one main terminal and a satellite pier. The Public Inquiry for Terminal 2 in 1980, looked into the increase in capacity from 16 mppa to 25 mppa. The BAA produced evidence on air noise in terms of the usual NNI contours and a considerable debate on the use of NNI and its implications was conducted at the Inquiry. The Inspector considered that too much time had been spent discussing NNI values; he concluded that NNI was the best method for assessing aircraft noise available. The number of aircraft movements to handle 25 mppa was debated at the Inquiry. Assuming the same number of passengers per aircraft, the general increase in NNI values would be  $15 \log 25$ , ie, 2.9 units, a "barely noticeable" increase.

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The proposed location of Terminal 2 with taxiing aircraft brought to within 300 m of existing residential development, caused concern over potential noise problems. Disagreement between each party occurred over the adoption of reference noise levels for aircraft taxiing operations. A continuous 11 m high earth mound, 1 km in length was proposed and has now been constructed to reduce ground noise for Surrey residents.

The technical evidence on ground noise at the Inquiry was presented using a number of different noise indices.

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Mole Valley District Council [7] compared the  $L_{eq}$  noise levels from taxiing operations with the pre-existing background noise level. For engine maintenance noise British Standard BS 4142 was used to assess impact. The British Airports Authority [8] used  $L_{eq}$  to describe ground noise events, but as an additional complementary procedure for taxiing noise and airborne aircraft noise, it was suggested that the peak noise level could be used to "evaluate the impact of short duration high noise events". British Standard BS 4142 was dismissed as "not applicable to transportation noise sources".

For night-time noise the difference between the peak noise level of an individual event and the background noise was used to assess the degree of disturbance.

The main assessment procedure for ground noise consisted of comparing the contribution of each source to the total overall  $L_{eq}$  level which could include airborne aircraft, road traffic and trains. No attempt to relate  $L_{eq}$  levels to community response was made.

The Terminal is currently under construction and expected to be opened in 1988

### 6.3 Stansted

It has long been the intention of BAA to develop Stansted as London's third airport. The mammoth Public Inquiry held in 1982 was the third attempt to obtain planning permission. Because of the far reaching consequence of the decision, the Inquiry Inspector considered all available alternatives for providing additional airport capacity including Heathrow Terminal 5 and developments at regional airports.

Stansted has a good existing runway, but currently only deals with 0.3 to 0.5 mppa. The proposal was to develop the airport initially to 15 mppa with a new terminal, allowing for a possible future expansion to a four terminal, two runway airport. Evidence on air noise illustrated the large increases in NNI values. If the future capacity of the existing terminal is taken as 2 mppa, and the number of passengers per aircraft is similar, the 15 mppa development would cause average increases of  $15 \log \frac{15}{2}$ , ie, 13 while the 50 mppa would cause increases of 21 - dramatic changes in noise exposure and annoyance.

The assessment of ground noise caused considerable debate at the Inquiry. The BAA's noise consultant assessed ground noise in the context of the total environment, [9], taking account of airborne aircraft, road, rail and other sources. Noise measurement and prediction locations were typically under flight paths or next to major roads. Ground noise was evaluated using  $L_{eq}$  (24 hours). The contribution of each source to the total  $L_{eq}$  was judged to be an indicator of the importance of each source. Generally the  $L_{eq}$  was dominated by the noise from airborne aircraft and ground noise contributions were judged as not significant. For locations away from flight paths, the absolute criterion of 55 dB(A)  $L_{eq}$  24 hour was used to judge the acceptability of ground noise sources. No account was taken of background noise levels ( $L_{90}$ ) but a noise assessment was carried out for the airport if no development took

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place. This system looked at the future noise environments, not the change from the existing noise levels, and assessed the importance of each different source of noise in the future environment.

The Local Authorities' noise consultant [10] calculated individual future ground noise levels in  $L_{eq}$  and peak noise levels and compared each of these units to the background  $L_{90}$  noise level. This method clearly illustrated the change in noise environment for the future developed airport. The Inspector complained of his difficulty in understanding each assessment system and reconciling the two conclusions; the BAA concluded that ground noise would have a "limited effect", while the objectors' consultant concluded that a "serious deterioration" in the noise environmental would occur. The difference between the two parties was that the objectors relied on an intrusion assessment while the proposer relied on an absolute noise level related to annoyance.

Because additional airport terminal capacity was required as soon as possible the Inspector [11] recommended that planning permission for the Stansted Development should be approved subject to conditions, and the Secretary of State concurred. A terminal to handle the first stage of the development with 8 mppa is now under construction.

### 6.4 Heathrow, Terminal 5

The application to develop a fifth terminal at Heathrow was lodged by Uttlesford District Council, the Planning Authority for Stansted, during the Stansted Inquiry. The Inspector agreed to look into this as part of his general appraisal of major airport developments. British Airways were in favour of Terminal 5 and presented evidence at the Inquiry. The initial proposal was to increase the capacity at Heathrow from 38 mppa to 53 mppa with a 15 mppa Terminal 5. The limit of 275,000 ATMS was not thought to prevent the airport dealing with 53 mppa as the average number of passengers per British Airways flight was estimated to increase from 109 in 1980 to 193 in the late 1990's. Assuming comparable future numbers of passengers per aircraft the increase from 38 mppa to 53 mppa would result in an increase of  $15 \log \frac{53}{38}$ , ie,

2 units - hardly noticeable.

The ground noise issue for Terminal 5 did not cause any great disagreement as the terminal would be sited between the existing runways at the western end of the airport with the closest residential areas only sparsely populated.

The Inspector preferred the Stansted development as extra terminal capacity was required as soon as possible, but recommended that the removal of Perry Oaks Sewage Works should be seriously investigated to allow future development of Terminal 5, if necessary.

### 6.5 London City Airport (STOLport)

The STOLport is an airport for Short Take-Off and Landing aircraft to be

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situated on land cleared from disused warehouses in the London Docklands. Regular passenger services are envisaged to UK provincial cities and continental centres by 50 seat De Havilland Dash 7 aircraft. This four engined turbo prop aircraft is quiet by comparison with current jet and propeller aircraft and can land and take-off on the short runway (762 m) at high angles.

1 mppa were expected to be handled with 100 ATMS per day. NNI contours were produced in the evidence of the developers' consultant [12], the GLC [13] and the Planning Authority [14]. It was unanimously agreed that no residential property would be exposed to above 40 NNI. The numbers of properties above 35 NNI varied from 50-100 depending on assumptions. The main concern of the objectors was that the initial proposal was the forerunner of a more substantial development with more significant noise levels from noisier aircraft types. The developer offered to provide sound insulation for properties above 35 NNI.

The terminal apron is overlooked by two blocks of multistorey flats, so that ground noise from aircraft on the apron is a potential problem. However, the terminal and stands form an effective noise barrier and a parapet on top of the structures will further help to reduce noise.

The technical input for the noise impact assessments was agreed before the Inquiry at working parties chaired by the CAA. This enabled everyone to start off with the same assumptions for aircraft types, numbers of movements and hours of operations with the result that there was very little difference in NNI contours produced independently by each side.

Ground noise was evaluated in  $L_{eq}$  and peak noise levels and compared with the existing  $L_{eq}$  and  $L_{90}$  levels. This area of the Docklands was in a depressed state with very little commercial activity and the docks were mainly used as a "parking area" for large ships, so that the surveys of existing noise levels did not reflect the considerable activity when the docks were in full operation. The introduction of the STOLport would not cause any significant change from this period of temporary quiet. Measured background noise levels were 50 dB(A)  $L_{90}$  by day and 42 dB(A)  $L_{90}$  in the evening. Most parties agreed that the impact of ground noise could be controlled to acceptable levels by a mixture of noise barriers and double glazing.

The London City Airport is currently under construction and expected to open for business in Autumn 1987.

### 7. FUTURE AIRPORT DEVELOPMENTS

The experience at Public Inquiries over the past years has shown considerable differences in approach between promoters and objectors of airport developments. The public are left in doubt over who to believe when they are told by one consultant that a development will have minimal impact and another, a serious impact. Even the Inspector at Planning Inquiries is in difficulties to sort out the facts between two opposing sides.

When future developments are proposed at UK airports it is to be hoped that all

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sides will get together before the Inquiry and agree on a framework for the assessment of noise impact. Then everyone can use the same agreed traffic assumptions and hopefully agree on assessment systems. The latest research on reactions to aircraft noise [15] indicates that  $L_{eq}$  is preferable to NNI for assessing the impact of noise from airborne aircraft. The use of  $L_{eq}$  has some advantages, eg, the inclusion of all aircraft, no matter how quiet. Let us hope that the changeover does not add to the confusion. Air noise  $L_{eq}$ 's and ground noise  $L_{eq}$ 's can be simply added together; it only remains for someone to decide on the meaning of the resulting total  $L_{eq}$ . We have a British Standard BS 5727, [16] which actually lays down procedures for measuring and evaluating air noise and ground noise, but this has not yet been used at Public Inquiries.

To avoid the confusion of conflicting evidence from each side, the appointment of an independent organisation to carry out an impartial environmental impact assessment would be a suitable compromise, but would be unlikely to satisfy everyone, although the credibility of acoustic consultants would be enhanced.



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## REFERENCES

- [1] Noise, Final Report, July 1963  
Cmd 2056 (The Wilson Report)
- [2] Department of the Environment  
Circular 10/73 "Planning and Noise"
- [3] British Airports Authority/Professor Large  
Heathrow, Terminal 4 Inquiry  
Proofs of Evidence
- [4] G H Vulkan 1978  
Heathrow, Terminal 4 Inquiry  
Proof of Evidence
- [5] C A Hill  
Heathrow, Terminal 4 Inquiry  
Proof of Evidence
- [6] I D L Glidewell 1979  
Heathrow, Terminal 4 Inquiry  
Inspector's Report
- [7] R W Hudson 1980  
Gatwick, Terminal 2 Inquiry  
Proof of Evidence
- [8] J B Large 1980  
Gatwick, Terminal 2 Inquiry  
Proof of Evidence
- [9] J B Large 1982  
Stansted Airport Inquiry  
proof of Evidence
- [10] J G Charler 1982  
Bickerdike Allen Partners  
Stansted Airport Inquiry  
Proof of Evidence
- [11] Graham Eyre QC 1984  
Stansted Airport Inquiry  
Inspector's Report
- [12] J G Charles 1983  
Bickerdike Allen Partners  
STOLport Inquiry  
Proof of Evidence

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- [13] G H Vulkan 1983  
Greater London Council  
STOLport Inquiry  
Proof of Evidence
- [14] R Taylor 1983  
London Docklands Development Corporation  
STOLport Inquiry  
Proof of Evidence
- [15] Department of Transport 1985  
United Kingdom Aircraft Noise Index Study: Main Report  
Prepared by Civil Aviation Authority
- [16] British Standard BS 5727:1979  
"Method for describing aircraft noise"