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postnote

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AIRCRAFT NOISE

For many living around airports, noise is the most evident environmental impact of aviation. This briefing examines the sources of noise from airports, the effects of noise on people and the implications of the Government's forecasts for the growth in aviation. Potential technical and policy options to reduce aircraft noise are outlined. A more detailed POST report is also available covering this and other environmental issues associated with aviation.[1]

Key points:

- **current aircraft noise can affect the quality of life of half a million people living close to UK airports**
- **increases in air traffic could outstrip technological progress in making individual flights quieter and so worsen the noise climate around many of the UK's airports over the next 30 years**
- **as a result, more people could be affected by sleep disturbance, annoyance and possible health effects**
- **aircraft noise could constrain airport expansion unless substantial noise reductions are made.**

The growth of aviation

The Government has forecast that aviation is likely to grow over the next 30 years at an average rate of 4.25% per year.[2] These forecasts are based on unconstrained growth – i.e. that airport and airline capacity is provided to meet all demand. The Department for Transport (DfT) points out that previous mid-range forecasts underestimated demand, with actual demand either following, or even exceeding the 'high' forecast growth curve; particularly for forecasts made before the emergence of the low-cost airlines in the late 1990s.[3]

To meet the maximum forecast demand for flights, additional airport capacity would be required equivalent to that which can be handled through five new runways – with three of these located in SE England. Spare capacity exists at some airports (particularly at Stansted and Luton at off-peak times) and so some of the forecast growth could be met without the need for additional infrastructure. However, on current policies, spare capacity is likely to be exhausted by 2015, so unless demand were managed or congestion tolerated, meeting the forecast growth to 2030 would require new capacity.

Aircraft noise

Sources

Aircraft landing and taking off are the chief sources of aviation noise. Individual aircraft have become quieter over the past 30 years, but flight frequencies have increased. As a result, aircraft noise is giving rise to increasing community concern. In particular, landing noise is increasing in importance, and has become the dominant reason for complaints at some airports. In addition, those living close to very large airports may experience 'ground noise' from sources on the airport such as taxiing aircraft, aircraft engine tests, generators or airside vehicular traffic. Transport links to an airport, particularly private vehicles and trains, can also make a significant contribution to noise around airports.

The box on the next page outlines how aircraft noise is measured. In essence, the DfT estimates current and future impacts of aircraft noise by determining the area exposed to average sound levels of 57dB(A) or more between 7am and 11pm. This measure was chosen as an indicator of the onset of what the government describes as 'community annoyance' in the daytime, following a study in 1985 which showed a good correlation of this figure with annoyance. However, it is apparent that the mix and types of aircraft, their frequency of overflight, the social and economic circumstances of affected people and general levels of environmental awareness and sensitivity have changed since the early 1980s. The Government has therefore commissioned a three year study to provide a firmer basis for the relationship between aircraft noise and annoyance. The first results from this new study should be available towards the end of 2004.

Measuring sound and noise

Environmental noise is measured with reference to the A-weighted decibel scale, dB(A). This reflects the fact that the human ear does not detect all frequencies of sound equally efficiently. To quantify sound levels which vary with time **equivalent continuous sound level** or $\mathbf{L_{eq}}$ is calculated. This indicates the average sound level over a particular time period. For example, an L_{eq}, 24h of 57dB(A) indicates that the sound energy produced by the noise source is equivalent to a constant sound of 57dB(A) over 24 hours. Other measures of noise are also available, that relate to different measurement periods, such as the instantaneous maximum noise level (L_{max}), or the average over certain periods, such as evening or night (L_{den}).

Aircraft noise at airports

The Government considers noise to have the potential for the onset of *significant community annoyance* above a level of 57dB(A) L_{eq}, but recognises that some people are annoyed at lower levels. Contours of noise from airports are drawn, showing the area exposed to average sound levels of 57dB(A) L_{eq} or more between 7am and 11pm. Contour areas are then compared with population data to determine the number of residents within that contour. Contours are calculated by summing and averaging the noise from arriving and departing aircraft. For example, at Heathrow in 2002, nearly 130 km^2 of land from Fulham to Windsor was within the 57dB(A) L_{eq} contour. Calculations of future noise exposure must also take account of the known or planned flight paths to and from the airport and (since different types of aircraft make different amounts of noise) the known or estimated fleet mix at that airport.

Effects

The Government acknowledges that noise can be *"one of the most objectionable impacts of airport development."*[4] Aircraft noise can affect concentration or sleep and result in feelings of anger, frustration and powerlessness to control the noise. These factors can thus adversely affect people's quality of life. However, while many express concerns over aircraft noise, there remain considerable uncertainties over the precise nature of its impacts. The box opposite outlines the key effects of aircraft noise. Overall, much of the research in this area is either contradictory or inconclusive and many, including the World Health Organisation have called for considerably more research. Evidence to date suggests that most people exposed to aircraft noise are not adversely affected, but more vulnerable groups may be at increased risk; particularly those with pre-existing sleep problems, stress or mental health problems.

Aircraft noise already has the potential to affect the quality of life of at least half a million people in the UK – with 80% of these living close to major airports in the southeast of England. The figure opposite shows the extent of noise pollution around five major airports in the UK under DfT's growth forecasts.[5] For each situation, under worst-case scenarios, more people are likely to be exposed. Under the central scenarios, increases will be expected at Manchester, Birmingham and Stansted. Reductions at Heathrow and Gatwick would result from technological improvements alongside severely constrained growth.

The effects of aircraft noise

Annoyance

Noise can lead to people feeling stressed and angry. It may interfere with conversations and leisure activities in the home, disrupt activities requiring concentration, and discourage people from using outdoor spaces. Further factors may affect whether noise is viewed as 'annoying':

- occurrence of exposure – noise may be more annoying if it occurs often, even if each noise event is quieter
- fear of accidents – concerns about air crashes may increase some people's sensitivity to aircraft noise
- fear of the future – especially about future growth in air travel and potential increases in the frequency of flights
- lack of control – inability to alter or escape from the noise source may make it more annoying. [6]

The subjective responses to aircraft noise makes it difficult to quantify the relationship between noise and annoyance. However, noise levels below 50dB(A) L_{eq} are unlikely to cause community annoyance while levels of 55dB(A) L_{eq} may severely annoy some people. In the UK, the DfT uses a level of 57dB(A) L_{eq} as an indicator of the onset of community annoyance in daytime. Nevertheless, there are likely to be people exposed to more than 57dB(A) L_{eq} who will not be affected, and also those exposed to lower levels who will be affected. The location of the 57dB(A) contour is therefore not a precise guide (see the box on the next page).

Sleep disturbance

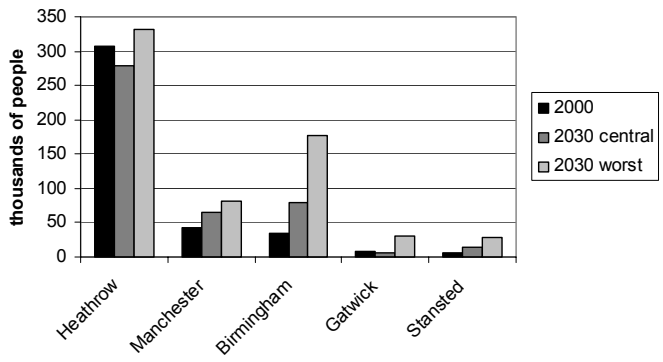
Interference with sleep patterns is frequently reported by those living near airports operating night flights. A recent study of residents in high noise areas close to Heathrow, Gatwick, East Midlands and Coventry airports found between 1 in 5 and 1 in 10 people often reporting difficulty getting to sleep or being woken early . The European Court of Human Rights has ruled that the UK Government's procedure for decision-making about night flights was flawed, and that this flaw amounted to a "*violation of the respect for private and family life and the home*" under the European Convention on Human Rights. This judgement did not state that night flights themselves were a violation of human rights. The Government is appealing the decision. In the meantime, night flights continue as before, but if the judgement is upheld, the Government would need to review the regulation and operation of night flights.

Other effects

- **cardiovascular effects** – The WHO points to a 'weak link' between frequent exposure to loud noise and effects on the cardiovascular system, but has called for further research before it can offer any guidelines.
- **mental health** – there is limited evidence that noise can affect existing mental illness, but not cause it
- **educational achievement** – it is not clear whether noise affects school performance directly or from cumulative loss of teaching time where disrupted by loud noise.

Forecast noise exposure[3]

(actual figures for 2000, central and worst-case forecasts for 2030)



Airport expansion: the Sydney experience[7]

The opening of a third runway at Sydney's Kingsford-Smith airport in 1994 led to an immediate outcry from residents who found themselves significantly disturbed by noise, despite living outside the area designated as likely to be significantly affected during the planning process. This became a high profile political controversy, including creation of a single issue 'No Aircraft Noise Party', and led to the establishment of a Senate Select Committee on Aircraft Noise in Sydney. The Committee concluded that opening of the third runway had "*scarred a city*" and "*irretrievably complicated the future of airport development in Australia*", as well as being an "*environmental and social tragedy*". It also commented that the policy in Sydney at the time of concentrating noise pollution in one area was "*a form of discrimination*".

The Committee found that Sydney residents felt that they had been misled by use of noise contours to give an indication of likely noise impacts of the 3rd runway. Further, the Australian Department of Transport and Regional Services had proposed measuring noise exposure relative to the number of events above a given threshold. This implied that once noise reached a level high enough to be intrusive, the level of noise beyond this would be irrelevant. This relates to the relative importance of the frequency of noise events against the loudness of individual events in determining annoyance. Last, the case demonstrated that residents were most likely to be annoyed by and complain about aircraft noise if they felt they had been misled about it. The Committee found that providing user-friendly information about aircraft noise to prospective house buyers and tenants near major flight paths could have reduced complaints about aircraft noise.

Managing aircraft noise

Aircraft noise in the UK is governed through international, EU and national regulation. At international level, the International Civil Aviation Organisation (ICAO) sets progressively tighter certification standards (known as Chapters) for noise emissions from civil aircraft. In addition to these specific requirements, the ICAO requires members to adopt a 'balanced approach' to airport noise management:

- reducing aircraft noise at source
- land-use planning
- changes to operational procedures
- restrictions on the use of the noisiest aircraft.

Reducing noise at source

Over the past 30 years, improvements in aircraft technology have resulted in substantial reductions in the noise of individual aircraft. Around 20% of the current fleet already achieves a noise target 14dB better than the current (Chapter 3) standards. By 2004, British Airways expects 90% of its fleet to meet these levels of performance. Indeed, RollsRoyce reports that modern aircraft can achieve 18-24dB below the Chapter 3 standard. However, further improvements beyond the forthcoming Chapter 4 standards (which, from 2006, will require only a 10 dB(A) reduction on current standards) will be increasingly difficult to achieve.

Aircraft noise arises from engines and from the movement of turbulent air over the physical structure (airframe) of an aircraft. To date, noise reduction has focused mainly on reducing engine noise. This is now sufficiently low that tackling noise from the airframe is becoming as important (although it may be more challenging to reduce).

Technologies under development point to the perceived noise level from individual aircraft being halved, but translating laboratory-tested concepts into a fully functioning aircraft is difficult. In particular, the noise performance of a new aircraft is difficult to characterise fully before it is built and flown.

Land-use planning

Many UK airports are located in populated areas, so the potential for land-use planning to reduce noise exposure from existing airports is limited. However, planning has a role to play both for new developments near existing airports and for the development of new airports. The two main ways by which land-use planning can be used to help control aircraft noise are:

- planning permission – government planning guidance advises that planning permission for housing should normally be refused in areas exposed to noise from any source louder than 66dB(A) L_{eq} during the day (and 57dB(A) L_{eq} at night). At noise levels between 57 and 66dB(A) L_{eq} mitigation measures should be a condition on planning permission, but noise below 57dB(A) L_{eq} need not be considered.[8]
- zoning – land around airports can be demarcated as either qualifying for compensation and support for noise insulation, or as being inappropriate for residential development given current or future noise levels.

Changes to operational procedures

The management of airspace for safety, navigation and logistical reasons leads to a concentration of air traffic along a small number of specific airways. The area on the ground affected by noise from departing aircraft depends both on the flight path followed, and on the rate of ascent of the aircraft. Controls on **night noise** at Heathrow airport are described in the box on the next page. There are three main ways to control **take-off** noise:

- noise preferential routes (NPRs) – where aircraft fly over the least populated areas after take-off
- managing thrust – maximum thrust generates extra noise close to the runway, but an aircraft gains height quickly. For residential areas, less thrust may reduce noise, despite the slower climb rate.
- concentrating or 'sharing' noise – an airport may adopt a policy to concentrate noise on a small number of residents under NPRs or to distribute it more widely.[9]

The Government acknowledges that where airports are close to populated areas, **landing noise** is increasingly a more serious problem. Here, final approach paths must operate in straight lines for safety reasons, so there is little flexibility in deciding which areas will be overflown. Reducing noise from landing aircraft has thus focussed on the continuous descent approach (CDA). This is

Night-time noise control at Heathrow airport

There are restrictions on the total number of aircraft movements at night (11.30pm-6am) and the types of aircraft which can be used at night. In addition, there is a noise 'quota' for the total noise allowed at night at each airport over a whole season (summer or winter) – in effect, the noisiest aircraft are banned between 11pm and 7am. Aircraft used for night movements are assigned points according to how noisy they are, which count towards the noise quota. This can provide a powerful incentive to airlines to operate aircraft in the lowest categories possible for the size and type of aircraft, particularly for many long-haul routes to the Far East, whose flights leave the UK in the late evening and arrive in the early morning.

where an aircraft descends smoothly from around 6,000ft, usually at an angle of around 3 degrees, rather than descending through a series of level flights and steeper descents. This allows operation on low power and with low drag, minimising changes in engine tone.

A further option could be to adopt steeper descent angles so that aircraft are higher at any particular distance from the airport during their final approach. However, current air traffic control procedures would find it difficult to safely manage aircraft approaching at different angles. Were future aircraft designs and safety regulations to allow steeper approaches, it would remain challenging to use these procedures while older and larger aircraft were using the same runway. It may be feasible however, to use longer runways for larger aircraft and shorter runways for smaller aircraft approaching more steeply.

Restrictions on the use of the noisiest aircraft

Airports already impose restrictions on certain categories of aircraft at night (see the box above). However, under an EU directive on aircraft noise (2002/30), restrictions on the noisiest aircraft can be introduced only after land-use controls and changes in procedures have been considered.

Further measures to reduce aviation noise

A number of further policy instruments could be used to reduce noise from aircraft, including:

- voluntary initiatives such as agreements between airports and local communities on the number or types of day and night flights; and between airports and airlines on procedures to minimise noise
- guidance to airport operators on potential mitigation measures such as a list of take-off noise limits realistically achievable by different aircraft types
- regulation such as legal sanctions for failure to follow noise preferential routes (track keeping), take-off noise limits, or the number of night flights, possibly enforced via fines on offending airlines or airports
- economic instruments such as landing charges that vary according to the noise performance of aircraft, or an airline's record on track keeping.

The Government is currently consulting on the use of economic instruments to tackle the environmental impacts of aviation. This is considered briefly in the previous POST report on aviation and the environment, but POST will also produce a specific briefing on this topic in the autumn of 2003.

The limits of technology

Historically, international regulation through the ICAO Chapters have been the main drivers for innovation to reduce engine noise. However, the forthcoming ICAO Chapter 4 standard is mandatory for new aircraft from 2006, and most new aircraft designs can easily meet these standards now. Some, such as the British Air Transport Association thus argue that these provide little incentive to go beyond current regulatory limits. Therefore, many now agree that national level controls (such as night noise quotas) are now stronger drivers towards innovation in engine and airframe technologies to meet environmental requirements.

However, while individual aircraft can be made quieter, the rate of innovation and uptake of new technology are likely to be much slower than the rate of growth of air travel. Consequently, within the Government's planning horizon for the future of aviation (to 2030), it is highly likely that following a period of relative improvement over the next decade, local environmental impacts from aviation could worsen. The question remains therefore over whether growth should be constrained to stay within acceptable limits, or whether the environmental impacts arising from meeting anticipated demand can be justified against other social and economic factors.

Endnotes

1 *Aviation and the Environment*, POST report 195, Parliamentary Office of Science and Technology, April 2003. This report is available from POST. It is free to Parliamentarians, and costs £10 for non-parliamentarians. See below for details.
2 *Air Traffic Forecasts for the UK 2000*, Department of the Environment, Transport and the Regions, 2000.
3 *The future development of air transport in the United Kingdom: a national consultation*, Department for Transport, July 2002 (and second edition, February 2003).
4 *Guidance to the Civil Aviation Authority on environmental objectives relating to the exercise of its air navigation functions,* Department for Transport 2002.
5 This is related to noise above a threshold for 'community annoyance' adopted by the government. This threshold is 57dB(A) L_{eq} and is discussed further in the full report.
6 *Towards sustainable aviation*, Upham, P. et al (eds), Earthscan, 2003.
7 *Falling on Deaf Ears*, Report of the Senate Select Committee on Aircraft Noise in Sydney, November 1995.
8 *Planning Policy Guidance note 24: Planning and Noise*, Office of the Deputy Prime Minister, 1994 (and currently under review).
9 The example of Sydney airport is apposite here. Previous policy was to concentrate noise but an Australian Senate inquiry described this policy as discriminatory and policy was changed to disperse aircraft noise over a wider area.

POST is an office of both Houses of Parliament, charged with providing independent and balanced analysis of public policy issues that have a basis in science and technology.

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