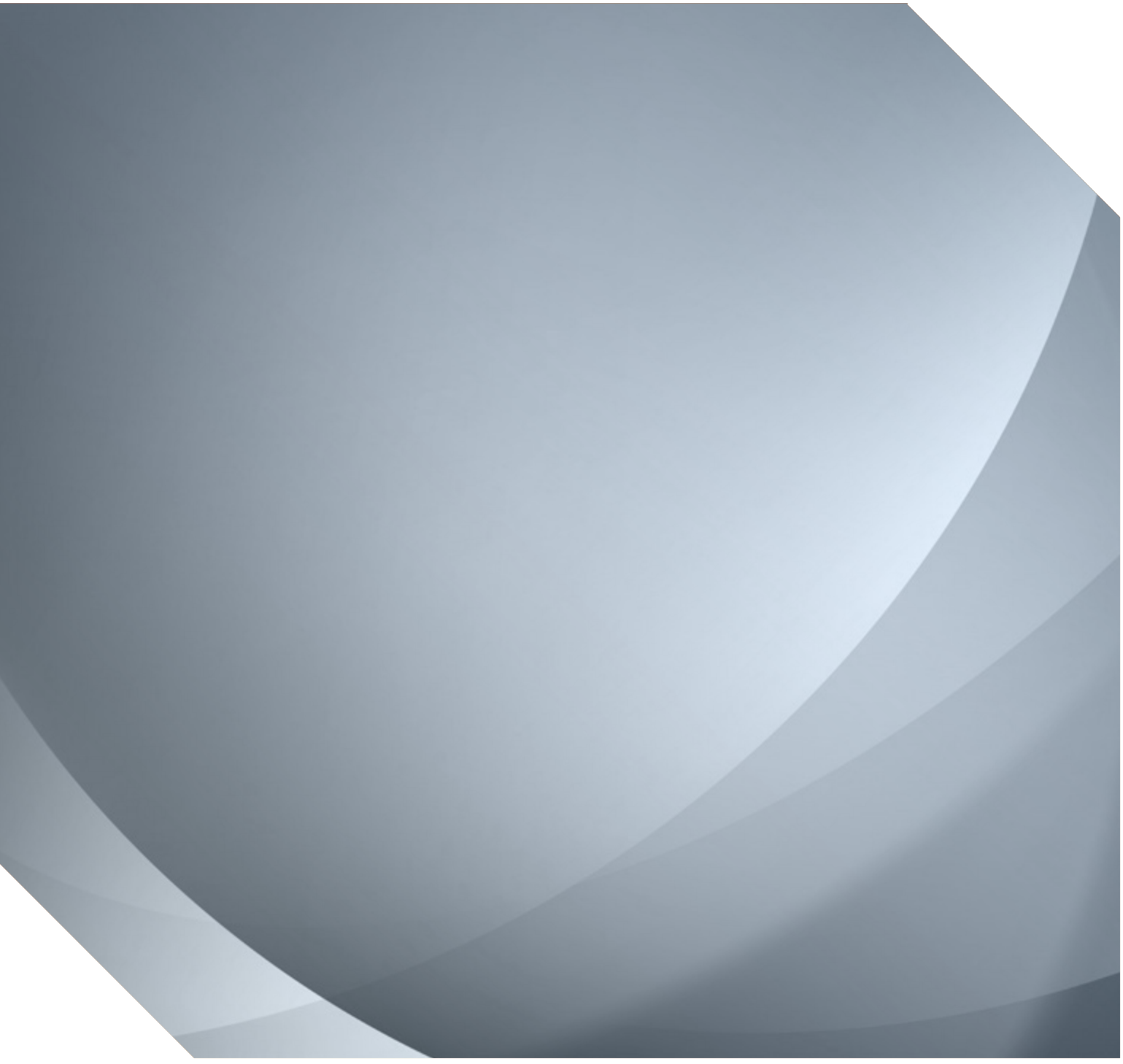
Civil Aviation Authority

Noise envelopes

CAP 1129



Environmental Research and Consultancy Department

Civil Aviation Authority

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Executive summary

This review provides information in response to the Department for Transport's (DfT) Aviation Policy Framework (APF)[1]. The overall aim is to inform the definition of a noise envelope concept which can be applied to airports looking to increase their capacity, which:

- is aligned to the Government's overall noise policy;
- helps achieves a balance between growth and noise reduction; and
- incentivises noise reduction at source through airline fleet evolution.

As part of this, the study addresses how the noise envelope concept could be used to help share the benefits of quieter aircraft technology between industry and local community stakeholders.

The key characteristics that we believe an envelope should have are listed, and ideas presented on how a noise envelope could be defined, principally in terms of measurable parameters grouped according to whether they restrict inputs, noise exposure or noise impact. The variation in noise impacts depending on the time of day that aviation activity occurs is also addressed.

Having considered the parameters, approaches for setting their limits to control the noise produced by the associated airport are addressed. This is done in the context of sharing the benefits of quieter aircraft technology, providing assurance to stakeholders, a framework for periodic review of a noise envelope, and the ways in which the limit requirements may differ from one airport to another.

The process of implementing a noise envelope is looked at next, including obtaining agreement from stakeholders, how a noise envelope might be applied within current legislation and the Government's role in the implementation.

Finally, once an envelope is in place, consideration is given to operational aspects such as how compliance with the limits is monitored and enforced. The concept of a local monitoring and enforcement plan is introduced.

Throughout the study, illustrative examples are provided of where some of the ideas have already been put into practice.

1 Aviation Policy Framework, Department for Transport, March 2013.

The key conclusions and messages arising from this study are as follows:

1. For an envelope to function as intended, it is essential that full agreement is achieved between all stakeholders on the envelope's criteria, limit values and means of implementation and enforcement.
2. The benefits of future technological improvements must be shared fairly between industry and local communities. This is fundamental to the noise envelope concept, and will be considered when defining parameters and setting limits.
3. An envelope is likely to be defined by a combination of parameters.
4. The life-span of an envelope must be agreed, and its parameters defined to maintain appropriate sharing of the benefits over its intended life-span.
5. The parameters and limits, and means of implementation and enforcement of a noise envelope must be tailored to individual airports and their respective local conditions.
6. The current planning system offers limited flexibility in the means available to implement a noise envelope. A change in primary or secondary legislation may be required for noise envelopes to be implemented effectively and enforceable by law.
7. A possible need has been identified for independent third parties to assist stakeholders to reach agreement where necessary.

CHAPTER 1

Purpose

The purpose of this review is to provide information in response to the Department for Transport's (DfT) Aviation Policy Framework (APF), and to support an objective of the Civil Aviation Authority's (CAA) Environmental Strategy.

Aviation Policy Framework

In the Aviation Policy Framework, the Government sets out its overall objective on noise which is 'to limit and where possible reduce the number of people in the UK significantly affected by aircraft noise'. To this end, the Government makes clear its expectation that airports 'make particular efforts to mitigate noise where changes are planned which will adversely impact the noise environment'. Such cases of particular relevance include proposals for new airport capacity, changes to operational procedures or where an increase in movements is expected which will have a noticeable impact on local communities (i.e. individuals as well as groups).

This is in the context of the Government's aim to 'strike a fair balance between the negative impacts of noise (on health, amenity (quality of life) and productivity) and the positive economic impacts of flights'. The aviation industry must therefore continue to reduce and mitigate noise as airport capacity grows, and as noise levels fall with technology improvements, the Government expects industry to share the benefits from these improvements with local communities.

This is complimented by another of the objectives in the APF which is 'to encourage the aviation industry and local stakeholders to strengthen and streamline the way in which they work together'.

Whereas the ICAO aircraft noise certification standards[2] have resulted in steady progress to reduce global aircraft noise emissions, they do not address specific noise issues at individual airports. The Government has set out that it 'wishes to pursue the concept of noise envelopes as a means of giving certainty to local communities about the levels of noise which can be expected in the future and to give developers certainty on how they can use their airports'. As such, the Government has invited the CAA to provide information to help develop technical guidance on the concept.

2 International Civil Aviation Organisation, Annex 16 - Environmental Protection to the Convention on International Civil Aviation, Volume I.

In the case of any nationally significant airport development project, the Government is likely to develop a National Policy Statement (NPS) which, if appropriate, could define the principles for the noise envelope having regard to the following:

- The Government's overall noise policy;
- The Government's policy on aviation noise;
- Within the limits set by the envelope, the benefits of future technological improvements should be shared between the airport and its local communities to achieve a balance between growth and noise impact; and
- The objective of incentivising airlines to introduce the quietest suitable aircraft as quickly as is reasonably practicable.

At existing airports which are not designated for noise management by the Secretary of State, local communities are encouraged to work with airports to develop acceptable solutions which are proportionate to the scale of the noise impact and be involved in discussions about what is the appropriate level of noise impact. The CAA believes that the process of designing and consulting on a noise envelope may be a suitable mechanism to help achieve this.

The CAA also considers that the concept of a noise envelope should be applicable to airports of all sizes and uses. By attributing an appropriate set of parameters to the envelope concept which enable limits to be set on an airport-by-airport basis, it should be possible to achieve proportionate solutions for individual airports. This is not to say that a noise envelope should be implemented at all airports, only that the concept, if taken forwards, should ideally be applicable and available for use by all airports should the need arise.

CAA Environmental Strategy

The CAA's environmental strategy (CAA and the Environment) sets out a work programme designed to enable the CAA to take a coordinated and consistent approach to addressing environmental issues. Through this, we are considering different ways of managing aviation noise to contribute to the Government's overall objective, as stated above. One such area of study is the concept of a noise envelope which may have a use in the control of aircraft noise.

Aim

This study responds to the Government's proposed 'Next Step' (5.26 (b) in the APF), that it '…will work with the CAA during 2013 to further develop the concept

of noise envelopes, with the aim of producing guidance which can be used in the context of any proposals for new airport capacity and the work of the Airports Commission.'

The overall aim of this study is therefore to inform the definition of a noise envelope concept which can be applied to airports looking to increase their capacity, which:

1. is aligned to the Government's overall noise policy;
2. helps achieves a balance between growth and noise reduction; and
3. incentivises noise reduction at source through airline fleet evolution.

To supplement this aim, the study addresses how to set the limits of an envelope so as to share the benefits of quieter aircraft technology. It also considers how noise envelopes could be implemented at airports, and the ongoing monitoring and enforcement of such noise envelopes.

CHAPTER 2

Current thinking on the Noise Envelope concept

This section provides a recap on the work carried out prior to this study to develop the noise envelope concept. It includes the advice the CAA offered to the DfT during the preparation of the APF. It gathers published views of industry and local community stakeholders and summarises the responses to the question in the APF consultation relating to noise envelopes.

CAA's input to the APF on the noise envelope concept

Appendix A presents key information from the APF Scoping Document, and the CAA's responses to it, relating specifically to noise envelopes. This summarises our prior work and thoughts on the subject, which have been taken forwards to the development of the noise envelope concept.

Stakeholder Views

The Government intends that noise envelopes provide a means of giving certainty to both local communities on future noise levels, and to developers on how they can use their airports in the future. Therefore, consideration must be given to the opinions of local community and industry stakeholders in the development of a noise envelope concept if it is to function as intended.

The development of the APF included consultation on the Draft Aviation Policy Framework. This sought stakeholder views to inform the final policy document. The consultation posed a number of questions on the various elements of the framework. Of these, Question 12 addressed noise envelopes: 'Do you agree with the proposed principles to which the Government would have regard when setting a noise envelope at any new national hub airport or any other airport development which is a nationally significant infrastructure project?'

The DfT published a Summary of Responses to the Draft Aviation Policy Framework[iii]. Key points from the responses are presented here.

- Of the responses to the consultation, 39.0% agreed with the proposed principles, 22.3% disagreed and 37.8% neither agreed nor disagreed.
- By respondent type, the greatest number of views was given by Local Government, followed by Local Community Group, then Business Association.

- Considering the Member of the Public category, 26% agreed with the proposed principles, 31% disagreed and 49% neither agreed nor disagreed.
- Five broad themes emerged from the textual responses:
  - Theme 1: Neutral or generally in agreement, but further details are required on how noise envelopes would be established, enforced and managed over time.
  - Theme 2: The explanation in the Draft APF is too vague or lacks examples.
  - Theme 3: Adoption of noise envelopes would do nothing to reduce noise from a (London) hub, and perhaps could be exploited as an opportunity to increase noise or evade criticism.
  - Theme 4: No expansion or new hubs are required.
  - Theme 5: The principles should be extended to lesser infrastructure. There was a counter-argument that any such proposals must not be regarded as suitable for a 'one size to fit all' and that local and regional differences have a role to play in any (significant) infrastructure development.

Additionally, through submissions to the Draft APF and the Airports Commission, a range of stakeholder views on the noise envelope concept was received. A sample of these views is summarised below:

- Some people living with the burden of aircraft noise are wary about the concept of a noise envelope.
- There was concern that a noise envelope could be used to push through excessive growth without bringing any real benefits to residents.
- Additional measures should be introduced to reduce noise should the noise envelope be breached, with compensation where appropriate.
- We continue to support the idea and exploration of noise envelopes.
- It is recognised that there are several means of employing noise envelopes.
- Any such arrangements must have extensive and transparent data collection, analysis and reporting arrangements.
- While noise envelopes could potentially be used to support longer-term commitments and incentives which minimise aviation's noise impacts, they must not be used to imply that current arrangements and impacts are acceptable.

- An envelope could potentially give local residents faced with growth the sort of certainty they have not had before. For this to be the case it should be carefully and transparently designed, agreed between stakeholders, and be legally binding.

Others views that are concerned with specific envelope parameters are included, as appropriate, in the next section which looks in detail at the different ways a noise envelope could be defined.

CHAPTER 3

Defining a Noise Envelope

In this section, we present our development of what a noise envelope could comprise. We list the key characteristics we believe an envelope should have, set out possible approaches to define envelope criteria and, within these, identify parameters which could be used to define a noise envelope. We set out the advantages and disadvantages of using each parameter, including examples where such parameters have already been used at airports and a sample of stakeholder views where applicable. We also consider how combinations of these parameters could be used in the definition of an envelope and how these parameters could be applied in terms of diurnal and seasonal time periods.

Characteristics

To function as intended, a noise envelope should as a minimum:

1. be clearly defined
2. be agreed among stakeholders
3. be legally binding
4. not be compromised by the lack of up-to-date understanding of the relationship between annoyance and the exposure to aircraft noise
5. take account of new technology
6. have proportionate aims which are appropriate for the airport to which it applies i.e. to permit growth, maintain a status quo, or manage a reduction in noise impact.

Parameters

There are three possible approaches to setting an envelope. These comprise:

- restricting inputs
- restricting noise exposure
- restricting noise impact.

As we have seen from current practice at UK and European airports, these could be used singularly or in combination. In addition, other more bespoke parameters could also be used as the basis for restrictions.

Parameters which could be used for defining noise envelopes are discussed in this section under these three approaches.

Restricting inputs

There are many factors which affect the amount of noise that is produced by an airport. Some of these have a very noticeable effect, whereas others are more subtle.

In general terms, a busy airport tends to make more noise than one which is less busy. For example, a high passenger throughput requires accordingly high numbers of aircraft operations. Even where fewer operations by large aircraft carry the same numbers of people as more operations by smaller aircraft, the larger aircraft typically produce more noise.

It is therefore possible to use inputs as a proxy for the amount of noise created. Possible input parameters are described below, to which limits could be applied to define an envelope.

Aircraft movement cap

It is standard practice to characterise aircraft noise near airports using long-term noise exposure indices. These are effectively measures of the amount of noise energy that reaches points on the ground from aircraft operations. One of the principal quantities which contribute to this is the number of 'noise events' (over-flights by aircraft arriving at or departing from the airport in question affecting a point on the ground).

Increasing the number of noise events results in a proportional increase in the noise energy. Doubling the number of events (of a given level), for example, would result in a doubling in noise energy. On a logarithmic scale, a doubling of noise energy represents a 3 dB increase in noise exposure.

Because the number of events has a direct effect on the noise exposure, there is a rationale for using the number of events as a proxy for the amount of noise created. Additionally, as aircraft technology is improving and the demand for air travel increases, reports suggest that people are becoming increasingly sensitive to the frequency of aircraft noise events.

Considering the noise created by an airport on the surrounding area as a whole, rather than the noise at a specific point on the ground, we become interested

in the number of aircraft 'movements' (total number of arrivals and departures) which occur at the airport over a given period of time.

Movement limits can then be set at an agreed amount corresponding to an equivalent level of noise exposure not to be exceeded. Some local community stakeholders strongly support a movement cap. This may be due to its simplicity and transparency as a metric, or because it offers the most tangible means to limit the growth of an airport.

The simplicity of the movement cap is clearly attractive in terms of engaging people, but it has drawbacks as well. A key drawback is that it does not take into account the noisiness of aircraft and would therefore not offer incentives to industry to operate quieter aircraft. If newer and quieter aircraft are brought into service at an airport whose activity is limited by a movement cap, the local communities' share of the benefits would be greater than that of the industry who brought about the changes in the first place. A movement cap may therefore not be appropriate for long-term agreements if an appropriate balance is to be struck between controlling noise and enabling economic growth. Sharing the benefits is dealt with in more detail in the section on Sharing the benefits starting on page 39.

Examples of prior use

Annual movement limits have been in use for many years at many UK airports, from small aerodromes to large hub airports such as Heathrow.

Under the Heathrow Terminal 5 planning agreement, the number of air transport movements (ATMs) is limited to 480,000 each year. During the Public Inquiry out of which this condition arose, the Inspector highlighted that the annual movement limit was needed in addition to a contour cap (discussed below), as the L_{eq} [3] index on its own was, in his view, insensitive to the number of air transport movements.

Heathrow is currently operating close to its movement limit (which is also close to its current operating limit). The L_{eq} noise contours are shrinking due to improving technology, and with capacity capped at approximately current levels, material growth is not possible. This is therefore an example where all the benefits go to local residents rather than being shared with industry.

3 Equivalent sound level of aircraft noise in dBA, often called 'equivalent continuous sound level'. For conventional historical contours this is based on the daily average movements that take place within the 16-hour period (0700-2300 local time) over the 92-day summer period from 16 June to 15 September inclusive.

The Night Restrictions Regime for Heathrow, Gatwick and Stansted is set periodically by the Government, following a consultation process, which requires, amongst other things, an agreed movement limit for night operations (between 23:30 and 06:00) which is not to be exceeded on a seasonal basis.

Currently, Stansted Airport has a movement cap of 264,000 ATMs per year, and London and Belfast City Airports are restricted to 120,000 and 48,000 ATMs per year respectively.

Stakeholder views

Some views from stakeholders on movement caps are presented below:

- The current contour cap is too easily achieved. It has not required any reduction in movements and, as a result, bears no relationship to the level of annoyance actually experienced. Improvements in the noise performance of new aircraft are therefore not shared with the community.
- The development of a noise envelope should open a new, creative approach to meeting the needs of residents. The degrees of freedom enabled by a noise envelope combined with a higher ATM cap should be fully explored.
- An envelope comprising simply a cap on the number of aircraft allowed to use the airport would be warmly welcomed by most residents.
- The correct envelope could bring benefits to both the industry and local communities but, without a cap on flight numbers being a part of any envelope, local communities are likely to remain nervous about the concept.

Advantages

- Simple and easy to implement.
- Addresses people's growing sensitivity to the frequency of aircraft noise events.

Disadvantages

- Does not take account of the noisiness of aircraft and therefore does not incentivise the use of quieter aircraft.
- If set with headroom to permit airport expansion, it may be too high to be acceptable to local communities.
- If set to proactively reduce noise, it may be too low, or become too low over time, to enable equitable levels of growth.

Passenger throughput

A variation on a movement cap is a limit on the number of passengers that can use an airport. Although it is possible to increase passenger throughput without affecting the number of operations or fleet mix by increasing load factors (i.e. flying aircraft with fewer empty seats), significant increases in passenger throughput require more movements, larger (typically noisier) aircraft, or a combination of the two. Passenger throughput limits can therefore be set at an agreed amount corresponding to an equivalent level of noise exposure not to be exceeded.

As a given number of passengers can be transported in a variety of combinations of aircraft sizes and types, numbers of movements and load factors, this limit provides more operational flexibility than a simple movement cap. Because the relationship between passenger throughput and noise is weaker than that between movement numbers and noise, passenger throughput is therefore not considered to be as good a proxy for noise.

A passenger throughput limit does offer incentives to use smaller aircraft which are usually quieter than larger types. However, it does not directly incentivise higher load-factors, so the incentive to reduce movement numbers is lower, as is the limit's ability to control noise emissions.

Another disadvantage of a passenger throughput limit is that its implementation requires a burdensome administration process. This may give rise to a lack of transparency which could act as a barrier to a developing and maintaining effective relationships between industry and local community stakeholders.

Examples of prior use

Belfast City Airport currently operates with a passenger limit of 2 million passengers per annum (mppa), which is implemented by means of a limit on the number of 'seats for sale'. This is in addition to the movement limit mentioned above. Stansted Airport currently has a 35 mppa limit.

Stakeholder views

No specific views were identified in relation to using passenger throughput as a limiting parameter.

Advantages

- Aims to control aircraft size

Disadvantages

- Does not directly take account of the noisiness of aircraft or the number of operations
- Limited ability to control noise emissions
- Requires a burdensome administration process which gives rise to a lack of transparency

Restricting noise exposure

The previous section considered using the inputs which affect how much noise an airport makes as a proxy for the amount of noise made. This section focuses on the actual noise produced by an airport and the parameters which could be used to restrict it.

Noise quota

In addition to the number of aircraft movements (see section on Aircraft movement caps starting on page 15), the other principal quantity which contributes to long-term noise exposure due to an airport is the noise level of each aircraft operation. Therefore, a limit based on a parameter which takes account of both the number of movements and the noise levels of the operations is a better proxy for noise than one based solely on movement numbers.

Under such a scheme, aircraft types are classified (usually separately for landing and taking off) according to a system which is based on official noise certification data.

Each aircraft type is assigned a 'noise classification' according to its noise performance; the noisier the aircraft, the greater the noise classification. The numbers of movements of each aircraft type, over a given period, are multiplied by the corresponding noise factors, and these 'noise factored movements' are counted against an overall noise quota (or noise budget) for an airport. The noise quotas may be set separately for winter and summer seasons, relevant when daylight saving changes also result in schedule changes. They may be sub-divided between arrivals and departures, or between types of services in other ways, depending on the degree of flexibility required within the permitted limits.

The noisier the aircraft used, the higher its noise factor and the greater the amount of the quota budget each movement uses up, thereby providing an incentive for airlines to use less noisy aircraft.

Noise quota budgets may be set to permit a limited amount of growth, i.e. to share the benefits of improving aircraft technology. This would be via the choice

of whether to introduce headroom, to leave the limit unchanged, or to tighten the limit over time. Calculations are usually undertaken on forecast traffic to inform proposed budgets which are consulted upon before they are adopted.

For instance, where there are plans at an airport to replace noisier aircraft with quieter aircraft, a reducing quota budget could allow growth in movement numbers and/or larger aircraft while ensuring that overall airport noise exposure reduces. In this way, the benefits of operating quieter aircraft are shared between industry and local communities.

Exactly how the benefits are shared is determined by how the quota budget is set. For example, under the quota system at the designated airports, one Boeing 747-400 arrival is worth four Airbus A380 arrivals (depending on the engine type). Although replacing a Boeing 747-400 arrival by an A380 arrival would permit three additional arrivals, parties might agree to tighten this part of the budget to an increase of, say, two movements. Considerations such as these could be used to facilitate debate between airports and local communities to ultimately reach agreement over how the benefits are shared.

Examples of prior use

The Night Quota Scheme is in operation at Heathrow, Gatwick and Stansted Airports as part of the night restrictions imposed by the Secretary of State. The scheme applies to the core night period from 23:30 to 06:00 hours, and different quota limits apply to summer and winter seasons.

For many years at Heathrow and Gatwick, the main form of night restrictions was a movement cap. In 1993, the then Secretary of State wanted to discontinue this control and instead rely solely on the noise quota limit. Following a legal challenge, the High Court ruled that a noise quota limit was contrary to the provisions of section 78(3)(b) of the Civil Aviation Act 1982 which gives the Secretary of State the power to set a maximum number of aircraft that may take off or land at an airport during certain periods. As a result, the noise quota provisions are now a supplementary measure; it would not be possible to rely solely on noise quotas to restrict aircraft noise at night unless the legislation was changed.

A noise quota or noise budget system could also be used to control daytime noise. A daytime scheme is already used at London City Airport, whereby an annual noise quota limit applies over a calendar year.

Stakeholder views

No specific views were identified in relation to noise quota systems.

Advantages

- Quota counts are a better proxy for noise exposure than numbers of movements alone.
- Would offer a clear incentive to airports to encourage airlines to operate the quietest fleets practicable.

Disadvantages

- Is more complicated to administrate than a movement limit.
- The level of reassurance it gives to stakeholders relies on mutual agreement of the noise budget set, which may be difficult to achieve.

Noise contour area

Noise exposure contours are routinely used to assess long-term noise exposure at airports. As highlighted in the APF, average noise exposure contours are a well-established means of assessing aircraft noise annoyance and are important for showing historic trends in total noise around airports. These contours can be used as a basis for setting restrictions associated with noise exposure.

A clear and concise way of describing the noise exposure in the vicinity of an airport is to quote the area enclosed by the noise contour of a particular noise metric and level. Being a single numerical value, it is straightforward to set a limit on this value to restrict aircraft noise exposure in the vicinity of an airport.

Limits could be applied to the area of a contour of any agreed metric and at any agreed level. In some cases it may be appropriate to use a noise metric which has a precedent for use in noise control or the assessment of noise impact. For instance, the 57 dBA $L_{eq,16h}$ daytime noise contour which marks the threshold of the onset of significant community annoyance.

Although average noise contours accurately quantify long-term noise exposure, the Government recognises that people do not experience noise in an averaged manner and that the value of the L_{eq} indicator does not necessarily reflect all aspects of the perception of aircraft noise. For instance, the Inspector at the Heathrow Terminal 5 inquiry reported that the annual movement limit was needed in addition to a contour cap, as the L_{eq} index on its own, in his view, was insensitive to the number of air transport movements.

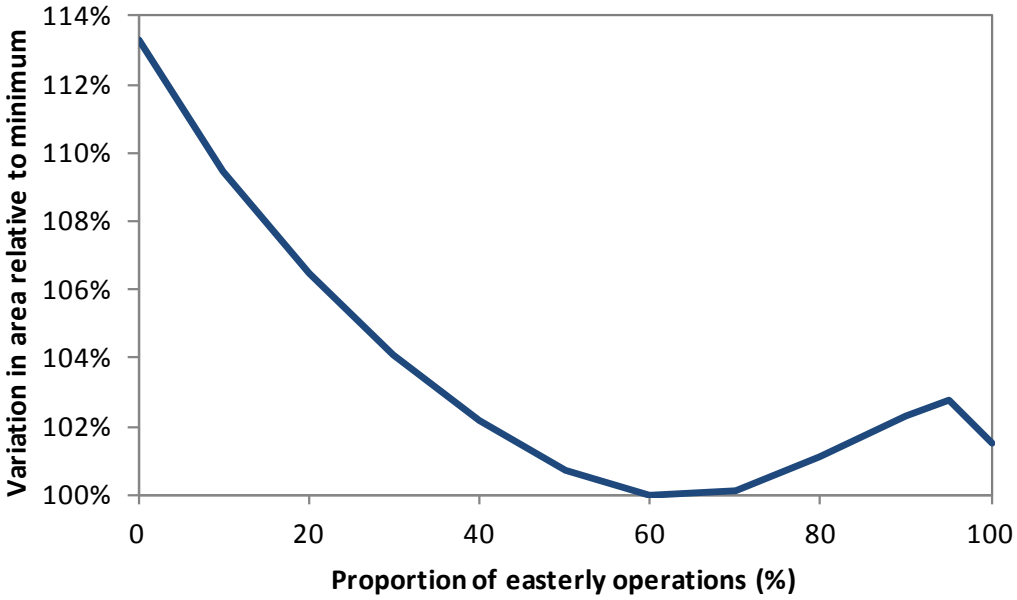
A contour limit may therefore be supplemented by a limit(s) that reflects other key aspects of this perception. Stansted airport, for example, is limited to 264,000 ATMs, 35 mppa and a 57 dBA $L_{eq,16h}$ contour area of 33.9 km².

Different stakeholders may also hold different views on which noise indicator best reflects their perception of how aircraft noise affects them. Obtaining consensus amongst stakeholders on the noise metric to be used may be both one of the highest priorities and principal challenges in designing a noise envelope for an airport which uses noise contour area as a parameter. This is discussed further in the section on Obtaining agreement among stakeholders starting on page 47.

Consideration should be given to whether to exclude any areas of land upon which there will be no community residences for noise to impact upon. For instance, airport land and geographical features such as lakes and the sea. In such cases a simpler alternative may be to use a higher contour level. For example, the 57 dBA $L_{eq,16h}$ noise contour for Manchester Airport includes a largely unpopulated wooded area, but the higher 60 dBA contour level does not. The latter was chosen to define the envelope limit to control noise where it affects the majority of people.

Contour area is also sensitive to factors which are outside the control of the airport and/or the airline, such as the weather which may affect modal split, profile and heading, and market forces which affect route distribution. In Figure 1, data for a specific airport has been used to show how contour area might vary with changing runway modal split.

Figure 1: Effect of runway modal split on noise contour area



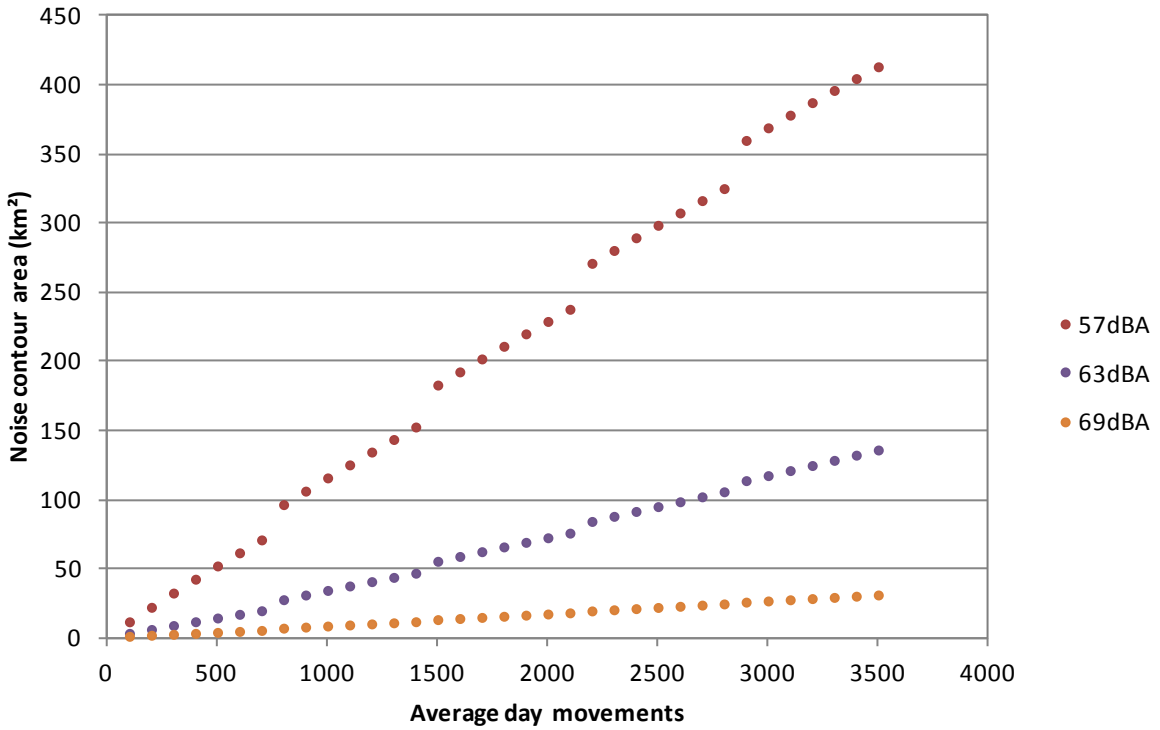
Although there is more scope for mitigation, undertaking essential maintenance to runways and taxiways may have a similar effect. This is explored in more detail on page in the section on Noise contour shape starting on page 26.

The application of such a metric specifically to the development of a hub airport for the UK requires an understanding of how such a parameter would change with the introduction of new runways. Contour area metrics such as L_{eq} and L_{den}[4] are sensitive to the spatial distribution of noise, therefore contour area is sensitive to the number of runways, unlike the parameters considered so far.

To illustrate this point, modelling was undertaken to calculate the areas enclosed by contours for a theoretical airport under increasing numbers of aircraft movements on straight arrival and departure routes. Assuming a mixed-mode runway capacity of 700 daily movements, a new wide-spaced runway was added to the model whenever multiples of 700 movements were exceeded.

The graph in Figure 2 below shows how the 57, 63 and 69 dBA $L_{eq,16h}$ noise contours increase in area under these conditions. It can clearly be seen that the addition of a new runway has the effect of suddenly increasing the area exposed to noise. The incremental increase thereafter is at a lower rate compared with the overall rate until the subsequent runway addition occurs.

Figure 2: The effect of adding new runways on noise contour area



The wide-spaced pairs runway scenario is the limiting case. If the analysis was to be repeated using close-spaced pairs of segregated-mode runways instead, it

4 Equivalent sound level of aircraft noise in dBA for the 24-hour annual average period with 5 dB weightings for $L_{evening}$ and 10 dB weightings for L_{night}.

would be found that the steps associated with adding a new runway/pair would be no greater than the steps shown above.

The choice of metric also has consequences in how the benefits of improvements in aircraft technology are shared between industry and local communities. The L_{eq} and L_{den} metrics are based on the equal energy principle, whereby changing the noise energy by a given amount through either a change in numbers of aircraft movements or a change in noise event duration has the same effect on the metric. For example, doubling the number of noise events (of an average noise level) or doubling the duration of each event would increase the L_{eq} level by 3 dB.

Today's aircraft are quieter than those in service when the L_{eq} metric came into use, but the numbers of operations at airports are more numerous. Some stakeholders have therefore identified that the equal energy principle does not give sufficient weight to the contribution of the number of operations that presently occur. Giving more weight to numbers of movements would result in noise contour areas increasing at a faster rate for a given rate of growth. This would clearly affect the balance when sharing benefits between an airport and its residents.

Examples of prior use

At Heathrow, the Government proposed that 'any further development could only be considered on the basis that it resulted in no net increase in the total area of the 57 dBA L_{eq} noise contour compared with summer 2002, a contour area of 127 km^2'[5].

Also at Heathrow, with effect from the 1 January 2016, the area enclosed by the 57 dBA $L_{eq,16h}$ (07:00-23:00) contour, when calculated and measured by the CAA's Aircraft Noise Contour Model, or any system that succeeds it, shall not exceed 145 km^2.

The airport also operates a number of noise insulation and relocation schemes. Eligibility is based on the extent of airport noise contours.

According to their 2010-2015 Noise Action Plan[4], Manchester Airport has a long-term aim to 'limit and reduce where possible the number of people affected by noise as a result of the airport's operation and development'. One objective to help the airport meet its aim is to 'make sure that aircraft noise does not go above the levels recorded during 2001/2002' (i.e. the year the second runway opened).

5 The Future of Air Transport, Department for Transport, 2003. Paragraph 11.53.

They 'report the area and population contained within [their] daytime and night-time 60 dBA L_{eq} contours', and 'guarantee that the areas will not be larger than [the areas recorded in] 2001'.

Additionally, 'the average level of noise of the 10% noisiest departures (over a 24-hour period) will remain lower than that in 2001; and the average level of noise for the 100 noisiest departures during the daytime and night-time, separately, will remain lower than those in 2001'.

This is an example of an envelope comprising a number of components which aims to address the different ways in which people perceive, and are annoyed by, aircraft noise.

In August 2006, the Examination in Public (EIP) panel published their report[5] on its examination of key issues relating to the Belfast City Airport (BCA) Planning Agreement. It addressed the concept of an 'indicative noise contour' as a control and means of assessing whether airport growth was reasonable.

Most parties accepted that the principle of comparing annual contours against a defined limit as a way of assessing whether airport growth was reasonable. In practice, however, residents' groups had little confidence that the annual contours accurately reflect the noise climate on the ground, especially with regards to changes in fleet mix. This was reported to be due to the following which are not accounted for in annual noise contour:

a) the tonal quality of that noise (lower frequency)

b) the visual effects - several participants mentioned a threatening feeling

c) the fear that the wake vortex could be linked to vibration and possible structural damage

d) the perception that the aircraft are flying lower (although the airport operator assured participants that this was an illusion as all aircraft use the 3° glide path).

The panel also suggested that a system of factored movements should be kept under consideration for the longer term, in association with the suggestions for revisiting the opening hours of the airport.

Stakeholder views

A contour cap is of little benefit without an associated cap on movements.

Advantages

- L_{eq} noise contours, by definition, represent long-term noise exposure

A contour area, expressed as a single numerical value, is easy to understand and apply as a criterion

Disadvantages

- The L_{eq} indicator does not necessarily reflect all aspects of the perception of aircraft noise
- Noise contours are produced retrospectively, so controls only take effect after a noise breach has occurred
- This may be mitigated with forecasting and active noise management, greater complexity

Noise contour shape

Many of the principles of using the area of a noise contour apply to a greater or lesser degree to using the actual shape of the contour as a limit. This criterion goes beyond the remit of the area limit by being explicit on how much noise each neighbouring community can expect to be exposed to. In doing so, it leaves little scope for redistribution of noise geographically within a reporting period without breaching the limit.

It is therefore more onerous to the airport than the area criterion, particularly if factors beyond the airport's control, including weather, result in a breach in one area despite better than expected performance in another. This situation occurred at Amsterdam Schiphol airport, see below, where one of the airport's runways had to be closed for 3 months to avoid breaching the limit.

Correspondingly, the tighter controls have the potential to offer a more comprehensive deal to local residents.

There are a number of different methods that could be employed to control the shape of a noise contour around an airport. Schiphol airport is probably the most well-known example where a system is in place that sets limits on noise exposure levels at specific locations around the airport's perimeter and thereby controls the shape of the noise contour. This is explained in detail below.

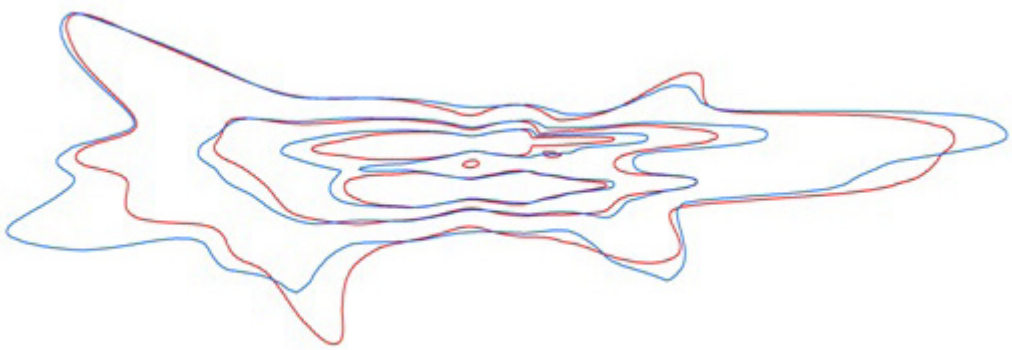
The system is rather complex, particularly in terms of calculating limiting values in the first place and then in terms of planning runway operating modes to avoid breaches. Some allowance for weather variations is incorporated into the limit values. If the limits are breached, investigations are carried out to analyse whether it was due to atypical weather or due to other reasons. When maintenance work

is undertaken that restricts access to a runway, adjustments to the limits values need to be consulted on and agreed.

The system is particularly relevant to an airport like Schiphol with five runways that may be used in a variety of different operating modes, to enforce distribution of noise and avoid concentration on a few preferred runways, and in setting clear expectations for residents.

For airports with far fewer runways there is much less scope for varying the mode of operation and thus less value to be gained from such an enforcement system. Secondly, market changes, such as growth in emerging markets could lead to a change in use of flight paths and thus a change in noise exposure at enforcement points. Figure 3 below illustrates an example of this at Heathrow Airport.

Figure 3: Change in contour shape at London Heathrow between 2002 and 2006 due to combination of market changes and runway maintenance.



Unless this is accounted for, it could in extreme situations lead to sub-optimal use of flight paths and thus additional track miles flown, leading to increased carbon emissions.

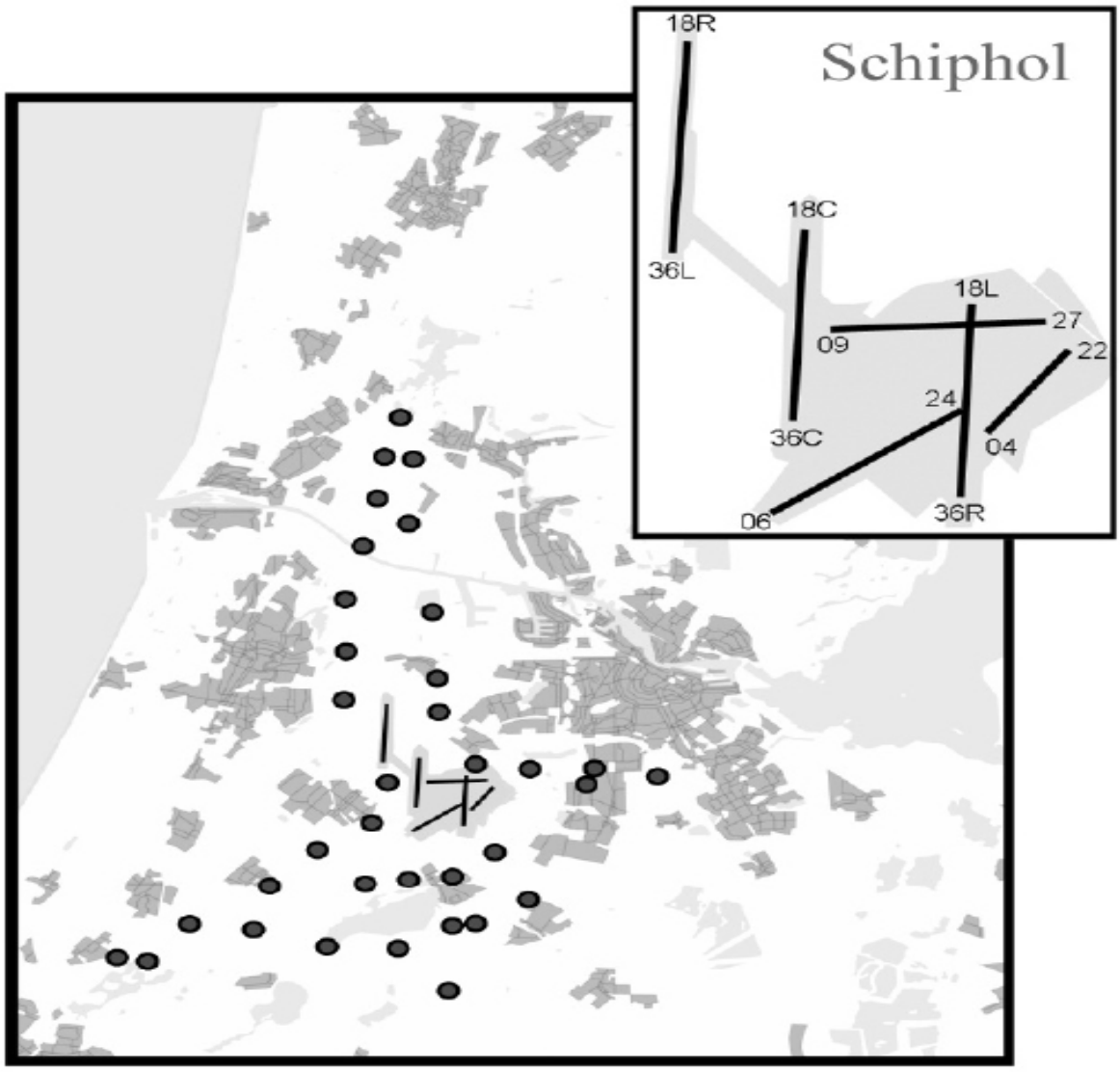
Examples of prior use

Amsterdam Schiphol airport has five runways and during periods of weather with good visibility and light winds, the runways may be operated in a number of different configurations. A sequence of runway preferences has been defined that determines the preferred operating runways, weather permitting. In order to control the runway preference system and thereby control the distribution of noise around the airport, a noise budget restriction system was developed and implemented to set limits on noise exposure at specific locations.

The noise budget restriction system, enacted in primary legislation, is applied through enforcement of maximum noise exposure limits at a large number of locations in the vicinity of the airport. In total there are 60 enforcement points, 35 points for the 24-hour period with maximum limits defined in L_{den} (see Figure 4

below), and 25 points for the night period with maximum limits defined in L_{night} [6]. Each enforcement point has its own limiting value, which may not be exceeded at the end of the year. The limiting values were determined from assessment of a specific scenario meeting specific 'equivalence' criteria expressed in maximum numbers of people and/or households adversely affected by noise, among others.

Figure 4: Enforcement points for L_{den} and runway layout at Schiphol Airport[7]



6 Equivalent sound level of aircraft noise in dBA for the 8-hour annual average night (23:00-07:00 local time) period.

7 Figure reproduced from 'Noise Load Management at Amsterdam Airport Schiphol', T.R. Meerburg, R.J. Boucherie and M.J.A.L. van Kraaij, April 2007.

The noise contribution of an aircraft operation at each enforcement point is determined through noise calculations that take into account the aircraft type, type of operation, runway, flight path and time of day. Noise load at each enforcement point is tracked on a daily and two-weekly basis. If needed, the runway preference system is altered so that the noise load at each enforcement point stays below the maximum limit values.

Measurements are not used in calculating the noise load at each enforcement point since they are not reliable enough for use in an enforcement system. Measurements are subject to interference from other noise sources and also from measurement equipment variation.

Owing to dissatisfaction with the system from both the industry and local communities (see Stakeholder views below), Schiphol is moving to a new system as a result of extensive negotiations with local and national government, the aviation sector and community representatives. The aim is to have a clearer more transparent system which uses the runways in a way that minimises the number of people likely to be annoyed by aircraft noise. The latter underpins the governing criteria of the system, i.e. the limit on the number of people which may be annoyed.

The new system is anticipated to move away from restricting noise exposure, and instead be based on restricting inputs. A new set of ATM rules on runway usage has been proposed and a movement cap is to be introduced to apply up to 2020, limiting the airport to 510,000 movements, of which 29,000 will occur at night. This is a revised version of the original night movement cap which was to permit 32,000 night movements. As certain steps to introduce CDO (Continuous Descent Operations) could not be achieved, the lower night movement limit was implemented in order that the same reduction in the number of people which may be annoyed is realised. To help make the requirement realistic, the airport is obliged to meet the tighter night movement cap over a period of three years rather than immediately.

Compliance will be checked using the forecasts at the start of the year, and again at the end of the year.

Stakeholder views (on the current/old Schiphol scheme)

The airport was not happy that at traffic volumes far below their permitted 510,000 movements, noise limits were breached due to inflexibility of the system.

Local authorities and communities were not happy because of the unintended consequence of the airport using less preferential runways to meet throughput demands.

Advantages

- Provides a very tight noise control and the potential to offer a comprehensive deal to local residents

Disadvantages

- Significantly restricts operational flexibility
- Has some unintended consequences

Noise level caps

Noise contours use noise measurement and prediction to establish noise exposure over the geographical area in the vicinity of an airport. Alternatively, an airport's noise monitors offer a direct means of assessing noise exposure with very limited post-processing.

The noise levels from each noise monitor integrated over a period of time could be compared with an agreed limit value. A breach would occur if the measured level at any of the noise monitors exceeds the limit.

Examples of prior use

Such a system is in operation at Paris Charles de Gaulle Airport. It uses the 'Indicateur Global Mesuré Pondéré' (IGMP), which translates as the Global Indicator Measure Weighted. Raw noise levels are measured in the airport vicinity at either end of the runways. The measured noise energy is weighted using the following multiplication factors:

- 1x for daytime (06:00-18:00)
- 3x (i.e. +5 dB) for evening (18:00-22:00)
- 10x (i.e. +10 dB) for night (22:00-06:00)

The IGMP is capped at a regulatory level set at the annual average noise measured from year 1999 to 2001. Noise energy in subsequent years is expressed as a percentage of the cap. Between 2001 and 2011, the level had dropped to 81.4%. Quite a lot of headroom had therefore been created over the decade.

Advantages

- Uses measured levels, therefore simple and transparent
- Best suited to airports with simple departure route structures

Disadvantages

- Measurements are subject to extraneous noise and equipment precision
- Depending on the siting of the noise monitoring terminals, aircraft can be operated in ways which optimise low noise over the monitors, potentially resulting in higher noise elsewhere.
- Being based on measurements, breaches are identified retrospectively, so in theory, the mechanism cannot guarantee that there will be no breaches.

Restricting noise impact

Noise exposure, in this context, is concerned with identifying how much noise is produced by an airport. Noise impact extends this to identifying how many people are exposed to aviation noise, and further, to assessing how many of these people are likely to be annoyed or adversely affected in some other way.

Since noise impacts are calculated using noise exposure contours, they are also sensitive to the factors outside the airport's control, principally weather and market forces.

Population/dwellings exposed to noise

As well as calculating the area enclosed within a noise contour, it is also straightforward to count the population and number of dwellings enclosed. Being single numerical values, they lend themselves to use as envelope limit parameters.

These are arguably more appropriate in terms of noise control than contour area, as they address actual numbers of people affected. It is people, after all, who perceive the noise, not the land on which people live.

Calculating population and/or dwellings is relevant as their distribution in the vicinity of an airport (or anywhere else, generally) is not homogeneous. Tools such as noise preferential routes (NPRs) provide the means for airports to concentrate aircraft operations (thus aircraft noise) over less densely populated areas to reduce the noise impact in terms of the number of people affected.

An envelope limit based on population or dwellings takes account of such noise mitigation measures and enables airports to share the benefits of taking an active role in noise management. This may incentivise activity in such a role.

It would be necessary, however, to address how the local population changes over time. The rate of population encroachment is outside the airport's control and under certain circumstances, a worsening in noise performance may be indicated despite improvements having been realised, due to positive encroachment.

Use of this parameter as the basis for a limit would require local authorities to set and enforce appropriate land-use planning policies under the guidance of the ICAO Balanced Approach to Noise Management.

The contour level used as the criterion for the metric should be chosen considering how noise is to be most fairly distributed around the airport. As the emerging performance based navigation (PBN) technology enables aircraft able to fly more accurate and repeatable three dimensional flight paths, the paths of departing aircraft in particular will naturally become increasingly concentrated along the Standard Instrument Departure routes (SIDs). This would most likely reduce noise levels except for those living more directly beneath the routes, who may experience increases in noise.

The policy on whether to concentrate or disperse the paths of aircraft, or the use of operational measures to introduce a dispersion effect using multiple routes, could therefore have a bearing on the numbers of people exposed to certain levels of noise. The contour level would need to be selected in order to reflect the area to be captured and controlled by the envelope to address how noise impacts are shared in the vicinity of an airport.

Advantages

- Reflects the number of people affected by noise
- Offers incentives to airports who share the benefits of taking an active noise management role

Disadvantages

- Subject to the problems associated with using noise contours for this purpose, as previously explained
- Population encroachment is outside the airport's control and would need to be accounted for
- Provides limited means to differentiate between people acutely or mildly affected by noise

Number of people annoyed (daytime)

Noise affects different people by different amounts. Research in the field of noise attitudes has developed exposure-response relationships for various parameters, including the percentage of people who are highly annoyed by daytime aircraft noise at different L_{eq} levels. This relationship can be applied to counts of the numbers of people exposed to different noise contour levels to estimate the total number of people who are highly annoyed by aircraft noise at a given airport.

Although the process of obtaining this result is relatively complicated, the single numerical value lends itself to use as a noise envelope parameter.

Because it is calculated using the numbers of people exposed at different noise levels, it accounts for not only population distribution, but also how the noise is distributed over the population. In other words, whereas the population/dwellings exposed to noise parameter (above) incentivises the concentration of flight paths to reduce the total number of people exposed above a certain level, this parameter accounts for the extra annoyance experienced by those people living beneath the lines of concentration.

This parameter relies on the exposure-response relationships, which are subject to change in light of advances in understanding resulting from annoyance research. This introduces an element of uncertainty which could have an impact on planning decisions, and ultimately constitute a risk to the aviation industry which would need to be managed.

Advantages

- Takes into account the increased risk of being annoyed by aircraft noise at higher exposure levels

Disadvantages

- Subject to the same problems associated with using noise contours for this purpose, as previously explained
- More complicated to calculate
- Changing understanding of exposure-annoyance relationship may introduce long-term planning uncertainty and risk to aviation industry

Number of people sleep-disturbed (night-time)

Whereas noise from aircraft operations during the daytime results in annoyance, noise from night operations tends to disturb people's sleep. This parameter is almost identical to the number of people annoyed (above), but requires a different exposure-response relationship, namely the percentage of people who are highly sleep-disturbed by night-time aircraft noise at different L_{eq} levels.

Advantages

- Takes into account the increased risk of sleep disturbance at higher noise exposure levels

Disadvantages

- Subject to the problems associated with using noise contours for this purpose, as previously explained
- Complicated to calculate
- Changing understanding of exposure-annoyance relationship may introduce long-term planning uncertainty and risk to aviation industry

Person-Events Index (PEI)

Another means of calculating the noise impact on a resident is to calculate the number of noise events above a defined threshold level that the resident is exposed to. This is often referred to as the Number Above metric. There is no agreed definition of the threshold level to be used, however, where the concept was pioneered, in Australia, a threshold level of 70 dBA Lmax was adopted, on the basis that this level equates to 60 dBA indoors for a typical Australian dwelling and 60 dBA is an approximate indicator for the threshold of speech interference.

The number of noise events each resident is exposed to above, say 70 dBA, can then be summed to give a figure that represents the total noise load or burden the airport places on the surrounding population, and is termed the Person-Events Index (PEI). Mathematically it equals:

$$PEI_{(x)} = \sum(P_N\ N)$$

Where

- x is the single event maximum noise level threshold in dBA
- P_N is the number of persons exposed to N events above x dBA

PEI is then summed between N_{min} (a defined cut-off level) and N_{max} (the highest number of events above x dBA that a resident is exposed to).

PEI is a useful indicator in that it gives a single numerical measure of the total noise burden or load of an airport. The more noise is concentrated on fewer people, the lower the value of PEI will be. It also assists in the interpretation of noise exposure distributions when considering different operating arrangements at an airport. The index enables a quick assessment to be made of noise exposure information and reveals a somewhat different picture to initial conclusions based solely on the populations exposed.

Examples of prior use

As part of the consultation on Sydney (Kingsford Smith) Airport's third runway, the Australian Department of Infrastructure and Transport brought in this additional metric (along with the AIE below) for assessing the airport's noise effect.

PEI highlighted that certain populations received much higher noise doses than other populations. Significant public engagement led to Sydney adopting the principle that noise sharing should be prioritised at the expense of total exposure, i.e. AIE should be minimised at the expense of increasing PEI – spreading the noise around more people

Advantages

- Reflects the number of people affected by noise
- Reflects the number of events each person is exposed to, and in a linear metric
- Decreases as noise is concentrated onto the least number of runways and flight paths

Disadvantages

- PEI values are produced retrospectively, so controls only take effect after the noise 'breach' has occurred. This may be mitigated with forecasting and active noise management, giving greater complexity.
- Population encroachment will impact on the value of PEI.

Average Individual Exposure (AIE)

PEI gives an indication of total noise load on the surrounding population, but not how it has been distributed across the population. Dividing the PEI by the total exposed population gives the average number of noise events per exposed person, more commonly known as the Average Individual Exposure (AIE).

AIE responds in the opposite way to PEI. Dispersing noise over more runways and more flight paths will increase PEI, but it will reduce the AIE. Together the two metrics provide policy makers with tools to assess policies to concentrate or to disperse noise. Both could form the basis of a noise envelope, however, since they are sensitive to changes in the population distribution in the vicinity of an airport that are affected by population encroachment towards the airport.

Examples of prior use

See Sydney Airport example above.

Advantages

- Reflects the average number of noise events each person is exposed to and is a linear metric.
- Increases as noise is concentrated onto the least number of runways and flight paths, decreases as noise is dispersed over a wider population.

Disadvantages

- Like PEI, AIE values are produced retrospectively, so controls only take effect after a noise breach has occurred. This may be mitigated with forecasting and active noise management, greater complexity.
- Population encroachment will impact on the value of AIE.

Restriction of other parameters

To address other ways in which people perceive noise, a range of parameters are available. To control the noisiest aircraft operations, a limit could be set around the average level of noise of the 10% noisiest departures (over a 24-hour period), or the average level of noise for the 100 noisiest departures during the daytime and night-time.

Parameters such as these focus on noise caused by individual aircraft operations. They are intended to provide reassurance to local communities that limits are set not just to control long-term average noise levels, but also to control the noise of individual events which may be of significant concern.

Examples of prior use

At Manchester Airport, there are a further two requirements in addition to the noise contour limits mentioned above. These are: the average level of noise of the 10% noisiest departures (over a 24-hour period) will remain lower than that in 2001; and the average level of noise for the 100 noisiest departures during the daytime and night-time, separately, will remain lower than those in 2001.

This is an example of an envelope comprising a number of components which aims to address the different ways in which people perceive, and are annoyed by, aircraft noise.

Combining parameters

Examples of prior use

Following approval of the G1 planning application in 2008, Stansted's growth is currently limited by conditions which restrict annual air transport movements to 264,000, passenger numbers to 35 mppa and the area within the 57 dBA $L_{eq,16h}$ contour to 33.9 km^2.

This is an example of an envelope based on three parameters: the numbers of passenger and air transport movements, and an area enclosed by a noise contour. The stepped growth of the limits since 1991 and the lobbying of local residents against expansion at the airport which has occurred over the years highlights that an envelope will not function as intended and provide reassurance to both the aviation industry and local residents if it is permitted to grow in this way.

Time periods

For various reasons, the type and degree of impact of noise exposure varies depending on the time of day (or night) that the noise exposure occurs. The degree of impact also varies depending when in the year the noise occurs, again for a variety of reasons.

Where limits are set, consideration should be given to whether the limits apply to daytime, evening or night-time operations. Some airports may only operate during daytime hours, in which case a simple daytime only criterion may be sufficient. Other airports may operate 24-hours per day, hence separate day and night criteria may be more appropriate.

Circumstances may require assessment against more specific time windows (e.g. early morning from 06:00-7:00 hours) or combined periods with weightings (such as us of the L_{den} metric). This will depend on how the airport operates and possibly on the types of local communities affected.

Where limits are set, consideration should also be given to whether the limits apply to summer, winter or annual average operations.

For a noise envelope to be effective, it should be simple and easily understood by all stakeholders. Therefore, the introduction of separate criteria for different time periods and/or seasons must be on the condition that there is a clear and justifiable need for it.

Examples of prior use

To reduce night-time aircraft noise impacts around Paris Charles de Gaulle airport, the French Minister of Transport order of 6th November 2003 settled a limitation in the number of night movements as of 28th March 2004. The limitation was to apply between 00:30 and 05:29 local time for arrivals, and between 00:00 and 04:59 local time for departures from parking stand.[6]

COHOR, the organisation appointed by the French Authorities to allocate slots at busy French airports, provides information on the current night operation restrictions at Charles de Gaulle. In relation to seasonal quotas, its website currently states that any unused or deleted night slot is lost for the current season. If this results in fewer flights during a season, this may have the effect of reducing noise exposure in the vicinity of the airport. Alternatively, it may create a perverse incentive to operate empty or low value flights only to retain the slot. This would mean the reductions in noise, emissions and fuel consumption, which would otherwise have resulted from the flight not going ahead, would not be realised.

Advantages

Very explicit in defining how much noise communities can expect to be exposed to.

Disadvantages

It is not forgiving to factors which fall outside the airport's control, such as weather and market forces.

Overly complex system for airports with relatively few opportunities to vary their mode of operation.

CHAPTER 4

Setting the limits

The parameters should be set based on an agreement reached between industry and local community stakeholders in line with the vision defined by the Noise Policy Statement for England (NPSE)[8], reiterated as to 'promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development'. In other words, an appropriate balance between minimising noise impacts and maximising sustainable growth must be struck.

Sharing the benefits

A stakeholder response to the draft APF considered that aviation should be allowed to grow within specified environmental limits on noise. If the industry is to be encouraged to research and deploy innovative approaches to environmental issues then it should be rewarded with access to growth.

Indeed, within this study, we have identified that Heathrow's noise contour is shrinking, whilst no further growth beyond 480,000 ATMs per year is currently permitted. The cost to shrink the contour is incurred by aircraft manufacturers in the development of quieter aircraft technology (such as the Airbus A380 and Boeing 787), and by airlines in any extra fuel required as a result of the physical noise mitigation measures on the airframe. Local communities receive the majority of the benefit of the work undertaken by industry in this case.

By contrast, Stansted has made a series of successful applications to increase its throughput to over three times its original permitted limit. At each step change local communities have experienced corresponding increases in permitted traffic levels, while industry has benefitted from growth as and when it has needed it.

Clearly, striking the right balance is not an easy task. Quantitative evidence may be necessary to inform how the needs of all stakeholders can most appropriately be met. For this, an independent assessment of the economic case for growth could be undertaken to provide input data and/or context for any noise predictions. Such an assessment could be funded jointly by the airport and the local authority to promote impartiality.

8 Department for Environment, Food and Rural Affairs (Defra), March 2010

Using composite parameters to set equitable limits (per unit of aviation activity)

Any of the noise exposure or impact parameters could be divided by either of the following 'per unit of aviation activity' parameters to assess the amount of environmental detriment per unit of aviation activity.

Composite parameters could not be used as envelope limit parameters themselves; as such limits would relax as airport activity increases which would not meet the aims of the envelope concept.

These parameters could, however, provide a relative measure of the environmental efficiency of an airport and enable equitable limits to be set for airports having different levels of activity and impact. The latter could be particularly useful in the situation where a noise envelope criterion at an airport is found to be effective, and a second airport of a different size wants to set the same limit, but appropriately scaled for its operations.

Aircraft movements

Use of this could enable equitable exposure or impact-based limits to be set at different sized airports according to the numbers of aircraft movements they handle.

Passenger throughput

Use of this could enable equitable exposure or impact-based limits to be set at different sized airports according to passenger throughput.

Revenue Tonne-Kilometres

The entire payload of a flight may be expressed as Revenue Tonne-Kilometres (RTK) by multiplying the number of passengers by a notional weight (which includes their baggage) and adding it to the cargo traffic before making the distance calculation. Use of the annual RTK for an airport could enable equitable exposure or impact-based limits to be set at different sized airports according to the different economic benefit they generate.

Setting limits to facilitate sharing the benefits

If limits based on inputs are held at a constant level, once they are met, no further growth would be permitted and any improvements in quiet aircraft technology would be of greatest benefit to local communities rather than to industry. An example of this is the Heathrow Terminal 5 movement cap.

Conversely, if limits based on noise exposure or impact are held at a constant level, the improvements in quiet aircraft technology would most likely be used to

permit increased numbers of movements. As such, the greatest benefit would be to industry rather than to local communities.

In the former case, there would be little, if any, incentive to realise further noise reductions through the continued development of quiet aircraft technology. In the latter example, it is likely that industry would be highly incentivised to realise noise reductions.

To incentivise noise reduction such that the benefits are shared between industry and local communities, noise envelope limits could be dynamic. For example, as aircraft technology improves, the noise contour limit could reduce or tighten at a predefined rate in conjunction with a steady increase in the numbers of permitted ATMs. The setting of this rate of change could be informed by forecasting the rate of improvement of aircraft technology using manufacturers' data and identifying trends from historical noise data and using this to make predictions.

On the other hand, the longevity of aircraft and the significant lead times involved in aircraft manufacture results in a slow rate of fleet evolution. Therefore, any schedules for tightening the limits within a noise envelope regime are likely to be able to offer only marginal incentives to make technological improvements over and above the incentives provided by other noise restrictions currently in use at airports. If limits tightened enough to prevent services, there is the risk that the envelope could become an operating restriction rather than an assurance for stakeholders. Operating restrictions are controlled through EU legislation and may thus apply to some forms of noise envelope.

Where static limits based on inputs have been set in the past, obtaining planning permission for an increase in the limits has enabled further growth. The problem with this is that this may lower the trust and goodwill of the local communities. This is considered in more detail in the following section.

Providing assurance

The basis for setting the limits is likely to be forecast airport capacity and assessment and analysis of the noise impacts this would lead to.

The temporal horizon for which we have sufficient information on future aircraft noise levels to enable predictions to be made is limited by information provided by aircraft manufacturers. As it would be unfair to set envelope criteria to be applied at a future time for which we cannot make sufficiently accurate predictions, this horizon to some extent defines the lifetime of a noise envelope regime. In other words, even though a noise envelope regime should be a long-term agreement, it must also be finite and require renewal.

Stansted example

Stansted airport provides an example of how growth has been achieved using static noise management limits, at the expense of significant local community support.

The first Stansted noise insulation programme came into effect on 1 June 1991. The boundary, which had been drawn up by a working group including representatives from Stansted Airport Limited (STAL), the DfT and other organisations, was based on a forecast noise climate and traffic forecasts of the number and types of aircraft likely to be operating when the airport reached 78,000 passenger air transport movements (PATMs); equivalent to 8 mppa.

STAL undertook a commitment to review the programme when the actual noise climate associated with Stansted operating at 8 mppa was known, and to introduce a further programme related to any increase in the PATM approved by Parliament.

Passenger throughput at Stansted reached 8 mppa in the summer of 1999 and in July 1999 Parliament approved a new PATM limit of 185,000 per annum (equivalent to 15 mppa).

In 2003, the CAA's Environmental Research and Consultancy Department (ERCD) was tasked to establish the actual noise climate for Stansted operating at 8 mppa and to compare this with the original scheme, to consider the criteria on which a new scheme should be based and to generate noise exposure maps, based on forecasts of aircraft movements and operations, when traffic reaches 185,000 PATMs or 15 mppa[7].

Following approval of the G1 planning application in 2008, Stansted's growth is currently limited by conditions which restrict annual air transport movements to 264,000, passenger numbers to 35 mppa and the area within the 57 dBA $L_{eq,16h}$ contour to 33.9 km^2.

The stepped growth of the limits since 1991 and the lobbying of local residents against expansion at the airport which has occurred over the years highlights that an envelope will not meet its aim to provide reassurance to both the aviation industry and local residents if it is permitted to grow in this way.

It is vital that the time-period over which an envelope is to apply is clearly defined and properly adhered to if all parties are have the assurance an envelope is intended to provide.

Frankfurt example

Frankfurt Airport is one of Europe's busiest airports. It has undergone several expansions since it opened in 1936, now having two terminals with a capacity of approximately 65 mppa, and four runways.

Terminal 1 was opened to the public on March 14, 1972 on the assumption that the terminal capacity would be sufficient for the following 30 years. However, in 1990, construction began of a new Terminal 2 as it was anticipated that Terminal 1 would reach its capacity limit sooner than previously expected. The new Terminal 2 was opened in 1994, which increased the airport's terminal capacity to 54 mppa, eight years early.

In the intervening years, planning for a third runway began in 1973. The proposed increase in noise and pollution, and the felling of protected trees in Frankfurt City Forest caused protests by residents and environmentalists. The runway opened in 1984 despite the protests and related lawsuits, and the protests even continued for a further three years after opening.

More recently, on 20 October 2011, operations began on Frankfurt Airport's fourth runway. This is anticipated to enable the airport to meet the predicted demand of around 700,000 aircraft movements in 2020. To accommodate the 90 mppa which are forecast to use the airport in 2020, a new terminal section for an additional six million passengers opened on 10 October 2012, and construction of a large third terminal for 25 mppa is under consideration.

Again, there were protests prior to, and following, the construction of the fourth runway. Protesters have staged demonstrations in the terminal building every Monday since the fourth runway opened.

Again, the stepped growth of the airport and the vociferous protests identify that an envelope must handle growth clearly and transparently and with unilateral agreement if it is to function as intended.

Reviews

To strike the right balance, it is essential that the limits continue to be relevant and provide appropriate incentives at all times. Where capacity is constrained by noise, there should be a mechanism to release capacity at set intervals when incrementally challenging noise improvements have been achieved.

For this to occur, the degree to which the benefits are shared needs to be regularly tested. In light of the Stansted and Frankfurt examples above, designing noise envelopes with an agreed built-in review schedule are likely to be preferable

to infrequent overhauls through planning applications which have historically invited opposition and protest.

Reviews could include consideration of a number of actions or elements, some examples of which are given below. The aim would be to maintain the agreed balance between meeting the needs of industry and local community stakeholders. The appropriateness of these actions and elements may vary depending on local conditions and timing.

- Relaxing one or more input restrictions by an agreed amount when an agreed amount of improvement has been made to noise emissions.
- Tightening one or more noise exposure-type limits where sufficient improvements have been realised in these parameters.
- Revising underlying noise calculations following the new noise information on emerging and proposed aircraft types being made available.
- Revising how benefits are shared, such as agreeing the exchange rate between new and retiring aircraft of different levels of noisiness. For example, the number of Airbus A380 operations that could fairly replace one Boeing B747-400 operation, and how could this could be varied in the event of a modification which changes the noise emissions of either aircraft.

The frequency of reviews should be set to give the aviation industry certainty without fossilising the restrictions[8] whilst giving local communities the assurance that growth will not be permitted without their agreement. The review cycle of the Environmental Noise Directive (END) is every five years. The Night Flying restrictions (which apply to the designated airports) have historically been reviewed every five or six years, however the latest proposal is for a three-year regime. These precedents may be useful in informing appropriate reviewing cycles for noise envelopes.

In addition to this short-term view, it would also be advisable to take a long-term strategic view to steer the system in alignment with the long-term policy aims (such as those to 2050), say over a period of 30 years.

All reviews should take early account of major developments to maintain trust with local residents and credibility with industry.

Different envelope limits for different airports

Conditions vary between airports. Some airports are more prone to variations in the market than others which could have an effect on aircraft fleets and how they operate, e.g. use of SID (Standard Instrument Departure), stage length (how far a departing aircraft is travelling), peak operating times etc. Airports exposed to more

volatile weather patterns may have less operational flexibility than others which are more meteorologically stable. Airports in different geographical locations affect different distributions of local populations, and different demographic groups which have different attitudes towards aircraft and aircraft noise.

For example, over the past decade noise complaint levels have been similar between Gatwick and Heathrow airports, despite Heathrow's population noise exposure being sixty times higher. This shows that a 'one size fits all' approach that was normalised, say, on the basis of noise exposure, may not be appropriate. A noise envelope should address precisely the noise issues local to the airport under consideration.

We also saw in the section on Noise contour area how the noise contour limit at Manchester Airport was defined not by the 57 dBA $L_{eq,16h}$ noise contour, but by the 60 dBA contour in order that noise was controlled for populated areas, and not for to the largely unpopulated wooded area which is located between the 60 and 57 dBA contours.

Airports which host a based carrier would need to accommodate the airline's existing fleet and its fleet replacement strategy. For example, operations at Heathrow are dominated by British Airways, at Stansted, dominated by Ryanair, and at Luton, by EasyJet. Fleet replacement decisions by these carriers will have a key bearing on their respective airport's future noise exposure. Airports which do not host a based carrier would have a different set of fleet-related considerations, possibly with greater diversity, but perhaps also less predictability.

This highlights that different airports are subject to different constraints. Any noise envelope would therefore have to take these into account. This was reflected in some of the stakeholder views.

Stakeholder views

We support this concept in principle but careful exploration and discussion needs to take place to understand all the implications, risks and benefits for each airport.

It is important to avoid a 'one-size-fits-all' approach to noise envelopes, and that community stakeholders are involved in developing suitable metrics to measure noise envelopes where they are deemed appropriate.

CHAPTER 5

Implementation

Having identified what a noise envelope could comprise, and having set the limits to achieve the appropriate balance between the needs of stakeholders, this section covers the process of implementing an envelope at an airport. It looks specifically at the process of obtaining agreement amongst stakeholders and the legal basis for implementing the envelope.

Process

The key stages in the process of implementing a noise envelope at an airport are likely to include:

1. Establishing the need. A noise envelope would be necessary for a new major airport or a major airport undergoing significant expansion. A decision may also be required on how a major airport is defined[9]. Depending on the views of the stakeholders, it may be appropriate to implement envelopes at airports not undergoing development, and at smaller airports.

2. Identify stakeholders. These are the groups of people for which the noise envelope is intended to provide assurances over the future growth and associated noise impact of the airport. This will include, as a minimum, the airport operator and the local authority responsible for licensing the airport. In addition, it may include representatives from local authority responsible for areas not including the airport, but in the vicinity of, and affected by, the airport. It may also include airline representatives. The DfT Guidelines for Airport Consultative Committees[10] offers useful advice in this regard.

3. Set up an envelope design team including technical and legal representatives from stakeholder groups.

4. Produce a proposal for the noise envelope design including appropriate metrics and respective limit values.

9 The EU states that a 'major airport' shall mean a civil airport, designated by the Member State, which has more than 50 000 movements per year (a movement being a take-off or a landing), excluding those purely for training purposes on light aircraft. Directive 2002/49/EC of the European Parliament and of the Council of 25th June 2002 relating to the assessment and management of environmental noise, Article 3(p).

10 Guidelines for Airport Consultative Committees, December 2003

5. Undertake an appropriate consultation exercise, with the extent of coverage, means of informing and duration agreed between stakeholders.
6. Revise envelope design in light of consultation responses.
7. Write the envelope criteria into the planning agreement between the local authority and the airport. More details are provided in the section on Legal basis, planning controls starting on page 48.

Obtaining agreement among stakeholders

If a noise envelope is to be effective at a given airport, it is essential that the majority of, if not all, stakeholders are in genuine agreement on the parameters used to define the envelope, the way in which it is enforced, and above all, about how growth of an airport can be controlled so that the noise aspect is sustainable. Without this agreement, the stakeholder(s) whose needs have not been appropriately met will have difficulty in engaging with the envelope and may continue to be, or become, objectionable.

One example is that there are a range of views amongst people over which noise metric best reflects people's perception of how aircraft noise affects them. This may even be different from one airport to another, depending on how the airport operates. For instance, people have proposed that the L_{eq} metric does not adequately reflect the numbers of operations at the busiest airports, and that an alternative metric which puts a higher weighting on the number of movements may be more appropriate. Others have raised concern that the A-weighting of the frequency spectra of noise events does not adequately account for the tonal features of aircraft noise, and that other metrics which account for the spectral content of aircraft noise in other ways, such as those based on EPNL (Effective Perceived Noise Level), may be preferable.

Although the APF states that the noise-designated airports will continue to provide annual $L_{eq,16h}$ noise contours, it states in paragraph 3.16 that airports are not precluded from producing results using other indicators to describe the noise impact of their operations.

In general terms, where unilateral agreement cannot be achieved using standard metrics, consideration should be given to designing envelopes using other metrics provided that they are scientifically valid and robust.

Schiphol example – Alders platform

To obtain consensus at Schiphol airport, a meeting platform was started in 2006, led by Hans Alders (former Dutch Minister of Environment). Its assignment was

to advise the Dutch Government on the development of Schiphol Airport and its surroundings until 2020. The advice had to be based on consensus at the Table, which comprised participants from national and local governments, aviation sector and community representatives.

The advice applied to set time periods and was agreed by means of 'covenants' which the Table signed up to. The advice and the covenants were concerned with items including:

- Selective growth of Schiphol Airport, movement limits
- Noise management system and abatement measures
- Quality of living environment
- Operational restrictions and fees
- Noise insulation
- Information for local communities

Legal basis, planning controls

The possible mechanisms for making a noise envelope legally-binding are presented in this section. Different mechanisms will be appropriate to different airports.

National Planning Policy Framework

Guidance on the use of planning conditions and obligations is given in the National Planning Policy Framework[11] (paragraphs 203 to 206), as below.

'Local planning authorities should consider whether otherwise unacceptable development could be made acceptable through the use of conditions or planning obligations. Planning obligations should only be used where it is not possible to address unacceptable impacts through a planning condition.

Planning obligations should only be sought where they meet all of the following tests:

- necessary to make the development acceptable in planning terms
- directly related to the development
- fairly and reasonably related in scale and kind to the development.

11 National Planning Policy Framework, Department for Communities and Local Government, March 2012.

Where obligations are being sought or revised, local planning authorities should take account of changes in market conditions over time and, wherever appropriate, be sufficiently flexible to prevent planned development being stalled.

Planning conditions should only be imposed where they are necessary, relevant to planning and to the development to be permitted, enforceable, precise and reasonable in all other respects.'

The two types of planning controls which could be used to implement a noise envelope are described below.

Planning conditions

The Department for Communities and Local Government published Circular 11/95[12] which provides guidance on the use of condition in planning permissions.

It states that the 'power to impose conditions when granting planning permission is very wide. If used properly, conditions can enhance the quality of development and enable many development proposals to proceed where it would otherwise have been necessary to refuse planning permission.

The objectives of planning, however, are best served when that power is exercised in such a way that conditions are clearly seen to be fair, reasonable and practicable. This Circular, with its Annex, sets out guidance on how this can be achieved.'

On a number of occasions the courts have laid down the general criteria for the validity of planning conditions. In addition to satisfying the court's criteria for validity, the Secretaries of State take the view that conditions should not be imposed unless they are both necessary and effective, and do not place unjustifiable burdens on applicants. As a matter of policy, conditions should only be imposed where they satisfy all of the tests described in paragraphs 14-42 of the circular. In brief, these explain that conditions should be:

i) necessary

ii) relevant to planning

iii) relevant to the development to be permitted

iv) enforceable

v) precise

vi) reasonable in all other respects.

12 Circular 11/95: Use of conditions in planning permission

By way of example, a selection of model conditions which control noise by restricting the use of an aerodrome or part of an aerodrome are contained in Annex 4 to former Planning Policy Guidance note PPG24: Planning and Noise (England only).

Planning conditions are only drawn up and agreed at the time of a planning application. Using planning conditions as the vehicle for implementing noise envelopes offers very limited flexibility in terms of when and under what circumstances an envelope can be invoked.

Section 106 agreements[13]

Planning obligations under Section 106 of the Town and Country Planning Act 1990 (as amended), commonly known as s106 agreements, are a mechanism which make a development proposal acceptable in planning terms, that would not otherwise be acceptable. They are focused on site specific mitigation of the impact of development.

An s106 obligation can:

- restrict the development or use of the land in any specified way
- require specified operations or activities to be carried out in, on, under or over the land
- require the land to be used in any specified way
- require a sum or sums to be paid to the authority (or, to the Greater London Authority) on a specified date or dates or periodically.

An s106 obligation can be subject to conditions, it can specify restrictions definitely or indefinitely, and in terms of payments the timing of these can be specified in the obligation.

If the s106 agreement is not complied with, it is enforceable against the person that entered into the obligation and any subsequent owner. The s106 agreement can be enforced by injunction. In case of a breach of the obligation the authority can take direct action and recover expenses.

The s106 obligation is a formal document, a deed, which states that the requirements that it sets out are obligations for planning purposes, identifies the relevant land, the person entering the obligation and their interest and the relevant local authority that would enforce the obligation. The obligation can be a unitary obligation or multi party agreement. The obligation becomes a land charge.

13 From planning Advisory Service website (http://www.pas.gov.uk/pas/core/page.do?pageId=12516)

The legal tests for when you can use an s106 agreement are set out in regulation 122 and 123 of the Community Infrastructure Levy Regulations 2010 as amended. Regulation 122 states that an s106 agreement may only be used for a particular development where it is:

- necessary to make the development acceptable in planning terms
- directly related to the development
- fairly and reasonably related in scale and kind to the development.

Similar to planning conditions, s106 agreements are inflexible due to only being drawn up and agreed at the time of a planning application. Because planning obligations can specify restrictions as well as be subject to conditions, they offer more flexibility than planning conditions alone and may therefore be the most suitable existing vehicle through which to implement a noise envelope.

Consequences of a breach in the context of the planning controls

When a development fails to comply with planning agreements and conditions, it becomes unacceptable in planning terms. This could result in the closure of a development.

This may be considered too grave a consequence for breaching one of possibly a handful of noise envelope criteria. Instead, it would be appropriate to draft the planning controls such that failure to take appropriate action following a breach (rather than the breach itself) constitutes failure to comply with the planning control.

Different actions would be appropriate for different situations, but are likely to include aspects such as:

- any breaches in an envelope criterion should be rectified such that similar breaches do not occur in a subsequent measurement period
- financial compensation should be paid to a community fund
- the limit criterion becomes accordingly tighter for the subsequent measurement period to off-set the excess in impact which occurred in the current period.

Civil Aviation Act 1982, Section 78[14]

Controls under the Civil Aviation Act apply only to designated aerodromes (as defined by the Act), and as such, the Secretary of State would be responsible for a noise envelope implemented at an airport designated under the Act. The opportunity to implement a noise envelope through a planning agreement or condition occurs only when an airport submits a planning application. By contrast, implementing a noise envelope under the Act would have the advantage that the envelope could be applied to existing circumstances and independent of the planning process, albeit only at the three designated airports.

Any scheme implemented this way would then be subject to the support of the Secretary of State. This may leave the envelope vulnerable to changes in government and policy, thus increasing the risk of change at a future date. It is also somewhat contrary to the spirit of the Localism Act 2011[15].

Section 78 deals with the basis for implementing noise restrictions, but it is doubtful whether noise envelope criteria could be considered noise restrictions. Section 78(3) enables the Secretary of State to prohibit aircraft from taking off or landing, or limit the number of occasions on which they may take off or land, at the designated aerodrome during certain periods if he/she considers it appropriate for the purpose of avoiding, limiting or mitigating the effect of aircraft noise and vibration. The Secretary of State may:

a) prohibit aircraft of descriptions specified in the notice from taking off or landing at the aerodrome (otherwise than in an emergency of a description so specified) during periods so specified;

b) specify the maximum number of occasions on which aircraft of descriptions so specified may be permitted to take off or land at the aerodrome (otherwise than as aforesaid) during periods so specified; and

c) determine the persons who shall be entitled to arrange for aircraft of which they are the operators to take off or land at the aerodrome during the periods specified under paragraph (b) above and, as respects each of those persons, the number of occasions on which aircraft of a particular description of which he is the operator may take off or land at the aerodrome during those periods.

14 Civil Aviation Act 1982 (amended 2006), Section 78

15 Localism Act 2011

In each case, the actions apply to specified aircraft, such as aircraft of a certain ICAO chapter or Quota Count value. However, the majority of noise envelope parameters are not concerned with particular aircraft types. Therefore, there is doubt over whether the Act is an appropriate way to implement an envelope.

Voluntary agreements

We have also considered the possibility of implementing noise envelopes by means of voluntary agreements between airports and local communities. Such an agreement might take the form of a Memorandum of Understanding (MoU), an item on an airport Noise Action Plan, or a verbal agreement such as the Cranford Agreement at Heathrow Airport (which in 2009 the Government committed to bring to an end).

An MoU defines a protocol within which two parties agree to operate. It is appropriate for use in circumstances where both parties have objectives and desired outcomes which are aligned. Although this may be the case where the relationship between an airport and its local communities is amicable and well managed, envelopes are intended for use in situations where such relationships do not exist. There is also no means of enforcing the terms of a MoU, so it would have limited power to enforce the terms of an envelope which would not provide equal reassurance to both parties.

Major airports are required, under the Environmental Noise Regulations, to produce airport Noise Action Plans on a five-yearly cycle, or 'when a major development occurs affecting the existing noise situation'. These plans set out actions that the airport pledges to undertake in order to reduce noise emissions. The aim is to reduce noise impact on local communities as evidenced in the corresponding noise mapping exercises which are carried out on an according timescale. Although the noise action plans put pressure on airports to realise tangible reductions in noise, airports do not have a legal obligation to meet the actions set out.

The Cranford Agreement was an oral undertaking by the Government in 1952 to the residents of Cranford in west London to reduce the impacts of aircraft noise on the residents. The protocol was written into the airport's manual of operating procedures, with its application being limited by what is practical. It is therefore not legally enforceable in the same way that the terms of a planning consent are. Furthermore, its implementation involved Government intervention which may not be appropriate for non-designated airports.

It is our view that voluntary agreements would not have the legal weight to provide the necessary assurance to stakeholders, particularly those from local communities, that a noise envelope would be adhered to.

The role of Government in implementing envelopes

The above indicates that for all UK aerodromes, including those designated for noise management by the Secretary of State, the planning system is currently the most appropriate vehicle for implementing a noise envelope, despite its inflexibility. There is therefore currently no ideal mechanism for the Government to mandate a noise envelope at a UK airport.

For an envelope to be effective, more flexibility would be required in terms of when and under what circumstances the envelope could be implemented. Additionally, it would require a firm legal basis, so implementing through primary or secondary legislation would be an obvious route.

This may, however, go against the spirit of the Localism Act (2011). A weaker approach which aligns more closely with the Localism concept would be to take no more than an influencing role through the issue of guidance to assist local authorities to invoke noise envelopes through the planning system.

Independent third parties

In the event that agreement between stakeholders cannot be achieved in setting an envelope, there may be a role for an independent and impartial third party to become involved to act as a broker between stakeholder groups in order to reach an agreement.

An independent expert, or group of experts, in the field of aviation noise and economics could be set up to undertake this mediation role for an airport that requires it. This third party should be able to work with the airport's consultative committee, and those of other UK airports to assist with the sharing of good practice and information between them.

Countries including France and the United States of America run national airport noise compensation schemes. Accordingly, they have a single regulatory body responsible for implementing the schemes. In France, it is the Airport Pollution Control Authority (ACNUSA) which carries out this role. This independent body was created in 1999 whose main aims are to reopen communication channels and rebuild trust. Its activity and recommendations focus on:

- Measurement of noise and setting up suitable measuring indicators
- Assessment of noise pollution
- Control of noise disturbance
- Limitation of the impact of air transport and airport activity on the environment
- Levying of fines on airlines when they breach regulatory limits

In the USA, it is the Federal Aviation Authority (FAA) which takes a similar independent role.

The UK does not operate a national compensation scheme, and as such, setting up a national regulatory body in the UK may be considered contrary to the spirit of the Localism Act 2011 and therefore not appropriate. This again recognises that, in the UK, there is no one solution for all airports. To be effective, solutions should be tailored to local circumstances.

CHAPTER 6

In operation

The previous section considered putting a noise envelope into effect. This section discusses the running of the envelope following implementation. It considers monitoring compliance, enforcement action in the event of a breach, and the need to formalise the arrangement in a published monitoring and enforcement plan.

Monitoring compliance in operation

Monitoring compliance may comprise two somewhat distinct activities. Firstly, where the envelope comprises time-bound limit criteria, such as annual air transport movements, a simple check of the actual movement numbers against the limit will be required at the end of the monitoring period. This would be required for all such limit criteria such that enforcement action can be taken in the event of a breach. This would formally be undertaken by the local planning authority.

Secondly, regular monitoring of the parameters would be required throughout the monitoring period as part of the airport's noise management. If a periodic review indicates that a breach may be likely, the airport can take early preventative action to avoid the breach.

Certain parameters will be better suited to monitoring than others. Parameters such as air transport movement numbers can be predicted in advance through the airport's standard scheduling processes, and then closely monitored, potentially on a daily basis, if necessary.

Parameters such as noise contours are most usually produced retrospectively to assess the noise produced over a recent period. If these are used as a means for assessing performance against a limit, by the time that a breach of a limit has been identified, a level of noise exposure above the agreed limit will have already occurred.

It may be that a scheme is agreed which permits a breach, if this is then offset in some way, perhaps with a corresponding tightening of the limit in the subsequent year. On the other hand, if a breach is not deemed acceptable, a combination of forecasting on the basis of schedules and a regime of active noise management at the airport would be required to make the system effective, and may also require some headroom to be built into the system, potentially making the envelope tighter than originally conceived.

Some airports regularly publish operational data on their website. If this is done appropriately, and with the support of local stakeholders, this may further the effectiveness of the noise envelope.

Enforcement

To maintain public confidence in the planning system it is important that planning controls are enforced effectively. Although enforcement action is not mandatory, local planning authorities should take proportionate action in responding to suspected breaches of planning controls.

Clearly, any enforcement measures should be agreed during the design of the noise envelope and the writing of the associated planning controls. Such measures could include fines levied on the airport payable to a community fund, or a proportionate tightening of the controls in the subsequent measurement period as described above.

Local monitoring and enforcement plan

As part of the design of a noise envelope, a local monitoring and enforcement plan should be established with unilateral stakeholder agreement, and published. This should set out how the local planning authority will monitor the implementation of planning permissions, investigate alleged cases of unauthorised development and take action where it is appropriate to do so. The plan should highlight how this is to be undertaken proactively and in a manner that is appropriate to the circumstances.

CHAPTER 7

Conclusions

The key conclusions and messages arising from this study on the Noise Envelope concept are as follows:

1. For an envelope to function as intended, it is essential that full agreement is achieved between all stakeholders on the envelope's criteria, limit values and means of implementation and enforcement.
2. The benefits of future technological improvements must be shared fairly between industry and local communities. This is fundamental to the noise envelope concept, and will need to be considered when defining parameters and setting limits.
3. An envelope is likely to be defined by a combination of parameters.
4. The life-span of an envelope must be agreed, and its parameters defined to maintain appropriate sharing of the benefits over its intended life-span.
5. The parameters and limits, and means of implementation and enforcement of a noise envelope will need to be tailored to individual airports and their respective local conditions.
6. The current planning system offers limited flexibility in the means available to implement a noise envelope. A change in primary or secondary legislation may be required for noise envelopes to be implemented effectively and enforceable by law.
7. A possible need has been identified for independent third parties to assist stakeholders to reach agreement where necessary.

APPENDIX A

Further information

The development of the APF involved consultation on a scoping document and a draft document. As a consultee, we responded to both stages of the consultation. These responses underlie the work carried out and presented in this study.

Scoping document

The DfT published the Scoping Document[16] in March 2011. There was a two-part question on the subject of noise envelopes: 'What are your views on the idea of setting a 'noise envelope' within which aviation growth would be possible, as technology and operations reduce noise impacts per plane? What do you consider to be the advantages and disadvantages of such an approach?' Our response[17] was as follows:

'It is for the Government to set the outcomes which it wishes to see achieved with regard to addressing aircraft noise disturbance impacts. It is fundamental for clear outcomes to be established in order to ensure that a 'noise envelope' sets appropriate incentives.

Subject to the desired outcomes, a noise envelope could be implemented according to a number of approaches:

- In terms of the inputs that contribute to noise created
- by measurement of the noise itself, or in terms of the impact created by noise, or
- through a combination of the above approaches.

Input measures can be used as a proxy for the amount of noise created. Other things being equal the greater the level of inputs the more noise will be created. Input measures could play a useful role in developing a 'noise envelope' approach as measures such as numbers of air transport movements or passengers are in general relatively easy to understand and measure, objective and for the most part trusted by local residents and politicians.

16 Developing a sustainable framework for UK aviation: Scoping document, Department for Transport, March 2011.

17 Department for Transport Consultation, Developing a Sustainable Framework for UK Aviation. Response by the Civil Aviation Authority, October 2011.

The standard method of measuring aircraft noise is to take into account the number of noise events combined with the sound levels and duration of those noise events over a given period to give an equivalent continuous sound level. Research has shown that there is a reasonable statistical relationship between these types of metric and community annoyance. Noise exposure contours can be used to provide a graphical demonstration of the distribution of noise in the vicinity of an airport.

An alternative approach is to consider an inventory approach to noise management. The most common way of describing the noise contours in numerical format is by stating the area of the region encompassed by the outer contour. This has been used numerous times in planning conditions. Setting a limit on contour area contains the extent of the noise impact but does nothing to minimise the number of people affected or put any restriction on the severity of the impact experienced by individuals within the contour area.

Noise exposure contours and other metrics can be used to form dose response relationships. The impacts of noise range from annoyance, sleep disturbance, effects on children's learning through to health effects. In principle, it would be possible to establish a noise envelope based on these impacts. For example, that an airport should ensure that its operations generate no more than a set number of highly annoyed people or a given number of awakenings per night. Any such noise envelope would be subject to the same difficulties as those previously described in attempting to limit the number of people exposed to a stated amount of noise compounded by difficulties in uncertainties inherent in any dose-response relationship (a statistical model that enables the impact of a given amount of noise to be predicted) employed for the purposes of the noise envelope.

Noise metrics can be combined in different ways. A noise envelope might be defined by a set of objectives, all of which must be met to meet the noise envelope criteria. For example, a movement limit might be combined with a noise exposure contour area cap. An alternative but complementary approach would be to assess the amount of environmental detriment per unit of productivity. For example, measurement of the noise exposure contour area divided by the number of air transport movements provides a relative measure of environmental efficiency. Such relative measures are helpful in assessing whether the amount of environmental damage is minimised for a set amount of productivity.'

This response was summarised in the CAA Insight Note 02[18].

18 CAA Insight Note 02, Aviation Policy and the Environment. Civil Aviation Authority, December 2011.

Draft APF

Further to the Scoping Document, the Draft Aviation Policy Framework[19] was published in July 2012. This posed a single question on noise envelopes: 'Do you agree with the proposed principles to which the Government would have regard when setting a noise envelope at any new national hub airport or any other airport development which is a nationally significant infrastructure project?'. Our response[20] was as follows:

'The proposed principles align with Government policy on noise as set out in this consultation, i.e. to limit and where possible reduce the number of people significantly affected by noise. The principles may also assist in meeting the aims of the Government's Noise Policy Statement for England if the envelope criteria are set appropriately. The CAA therefore considers that the noise envelope principles should also have regard to prioritising those most significantly adversely affected by aircraft noise.

The CAA agrees with the principle of setting a noise envelope to encourage the sharing of the benefits of future improvements in technology between the aviation industry and local residents. We consider that the application of an appropriate noise envelope should provide clarity and assurance to local communities that growth would be delivered in a sustainable way and up to an agreed limit.

It is our view that growth should only be allowed if clear and realistic incentives are present for airlines to introduce the quietest suitable aircraft as quickly as is reasonably practicable. We agree with the principle that a noise envelope should contribute to this incentive, and also to incentivise airlines and airports to operate in ways to limit, and if possible, reduce noise impact.

The suggestion in the consultation document is that noise envelopes would be set at any new national hub airports or airport development which is a nationally significant infrastructure project. The CAA suggests that the principles which underpin the envelope concept should be sufficiently robust and standardised that they should be applicable to airports of all sizes and significance.'

19 Draft Aviation Policy Framework, Department for Transport, July 2012.

20 Draft Aviation Policy Framework Consultation, The Civil Aviation Authority's Response to the Department for Transport's Consultation on the Draft Aviation Policy Framework, October 2012.