EUROPEAN COMMISSION
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DIRECTORATE F - Air Transport

Study of Aircraft Noise Exposure at and around Community Airports : Evaluation of the Effect of Measures to Reduce Noise

Final Report

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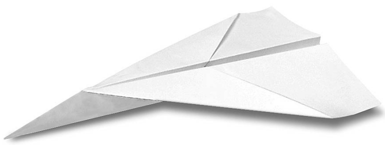
Submitted by:

M P D Group Limited



In Association with :

Environmental Resources Management

and CE Delft

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1 Executive Summary

1.1 Objectives and Approach

In 2002, the EU adopted Directive 2002/30 concerning noise-related operating restrictions at EU airports. World-wide agreement had been reached in ICAO for the banning of the older and noisier Chapter 2 and this took effect in April of that year. More recently, agreement had been reached in ICAO on Chapter 4 setting noise standards for new aircraft entering service, but no timetable was set for the phasing out of Chapter 3 aircraft. The Directive envisaged operating restrictions on aircraft that were marginally compliant with Chapter 3 being adopted at individual airports within the framework of the "Balanced Approach" set out by ICAO, and set out rules for the establishment of those restrictions. The Directive mandated the Commission to carry out a review after five years. This study is designed to help the Commission to discharge that task.

In particular, the study contains:

§ an assessment of the changes in the total impact of aircraft noise within the European Union since the entry into force of the Directive;

§ an inventory of measures to mitigate that noise at and around Community airports since its entry into force;

§ an inventory of already planned actions to mitigate aircraft noise with respect to gradual withdrawal of marginally compliant aircraft and to night flight restrictions;

§ a detailed analysis of the above with a view to establishing how likely the Community is to achieve its objective of limiting aviation noise at and around Community airports under existing legislation, and to identify possible improvements to that legislation, inter alia by examining more stringent phase out options.

The study has attempted to take in all 70 or so airports covered by the Directive, comprising:

§ obtaining facts and plans from the airports concerned – approximately three-quarters were able to co-operate fully with the study;

§ a comprehensive statistical analysis of aircraft movements at the airports for 2002 and 2006, thanks to the generous assistance of EUROCONTROL in providing data to the Commission;

§ detailed analysis of noise trends at five Case study airports selected to give a representative mix of types of airports, together with forecasts of future noise.

1.2 Noise Abatement Measures in Force and Planned

Of course, most airports had noise alleviation measures in force and some had others planned before the introduction of the Directive. Thus, it is not easy to show any measures that were adopted as a result of the Directive. Indeed, many airports said they were able to adopt measures under pre-existing national law. Some even thought the Directive's only effect was to inhibit new noise alleviation measures because of the burden of compliance with the assessment procedures. However, three or four were firmly of the view that restrictions they had introduced would have been impossible without the Directive. Others found it helpful in raising awareness or demonstrating to stakeholders (neighbours, politicians and airlines) that they were operating within an international framework.

In Section 5.2 we summarise the restrictions introduced by type, namely:

- On marginally compliant Chapter 3 aircraft as defined (by 5dB or less);
- On Chapter 3 aircraft that are more than marginally compliant, but not meeting Chapter 4 standards;
- Night restrictions;
- Noise Budgets;
- Limits on movements.

Naturally, at many airports, there was more than one type of restriction in force.

Amongst the respondent airports, some highlights are:

- Only three airports have totally banned "Minus 5" aircraft or are in the process of doing so, including one City Airport (one of the four defined in the Directive) and Paris CDG. Another four have reported partial bans, mainly at night. Bans are actively being considered at another ten.
- "Minus 8" aircraft are banned at night at one airport, and three airports (two of them City Airports) are considering a move to Chapter 4 standards. In total, these bans, actual or planned, total or partial, affect about 40% of the airports for which we have information. In addition the operation of noise quotas may have the effect of limiting the use of marginally compliant aircraft.
- Noise quotas are in operation at a few airports. The most notable is Amsterdam, where there is an elaborate scheme described in Chapter 8. At the main London airports, night restrictions are related to a noise Quota Count.
- We identified two airports, Paris Orly and Düsseldorf with limits on the overall annual number of movements.

The authorities have to balance the economic benefits to their regions of air services and the environmental impacts. As such, they are anxious that restrictions should not drive away air services. We were told of two re-locations in the 1990s and there is the more recent case of DHL's planned move of services from Brussels to Leipzig because of night restrictions. Apart from this, airline reaction to restrictions seems to have been re-scheduling or change of aircraft, and we were only told of one instance where it was believed an air service had been lost.

Of the remaining elements of the "Balanced Approach", we note:

- At virtually all airports there are mandatory operational procedures such as noise preferential routes, maximum actual noise at specified points, continuous descent approach, track keeping and ground noise. Some are backed by penalties for infringements. We only discovered five instances, all at medium-sized regional airports, where such procedures have been introduced since the Directive came into force.
- Land use management – including controls on building in noise-affected areas, apply around about 60% of the airports responding.
- Noise insulation schemes operate around about two thirds of the airports contacted, a third of those have come into force since 2002. The qualification criteria, the scope of work and the costs, vary considerably across Europe.

- Finally, though not formally part of the Balanced Approach, charges differentiated by night/day and/or noise category, apply at most airports. At about half of the airports contacted, there is differentiation by noise category. A few others are considering such charges. These are usually revenue neutral, but nine airports use the revenues to defray particular costs. Some 70% of respondents consider the charges to be effective noise-management tools.

Quantification of the effects of each of these factors is not generally considered feasible, but one airport claimed a reduction of 45% in the noise contour.

1.3 Growth in Traffic and the Use of Marginally-Compliant Aircraft

The study's Base Year is the twelve months from April 2002 to March 2003 – selected as the first complete period following the phase out of Chapter 2 aircraft. It was a period which had seen widespread falls in traffic because of September 11th and the SARS epidemic. At our 70 airports, the EUROCONTROL data shows a growth in traffic of approximately 3% p.a. to reach 11mn aircraft movements (landings and take-offs) by 2006. The growth of jet aircraft as defined in the Directive averaged 3.9% p.a. with a drop in the numbers of movements by other aircraft. There was also a slightly faster increase in the standard eight-hour night period. The 70 airports comprise approximately 70% of total European traffic. However the remaining smaller airports are primarily in more lightly-populated areas, with a greater proportion of non-jet and smaller aircraft, and thus probably contribute only a small proportion of the total noise disturbance caused by civil air transport.

As the Terms of Reference required an analysis of changes to the stringency level used to define marginal compliance, considerable effort was expended in the study to analyse the extent of present and likely future use of aircraft which do not meet Chapter 4 standards. Our analysis indicates a very significant drop – approximately 80% - in the number of movements by marginally compliant aircraft. There were also falls of some 20%-25% in movements by aircraft compliant by between 5dB and 10dB, with a growth of some 20% in aircraft meeting Chapter 4 standards.

We analysed aircraft fleets and spent considerable effort in trying to identify the certificated levels of individual aircraft. Of the qualifying aircraft (jets over 34 tonnes or 19 seats) registered in the "Community" (EU, EEA and Switzerland) we only identified 49 aircraft that are only marginally compliant and only 600 or so that do not meet Chapter 4 standards, out of a total fleet of some 4,600 jet aircraft as defined and 11,000 aircraft in total. In addition, Community airports attract operations by aircraft based elsewhere. Overall, we estimate that at the 70 airports, only 0.4% of movements are by marginally compliant aircraft, and 88% are by aircraft meeting Chapter 4 standards.

1.4 Change in the Noise Climate in Europe

In 2003, the Commission received a report from ANOTEC that modelled noise contours at 53 airports in the then EU and produced forecasts of future exposure. We have built on this work by additional analysis of the 2003 work, detailed analysis of aircraft movements at 70 airports in the enlarged EU, EEA and Switzerland, and by detailed study of five representative airports. Our approach has been to devise a methodology which enables changes in the noise climate, with and without specific measures, to be assessed. The methodology does not permit us to make viable estimates for individual airports – Member State are required to produce those for the Commission by the end of the year.

We conclude that there has been a very slight increase since 2002-03 in the level of exposure – the contour areas have expanded at some airports and declined at others. Thus, the significant increase in traffic has been approximately balanced by the decreased use of the noisiest Chapter 3 aircraft. From the Anotec work, at the 51 airports they modelled, we estimate that approximately 2.2mn people were living within the 55 Lden contour in both years.

The assessment of future trends has been based on the Europe-wide forecasts produced by EUROCONTROL, applied to individual airports in the light of specific information. Overall, the assessment envisages an average growth of 3% p.a. in the number of aircraft movements.

There are many factors that will determine whether the population exposed to noise around a particular airport will increase or decrease in the future to 2010, 2015 and beyond. These factors can be broadly grouped as follows, when considered in the context of this study:

- the rate of overall growth in air traffic;
- distribution of that growth over the day/evening/night periods;
- the extent to which Chapter 3 aircraft are phased out;
- the extent to which Chapter 4 aircraft are themselves replaced by quieter types;
- the benefit of improved operational procedures; and
- changes in population distribution (neighbouring land-uses).

We have shown that Chapter 3 fleet retirements will off-set traffic growth to reduce population exposure by a few percent. Changes to the Chapter 4 compliant fleet up to 2015 will add to this. Whether or not all these off-setting factors will be enough to avoid actual year on year noise exposure increasing will, we suspect, vary greatly from airport to airport.

Our conclusion is that, overall, the population exposed to noise is likely to increase across the Community. At most (although not necessarily at all) airports, there will be increases in the contour areas. This holds even if all aircraft other than those meeting Chapter 4 standards are withdrawn.

1.5 Policy Options

The principal objective of Directive 2002/30 EC is to "limit or reduce the number of people significantly affected by the harmful effects of noise", while the preamble declares that sustainable development requires "reducing the noise nuisance at airports with particular noise problems". This study concludes that with measures in force, noise exposure will in fact increase across the Community, although this may not necessarily be the case for all airports.

Of the options considered:

- Entirely removing marginally compliant aircraft ("Minus 5") will make a small difference, but these aircraft are being retired.
- Banning all aircraft that do not meet Chapter 4 standards ("Minus 10") will make some difference but not enough to contain the growth in the numbers of people affected. By 2015, it is likely that many of these aircraft will also have been retired.
- Other elements of the Balanced Approach – land use management (including in rare cases a new runway or new airport), insulation, property purchase and operating procedures are already being used within the limits of national laws. Further measures in this area, with the possible exception of continuous descent approach procedures, will only help to a small extent.

This implies that significant improvements will only be obtained by tackling noise at source or by further operating restrictions. Possibilities are:

- Developing a "Chapter 5" reflecting the potential of current technologies. This could only have an effect in the long-term.
- Defining levels of stringency which are greater than "Minus 10"
- Greater use of effective and enforced noise budgets such as those applying at night at the London airports.
- Sharper differentiation in airport charges according to noise. This would help to incentivise airlines to use quieter aircraft.

1.6 Changes to the Directive

We recommend consideration should be given to some changes to the Directive, some of them minor:

- Further clarify the Directive to make clear what exactly it permits and prohibits;
- Reconsider the formulation in Article 5.1 and the requirements posed in Annex 2;
- Change the definition of marginally compliant aircraft by increasing the margin by which Chapter 3 standards have to be exceeded
- Consider achieving further consistency of aircraft categorisation in the long term;
- Consider widening the scope of the Directive to apply to smaller aircraft types as well.

Overall, we consider the effects of the Directive have been modest and will continue to be so.

2 Introduction

2.1 Objectives

This Report has been prepared for the European Commission by MPD Group Ltd in association with CE Delft and ERM Ltd, to appraise and comment on aircraft noise exposure at and around Community Airports and to evaluate the effects of measures to reduce noise.

In particular the study specifications require the consultant to research and report on the five key areas noted below:

- an assessment of the changes in the total impact of aircraft noise within the European Union since the entry into force of Directive 2002/30/EC;
- an inventory of measures to mitigate that noise at and around Community airports, taken into accordance with the provisions of the Directive since its entry into force;
- an inventory of already planned actions to mitigate aircraft noise with respect to gradual withdrawal of marginally compliant aircraft and to night flight restrictions;
- the impact of the above measures on the future noise climate;
- a detailed analysis of the above with a view to establishing how likely the Community is to achieve its objective of limiting aviation noise at and around Community airports under existing legislation, and to identify possible improvements to that legislation;, inter alia by examining more stringent phase out options.

This Report presents our analysis, findings and conclusions in relation to the above four issues.

2.2 Background and Context

The need for the study arises from Article 14 of Directive 2002/30/EC which requires that the Commission shall report to the European Parliament and to the Council on the application of this Directive no later than five years after its entry into force. The Commission's report may need to make proposals for revision of the Directive. It therefore has to contain an assessment of the effectiveness of this Directive, in which context particular stress is laid upon determining whether there is a need to revise the current definition of "marginally compliant aircraft" (Chapter 3 minus a cumulative 5 EPNdB) in favour of greater stringency.

This study is designed to assist the Commission in preparing that report, addressing the issues with which the Commission's report must deal.

The Directive's objectives may be summarised as :

- to ensure respect for the ICAO Balanced Approach to aircraft noise limitation;
- to provide a framework of rules so that individual airport restrictions are introduced in a consistent way so as to "limit or reduce" the number of people significantly affected by (aircraft) noise;
- to ensure maintenance of internal market needs;
- to promote environmentally compatible airport capacity development;

- to help achieve individual airports' specific noise abatement objectives; and
- to enable the achievement of maximum environmental benefit in the most cost-effective way, through the selection of appropriate measures.

The essential aim of our work has thus been to see how well those objectives have been achieved, and how far the application of the Directive has contributed to that degree of achievement. It was therefore important to assess changes in the Community noise climate since 2002, and to see to what extent the Directive's regulatory framework has contributed to those changes. Clearly such quantitative and qualitative work called for a detailed inventory of measures already taken or planned at airports, under the Directive, so that we could judge their effectiveness.

Concomitantly, we assessed the current and future appropriateness and effectiveness of the Directive's definition of "marginally compliant aircraft". Another area needing particular attention was the use of partial operating restrictions, generally applied to the night hours.

2.3 Our Approach and Methodology

We employed a three-fold strategy in tackling these questions, each element interactive with the others and assuring internal consistency :

- desk research and fieldwork for data acquisition, notably analysing EUROCONTROL'S database to determine day, evening and night movements, defined in local time, by aircraft type in our 2002/03 base year and calendar 2006, at some 70 airports currently or potentially soon to be covered by the Directive's traffic threshold;
- a comprehensive interview programme, covering the same airports; seeking facts and figures on restrictions and other issues, policy definition and expert opinions on a wide range of noise measures;
- actual and forecast noise contour modelling at five sample case study airports, for grossing up to Community level on noise climate changes.

While the participating partners worked as a team, very broadly MPD Group had primary responsibility for data acquisition and analysis, ERM for noise modelling, and CE for policy matters. This report describes our analysis and conclusions.

2.4 Acknowledgement of the assistance of EUROCONTROL

We are very grateful for the assistance we have had from EUROCONTROL in providing us with a significant volume of data which has been vital for our statistical analysis.

2.5 Acknowledgement of the co-operation of airports

We are also grateful for the co-operation of the airports who responded to our questionnaire and particularly those who assisted with our various modelling exercises. We also received help and advice from the staff of ACI EUROPE.

2.6 Acknowledgement of the co-operation of ANOTEC

The assistance and technical data we received from ANOTEC on which to base much of our noise contouring work is acknowledged with appreciation.

3 Background

3.1 ANOTEC Study

3.1.1 Objectives, Achievements and Limitations

The 2003 ANOTEC study[1] in its finally corrected version, in effect modelled current and forecast Lden and Lnight contours (and determined the numbers of residents exposed to noise within them) at the 53 airports then subject to Directive 2002/30/EC. The study estimated the numbers of people exposed to noise in the (15 Member State) Community, in terms of residence within modelled current and future Lden and Lnight contours.

Their report provided the first comprehensive estimate of noise exposure around the European airports covered by the Directive at that time. Noise contours were generated using Lden and Lnight noise metrics for the years 2002, 2007 and 2015.

It is therefore the natural base on which to build our assessment of how effective the Directive has been, and whether it needs amendment for future effectiveness, with particular attention to the question of marginally compliant aircraft. ANOTEC's study had, however, some limitations in relation to our differently focussed work, associated with their timing, methodology and objectives, including :

- As noted above, it covered only 53 airports in a smaller European Union. To reflect today's Community, we have studied 70 airports.
- A base year of 2002 included the last three months of Chapter 2 operations under Council Directive 92/14/EEC. Addressing Directive 2002/30/EC, our base year for comparative analysis was April 2002 to March 2003.
- Its airport questionnaire response rate was 24%. We learned from this experience and worked by telephone and personal questionnaire-based interview, also briefing ACI-EUROPE's Environmental Strategy Committee, achieving a 74% response rate.
- The adoption of a limited number of representative types of aircraft as proxies for groups of different aircraft was essential to make their enormous individual airport modelling task possible. They modelled sample aircraft at all airports while we model all aircraft at sample airports. This is partly due to our need to look at aircraft in greater detail (especially marginal types), and partly because compatible replication of their work, dependent on proprietary software, would be impracticable even if it were appropriate.

Furthermore, our present study is being conducted in a different ambient context with regard to noise measurement. Under Directive 2002/49/EC, the Community's authorities at and including major airports have to undertake their own detailed estimates of population affected by noise through 'noise mapping' by June 30, 2007, and to report the results to the Commission by December 2007. Thus in contrast to the ANOTEC work upon which it builds, our study is set against a background where there are soon to be comprehensive statistics on population exposure to noise at all the relevant airports.

Accordingly the focus of this study is therefore not to repeat ANOTEC's valuable pioneering work, but rather, with particular emphasis upon the past and future

[1] ANOTEC Consulting S L : Study on current and future aircraft noise exposure at and around Community airports, Final report and update corrections 2003/04 and CD data.

effectiveness of Directive 2002/30 and, to develop and build upon it, albeit with a rather different focus.

ANOTEC's corrected 2002 estimates were of :

- 2.2 million people within the 55 dB(A) Lden contour; and
- 2.7 million people within the 45 dB(A) Lnight contour

at 53 airports accounting for 8.7 million aircraft movements.

We have studied 70 airports, accommodating 9.8 million total IFR movements in 2002/03. These airports are identified in the following paragraphs.

3.2 Airports Studied

3.2.1 Data List

As noted above, we have extended the geographical scope of the study of airports in the context of the Directive, to include the 12 Accession States which have joined the Community since 2002, and Switzerland (whose three major airports[2] of Basel, Geneva and Zurich contribute to the Community's noise climate). Actually only five airports (Larnaca, Prague, Budapest, Bucharest and Warsaw) from the Accession States now or potentially seem likely to soon meet the Directive's 50,000 jet[3] movements per annum applicability threshold.

A further 11 airports not covered by ANOTEC were added to our list for data acquisition as they are currently at or appear likely to reach the Directive's threshold in the reasonably near future. The final alphabetical list of 70 airports (including four City Airports) for which we obtained traffic data and sought further information, is at Table 3.1. Appendix C gives further detail with 2002/3 and 2006 jet and total movements at these airports together with a graphical illustration of each airport's relative size.

[2] Of which two, GVA and BSL/MLH, have a joint Swiss/French identity in traffic terms.

[3] Civil subsonic jet aeroplanes with a maximum certificated take-off mass of 34000 kg or more, or with a certified maximum internal accommodation of more than 19 passenger seats.

Table 3-1 Airports Studied

Airport Name	IATA Code
Aberdeen	ABZ
Alicante	ALC
Amsterdam	AMS
Athens	ATH
Barcelona	BCN
Basel/Mulhouse/Freiburg	BSL/MLH
Belfast City	BHD
Bergamo	BGY
Berlin Schoenefeld	SXF
Berlin Tegel	TXL
Berlin Tempelhof	THF
Bilbao	BIO
Birmingham	BHX
Bologna	BLQ
Bristol	BRS
Brussels	BRU
Bucharest	OTP
Budapest	BUD
Catania	CTA
Copenhagen	CPH
Dublin	DUB
Duesseldorf	DUS
East Midlands	EMA
Edinburgh	EDI
Frankfurt/Main	FRA
Geneva	GVA
Glasgow	GLA
Gothenborg	GOT
Hamburg	HAM
Hannover	HAJ
Helsinki Vantaa	HEL
Heraklion	HER
Koeln-Bonn	CGN
Larnaca	LCA
Las Palmas	LPA
Leipzig-Halle	LEJ
Lisbon	LIS
London City	LCY
London Gatwick	LGW
London Heathrow	LHR
Luton	LTN
Luxembourg	LUX
Lyon Satolas	LYS
Madrid Barajas	MAD
Malaga	AGP
Manchester	MAN
Marseille	MRS
Milan Linate	LIN
Milan Malpensa	MXP
Muenchen	MUC
Naples	NAP
Newcastle	NCL
Nice	NCE
Nuernberg	NUE
Palma De Mallorca	PMI
Paris CDG	CDG
Paris Orly	ORY
Prague	PRG
Rome Fiumicino	FCO
Stansted	STN
Stockholm Arlanda	ARN
Stockholm Bromma	BMA
Stuttgart	STR
Tenerife Sur	TFS
Toulouse	TLS
Valencia	VLC
Venice Marco Polo	VCE
Vienna	VIE
Warsaw	WAW
Zurich	ZRH

Note: Emboldoning designates Interviewed Airport

3.2.2 Interviews

For initial contact with all airports listed we prepared an introductory summary of the aims of the study and our requests for information and opinions, backed by the authority of a letter from the Commission. We also prepared an "interview framework" for consistent conduct of the interview programme among the study team. After the EUROCONTROL statistical database was received, certain statistical elements of the interview could be omitted.

These airport interviews were largely conducted by telephone, some involved personal visits as well. Some airports were dealt with through a central office, for instance BAA's London airports, AENA in Spain, ADV in Germany, and SEA's Milan airports.

In addition, for the German airports, ADV provided a central answer to three of the questions. A few airports preferred to complete the "interview framework" documents as an electronic questionnaire. As is evident from the analysis of replies in Section 5, not all airports answered every relevant question fully. Overall, responses were achieved from 52 airports, a response rate of 74%, these airports being identified by emboldening in Table 3.1 above. A further three specifically refused co-operation as they felt it either irrelevant to them, or could not make free the time to speak to us – itself an interesting finding. The remaining 15 were unsuccessful for broadly 'administrative' reasons.

Personal visits were also made, of course, to the five airports selected as sample Case Studies – Amsterdam, Glasgow, Lisbon, Toulouse and Warsaw, dealt with in Section 8.2

It was made clear to all airport interviewees at the outset that under the terms of the Study specified by the Commission we could not promise confidentiality in using the factual data which they supplied, but the facts we were requesting would not normally be confidential anyway. However we did promise anonymity, if they so wished, regarding any opinions they expressed. We asked them to alert us at any point if what they told us was confidential and thus "off the record". At the end of the interview we again asked if there was anything confidential we ought not to use in our report. Certain airports did request confidentiality for some of the statements and opinions they put forward. As a result, in our report on the interview findings in Chapter 5 we have not identified airport names in those sections where to do so would breach our confidentiality undertakings.

3.3 Marginal Chapter 3 Aircraft

3.3.1 Significance

An important issue to be addressed by this study is a possible change in the definition of marginality. In order to assess the current and future effectiveness of the Directive in population exposure terms, we will be postulating in Chapters 8 and 9 (for noise contour modelling) that all airports implement bans as permitted by the Directive on the operation of aircraft within various bands of marginality.

3.3.2 Identification

The certification rules lay down procedures for monitoring noise levels at 3 noise certification points (approach, sideline and flyover) in EPN (Estimated Perceived Noise level) dB. There are limits for each of the points that define Chapter 3 and Chapter 4. The limits at all three points have to be met, but a degree of trading is allowed between the 3 levels. Directive 2002/30/EC takes the sum of the 3 levels as the indicator of marginality (i.e. with no limit on trading). In line with the Directive we have considered the cumulative margin, not individual certification point levels. The cumulative Chapter 3 limit increases with aircraft weight and with the number of engines as shown in Figure 3-1

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Figure 3-1 Cumulative Noise Certification Levels

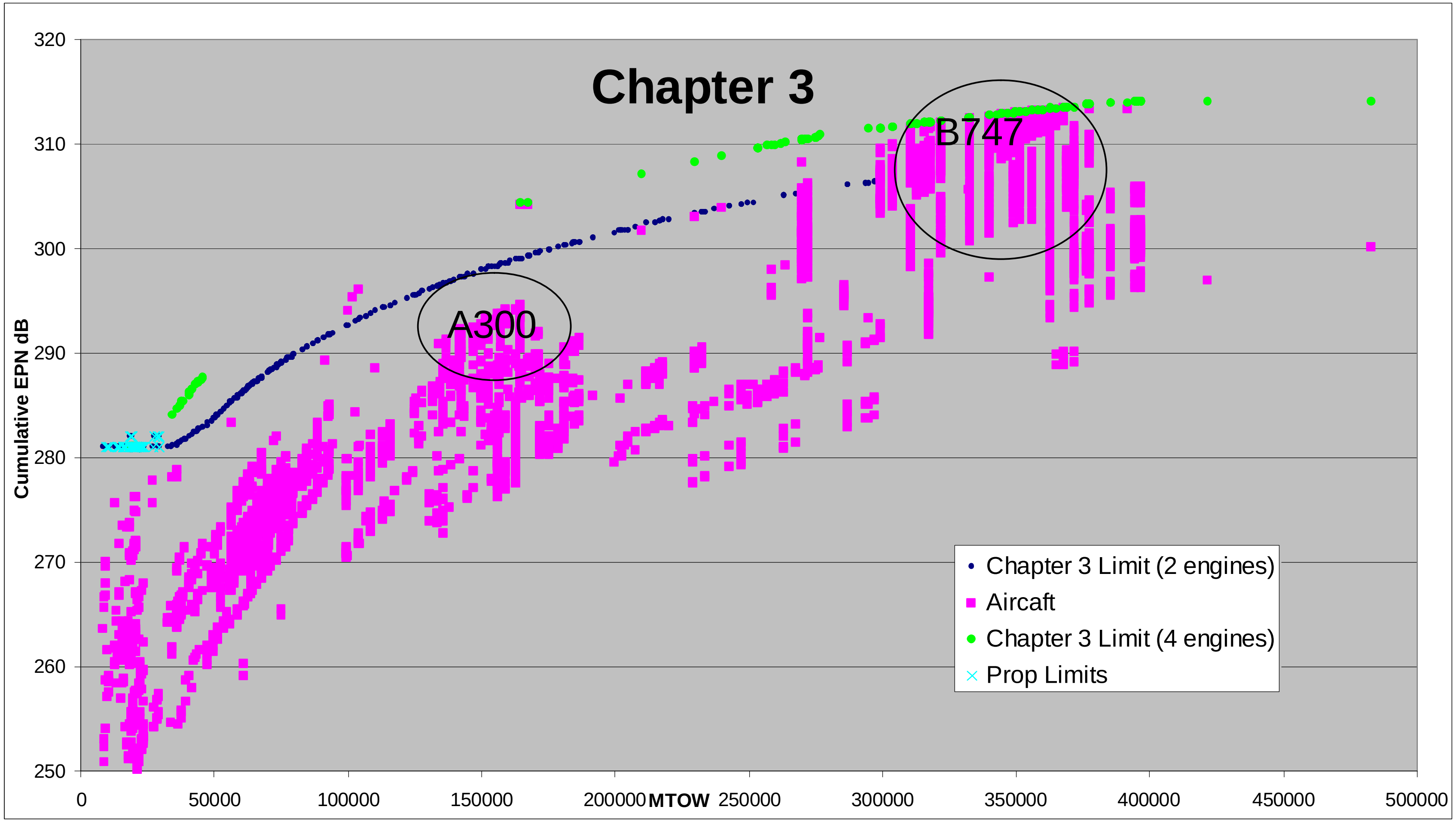


Figure 3.1 also shows a data point for each category of the world fleet of aircraft that has been certified and shows that the majority of the world fleet is Chapter 3 compliant. Two examples are highlighted, Airbus 300s (A300) and Boeing 747s (B747), both of which families include sub-types that are close to the Chapter 3 cumulative limit, i.e. they are marginal; and others which are Chapter 4 compliant.

In our work four bands of marginality have been studied, as defined in Table 3.2

Table 3-2 Marginal Aircraft

	Margin	Comment
Band 1	0-5 dB	Sometimes called 'Chapter 3 High'
Band 2	>5-8 dB	
Band 3	>8-10 dB	
Band 4	>10 dB	Chapter 4 compliant, subject to meeting measuring point trade-off limitations

Source : Consultants

3.3.3 Practicalities

In terms of the perceived noisiness of an aircraft the three bands are in fact quite similar because the margin used to distinguish them is the total (or cumulative) noise difference across the three measurement points. For example, a 5 dB marginal aircraft has a cumulative margin of 5dB, so on average it would be 5/3 dB less noisy than the Chapter 3 limit at each of the 3 points. In practice 5/3 or 1.7dB is a small noise difference that would generally be imperceptible to most people, so this aircraft would, on average, sound no quieter to most people than an aircraft that exactly met Chapter 3. A Band 3 aircraft, say 9dB marginal, would 'sound' on average 3dB quieter than one just meeting Chapter 3. Most people would judge this as noticeably quieter than the exact Chapter 3 aircraft. It is partly for this reason that a key element of this study is to consider the effect of operational restrictions on the less marginal aircraft up to 10 dB cumulatively quieter than the Chapter 3 standard.

It can be quite difficult or even impossible to identify which aircraft sub-types – or even which specific aeroplanes - fall within each band of marginality, particularly around the boundaries of each band. A lower certificated weight (MTOM) appropriate to the operator's commercial needs, a different engine nozzle or modification to the nacelle, or even a different flap setting, can shift an aeroplane from one band to another on recertification, by a difference in sound pressure level which is virtually imperceptible in practice.

A further problem in determining how many aircraft might be affected by existing or different definitions of marginality in the Directive, is that such aircraft can come from outside Europe. We have therefore to make sensible assumptions about this but there can be no single finite correct answer to this question of identification. Clearly all aircraft in the fleets of Community operators (even if leased from overseas) can be assumed to use Community airports. At the other end of the spectrum, the world fleet of identifiably long haul aircraft such as almost all B747 and A340 types and other types designated "ER" (Extended Range) can be considered as potentially operating at Community airports. There are however two "grey areas", both of which could include countries with less stringent aircraft noise regimes :

- foreign-operated medium-haul aircraft with perhaps limited Transatlantic capability but certainly the ability to reach Europe on long-haul (or multi-sector) flights from Africa and Asia; and
- foreign-operated short-haul aircraft from the Community's neighbours along its Eastern, Adriatic and Mediterranean boundaries

Our best efforts to identify marginal aircraft at Community airports and their impact on the changing noise climate are the subject of detailed analysis below, in Section 4 of this report.

4 Evolution of European Air Transport 2002/3 – 2006

4.1 Movement growth, Day/Night analysis, Aircraft types changes

4.1.1 Methodology

A comprehensive compilation of data was provided by EUROCONTROL which covered all IFR flights in 2002/03 and calendar year 2006 to and from the list of 70 airports (see Table 3-1 above) which we believe to fall or are close to falling within the scope of the Directive 2002/30[4]. These data detailed annual aircraft movements by type, weight and time of day - but not by operator (in order to preserve anonymity and protect commercially sensitive information). A total of over 695,000 records were received relating to over 20 million flights. We linked this base data to our own aircraft definition database to identify the 574 aircraft types in the EURCONTROL data set and determine which of them fell within the scope of the directive. Finally we corrected the UTC flight timings in the EUROCONTROL data to local times at each individual airport. Thus processed, the EUROCONTROL data provided a valuable and consistent reference source of statistical air transport movement information and served as the foundation of our traffic pattern analysis and the platform for our forecasting work.

4.1.2 Movement Growth

Air transport within Europe has grown rapidly between 2002/3 – a year where traffic was still suffering the after effects of 9/11 and SARS – and 2006. For the 70 airports in our study, overall movements as measured by EUROCONTROL have grown by 3% per annum, with faster growth of nearly 4% per annum in jet movements and a slight decline in small jets and turboprop aircraft movements.

Table 4-1 Aircraft Movement growth rates

Growth Rates in A/C Movements 2002/03 - 2006		
Jet	Non-Jet (see note)	All A/c types (Jet & non-Jet)
3.9% p.a.	-1.0% p.a.	3.0% p.a.

Note: "Non Jet" aircraft is here defined to mean Jets • 19 seats or Jets <34 tonnes <u>or</u> aircraft with turboprop or piston engines

EUROCONTROL data for each of the 70 airports, showing movements analysed by jet/non jet (as explained above) in 2002/3 and 2006 are shown in Appendix C. During this period, the proportion of jet aircraft movements (i.e. >19seats or >34 tonnes) has increased from 81% of total movements to 83% of total movements across the 70 airports.

A table showing overall percentage growths in total movements for each of the 70 airports is shown in Appendix .D

[4] Greater than 50,00 civil jet movements per annum where "jet" is defined as greater than 34 tonnes MTOW or with more than 19 seats.

Growth in total movements has averaged around 12% over the period, but there has been considerable variability across the 70 airports. Airports in the East European Accession States have experienced much stronger growth in movements - 36% at Warsaw, 60% at Prague, and 65% at Bucharest and Budapest, albeit Bucharest from a very low baseline. However, the four largest airports in Europe in 2002/3 in terms of movements – Paris Charles de Gaulle, Frankfurt/Main, Amsterdam Schiphol and London Heathrow - have all grown more slowly than the average at between 3% and 6% over the period. Growth has also been significant at smaller, regional airports, particularly those associated with operations by low-cost-carriers.

Table 4-2 Jet and non-jet night movements 2002/3 and 2006 as proportion of total movements, and growth

		2002/3				2006			Night Growth
	Night Mvts	Total Mvts	Night %age		Night Mvts	Total Mvts	Night %age		06 v 02/3
Jets	682,230	7,959,144	8.6%		837,487	9,178,412	9.1%		23%
"Non jets"	160,859	1,900,322	8.5%		148,465	1,841,119	8.1%		-8%
Total	843,089	9,859,466	8.6%		985,952	11,019,531	8.9%		17%

The EUROCONTROL database also contains details of the times of arrival and departure of air transport movements. Movements at night (defined by ICAO default as 2300 – 0700 local), often associated with higher levels of noise annoyance, have grown at 17% - a slightly faster rate than the average, albeit still representing less than 10% of all movements. Jet aircraft movements at night have grown faster at 23% overall, whereas non-jet movements have declined by 8%. Tables showing overall percentage growths in night movements for each of the 70 airports, and night movements as a proportion of total movements for the two years, is shown in Appendix E.

Many of the airports with a high proportion of night movements are used by freight operators – particularly Express carriers - or by leisure/charter operators. However, there is no particular pattern discernable in the differential night growth rates between airports over the period.

4.2 Marginality compliance listing of aircraft types

4.2.1 Methodology

As our source of data on aircraft emitted noise levels we drew upon the database maintained by the Direction Générale de l'Aviation Civile (DGAC) under the auspices of the International Civil Aviation Organization (ICAO). The database contains certified noise levels of civil transport aircraft types certificated mainly under the ICAO Annex 16, Chapter 3 and Chapter 4 Standards (and under Federal Aviation Regulations (FAR) Part 36, Stage 3 and Stage 4).

We also consulted the European Aviation Safety Agency (EASA) database which contains the type-certificate data sheet for noise (TCDSN) for particular aircraft types and sub-types. The EASA approved noise levels are the basis against which national authorities issue individual noise certificates to aircraft on their national registers according to the procedures of sub-Parts I of the Part 21 Annex to Commission Regulation (EC) No 1702/2003. For the most part we employed the DGAC database as our principal source (having checked sample aircraft for consistency between the two databases) and accessed the EASA data only when we found lacunae in the DGAC data.

4.2.2 Marginality of aircraft types

The 2006 DGAC/EASA databases thus provided a basis for assessing the marginality of aircraft by aircraft type across the world's fleets. We have grouped aircraft types according to the level of marginality, i.e. the extent to which their noise emission (as described in section 3.3.2 above) meets Chapter 3 definitions by:-

-0.1 dB to –5.0dB	Marginal - defined as Noise Band 1
-5.1 dB to – 8.0dB	Potentially Marginal - defined as Noise Band 2
-8.1 dB to –10.0dB	Fully Compliant - defined as Noise Band 3

In addition we have added another group where the same aircraft type may operate across a range of noise emissions depending on its weight, configuration, or modifications, but where examples of the aircraft type definitely fall within one of our Chapter 3 marginality definitions – grouped together as Noise band U.

There are many sub-types within generic aircraft types, some of which may have quite differing marginality. It is important to bear this in mind in the list of aircraft types which we have identified within marginality noise bands using the methodology described above:-

Chapter 3 Marginal (Band 1) aircraft types in world fleets

Jets

Boeing 727-100/200
Boeing 737-200
Boeing 747-100/200/300
Boeing B767-200
Boeing B767-300
Ilyushin Il 62
Ilyushin Il 96
Tupolev TU-154
Yakovlev Yak- 42
Antonov An-72
Antonov An-124
McDonnell Douglas DC9

Chapter 3 Potentially marginal (Band 2) aircraft types in world fleets

Jets
Airbus A300-B2/B4/600
Airbus A 321
Boeing 737-400
Boeing B767-200
Boeing B767-300
Boeing (McD Douglas) MD80
Yakovlev Yak –42

Jets • 19 seats
Dassault Falcon 50
Hawker HS125-700

Chapter 3 Fully Compliant (Band 3) aircraft types in world fleets

Jets
Airbus A300-B2/B4/600
Airbus A310
Airbus A321
Boeing (McD Douglas) MD80
Boeing B737-300
Boeing B737-400
Boeing B737-500
Boeing B767-200
Boeing B767-300
Boeing (McD Douglas) MD80
Tupolev TU-204

Jets • 19 seats
Dassault Falcon 20/200
Cessna 650

Turboprop
Fokker F27-200

Chapter 3 Possibly marginal (Band U) aircraft types in world fleets (in addition to above)

Jets
Boeing B747-400

Turboprop
BAe HS748-200
Antonov An-32

It should be noted that some aircraft types are represented in more than one band, and that there are also aircraft (quite often a majority of aircraft) within these types that are Chapter 4 compliant. This is explained further in sections 4.3 and 4.4. Also, not all of these aircraft types necessarily fly to or from the European airports covered by the Directive. An assessment of the number of Chapter 3 aircraft registered within the EEC/EEA/CH, within Europe, and worldwide - by level of marginality - is reported in section 4.4.

4.3 Movement changes by noise characteristics

4.3.1 Methodology

We have linked the EUROCONTROL database of movement activity by aircraft type to the DGAC and EASA databases. This is in order to estimate the change in movements between 2002/3 and 2006 by the noise characteristics of aircraft at the airports under consideration. This linkage can only be achieved by matching the MTOW and aircraft type (as defined by the ICAO aircraft type code) in the two databases as there is no engine information in the EUROCONTROL data and thus this is a less rigorous approach, but nevertheless we believe yields a broadly true picture. It should be noted that the EUROCONTROL database defines aircraft type through ICAO aircraft code alone, thus creating some ambiguity relative to the far more detailed aircraft type codes in the DGAC and EASA databases. It is recognised that the results shown hereunder are therefore only illustrative, and a much more stringent analysis based on tower logs at the case study airports is reported in section 8.3. The groupings of aircraft types into the various bands have been amended for this illustrative purpose, and where a type appears under more than one band heading as shown above, it is now classified <u>for this purpose</u> as band U. Also, when it is clear (from the aircraft fleet/DGAC analysis explained in section 4.4) that only a small minority of aircraft in a particular type are Chapter 3 certificated – i.e. they are Chapter 4 compliant – the type has been excluded completely from this Chapter 3 analysis.

4.3.2 Changes in Aircraft types operating at relevant European airports 2002/3 – 06

Table 4-3 Movements by aircraft type, 2002/3 – 06

Aircraft type	Total 2002/3	Total 2006	% change 2002 to 2006
B737-200	100,416	7,417	-93%
B747-200	36,046	20,350	-44%
TU-154	26,478	14,287	-46%
B727-200	26,324	528	-98%
DC-9-50	17,599	170	-99%
B727-100	7,211	307	-96%
Yak 42	4,273	1,886	-56%
DC-9-30	2,515	341	-86%
An-124	1,193	973	-18%
747-100	675	493	-27%
An-72/74	614	609	-1%
IL-62	351	189	-46%
Il-96	341	310	-9%
VC-10	298	181	-39%
DC-9-10	181	28	-85%
DC-9-20	31	3	-90%
B747SR	5	5	0%
An-74-300	0	9	*
Band 1 Total	224,551	48,086	-79%
Falcon 50	11,715	8,855	-24%
Yak 40	3,780	2,197	-42%
BAe HS 125	772	314	-59%
Band 2 Total	16,267	11,366	-30%
B737-300	714,480	570,231	-20%
B767-300	148,995	155,243	4%
A-310	71,904	38,356	-47%
F-27	30,273	11,531	-62%
Cessna 650	6,804	6,483	-5%
Band 3 Total	972,456	781,844	-20%
MD80	697,141	564,042	-19%
B737-400	382,704	337,901	-12%
A-300- 600	62,201	57,678	-7%
A-300B2/4	45,008	33,938	-25%
B767-200	29,607	38,806	31%
HS 748	11,133	5,133	-54%
Falcon 20/200	6,369	3,542	-44%
L-1011	4,109	1,745	-58%
Tu 204	3,729	2,320	-38%
AN 32	12	9	-25%
Band U Total	1,242,013	1,045,114	-16%
Chapter 3' Totals	2,455,287	1,886,410	-23%
Chapter 4' Totals	7,404,179	9,133,121	23%

Overall, the volume of flights by aircraft types which include significant numbers of Chapter 3 aircraft has fallen by 23% over the period, with a 79% reduction in aircraft types which include Band 1 (marginally compliant) aircraft. Practically all of the aircraft types containing Chapter 3 aircraft have reduced movements, with almost complete elimination of the noisiest B737-200 and B727-100/200 aircraft at Directive airports. The contrast with the growth in aircraft types which do not contain significant Chapter 3 aircraft, i.e. are Chapter 4 compliant, is at least indicative of a significant shift in operations from the noisier aircraft types to quieter aircraft in the period. The Chapter 3 aircraft types have fallen from 25% of total movements to 17%.

Operations at night at European airports by marginal aircraft types as defined above have also reduced during the 2002/3 to 2006 period.

Table 4-4 Movements at night by aircraft types 2002/3 – 2006

Aircraft type	Night 2002/3	Night 2006	% change 2002 to 2006
B737-200	7,512	466	-94%
B747-200	7,227	3,158	-56%
TU-154	1,673	605	-64%
B727-200	14,794	28	-100%
DC-9-50	1,089	21	-98%
B727-100	3,800	24	-99%
Yak 42	208	237	14%
DC-9-30	63	19	-70%
An-124	240	142	-41%
747-100	219	78	-64%
An-72/74	100	475	375%
IL-62	13	14	8%
Il-96	5	16	220%
VC-10	21	25	19%
DC-9-10	9	4	-56%
DC-9-20	1	0	-100%
B747SR	1	3	200%
An-74-300	0	1	*
Band 1 Total	36,975	5,316	-86%
Falcon 50	846	587	-31%
Yak 40	112	108	-4%
BAe HS 125	51	21	-59%
Band 2 Total	1,009	716	-29%
B737-300	61,777	56,029	-9%
B767-300	22,607	19,985	-12%
A-310	11,875	7,700	-35%
F-27	16,856	7,028	-58%
Cessna 650	364	284	-22%
Band 3 Total	113,479	91,026	-20%
MD80	41,804	32,963	-21%
B737-400	32,108	37,697	17%
A-300- 600	8,247	8,083	-2%
A-300B2/4	23,922	19,774	-17%
B767-200	3,679	11,133	203%
HS 748	7,097	2,977	-58%
Falcon 20/200	389	246	-37%
L-1011	750	355	-53%
Tu 204	1,297	1,209	-7%
AN 32	4	2	-50%
Band U Total	119,297	114,439	-4%
Chapter 3' Totals	270,760	211,497	-22%
Chapter 4' Totals	572,329	774,455	35%

The reduction in night movements (2300 – 0700 local) by Band 1 aircraft types has been very significant, with again almost complete elimination of B737-200 and B727-100/200 flights at night. The overall reduction of 22% in night movements by these aircraft types, compared to the growth in night movements of other aircraft types of 35% again is indicative that noisier aircraft at night are also being replaced by quieter aircraft. The Chapter 3 aircraft types have fallen from 32% of total movements to 21%. However such aircraft types still provide a greater proportion of flights at night than over the day.

4.4 Chapter 3 and Marginal aircraft

4.4.1 Methodology

As our source of data on individual aircraft within aircraft fleets we consulted the JP BUCHair database which contains over 59,000 comprehensive records of the world's air transport fleet as at March 2007. We filtered this database to eliminate those aircraft which are currently in storage or have not yet been delivered and also removed the semi-duplicate entries relating to those aircraft which are in the process of transferring their registration from one owner to another. Thus we arrived at a world wide total of 51,351 active aircraft.

The breakdown of fleet totals by geography (Worldwide, Europe and EEC/EEA/CH) and by categorisation as jet (<34 tonnes or •19 seats) is shown in Table 4.5

Table 4-5 Analysis of Operating Fleets

Total Fleets (All Noise categories)	EC/EEA/CH	EUROPE	WORLDWIDE
Jets	4676	6143	21345
Total A/c	10981	15068	51351

Source: JP BUCHair database, Consultants

We linked this modified JP aircraft fleet database with the DGAC and EASA aircraft noise databases by matching aircraft type, engine type and maximum take off weight (MTOW). We were thus able to identify the noise characteristics of nearly all individual aircraft whose type is classified as Chapter 3 compliant in section 4.2.2 above. Aircraft have been grouped into the three bands within Chapter 3 as above, or as "Chapter 4" where noise output is better than –10 dB. In some cases we did not have sufficient information to determine precisely the noise margin of a particular aircraft when this depended on flap settings or similar operational variables, or on configuration or modifications. Such aircraft have been simply classified as falling between –0.1 dB and -10.0 dB.

4.4.2 Analysis

<u>EU Fleets</u>

Detailed analysis of the databases down to the specific aircraft operated by Community (EEC + EEA + Switzerland) registered operators shows that the number of Chapter 3 aircraft of major types totals 633. All such aircraft in these fleets (even if leased from overseas) can be assumed to use Community airports. However there are only 49 aircraft in the Band 1 category of Chapter 3 –0.1dB to –

5dB, all of them jet aircraft as defined within the Directive. 35 of the 151 aircraft in Band 2 are jets •19 seats. The largest number of Chapter 3 aircraft are in the Band 3 category –8dB to –10dB, i.e. fully compliant. It should be noted, however, that there was insufficient information to determine precisely the noise banding within Chapter 3 of 107 jet aircraft (a significant number of A300 and A321 aircraft included) – i.e. some of them might even fall into the Band 1 or Band 2 categories. In addition there were 72 jet aircraft whose noise characteristics we were unable to determine. Full details are shown in Table 4-6.

Table 4-6 Marginal aircraft in EEC/EEA/CH by Major aircraft Types

		Chapter 3 Identified Aircraft				"Chapter 4"	Unidentified Aircraft
Generic A/C Type	EC+EEA +CH Total Fleets	-0.1 to -5.0dB	-5.1 to -8.0dB	-8.1 to -10.0dB	-0.1 to -10.0dB * Note	>-10.0dB	
Jets							
Airbus A300	52			9	26	17	
Airbus A310	35			3		32	
Airbus A321	199		8	14	33	133	11
Antonov AN72	8	6					2
Boeing B727-200	2	2					
Boeing B737-200	12	11			1		
Boeing B737-300	236			66		170	
Boeing B737-400	128		75	45			8
Boeing B737-500	124			2		122	
Boeing B747-200	35	22			8		5
Boeing B747-300	12				9	3	
Boeing B747-400	181				11	153	17
Boeing B767-200	25			4	10	8	3
Boeing B767-300	118			2	9	88	19
Boeing MD80	274		52	100		117	5
Tupolev T154	10	8					2
Yakovlev Yak40	16		16				
Jet Total	1467	49	151	245	107	843	72
Jets <19seats							
Cessna C650	21			10		8	3
Dassault Falcon 200	43				3	13	27
Dassault Falcon 50	37		23			8	6
Hawker HS125	88		12			71	5
Jet <19 seats Total	189	0	35	10	3	100	41
Turboprop							
Fokker F27	31			26	4		1
Bae HS748	6				3		3
Turboprop Total	37	0	0	26	7	0	4
Grand Total	1693	49	186	281	117	943	117

* Note: This column may include a few aircraft which may be quieter than -10.0dB depending on configuration or modifications

The 633 aircraft which we have identified as Chapter 3 aircraft in total represent less than 40% of all aircraft within the generic types, and the information relating to proportions of movements by marginal aircraft in sections 4.3 above should be considered in this context. It is also important to put the 633 aircraft in the context of 10981 aircraft registered with European (EEC + EEA + Switzerland) operators in total. Only 0.4% of EU + EEA.+Switzerland aircraft fleets are Band 1 (Chapter 3 marginal), and only 5.8% in total are certificated as Chapter 3 aircraft. In other words 94.2% of the EU+EE+Swiss fleet is quieter than Chapter 3 or outside the scope for classification (i.e. helicopters, very small aircraft etc).

European Fleets

Aircraft registered with operators across Europe as a whole (i.e. including countries such as Russia) are also likely to operate at Community airports. Analysis of this wider European database shows a higher number of identified Chapter 3 aircraft – 1062 jet aircraft and 1134 total aircraft. Full details are shown in Table 4-7.

Table 4-7 Marginal aircraft in Europe by Major aircraft Types

		Chapter 3 Identified Aircraft				"Chapter 4"	Unidentified Aircraft
Generic A/C Type	Europe Total Fleets	-0.1 to -5.0dB	-5.1 to -8.0dB	-8.1 to -10.0dB	-0.1 to -10.0dB * Note	>-10.0dB	
Jets							
Airbus A300	64		2	9	35	17	1
Airbus A310	43			3		34	6
Airbus A321	208		8	14	35	135	16
Antonov AN72	44	16					28
Antonov AN124	31	29					2
Boeing B727	3	3					0
Boeing B737-200	19	15			4		0
Boeing B737-300	278			92	4	182	0
Boeing B737-400	152		93	51			8
Boeing B737-500	167			10		157	0
Boeing B747-200	47	28			14		5
Boeing B747-300	13	1			9	3	0
Boeing B747-400	186				15	154	17
Boeing B767-200	32		3	6	10	10	3
Boeing B767-300	136			2	9	106	19
Ilyushin IL62	50	7					43
Ilyushin IL96	16	15	1				0
Boeing MD80	292		57	107		117	11
Tupolev T154	296	218					78
Tupolev T204	36		16	18			2
Yakovlev Yak40	232		39				193
Yakovlev Yak42	110	44					66
Jet Total	2455	376	219	312	135	915	498
Jets <19seats							
Cessna C650	22			10		9	3
Dassault Falcon 200	48				3	15	30
Dassault Falcon 50	39		25			8	6
Hawker HS125	93		16			72	5
Jet <19 seats Total	202	0	41	10	3	104	44
Turboprop							
Antonov AN32	13				8		5
Fokker F27	31			26	4		1
Bae HS748	6				3		3
Turboprop Total	44	0	0	26	12	0	9
Grand Total	2701	376	260	348	150	1019	551

* Note: This column may include a few aircraft which may be quieter than -10.0dB depending on configuration or modifications

Band 1 (marginally compliant) aircraft total 376 – an increase almost entirely due to the significant numbers of older Russian-built aircraft still operating in CIS country fleets, where aircraft noise regimes are less stringent. It is also noteworthy that there are many aircraft in these fleets (498 jets, 551 aircraft overall) where we were unable to identify noise characteristics, but which are very likely to fall within Chapter 3 noise bands, most of them (e.g. Il 62, T154, Yak 40/42) within Bands 1 and 2.

<u>Worldwide Fleets</u>

As noted in section 3.3.3 above, the worldwide fleet of identifiably long haul aircraft can be considered as potentially operating at European airports. The same would apply to many medium haul aircraft and to a limited number of shorthaul aircraft registered with non-European operators.

Altogether the number of Chapter 3 identified aircraft operating worldwide consists of 4138 jet aircraft, and 4469 aircraft in total. In addition, most of the 1132 unidentified jet aircraft are also likely to fall within Chapter 3 noise bands. Full details are shown in Table 4-8.

Table 4-8 Marginal aircraft Worldwide by Major aircraft Types

		Chapter 3 Identified Aircraft				"Chapter 4"	Unidentified Aircraft
Generic A/C Type	Worldwide Total Fleets	-0.1 to -5.0dB	-5.1 to -8.0dB	-8.1 to -10.0dB	-0.1 to -10.0dB * Note	>-10.0dB	
Jets							
Airbus A300	391		2	57	101	169	62
Airbus A310	221			74	12	118	17
Airbus A321	404		44	17	55	266	22
Antonov AN72	47	16					31
Antonov AN124	33	31					2
Boeing B727	421	169					252
Boeing B737-200	577	488			89		0
Boeing B737-300	1039			454	160	425	0
Boeing B737-400	461		242	204			15
Boeing B737-500	375			14		361	0
Boeing B747-100	34	18			16		0
Boeing B747-200	220	140			60	2	18
Boeing B747-300	70	10			53	7	0
Boeing B747-400	684				189	431	64
Boeing B767-200	176	2	16	9	31	105	13
Boeing B767-300	688	1	12	31	40	527	77
Ilyushin IL62	66	7					59
Ilyushin IL96	19	18	1				0
Boeing MD80	1045		274	580		131	60
Tupolev T154	361	256					105
Tupolev T204	42		16	20			6
Yakovlev Yak40	321		64				257
Yakovlev Yak42	117	45					72
Jet Total	7812	1201	671	1460	806	2542	1132
Jets <19seats							
Cessna C650	73			27		36	10
Dassault Falcon 200	146				5	23	118
Dassault Falcon 50	77		59			10	8
Hawker HS125	299		38			238	23
Jet <19 seats Total	595	0	97	27	5	307	159
Turboprop							
Antonov AN32	39				32		7
Fokker F27	153			99	21	3	30
Bae HS748	63				50		13
Turboprop Total	255	0	0	99	103	3	50
Grand Total	8662	1201	768	1586	914	2852	1341

* Note: This column may include a few aircraft which may be quieter than -10.0dB depending on configuration or modifications

Although the overall percentage of Chapter 3 aircraft in worldwide fleets is significant (19% for jets excluding unidentified aircraft, and nearly 25% including all unidentified aircraft), many of the shorthaul aircraft operating in the Americas, sub-Saharan Africa or Asia will not operate to Community airports. Of concern to the Community (apart from the Russian-built aircraft already noted in European fleets) may be the B747-200 aircraft in Band 1, and the A300 family aircraft whose marginality cannot be precisely identified - many of which are in freighter configuration – as well as a limited number of B747-400, B767-200 and B767-300 aircraft currently operated by non-Community airlines.

5 Airport Interview Findings

5.1 Application, interpretation and general effects of Directive

5.1.1 The Balanced Approach

The Directive requires Member States to "adopt a balanced approach in dealing with noise problems at (their) airports". The "Balanced Approach" is the compromise developed through the CAEP[5] process and adopted by the ICAO 33rd Assembly in October 2001, giving guidance on the principles of local noise management by individual airports, in the absence of agreement on a more stringent Chapter 4 coupled with a phase-out target for Chapter 3 aircraft.

Its elements summarily comprise :

- reduction of noise at source;
- land use planning and management;
- noise abatement operational procedures; and as a "last resort"
- operating restrictions;

with economic instruments as a permitted tool in the implementation of those elements.

The right of individual airports to restrict marginal Chapter 3 aircraft operations within the Balanced Approach framework was accepted internationally in the context of some ICAO Member States' wish at that time to see the repeal of the EC "hushkit" Regulation (925/1999). That Regulation banned "recertificated" aircraft from Europe, defined as aircraft meeting Chapter 3 only through hushkitting or recertification at a lower operating mass (re-engining, however, being permitted); and it was indeed repealed when Directive 2002/30 came into force because that allowed individual airports to ban marginally compliant aircraft.

As we understand it, the Directive was in part meant to provide guidelines to airports indicating under which circumstances they would be able to introduce restrictions on marginal compliant aircraft, without breaching ICAO regulations.

5.1.2 Application of the Directive

Even though Directive 2002/30/EC requires Member States to adopt the balanced approach, it focuses more particularly "on the establishment of rules and procedures (on) the introduction of noise-related operating restrictions". Our Terms of Reference required us to focus on the application of restrictions rather than on detailed analysis of the application of all aspects of the Balanced Approach, although all aspects must be addressed in determining how effective the Directive's rules have been and are likely to be in limiting or reducing noise exposure around European airports. Neither is this study an investigation of the nature and application of the procedures which must be followed when restrictions are applied – that was covered by the earlier MPD/ERM study on assessing night flight restrictions.

Any revision of the Directive to improve achievement of its ends could scarcely abandon the internationally agreed and self-evidently reasonable principles of the Balanced Approach. Thus the primary focus of this section of the interviews has been to see :

- how far operating restrictions permitted under the Directive have been applied; and/or

[5] International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection.

- may be applied in the future;
- what effect they have had;
- how have those effects been achieved; and
- how operators have responded.

5.1.3 Interpretation of the Directive

The above seemingly straightforward questions, when put to airports subject to national legislation implementing the Directive, have been found to reveal some more fundamental questions, which the airports do not universally interpret in the same way in terms of restrictions :

- what does the Directive permit them to do; and
- what does the Directive require them to do.

The second of these is fairly clearly understood – if the authorities introduce operating restrictions on civil subsonic jet aeroplanes after 28 March 2002 the Directive requires them to be introduced in the spirit of the Balanced Approach, and to be held to the minimum required[6,7]. Further, airports introducing restrictions must follow/have followed certain procedures regarding notice of introduction, assessment and implementation. In the course of this process, the planned effect of restrictions is supposed to be quantified.

As to what the Directive permits or prohibits, there are at least two areas of doubt:

- airports feel that much of what is permitted under the Directive could have been done anyway, and many restrictions were introduced before 2002., so it is difficult to point to what has been achieved by the Directive per se;
- the Directive does not expressly prohibit any particular form of restriction, for example any restriction applied to aircraft which are more than marginally compliant with Chapter 3. One airport takes the view that it has the powers to ban aircraft which are compliant by more than a 5 dB margin.

The manner, if not the substance, of some of the replies from airports seem to indicate that there are uncertainties, and potential conflicts between local Planning law requirements to restrict noise and the protection the Directive gives to airlines.

After being asked whether the Directive had influenced their actions in the field of noise management, the airports' responses were refined by asking what specific restrictions they had introduced under the Directive. They were then prompted to describe any actual or potential restrictions on marginal Chapter 3 aircraft ("minus 5" and/or "minus 8").

5.1.4 Effects of the Directive

There were very mixed reactions regarding the extent to which the Directive has been influential.

The majority of the airports indicated that the Directive had not influenced the noise management around the airport. Some airports indicated that what the Directive enables was already possible under the national law. This holds in

[6] One airport questioned its obligation to apply the Directive if introducing operating restrictions on aircraft with a maximum take-off weight below 34 000 kg, the limit as defined in the Directive. Even this requirement is not fully understood and in fact, the Directive does not pose any requirements on restrictions for such aircraft.

[7] One airport discussed to what extent quota count restrictions fall under the Directive. This point is taken up in section 5.2.4.

particular for the German and UK airports. However, one German airport also indicated that although the Directive enables restrictions on marginal compliant chapter 3 aircraft, some bilateral air service agreements prohibit the introduction of such measures. Several airports even went so far as to say that the Directive made noise management around the airport more difficult, due to the requirements of Annex 2. This annex requires a consultation and an assessment of the costs and benefits of alternative means of reducing noise around the airport.

In fact, despite the requirement of Article 5.1 for forecast noise contours with and without proposed restrictions "as far as appropriate and possible" airports (even the few highlighting restrictions applied in the context of the Directive) have not generally been able to isolate the effects of these actions quantifiably. Noise management, and indeed the application of the Balanced Approach, is seen as a package of measures designed to meet environmental goals. Sometimes these goals or achievements are quantified in terms of contour area, numbers of exposed people (or even numbers of complaints) but the specific contribution of each element of the airports' policies to these goals seems rarely specified. Some airports therefore called for the relaxation of the requirements in Annex 2. Two airports indicated a fear airlines might sue after the potential introduction of measures, under the argument that the Annex 2 requirements would not have completely been adhered to.

Some airports indicated that even though the Directive did not have direct influence on the noise management, indirectly it had contributed. Some comments from the interviews:

- 'the Directive has discouraged objectors and served as a useful checklist to highlight all potential measures available'
- 'the emphasis of the Directive on individual airport action encouraged the introduction of restrictions'
- 'the Directive helped to establish a climate of sustainable growth among stakeholders'
- 'the Directive has set a level playing field'
- 'the Directive raised awareness also among mid-sized and small airports'

Finally, there were three or four airports that were outright positive of the Directive and indicated that they had introduced measures that would not have been possible without the Directive. In total, seven airports (Belfast City , Malaga, Barcelona, Madrid, Manchester, Palma and Tenerife Sur) indicated to have introduced measures under the Directive.

When looking at these results, it should be remembered that one of the aims of the Directive was to enable noise management around airports with particular noise problems. Whether airports had such problems may in part have been dependent on what their national laws already enabled. Countries that had already national laws in place that enabled airports to manage noise effectively, will have less use of the Directive. However, at those airports where the national legislation was not effective, the Directive may have contributed to noise management.

Another outcome of the questionnaire was that most airports do consult the stakeholders before introducing noise management measures. It appears such consultation was already in place before the Directive had been adopted.

Remarkably, one airport that did indicate the Directive had been of influence, also commented that it had not had consultations.

Below we discuss the restrictions introduced under the Directive / national law and those that are planned for the coming years.

5.2 Restrictions introduced

There are different forms of imposing restrictions on marginally compliant aircraft. In the following sections we discuss restrictions on marginal chapter 3 aircraft, based on a cumulative margin of 5 dB(A) (section 5.2.1), on aircraft with a margin of 8 dB(A) or more (5.2.2), night time restrictions (5.2.3), the use of noise budgets (5.2.4) and finally in section 5.2.5 the effects these restrictions may have on traffic. Beforehand, we note that such a division cannot be made as clear-cut as the above suggests. For example, a number of airports have introduced night time restrictions on marginal chapter 3 aircraft. In addition, noise budgets often apply to the night time period. Therefore, the sections below overlap to some extent.

It may be noted that the Directive is somewhat unclear in this respect as well. Article 6.1 allows for operating restrictions on marginally compliant aircraft, if the assessment of all available measures, including 'operating restrictions of a partial nature' have been assessed. Operation restrictions of a partial nature affect the operation of civil subsonic aeroplanes according to the time period. The status of operating restrictions of a partial nature relating to marginally compliant aircraft or some subset of jets based on noise performance is not fully clear.

What we will see in the sections below is that even though many airports have indicated that the Directive had little or no influence on noise management, quite a number of airports have introduced operating restrictions more or less in line with the principles laid out in the Directive.

5.2.1 Restrictions Introduced : "Minus 5"

Non-operation rules (ban or withdrawal) for "minus 5" aircraft had been introduced by only two airports. One city airport (Belfast City) banned "minus 5" marginals as a pre-emptive measure, as it feared that hushkitted B737-200s might be introduced. The other airport (Madrid) recently introduced the non-operation rule in line with the Directive, projecting a full withdrawal by the end of 2012.

Only three airports said that they had introduced partial restrictions[8] on the operation of "minus 5" aircraft under the Directive, and went on to describe them. These comprised:

- two airports (Schiphol and Toulouse) which introduced night bans on "minus 5" aircraft; and
- one airport (Manchester) which prohibited "minus 5" aircraft on new routes (a sort of non-addition rule)[9],

Furthermore, we have consulted the website of the French DGAC, and note that "minus 5" aircraft are banned from operating at night at Paris CDG and will also be

[8] Article 6.1 of the Directive appears to permit the introduction of "operating restrictions of a partial nature" on unspecified aircraft types, as part of the preferential hierarchy of actions within the Balanced Approach preceding the 'last resort' withdrawal of marginal Chapter 3 aircraft

[9] Initially we were told that a ban of eventually all marginal chapter 3 aircraft was planned for if not achieved voluntarily, but at a later stage it was made clear that the policy comprised of not allowing greater use of marginal chapter 3 aircraft than in 2006.

banned by day from 2008. This forms part of a policy to contain the overall noise nuisance to the levels observed in 1999-2001.

In addition, Manchester and Lisbon have a night ban of aircraft with a quota count of 4 or higher. This may affect some marginal chapter 3 aircraft.

Of the airports which had not introduced such bans or restrictions, over 10 either definitely expected to do so, had considered or were currently considering doing so, might/would do so in certain circumstances; or are special cases (two City Airports s, as defined under the Directive):

- the definite expectations include one airport expecting a total "minus 5" ban to replace a pre-Directive hushkit ban "soon"[10], and one (EEA) airport using pre-2002/30 national legislation to ban "minus 5" operations at night with effect from 2008;
- one airport (Newcastle) had considered a "minus 5" ban but dropped the scheme after a major operator of a marginal aircraft type re-equipped, and the ban would no longer be effective;
- three airports are considering "minus 5" restrictions in the context of their noise action plans;
- two airports felt that they might have to restrict "minus 5" aircraft if local authority constraints were imposed on activity as the price of planned runway development;
- two airports felt they "might" impose "minus 5" restrictions without specifying conditions;
- two City Airports admit aircraft on the basis of locally-measured noise levels to meet local Planning requirements constraining the operation of the airport, in terms of absolute (rather than certificated) noise levels; this exemplifies the question of compatibility of the Directive with Planning law in some Member States.

The remaining airports reported no restrictions imposed (or in prospect) on "minus 5" marginally compliant aircraft, in the context of Directive 2002/30. This was sometimes because partial (night) restrictions had been imposed which were not specifically aimed at "minus 5" marginal aircraft, such as in Germany where partial restrictions are based on the Bonus list described in detail in Appendix H. In some cases it was simply not felt to be necessary, often with reliance upon operational noise abatement procedures and/or voluntary co-operation, coupled with economic instruments including fines for transgressing monitored noise limits.

It should be noted that not all airports define marginality in line with the definition proposed by the Directive. In Germany, a Bonus List is used, which is based on noise measurement instead of noise certification. Several airports introduced partial restrictions, banning aircraft that are not on the bonus list during the night. Another airport restricts access in first instance based on the noise certification for sideline noise. Access may be withdrawn if noise measurements point out the aircraft makes more noise than expected.

[10] This airport also indicated that a more stringent definition of marginally compliant (i.e. minus 8) would not be further restrictive, as the night quota count restrictions in place were already more strict.

In addition, at many airports aircraft with a certain quota count based on for example the UK QC system (Appendix J) are banned during the nightly hours, see also section 5.2.4.

One airport indicated that it would provide more clarity if there was more harmonisation across airports in the definition they apply for marginally compliant aircraft.

5.2.2 Restrictions Introduced : “Minus 8” and Beyond

Few airports have in place or are considering restrictions that go beyond the minus 5 dB(A). Only one has already restricted “minus 8” aircraft as such and two plan to require their withdrawal:

- one airport has had a night ban on “minus 8” aircraft in place since 2003, presumably under the aegis of Article 6.1 of the Directive, which is understood to regard “partial restrictions” (whether aimed at marginally compliant aircraft or not) as one of the preferential sequence of measures within the Balanced Approach preceding marginal Chapter 3 bans;.
- one City Airport has the declared intention of being “Chapter 4 only” by 2010;
- another airport indicated that any night time bans would be based on “Chapter 4” in the future;

In addition, two airports “might possibly” welcome an opportunity to restrict specific aircraft which could fall into this category.

Although asked explicitly, few airports showed interest in a further tightening of the definition of marginally compliant chapter 3 aircraft from minus 5 dB(A) to minus 8 dB(A).

It was noted by some interviewees that a difference of 3 dB(A) in a single noise event is about the minimum perceptible in practice, but that is of course not necessarily the same thing as a 3 dB cumulative difference at the three measuring points for the certificated noise performance of a given aircraft type.

One airport noted that an overly stringent definition of marginally compliant aircraft would only make it more difficult to introduce a withdrawal, because of the larger economic consequences it might have if more aircraft would be affected. Several airports indicated that such a tightening would only make sense in combination with making the withdrawal mandatory at all airports.

5.2.3 Restrictions Introduced : Night

This section deals with partial restrictions which are not necessarily aimed at particular levels of compliance with Chapter 3. They are nonetheless understood to be covered by Directive 2002/30/EC in terms of requiring formal assessment before they are introduced, unless they were already in place before the Directive became effective. The responses (some of which have been mentioned in the previous sections dealing specifically with marginally compatible aircraft) may be summarised as follows.

Four of our respondent airports (three of which are city airports, as defined under the Directive) are closed during night time. We also know that one non-respondent, Paris Orly, operates a curfew. In addition, a number of airports are closed during part of the night. Seven airports have banned marginally compliant chapter 3 aircraft during the night, one of which effectively banned chapter 3 – 8 dB(A) aircraft. In addition, several German airports only allow aircraft from the Bonus list. Quite a number of airports have a night noise quota count system in place, either in conjunction with a ban on the aircraft with the highest quota counts or not (see also section 5.2.4 and Appendix J). Some airports have night movement limits instead of a quota count system. About twenty airports indicated that they do not have any particular restrictions at night time, apart from the potential closure of a particular runway.

Night restrictions seem to be a slightly grey area in terms of applicability of the Directive. For instance, noise budgets may not target particular aircraft but in the allocation of slots, airports and operators are well aware that noisy aircraft use up the budget more quickly.

It should be noted that although the Directive thus does not allow for a differential treatment between different carriers, one airport indicated that the night restrictions that apply to the home carrier differ from those that apply to other carriers. Whereas aircraft are generally not allowed to land between 24h and 05h, for the home carrier a period from 01h to 04h is said to apply.

5.2.4 Airport Noise “Budgets”

Apart from the restrictions on marginal aircraft, or (partial) night closures, the application of noise budgets may also be regarded as a restriction. It is not fully clear to all stakeholders to what extent noise budgets fall under the Directive. The Directive regards ‘the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions’.

Operating restrictions are defined as ‘noise related actions that limit or reduces access of civil subsonic jet aeroplanes to an airport. It includes operating restrictions aimed at the withdrawal from operations of marginally compliant aircraft at specific airports as well as operating restrictions of a partial nature, affecting the operation of civil subsonic aeroplanes according to time period’.

Noise budgets do not directly restrict the operation of a particular aircraft, in contrast to night time restrictions and restrictions on marginal aircraft, but they restrict access by the fleet as a whole. Noise budgets restrict the overall noise during a certain period of time, which could be seasonally related or annual. The definition of operating restrictions does not particularly mention noise budgets.

On the other hand, noise budgets do limit the access of civil subsonic jet aeroplanes to an airport. It is not obvious to all stakeholders to what extent noise budgets as such are also the particular subject of Directive 2002/30/EC. More clarity could be provided if the Directive is revised[11].

The interviews show that the use of noise quotas is favoured at many airports above operating restrictions on particular aircraft. Particularly in the UK, noise quotas apply at many airports. Based on their noise performance, aircraft are classified and are allocated a quota count (QC). Noisy aircraft receive a high quota count, whereas less noisy aircraft have lower numbers allocated to them. The sum of the QCs at an airport during a particular season, or during a year at night is then restricted to a number prescribed, see also Appendix J.

It should be noted that in many instances this quota is related to partial restrictions. The noisiest aircraft with the highest quota counts are banned during the night.

[11] In fact, this was also mentioned by one of airports as a potential improvement of the Directive.

In total 10 of the 21 airports[12] responding to this particular question, have some sort of noise budget. None of these airports explicitly mentioned this measure to be taken under the Directive. At 6 airports, the measure was in place before the Directive became effective.

One airport with a night quota count indicated that it had introduced and planned to introduce further restrictions on marginally compliant chapter 3 aircraft so to use the quota count more effectively and allow more movements during the night.

At Schiphol, the noise budget takes a different form. The overall noise in Lden and Lnight is calculated for a number of points on the ground, and in each of these points, the noise may not exceed a particular predetermined value. Needless to say that such an approach leaves little flexibility to the airport, but offers a lot of certainty to the people on the ground (if managed effectively).

5.2.5 Effects of operating restrictions

Some airports offered their comments on the impact of operating restrictions introduced. There were several cases mentioned in which a major operator had reallocated to another airport that had no or less severe operating restrictions. Two of these cases dated from the 1990s.

It should be noted that relocation may or may not be a cost effective measure to reduce noise exposure, depending on the specific situation at the airports involved. Relocation may have severe economic impacts locally, but these are often balanced by the positive economic effects that will occur at the airport receiving the new operations. On the hand, the reduction in noise contour or exposed population that occurs at the one airport, may or may not be balanced with the increase in noise at the other. One may only hope that local democratic processes will work so that environmental restrictions are more stringent at the location where the noise results in the most nuisance. To what extent the local/national democratic processes can ensure an equal balance between noise exposure and economic benefits at both airports involved cannot, a priori, be determined.

With regard to the potential for relocation, one airport remarked that because of the combination of its strategic location and its high share of point-to-point traffic, it did not fear operators relocating. On the other hand, another airport indicated that it would only consider a ban on marginal chapter 3 aircraft if it were mandatory and applied across all airports.

In most instances, airports indicated that in their view, airlines had responded by using less noisy aircraft and some rescheduling between night and day time in case of partial restrictions.

Only one airport indicated that the restrictions introduced had resulted in fewer services and frequencies being offered.

The impacts of restrictions implemented should be seen in light of the balance between economics and environmental considerations that airports aim to strike. Clearly, airports do not wish to scare airlines away. Measures will predominantly serve as persuasion and encouragement, rather then being actually restrictive at time

[12] It is not quite clear how airports interpreted the question In fact, a movement limit could be regarded as a special case of a noise budget, with each aircraft being assigned a quota count of 1. Because of the low response rate, we feel this result does not deserve too much emphasis.

of introduction. An illustration of this is the airport for which a three year voluntary phase out of marginal chapter 3 aircraft during the night applies. If the voluntary approach is not effective, a ban may be considered.

Related to this issue is that the restrictions imposed are not always actual restrictions in a 'practical sense'. At one airport, the restriction on marginal chapter 3 aircraft was pre-emptive, to show the commitment to noise management to the local community and to deter any potential operators. At another airport the actual noise count is less than half the noise quota count. On the other hand, there are also airports at which environmental limits are relaxed as they start to bite.

5.3 Operational procedures

Of the airports reporting noise abatement procedures, measures (some applying only at night) include:- SIDs (Standard Instrument Departure routings), preferential runway use, NPRs (Noise Preferential Routes), specified track and noise abatement climb, CDAs (Continuous Descent Approach), departure noise limits, restrictions on maintenance engine run-up, and restrictions on APU running. We have only found two provincial airports which have not produced specific operational procedures in order to minimise noise exposure to local residents.

In most cases such operational procedures pre-date the Directive, some by a considerable period. Airports who have indicated that operational procedures have been introduced or enhanced since the Directive became effective (however not necessarily initiated by or resulting from the Directive) include Düsseldorf (enhanced movement limits), Gothenburg (noise abatement climb), Newcastle (NPR), Luton (CDA), East Midlands (CDA and reduced departure noise limits), London City (NPR), and Naples (mandatory track and height). No single airport has in fact claimed to have implemented or enhanced operational procedures under the Directive, many did not indicate whether or not operating procedures were implemented or enhanced under the Directive.

Many airports apply rigorous noise and track-keeping systems to monitor any infringements. In some cases this is in order to advise and counsel airlines and their flight operations personnel. However, eleven airports (10 of them privately owned, and 7 in the UK) confirmed that they impose financial penalties for such infringements. These are not very significant – typically €400-800 per infringing movement. The monies raised are earmarked and mostly applied to general Community activity, but one airport applies the funds to pay for housing insulation, and in one case (Toulouse) for reimbursement of the providers of the monitoring equipment.

Although most airports could not differentiate the effects on the noise climate of operational measures from other restrictions/measures, it was the opinion of the authorities at Brussels, Luton and Dublin that operational procedures had significantly reduced the number of noise complaints. At Birmingham it was calculated that there had been a reduction in absolute departure noise, while at Naples there has been a reduction of 45% in the area of the noise footprint since the introduction of such measures in 2003. The authorities in Bologna and Stockholm Arlanda also claimed measurable improvements in the noise climate due to the introduction of operational procedures for this purpose.

Apart from the costs to the airlines which are fined for infringements, airports and civil aviation authorities incur costs for investment in, and the operation of, monitoring equipment.

A view was expressed to us at one airport that if military aircraft which are presently exempt from legislation were forced to adhere to the operational procedures affecting civil aircraft, the noise climate could be considerably improved.

5.4 Land Use

Land use planning, or land use management controls, can be an effective method for limiting the populations located near airports and potentially affected by aircraft noise In our interview programme we found that 33 out of the 52 airports reported some land use planning or management controls affecting areas adjacent to the airport perimeter. In most cases such land use measures either pre-date the Directive, some by a considerable time beforehand, or would have been introduced anyway. Significant airports where land use measures have been introduced since the Directive (however not necessarily under the Directive) include the London airports of Heathrow, Gatwick and Stansted, as well as Athens. Although most of the controls have been designed specifically to limit noise exposures, in four cases including Aberdeen, Edinburgh and Glasgow the primary purpose has been to preserve land for potential runway extensions or new runways rather than the noise impacts of these developments.

The measures themselves vary. At 12 airports there is a complete ban on all new building beyond a particular noise contour varying from Lden 57 – 65dB. Four of these airports also limit new domestic housing beyond (typically) Lden 55-57 dB contours. For another 14 airports there is no official ban on new building, but new building – and especially housing - is discouraged either in an area defined by proximity to the airport or by reference to noise contours. For 5 airports new building is permitted within defined contours but only with appropriate noise insulation. At least two airports, though keen to reduce noise nuisance by statutory prevention of building adjacent to the airport, reported political difficulties or delays in implementing or enforcing building bans.

In nearly all cases these measures have been enacted by local or State authorities either as strict guidelines for local authorities or are otherwise legally enforceable. However there are a small number of airports e.g. Vienna, where local custom and practice has the same effect without official legislative authority.

In general the airports themselves have no direct authority on land use planning, though airport authorities have often been consulted on the suitability or scope of such measures. It is noteworthy that one respondent – Luton – was in the forefront of objecting to a housing development subsequently approved by the local authority knowing that the airport and not the local authority would have to deal with any noise complaints from residents thereafter.

In general these measures do not involve any financial costs to the airports, though there is an economic cost in terms of the opportunity costs for potential developers. However, Swiss law requires payment to landowners prohibited from construction on their property – and a contribution from the airports may be required.

5.5 Insulation

Another policy to reduce the problems with air traffic noise is insulation of properties in the neighbourhood of airports. This measure is effective in reducing the noise levels inside the properties. However, the nuisance will not be taken away fully, because people will still be affected by air traffic noise if they are outside and have to close the windows of their houses to take full advantage of the insulation. Finally, this policy will only provide benefits to those people who live or work in an insulated property. The people who live just outside the area where properties are insulated do not benefit. Due to these characteristics, insulation measures will be a less effective policy than noise reduction at source. However, in specific cases, insulation of properties can be a valuable measure to balance economical development and environmental concerns by decreasing the noise nuisance of air traffic.

Of the airports covered in our interview programme, 35 out of 52 airports responded that they were already committed to assistance with insulation of neighbouring properties in order to reduce noise for residents. A number of airports have adopted an insulation policy voluntarily - i.e. not specifically as a requirement by national or local government, but as a measure to reduce noise complaints. Twelve out of the 35 airports have introduced insulation schemes before the Directive became effective, 5 airports have actually planned to introduce insulation measures and another two (Warsaw and Athens) are considering doing so. Ten airports indicated that they didn't have an insulation programme, while two airports noted that there are no properties within their noise contours. Finally, five airports didn't answer the questions on insulation of properties.

Where there are insulation schemes, whether a property will be insulated or not is normally related to the location of the property within a specific noise contour as measured at each airport. Because the measurement of contours is expressed in different metrics (Leq, Lmax, Lden and Lnight, etc) across the airports it is difficult to compare criteria directly. In the UK for example, most airports have, or will, insulate those dwellings within the 63dB Leq contour, and public buildings within the 69dB Leq contour. However, at East Midlands the airport is liable to fund insulation for dwellings within the 55dB Leq night contour, and this will shortly be amended to include any houses included in the 90dB (A)SEL contour of the noisiest aircraft in regular use at night. At Gatwick the criterion is daytime 66dB Leq, and 90dB(A) SEL at night, while at London City (a City airport) the criterion is lower at 57dB Leq day. Cologne airport is required to insulate residences and public buildings exposed to 6 or more nightly single noise events of more than 75dB(A). The Helsinki contour is 50dB Lden, and at Gothenburg it is based on the 55dB FBN contour. Amsterdam is much more stringent with insulation required for all affected homes within the 26dB Laeq night contour. A number of Spanish airports have adopted the 65dB Leq day and 55dB Leq night contours as the criterion for insulation programmes.

Most airports have specific targets for the effectiveness of insulation, but these vary considerably. At Frankfurt the insulation target is 52dB(A) LAmax inside bedrooms that should not be exceeded regularly during night time, while at two other German airports (Cologne and Dusseldorf) insulation must cut out any single noise event at night above 55dB(A), slightly further relaxed at Nuernberg where up to six events above that level per night may still be audible. Dublin has as a quantified aim a reduction of 35dB in perceived noise, while at Budapest this is greater at 40dB in perceived noise. In Sweden the requirement is more stringent – an absolute level of Lmax 45dB(A) inside, and at Stockholm Bromma (a City airport) down to 30dB(A) indoors. More consistency can be found between the Spanish airports, which all have to meet the acoustic requirements contained in the "Norma Básica de Edificación" - 30 dB(A) Leq inside bedrooms, 40 dB(A) Leq inside other house areas at night time. The quantified aim at Geneva is 37dB at the window inside. Some other airports specify a reduction in noise levels through insulation of a given amount, e.g. Dublin specifies –35dB, Budapest –40dB.

The costs of insulation vary quite considerably across European airports, according to the level of noise suppression required as described above, as well as the extent of noise insulation. For example in Budapest noise insulation is restricted to secondary glazing in living rooms, whereas at the other extreme for Dublin the specification is very generous to include double glazing, doors, wall vents chimneys and roofs. Only at Stuttgart does the programme include insulated ventilators to allow fresh air without opening windows – to overcome the problem (especially in summer) of having to close the windows of their houses to take advantage of the insulation.

Overall costs are also impacted by the sizes of properties within the relevant noise contours, i.e. number of rooms etc to be insulated. Where our interviewees quoted specific costs for insulating homes these varied from €20,000 in Dublin, down to €500 in Budapest. Some variation may also be due to differing costs of labour and materials across the airports within the EU. The average cost of insulating a home across the 13 airports where specific costings were given to us was €10,000. Assuming an average population per household of 2.6, this implies that the cost of providing a quieter environment to people while inside their homes may amount to just under €4,000 per head.

Total costs of insulation programmes to date vary according to the length of time these programmes have been put in place, as well as the number of properties which qualify according to the criteria laid down for insulation. A number of airports have quite substantial programmes, e.g. at Manchester 26,000 domestic properties currently qualify, with 18,000 at Cologne. At Frankfurt 14,000 housing units have been insulated in a programme that will finish in 2009, together with 20 kindergartens, 5 schools, and 7 nursing homes. At the other end of the scale, at Stockholm Arlanda only 250 houses would qualify.

In most cases the costs of insulation are borne by the airport authority alone. Exceptions include Budapest where the municipality and the residents are required to contribute, and Dusseldorf and Amsterdam where the airlines make a specific contribution from airport fees or a governmental levy. At Toulouse and Lyon the costs are recovered from a Noise Pollution Tax paid by the airlines. National or Regional Governments bear all or some of the costs at Copenhagen and Milan Malpensa airports.

5.6 Acquisition

Only 7 of the airports out of the 52 airports interviewed currently have any sort of property acquisition policy, though 6 are about to launch and another 4 are seriously considering introducing such a scheme, 5 of them in relation to the noise impact of potential airport expansion.

Of those that do have such policies, the criteria for application usually mirror or are at a higher noise contour than those for insulation of property. For certain airports such as Madrid and Amsterdam the objective is simply to remove all houses exposed to very high levels of noise. At Düsseldorf, houses acquired have been reequipped as shops instead. Amsterdam also provides for acquisition of affected shops. A number of UK airports do not offer acquisition as such, but rather a home relocation assistance scheme, whereby financial assistance is provided to current home owners to relocate, thus removing their exposure to noise.

However, respondents reported that in practice very few houses have actually been acquired because so few residential properties lie within the higher noise contours, especially given historic land use regulations.

Only two airports provided detailed historic costs for their acquisition programmes, which vary between €200,000 and €500,000 per house. The UK relocation schemes are much cheaper, at around €20,000 per applicant for relocation.

In nearly every case it is the airport authority that bears the cost of the acquisition programmes, the only notable exceptions being Milan Malpensa, where the regional government takes responsibility and Amsterdam where airlines contribute via a governmental levy.

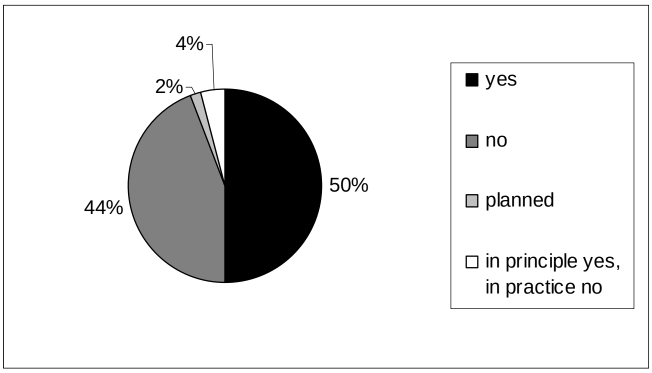
5.7 Market-based instruments

We have specifically asked airports about their practice of and opinion on the use of market based instruments to influence the timing of flights and the noise characteristics of aircraft. In particular, we asked whether Landing and Take-Off (LTO) charges were differentiated with respect to noise characteristics of the aircraft and / or the time of day.

5.7.1 Noise differentiated charges

Most airports use charges, differentiated by noise category or time of day or both. To the question whether the airport uses charges differentiated by noise category, half of the respondents indicated they do so and just over 40% indicate not. Two airports stated that they do have noise differentiated charges in principle, but not in practice, due to an ongoing legal dispute. One additional airport plans to introduce noise differentiated charges shortly, and two others consider extend the differentiation to either noise category or time of day. Distribution of the responses is shown in Figure 5-1.

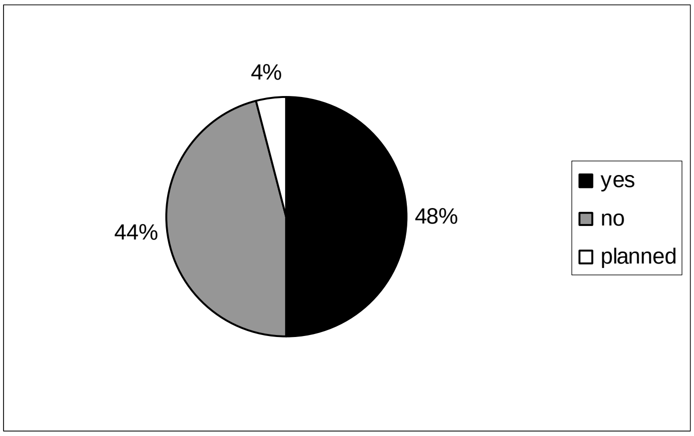
Figure 5-1 Noise differentiated charges



5.7.2 Day/Night time differentiated charges

Nearly half of the respondents to this particular question, indicate they use charges differentiated by time of day (in all cases the charge for night time being higher then for day time). Just over 40% of the respondents have no such differentiation in place. Two airports report day/night differentiated charges are planned for the near future. One airport mentioned, although not having a standard day/night differentiation, a surcharge is applied to delayed night flights. Distribution of the responses is shown in Figure 5-2.

Figure 5-2 Day/Night time differentiated charges in place

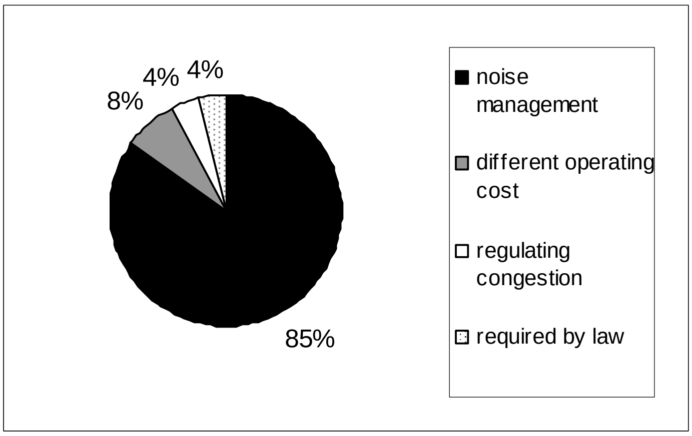


5.7.3 Reason for differentiated charges

85% of all airports indicated that they applied differentiated charging for the purpose of noise management. Only London City indicated they apply differentiated charging (only differentiation with respect to time of day) to regulate congestion. Furthermore, two airports (Belfast City and Bologna) indicated their charge differentiation was simply following the differentiation in operating costs: higher night charges reflect higher operating costs of airport at night (higher labour rates, lower utilisation etc).

One airport (Toulouse) reported differentiation of charges to be required by law (although other airports in that same country mentioned noise management as the reason for charge differentiation). Distribution of the responses is shown in Figure 5-3 .

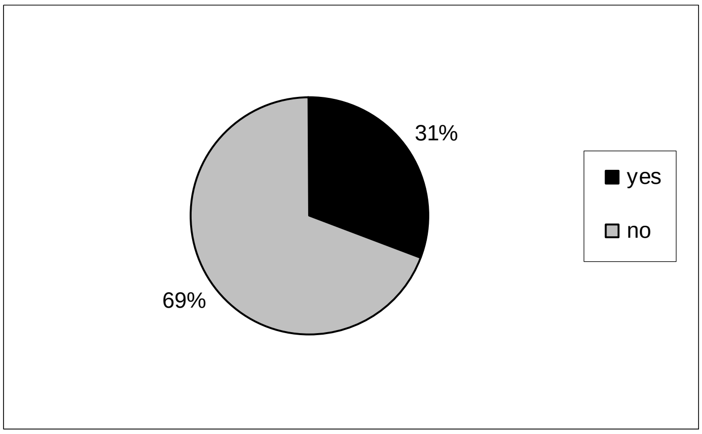
Figure 5-3 Reason for differentiation of charges



5.7.4 Net revenues

From the 29 airports in total that have differentiated charging, 8 airports reported net revenues. The funds are mainly applied for financing of mitigation measures, potential compensation payments and noise monitoring`, two airports use the revenues to offset extra costs (e.g. higher operating costs of airport at night). Six additional airports (not all of whom have differentiated charges) report that noise fines are used for mitigation or local funds. Two airports provided no information on revenues, and ten indicated that the differentiation was revenue neutral. Distribution of the responses is shown in Figure 5-4.

Figure 5-4 Net revenues from differentiated charges

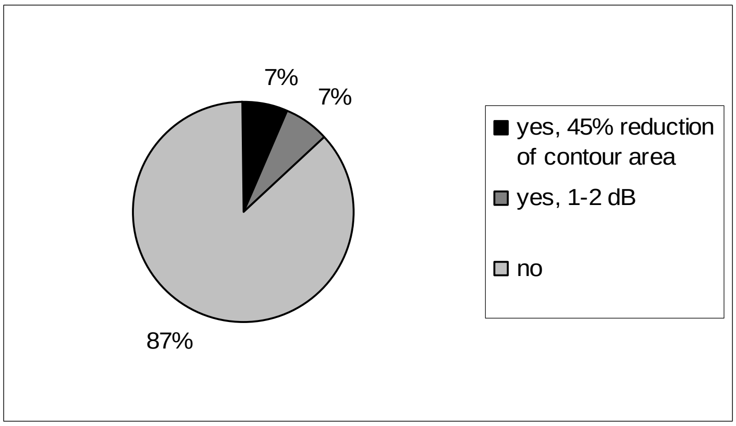


5.7.5 Quantification of the impact of differentiated charging

There is generally no quantification of the impact of differentiated charging on the contour area, the fleet that visits the airport or on the number of people affected. Clearly, singling out the impact of a particular measure, or separating the impact of measures from autonomous developments is very difficult. This holds especially when taking into account the delicate balance airports are trying to strike when providing incentives to airlines to use less noisy aircraft. In theory, a comparison between two airports of which only one has introduced a particular measure would be feasible. However, to single out the exact effect of one particular measure remains a very challenging task in practical terms, also because each airport has its particular characteristics, in part dependent on the home carrier. Some airports indicate that although they are not able to really quantify the impact of differentiated charging, they strongly believe these charges do indeed contribute to the formulated aims. Moreover, three airports state they believe stronger differentiation would even further reduce aircraft noise exposure.

Two airports actually quantified the impact of differentiated charging at their airport; as a noise reduction of 1 to 2 dB at one airport (Warsaw) and as a 45% reduction of the contour area at the other airport (Naples). Distribution of the responses is shown in Figure 5-5.

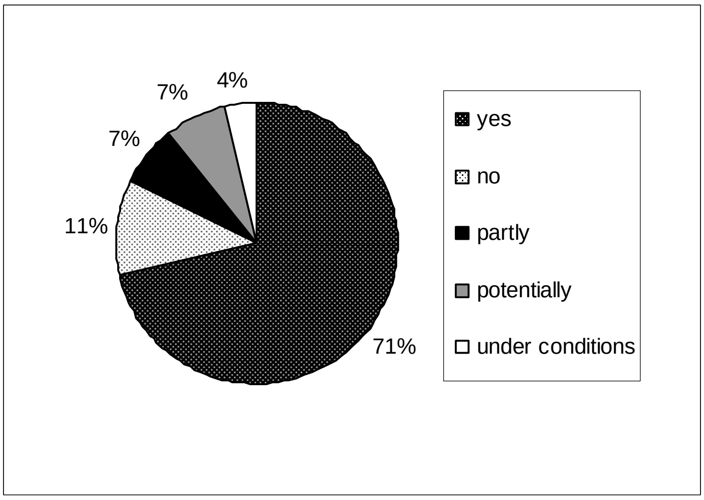
Figure 5-5 Quantification of impact of differentiated charges



5.7.6 Perceived effectiveness of Market Based Instruments

On the question on their opinion on market based instruments (MBI) in general, most airports (over 70% of the 28 respondents to this question) answered that market based instruments are considered effective tools to manage noise. Just over 10% of the respondents assess MBI as “not effective”. Almost 20% of the airports believes MBI at least partly, potentially or under particular conditions to be effective.

Figure 5-6 Opinion on effectiveness of market based instruments



One airport showed possible proof of their opinion of MBI to be effective. For this airport, a noise surcharge was introduced in 2005. A comparison between 2004 and 2006 showed a slight shift to quieter aircraft.

Nonetheless, these results should be put in perspective. Several airports indicated that environmental aims will always need to be balanced against financial aims. With the introduction of environmental policy measures, airports aim to strike a balance between giving incentives in the right direction, while at the same time trying not to scare airlines away. In the field of noise management, this means that airports try to avoid giving such large incentives that airlines relocate to other airports (in potentially less densely populated surroundings). This is very understandable. However, it must also be noted that in some situations this might in fact be a cost effective measure (from a social welfare perspective) to reduce noise exposure.

There were also some airports that indicated that they have not implemented differential pricing in fear of their competitive position. In relation to this, two airports indicated that differential pricing may be more effective at larger airports than for regional airports, which are not at full capacity and still trying to attract traffic.

Several airports indicated that they prefer a mix of voluntary measures and fines. Fines may be given if aircraft deviate from their path, do not follow other operating procedures or produce more noise that allowed (based on actual noise measurements). Three other airports (confidentially) expected that differentiated charges would be more effective if the differentials were increased.

5.8 Qualitative Findings

5.8.1 Introduction

This part of the interview dealt with the availability of public data on noise. This concerns availability of noise contours, of data on the number of people living in those contours and on noise actions plans.

If noise contours in the Lden and Lnight metric were already available for particular airports, that could be of use for two reasons. First, if the data relate to the precise data that we have been asked to assess in this study, we may make use of it. Within the scope of this study, we are unlikely to reach the level of detail that has been applied in the available airport-specific studies. Alternatively, available data may be used to calibrate our own analysis.

Apart from asking whether noise contours are available in Lden and Lnight, we have asked for the years for which such contours are available and also the level of the contours available.

Following up on this question, airports were asked to indicate to what extent data on the population within the contours is available.

Airports have also been asked about their awareness of the existence of a noise action plan, as specified under Directive 2002/49. The Directive requires the competent authorities to draft noise action plans before the end of 2008.

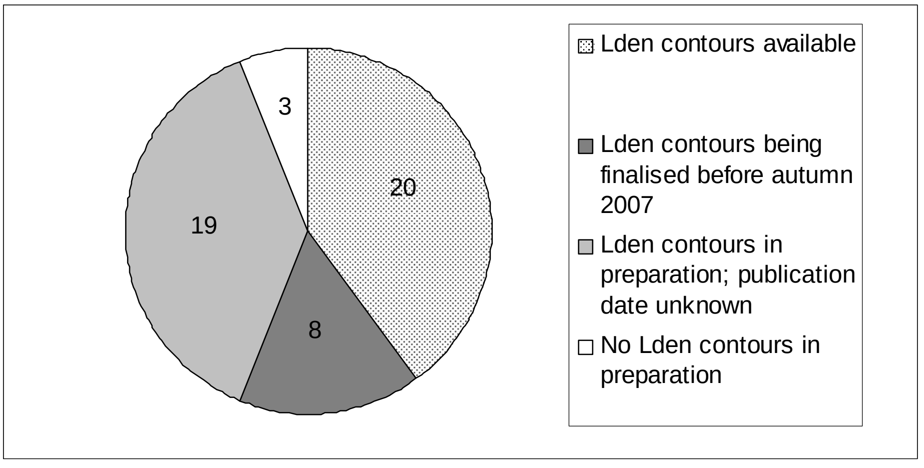
In the second part of the interview programme, after revision of the original interview framework, we started asking airports about the development of the noise contours around the airport. Have they been shrinking or increasing, and what are the expectations for the future? In addition, we wished to establish what are the underlying processes driving these developments.

In the next sections, the results from the interview program on these issues will be discussed one by one.

5.8.2 Availability of contours for Lden and Lnight

Of the interviewed airports, 50 have responded to the question on the availability of Lden and Lnight contours. The use of the L_{den} and L_{night} metric is prescribed by Directive 2002/49, which requires EU Member States to submit 'strategic noise maps' no later than 30 June 2007 for all major airports within their territories (Article 7.1). These noise maps should comprise estimates of the number of people exposed to noise with limit values over 55 dB L_{den} and 50 dB L_{night}, respectively, as well as maps showing noise contours of 55 dB and 65 dB L_{den} (Annex VI). All data should refer to the preceding calendar year, i.e. 2006.

Figure 5-7 Availability of contours for Lden



As can be seen in , 20 airports out of 50 indicated that Lden and Lnight contours are available for the airport at the moment of interviewing. Most airports for which no Lden and Lnight contours are available, voluntarily indicated that contours are currently available in other metrics, where the Laeq measure was most often mentioned. In addition, 22 out of the 30 airports without Lden contours noted that such contours were currently being prepared (often by the local or national authorities). For 19 of these airports the contours are likely to become available by the autumn of 2007 at the latest, while for the other 3 airports no publication date of the Lden contours were known. Even before the end of this study, the number of airports for which Lden and Lnight contours will be available will increase substantially.

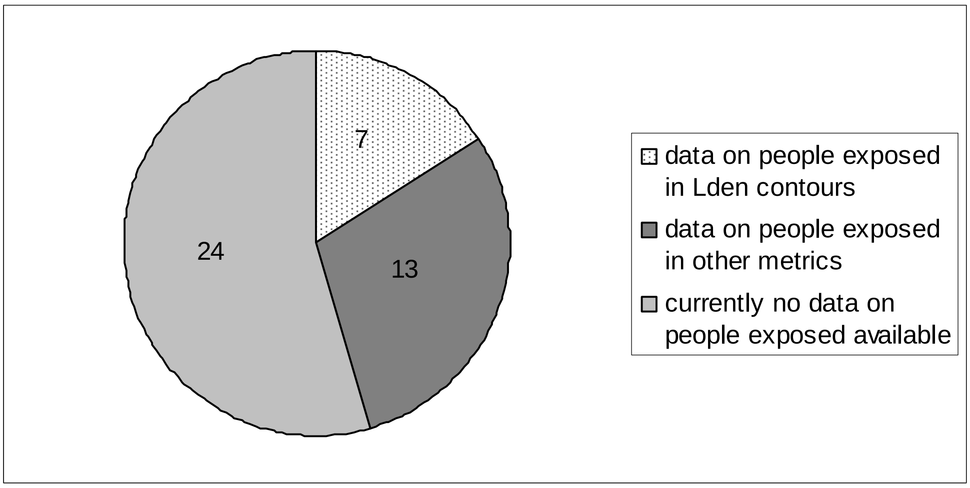
To what years these contours currently under development refer, remains to be seen. It is our expectation that the majority of the contours will relate to the current situation. Contours for 2002/2003, the base year of the ANOTEC study, will only be available for the airports that have applied modelling using the Lden metric for several years. Some airports have indicated that contours for the current situations are being prepared and that forecasts for e.g. 2010 or 2015 may become available only at a later stage.

For the twenty airports for which contours in Lden and Lnight have been prepared, some airports prepare these contours annually. One airport indicated that the contours were prepared but not in the public domain. In addition, for eight airports the contours are currently not publicly available (publication date is unknown). It is not yet clear to what extent forecasts are also available in Lden and Lnight. It may be expected that as more and more airports and authorities switch to the Lden and Lnight metric, future planning studies will also make use of these metrics.

5.8.3 Availability of population data within contours

The aim of this study is not so much to assess the development of the noise contours around airports, but to assess the number of people exposed to noise and thus living within the contours. Clearly, these issues are closely related. To assess the number of exposed people, we have asked airports to what extent data on the number of exposed within Lden and Lnight contours is available.

Figure 5-8 Availability of population data within contours



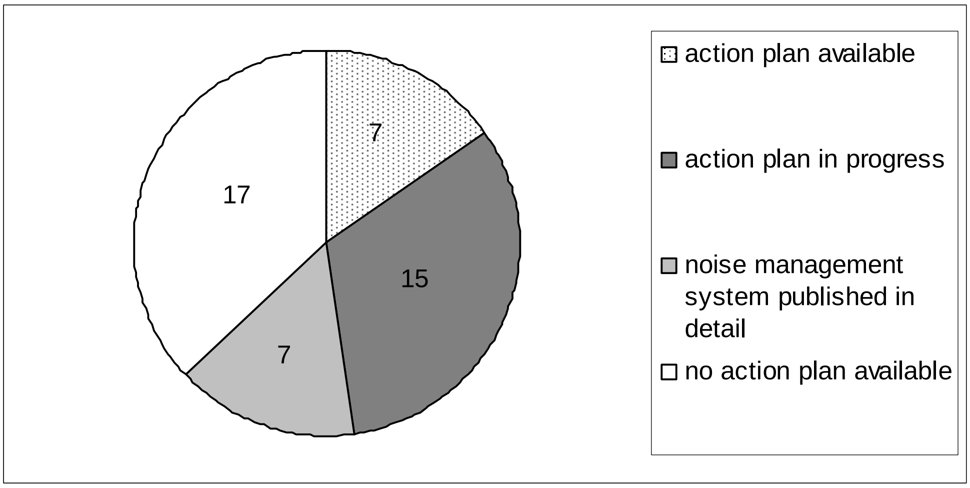
Of the interviewed airports, 44 answered on the question whether data on exposed people within contours were available. Twenty out of these airports indicated that they do have information on the number of exposed people, either in Lden (7 airports) or some other metric (13 airports). Six of the thirteen airports that currently have data on the number of exposed within a noise contour of some other metric, indicated that they expect data on the number of exposed within Lden contours to become available before the autumn of 2007. In addition, three airports for which currently no data on exposed people are noted that these data would become available before the autumn of 2007.

In general, such data may relate to either the number of exposed, or the number of dwellings within the contour.

5.8.4 Noise action plans

Under Directive 2002/49 the competent authorities are required to draw up noise action plans no later than 18 July 2008. These plans should be designed to manage, within their territories, noise issues and effects, including noise reduction if necessary (Article 8.1). We have asked the airports whether to their knowledge such action plans had already been prepared.

Figure 5-9 Availability of noise action plans



Only 7 out of the 46 airports who answered this question indicated that they currently have a noise action plan. A noise action plan was being drafted, under consultation , or under review for another 15 airports. The time frame indicated for publication was mostly 2008, in line with the requirement from the Directive. It can therefore not be expected that results can be taken into account in this study. Seven airports indicated that they have published their noise management system in detail and that this may be regarded as a noise action plan. In most cases, it was not the airport itself responsible for drafting the noise action plan.

5.8.5 Qualitative discussion of developments

After several initial interviews, we amended the interview framework to better meet our needs and to be more self-explanatory, as several contact persons indicated that they preferred to fill in the questionnaire themselves rather than discussing it over the phone. In addition, this allowed them the possibility to assemble all the data asked for from various sources.

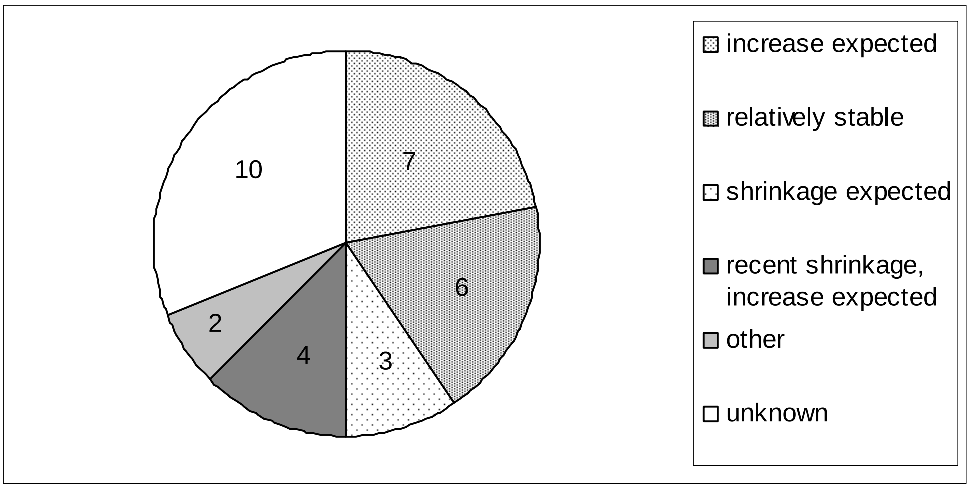
Part of this revision, was also the inclusion of a question related to the airports' qualitative opinion with regard to the development of the noise contours. The following questions were included in the interview:

- Have your noise contours changed since 2002?
- What are the airports expectations with regard to the development up to 2010 and 2015?
- How is this measured, in the number of people within a specific contour, or in the contour area?

- What has been the underlying reason for the changing contours and expected developments for the future?

Not all questions have been answered fully by all airports. The 32 answers on the development of the noise contours can be listed as follows in figure 5.10.

Figure 5-10 Expectations with respect to development of noise contours



There are several processes underlying the development of noise contours. First, the aircraft employed become less noisy. Airlines are updating their fleets (most currently produced types meeting Chapter 4), although we do not know how far this is due to environmental pressure including the possibility of action under this Directive, and how much has been due to fuel prices and efficiency imperatives, or other business considerations.

Second, the demand for air travel is increasing. This is in part due to the rise of low cost carriers, offering air travel at lower prices than before and at the same time disposable income is rising, making flying even more affordable.

Figure 5-10 shows the response of the airports to the questions. In the category 'Other', airports indicated that changes are expected, but it was unclear what changes. The second response was that there had been a sharp decline in the contour since 2003, but no forecast for the future was provided.

In total, 11 out of 32 airports indicated that they expect that contours would expand (measured by the area within the contour). More detailed answers provided gave the impression that during the last years, the individual aircraft making up the fleet have become less noisy. For some airports this was translated by a shrinkage in contour size, which was also attributed in part to active noise management. At other airports the effect of the quieter fleet was counteracted by increases in traffic volumes.

Ten airports were not able to give an indication of future noise contours mostly due to uncertainties with regard to regulatory requirements (definition of new noise metrics and/or noise limit values, fleet mix changes, etc.).

For the future, most airports expect significant growth in traffic volumes, which cannot be matched by similar improvements in the noise characteristics by specific aircraft. For this reason, 11 out of 32 airports expect an expansion of their noise contour over the coming 5 to 10 years.

5.9 Policy Issues raised by Airports

5.9.1 Introduction

We have asked two types of questions in the section on noise management issues. The first kind relates to the airport and its noise objectives. Does the airport consider itself to have a noise problem, and if so, what does it constitute and does it restrict capacity? In addition, we have also asked airports what body sets noise limits and whether they have a quantified noise objective.

The second type of question relates more directly with the primary aim of this evaluation. We have asked airports whether they consider themselves to have sufficient powers to regulate noise. This can either mean to keep it within the limits posed to them, or to achieve their quantified noise objective. We have furthermore asked whether the airport would like to see the directive revised, and if so, in what manner. In addition, we have asked whether airports feel the requirement of 50k movements would require revision.

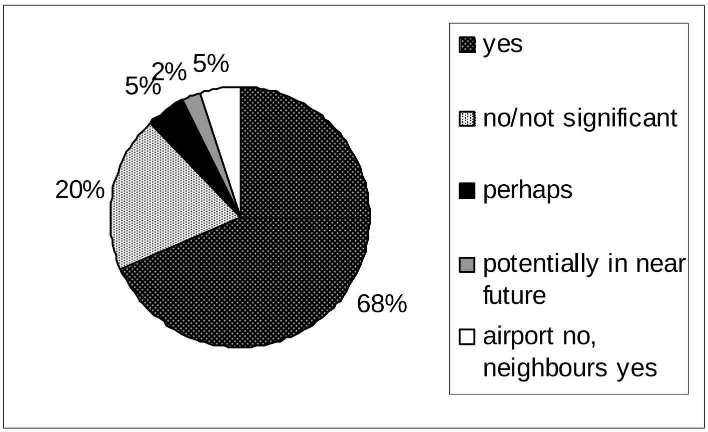
5.9.2 Noise problem

Clearly, the answer to the question whether airports have a noise problem is very subjective. Of the 41 responses to this question, about two thirds of the airports consider themselves to have a serious noise problem. Some airports indicated that there is only a minor problem, or that it is well taken care of. Three airports indicate that it is particularly night time noise, due to increases in night time movements. Brussels airport indicated that it is the complex regulatory environment that poses the main problem. 20% of the airports consider themselves not to have a significant noise problem, 5 percent are not sure, one airport indicated a potential noise problem in the near future due to a planned expansion of total movements. Two respondents indicate that it is not the airport, but the neighbours/media that have a noise problem.

Concluding, we can safely say that noise is considered a very serious issue by most airports, and that substantial efforts go towards minimizing the noise problem.

Distribution of the responses is shown in Figure 5-11.

Figure 5-11 Do airports consider themselves to have a noise problem?



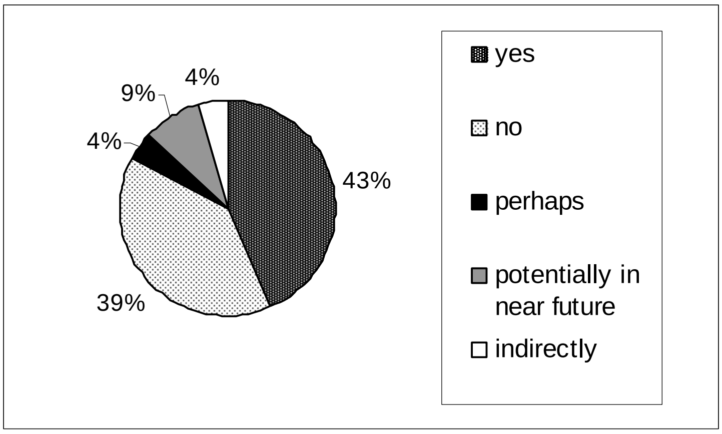
5.9.3 Capacity restricted

Twenty-three airports have answered the question whether the noise problem constraints capacity. Over 40% claimed that currently, capacity is constrained because of noise limits. Just under 9% indicated that capacity would be constrained in the future because of noise issues. Just under 40% reported that noise issues did not constrain the number of movements. One airport indicated that a capacity restriction could be the result of a currently ongoing legal dispute. One airport mentioned delays as an indirect capacity restriction caused by the noise problem.

Airports with capacity constrains sometimes mention a particular day time or night time capacity restriction, resulting in a movement shift between day and night.

Distribution of the responses is shown in Figure 5-12.

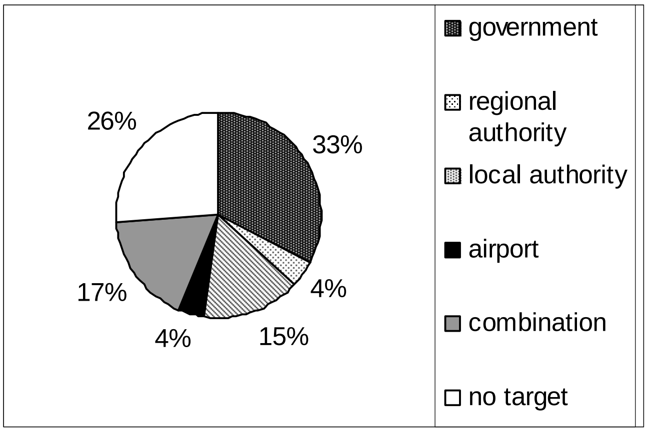
Figure 5-12 Does a noise problem constrain capacity?



5.9.4 Who sets targets?

From the interviews it became clear that in roughly half of the cases, it is either the local, regional or national authorities that set limits, in some cases in consultation with the airport. About a quarter report that there are no noise limits. Two airports indicate that there are noise limits in place, however not binding (recommendation only). Two airports set their own limits in consultation with the Community. One respondent stated that it is the environmental court that eventually determines the limits. Distribution of the responses is shown in Figure 5-13.

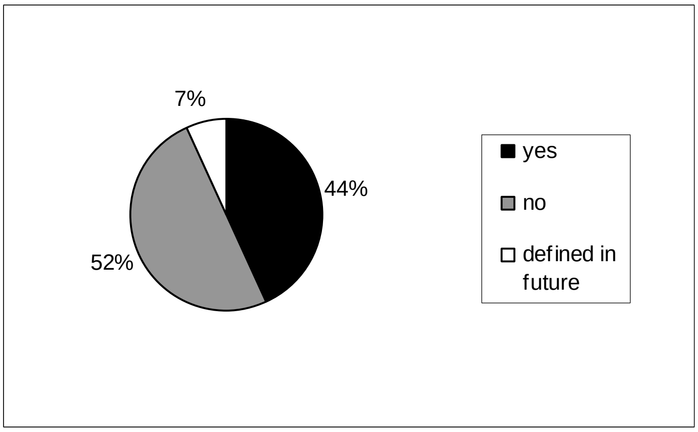
Figure 5-13 Who sets targets?



5.9.5 Quantified noise objective

The question whether there is a quantified noise objective was answered by 27 airports. About 40% of these airports indicated that there is a quantified noise objective, 1 airport indicates a quantified noise objective to be defined in the near future. Quantified noise objectives range from the achievement of the limits posed by the regional authorities to requirements on the fleet (decibel limits). Most airports have quantified aims in terms of contour areas. Objectives related to the number of people were not mentioned. In one case, the noise objective is defined as a maximum number of movements and a maximum number of noise complaints. About half of the respondents said they do not have quantified noise objectives. Distribution of the responses is shown in Figure 5-14.

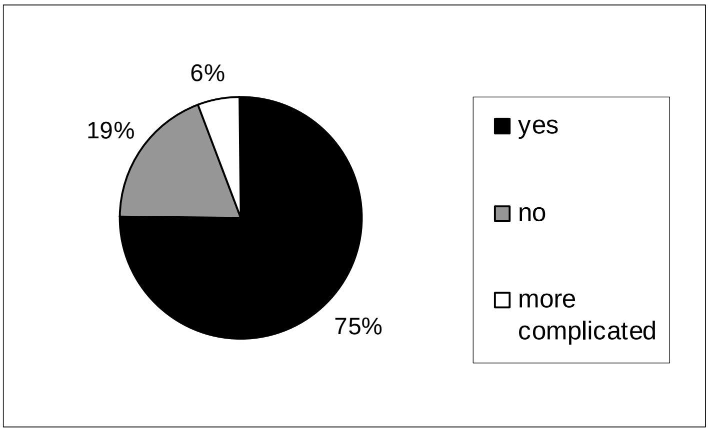
Figure 5-14 Do airports have quantified noise objectives



5.9.6 Sufficient power

As much as 75% of the 36 respondents feel they have sufficient powers under national and international legislation, to achieve their objectives with regard to noise management. Just under 20% experience a lack of power in this respect. A small group of 6% believes it is a bit more complicated then a full “yes” or “no”, although the origin of this complexity was not explained. Distribution of the responses is shown in Figure 5-15.

Figure 5-15 Sufficient power to reduce aircraft noise exposure?



Some of the airports felt they had sufficient power in their current situation, though some qualified their opinion. One airport commented that powers are sufficient at a national level, but at EU legislation made it difficult to impose restrictions that differentiate between carriers. The possibility of a favorable treatment of the home carrier would be appreciated by this airport, because of its large dependency on the home carrier. Another comment put forward was that greater powers to impose financial penalties would be appreciated.

One airport commented it had a lack of power because the noise stringency targets for new aircraft were insufficient.

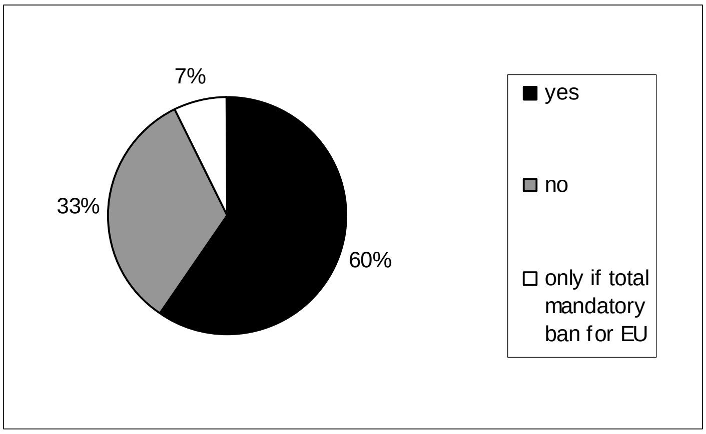
5.9.7 Revision of the directive

Although 75% of the respondents believe they have sufficient powers under current national and international legislation, 60% of the respondents believe a revision of the Directive is required to enable adequate noise management. 30% of the respondents disagree on this, while 7% states a revision only makes sense if the revised Directive would include a total ban on all marginally compliant Chapter 3 aircraft, for all airports to which the Directive applies. Clearly, airports fear for their competitive position if marginally compliant aircraft are banned at their airport only. This holds irrespective of the definition of marginally compliant aircraft.

One airport based their statement that mandatory phasing out of marginally compliant aircraft would have a great effect, with the following figures: 33% of the operations produce 66% of the noise.

Distribution of the responses is shown in Figure5-16.

Figure 5-16 Revision of directive required for adequate noise management



Many different comments were put forward. Two airports went as far as to say that the current Directive already gives too many rights to the airlines. One of these airports indicated that the procedure for implementing new or additional measures is much too complex, possibly preventing airports from implementing additional measures. As an unwanted result of that, the Directive is favouring airlines instead of favouring noise reduction. Another airport said the Directive is merely giving too many rights to the airport's opponents (e.g. environmental organisations, neighbourhood committee).

Of the airports that responded positively to the idea of revision, most mentioned that tougher standards and more stringent regulations on new aircraft were required. One airport was concerned that tougher standards would affect too many aircraft, potentially preventing airports from implementing a ban. A harmonised scheme for noise differentiation of LTO charges was suggested to be more helpful then a revision towards a ban.

Of the airports that responded positively to the idea of revision, almost 30% suggested a total ban on marginally compliant Chapter 3 aircraft.

The following potential revisions (possibly not all directly relevant for Directive 2002/30) were all put forward once:

- take account of the physical sound frequency in regulation
- regulate the track keeping of aircraft
- develop / prescribe better abatement procedures
- develop a standard for cost benefit analysis
- lower the jet weight limit of applicability

In addition, three respondents indicated that a further clarification of the Directive would be very helpful.

5.10 Overview of measures in action and measures planned

The following two tables provide a summary overview of all measures in action and planned. They also indicate whether they were implemented before the Directive, and if introduced since, whether airport indicated they were taken 'under the Directive' or would have been introduced anyway. In a number of cases, airports did not indicate when a measure was introduced. These answers are listed in the tables below in the sub-column "Not indicated" under "Introduced since 2002, or not indicated since when".

The overview shows that only a few airports have introduced or are planning measures under the Directive. Only in 13 cases, airports indicated that a particular measure was introduced under the Directive, or is planned to be introduced under the Directive. It should be noted though that airports did not always indicate whether a particular measure was taken under the Directive or not.

In addition to the measures listed below, 5 airports indicated they were considering (not yet planning) to introduce measures (these airports are not included in the table). Four airports indicated that there was no influence of the Directive, the fifth did not specify this.

Table 5-1 Operating restrictions, planned and in place

	In place before 2002	Introduced since 2002, or not indicated since when			Planned			Total answers (positive /total)
		Under directive	Not under directive	Not indicated	Under directive	Not under directive	Not indicated	
Marginal aircraft	3	3	2	2	2	1	0	(13/49)
Night ban	4	0	0	0	0	0	0	(4/52)
Partial restrictions	20	7	7	4	0	0	0	(38/50)
Noise budget	6	0	2	2	0	0	0	(10/21)

Total answers (total)= total responses to the related question in the questionnaire; Total answers (positive) = total positive responses, i.e. a measure is introduced or planned. With regard to noise budgets, we are uncertain of how airports interpreted the question, see also section 5.2.4.

Table 5-2 Other measures, in place and planned for

	In place before 2002	Introduced since 2002, or not indicated since when			Planned			Total answers (positive /total)
		Under directive	Not under directive	Not indicated	Under directive	Not under directive	Not indicated	
Land use planning	12	1	12	8	0	0	0	(33/39)
Operational procedures	15	0	13	19	0	0	2	(49/50)
Insulation	12	0	8	10	0	5	0	(35/47)
Acquisition	4	0	1	2	0	5	1	(13/46)
Market based instruments	10	0	10	9	0	0	4	(33/49)

6 Industry Perspective and Consultation

6.1 Context

Complementing our airport interview programme, we were invited to brief the Council for Environmentally Friendly aviation (CEFA) at one of its regular meetings in Brussels, in March 2007. The membership of CEFA includes :

- the Association of European Airlines (AEA), best known as representing the "mainstream" European scheduled service airlines;
- the European Business Aviation Association (EBAA);
- the European Express Association (EEA), whose full members are DHL, FedEx, TNT and UPS;
- the European Regions Airline Association (ERA), who act as the CEFA secretariat; and
- the International Air Carrier Association (IACA), traditionally representing "leisure" (holiday/charter) airlines.

We also approached the European Low Fare Airlines Association (ELFAA).

6.2 Study Focus

CEFA members emphasised that operating restrictions are only one strand of the Balanced Approach. The Directive offers protection to operators against the arbitrary imposition of such restrictions, as developed in the earlier MPD/ERM study on night flight restrictions[13] for the Commission, but our current work focuses upon the effectiveness of the Directive in managing the impact of noise, with particular reference to degrees of marginal compliance with current Chapter. 3 stringency.

CEFA members would have liked to see the study widened to assess the implementation of the Balanced Approach as a whole, and in particular :

- to note that some approaches to operational restrictions can lead to noise being spread over a wider area in order to reduce the impact in the most severely affected locations.
- to put more emphasis upon land use planning, including instances of reported exposure to aircraft noise having worsened due to density of population increasing in noise affected areas.
- the perceived emphasis of the Directive upon operating restrictions (albeit the protection it offers operators from their arbitrary imposition), and of this study upon the effectiveness of the Directive in terms of noise management, are seen as only one strand.

For our part, we were particularly anxious for guidance on fleet development, both historic and forecast, with particular reference to :

- the identification of marginally compliant aeroplanes, the difficulties of which are discussed in Section 4.2 above; and
- their historic and expected rates of retirement and replacement, although confidentiality is clearly an issue in the latter area.

We also invited all the representative associations contacted, at a later stage of the study, to give us their views on the possible revision of the Directive.

[13] MPD Group Ltd in association with ERM Environmental resources Management : Assessing the economic costs of night flight restrictions, Final Report February 2005

6.3 Industry Business Models

6.3.1 Introduction

In the event, the associations were generally unable to provide detailed factual data on the marginality of aeroplanes in their members' fleets, or their replacement planning, and time constraints prohibited a detailed survey among their members. We were, however, able to obtain the information regarding numbers of marginal aircraft currently in Community operators' fleets through the process of database analysis and matching described in Sections 3.3 and 4.

We have drawn upon relevant published and internet information, and airport interviewee comments about their airline customers, for the following notes and examples to illustrate the relevance of these issues to different business models n the industry; except in the case of Express and the regional airlines, where we report our interview and follow-up.

6.3.2 "Mainstream" Scheduled Service Airlines

Due to our time constraints, AEA were not able to fully survey their members, who undertake both passenger and cargo operations. Among the examples we have come across from airport interviews, however, we noted that at several airports a particular family of scheduled service passenger aircraft, operated by several AEA members and others, is perceived as one of the noisiest common generic types. We must stress that this is merely a random example which by no means identifies the statistically most numerous marginal aircraft in Europe and is not intended to target a particular type. Within that apparent contrast between perception and certification, it should be noted that several aircraft of this family meeting the "minus 10" criterion have apparently been recertificated at lower MTOM. Actual noise quantification can thus differ from perception, as noted in Section 3.3.

The potential marginal aircraft problem is not, however, confined to European domiciled airlines. Overseas long-haul carriers (not necessarily on scheduled services) operate marginal B747 and B767 sub-types, the "families" of which contribute significantly to the world marginal fleet, and they are potential visitors to Community airports.

6.3.3 Regional Airlines

A meeting was held with the staff of ERA. The majority of regional aircraft in service, particularly among airlines flying branded feeder services for major European carriers, are either turboprops or relatively small jets such as the Bombardier and Embraer series. These latter are a comparatively recent addition to world fleets and tend to be fully Chapter 4 compliant. The older BAe146 types are being retired though some may still be in service for some years. There is currently a trend for a growth in the size of regional jets being operated.

One regional operator flies B737-300 and B737-400 series aircraft and one flies older Russian types but only within the Russian Federation. Thus, the restrictions contemplated in this study are not likely directly to impact ERA members significantly. However, most regional operators are dependent on their mainstream alliance partners, and would be concerned if the economics of those operators were adversely affected by any new legislation. If our study leads to the conclusion that contour areas are likely to grow, the assumptions should be fully justified, particularly as regards the rate of introduction of newer quieter aircraft, which could be accelerated by stricter controls on emissions.

6.3.4 Leisure Carriers

IACA were unavailable for interview, but their website describes the association as representing "37 airlines operating over 750 state-of-the-art environmentally efficient aircraft". Elsewhere on the website, a total IACA members' fleet of "over 800 aircraft with an average age of 4.3 years" is mentioned. The apparent inconsistency may indicate operation of some relatively noisy aeroplanes, but our overall impression is that among leisure carriers utilisation and fuel efficiency are paramount contributors to the vital competitive yardstick, seat cost. Thus these airlines try to fly six-sector days within Europe, involving night movements at some airports. For flexibility and economy they have an incentive to fly modern, relatively quiet aircraft. Given the increasing popularity of long-haul holidays, however, there may be some potentially marginal B767ER types among their European-based fleets.

6.3.5 Low Cost Carriers

ELFAA replied to our enquiries by e-mail, but were unable to give any fleet marginality information. The average age of their members' aircraft is 3.9 years, decreasing, in response to the fuel and maintenance cost efficiency imperatives. By and large major low cost carriers appear to have fully compliant fleets. Indeed an example frequently cited during our airport interview programme was that of a particular low cost carrier, whose 2002/03 fleet included 21 marginal aeroplanes, all within the "minus 5" marginal band, generating perhaps 30,000 movements per annum at European airports. By 2006 they had all been replaced (and added to) by B737-800 series fully compliant aeroplanes.

6.3.6 Business Aviation

EBAA noted that their members' fleets already meet Chapter 4 standards, but were not individually able to give further information or opinions on their behalf. It should be recognised that there are about 700 business aircraft operators in Europe[14], not all of whom are necessarily EBAA members. On the other hand, a minority of business aircraft are currently jets (and most of those are too small to be covered by the Directive), although the European jet business fleet is expected to double to 2000 between 2005 and 2015 and to make up half the business fleet at the horizon. Already business aviation makes up 7% of all IFR movements in Europe and its growth accounts for up to 0.7 percentage points of total growth in such movements – probably less at our listed airports. Certainly business aviation is one of the fastest growing segments of the industry, and at least one airport interviewed cited business jets, alongside some marginal large freighters, as their noisiest visitors.

6.3.7 Express

6.3.7.1 Fleet Issues

EEA organised a conference call with one of our consultant team involving executives of three of its four full members plus the secretariat. They were able to

[14] Eurocontrol (Statistical and Forecast Service, STATFOR) 'Trends in air traffic, volume 1 - Getting to the point : Business aviation in Europe.

confirm that EEA full members currently have no "minus 5" aeroplanes operating in Europe, although their subcontractors may well have.

Three of these EEA airlines, (two in considerable detail) also responded to our data request and gave us information about historic fleet changes involving marginally compliant aircraft. We were also given indications of the number of movements generated by express freighters at European airports; and we are grateful for our respondents' frank co-operation. This was useful background to help us to understand operators' viewpoints, although we can not report on it more fully due to commercial confidentiality. In the event, we actually solved the marginal identification problem by database matching.

We learned, for example, that marginal B727-200 aircraft were returned to the parent (American) company for economic reasons, rather than because of environmental reasons or pressures. Other aeroplanes withdrawn from use were reported to have been returned to lessors or sold overseas – they might thus yet reappear at European airports.

We also gathered that the A300B family of aircraft maintains its popularity among express operators, due to its operational and economic suitability, although many such aeroplanes are cumulatively certificated between "minus 5" and "minus 10". Airbus investigated technical modifications to improve the noise performance of the A300B4, but the programme was abandoned as not economically feasible.

There were no examples reported by these EEA full members of the recertification of aircraft at lower weights in Europe since the introduction of the Directive. It is, however, regarded as a legitimate means of improving marginal compliance. Furthermore, if the potential maximum take-off mass is not operationally required for the aircraft's role, landing charges can also be reduced. It is a matter of balancing potential loss of fuel or payload against saved costs.

EEA also recognised Airbus and Boeing forecasts that much future freighter demand will be satisfied by converted (generally older) passenger aircraft, but pointed out that these are not necessarily less noise efficient and can include Chapter 4 aircraft (e.g. MD-11, B757).

6.3.7.2 Effectiveness of the Directive

EEA understands from the Commission that the only aircraft withdrawal requirement (as distinct from partial [night] restrictions) permitted by the Directive at non-City airports is the banning of marginally compliant aircraft.

The protection offered by the requirement for airports to apply the Balanced Approach, and to carry out assessments before imposing operating restrictions, is felt to be useful. However, the Directive is not seen by EEA as well implemented. Liège is cited as the only airport to have fully followed the Balanced Approach, although it is below the 50,000-movement threshold for applicability of the Directive.

The emphasis of the Directive, is felt to be disproportionately upon operating restrictions, with not enough attention being given to land use planning – repeating the point made at the CEFA briefing.

6.3.7.3 Revision of the Directive

(a) Article 6.1 sets a "time-line" for the implementation of withdrawal of marginally compliant aircraft. EEA believes there should be a similar "time-line" for the implementation of partial (night) restrictions. This is quite different from the periods of notice required by Article 11.

(b) Restrictions – including partial restrictions - on Chapter 4 aircraft should be specifically prohibited (cf. Article 6.2 for City airports), in EEA's view. For example, operating restrictions and penalties based on QC values or absolute noise levels could effectively prohibit or limit the operation of Chapter 4 compliant aircraft at night.

(c) EEA sees operational restrictions (such as the setting of monitored noise limits and preferential runways) as a potential "grey area" requiring clarification so as to avoid possible circumvention of the Article 4.4 requirement to base restrictions on certificated noise, and so as to prohibit effectively discriminatory restrictions, even if not so designed.

(d) So far as legally practicable, EEA think an amended Directive might appropriately be issued as a Regulation, in order to avoid possible inconsistencies of interpretation during transcription into individual Member State legislation.

6.4 Conclusions

We invited comment from operators' representative bodies, but also stressed our need for marginal aircraft identification assistance. In the event we were able to deal with the latter issue through database work., and it appeared that most industry bodies had made their points at our CEFA briefing meeting.

The aircraft operating industry understandably looks at Directive 2002/30/CE as "the Balanced Approach Directive", stressing the protection it offers them against the use of operating restrictions as a first resort, the timescale for their introduction when they are imposed, and the need for proper assessment of the costs and benefits of restrictions. This study takes a rather different perspective, assessing the effectiveness of the Directive as a legislative tool in the management of aircraft noise by airports. These are two sides of the same coin, but the difference in approach explains the difference in emphasis.

We did not note diametrically opposed views among various business models on the aircraft operating side. Some types of operator seemed to feel the marginal restriction aspects of the Directive almost irrelevant to them, however, as the economic pressures of their business have already driven them to virtual Chapter 4 fleet composition by "natural" replacement. We have the impression that other industry sectors would understandably prefer maximum protection from restrictions in the Directive, allowing the "natural" replacement they stress to run its course.

No industry representatives complained of network uncertainty arising from the ability of airports to impose local restrictions. Broadly the industry seems to think that while the Directive requires airports to follow a balanced approach in noise management, it does not give sufficient attention to the other aspects of that philosophy and how they should be implemented. We did receive some specific constructive suggestions from the Express industry on how they would like to see the Directive revised to overcome some difficulties of definition and interpretation, and to enhance and clarify the protection they feel the Directive should offer them. We have reported these suggestions neutrally as is appropriate in this Section; but we do agree that there does seem to be room for greater clarity in some areas. We have also seen or been advised of some inconsistencies in transcription to Member State legislation. These issues are dealt with more fully in Section 11 through 15.

7 Aircraft Movement Forecasts to 2010 and 2015 : Base Case

7.1 Introduction

7.1.1 Context

This section records our approach to, methodology for, and resulting quantification of the forecasts of aircraft movements at the 70 Community (and other relevant) airports whose traffic we have analysed[15].

7.1.2 Basis and Assumptions

These forecasts are limited to IFR aircraft movements.

They have been applied to the historic (April 2002 - March 2003) and current (calendar 2006) database kindly made available to us through the Commission by EUROONTROL. This lists numbers of IFR movements by aircraft type by hour for each of the 70 airports analysed.

The forecasts of aircraft movements are used (through grossing up of case study modelled results to airports grouped according to size and other relevant characteristics) to derive forecasts of exposure to aircraft noise for four scenarios as defined and discussed in Section 8.2

Such exposure estimates also require, in order to strip out extraneous influences on the population exposed, the working assumption that population density and distribution around airports will not significantly change before our planning horizon of 2015.

7.2 Limitations and Approach

7.2.1 Definition by Default

We may first define our approach to forecasting by excluding what we do not do.

Forecasts are not predictions. They are at best a view of what might reasonably be expected to happen in the future, based on current and historic knowledge, to provide a basis for assessing the effects of making decisions now which will themselves impact upon an uncertain future. The one thing of which we can be quite sure is that there will be other unexpected events and influences beyond our current control, affecting the economic, socio-political and technological drivers of the forecast baseline. Furthermore, the greater the depth of detail forecast,, the greater likelihood of changes in the event.

The essence of this study is not a movement-forecasting (or even a noise-forecasting) exercise. Its primary objective is consideration of the actual and potential effects of the Directive as it has been and might be applied by airports, and of how possible revisions of it (or even different approaches) might change those effects. It is thus the changes upon which we most usefully focus, rather than aiming at spurious and improvable accuracy in the absolute numbers of aircraft movements, and populations affected by noise. Nevertheless a baseline forecast of

[15] Those airports have been selected as composing a comprehensive list of those meeting (in 2006) or apparently soon likely to meet, the 50,000 three-year average annual jet movements threshold for applicability of Directive 2002/30/EC

aircraft movements is necessary in order to provide a benchmark against which to measure potential changes.

We do not therefore aim to produce individual airport forecasts as a basis for assessment of the effects of environmental restrictions, infrastructural investment, or other action at each of 70 specific airports. This is rather a "bottom-up" forecasting process, to construct a picture of future growth at the European level. The individual airport forecasts (with any single one of which local expertise could undoubtedly find fault) will be grouped into generic classes matching the size and other relevant characteristics of the sample case study airports, for grossing up of contour modelling results.

7.2.2 Authoritative Central Forecast Application

There is a wide range of forecasts of the future of air transport in Europe. They generally rely primarily upon economic drivers leading to traffic forecasts of various levels of detail and sophistication which, through estimates of average aircraft size and load factors, provide forecasts of aircraft movements. We have not sought to improve upon the facilities and resources available to international organisations, governments and stakeholders in trying to produce "better" forecasts than theirs. Our approach has been determined by our aim of presenting a baseline picture generally acceptable as "not unreasonable" overall, and therefore applies authoritative forecasts from the most appropriate sources, rather than generating and justifying new ones.

We have produced a single central forecast for each of 70 airports in 28 countries[16], since it is rather the effect of possible policy and legislative changes which is our focus, than the absolute baseline numbers. We thus implicitly accept that our results, in terms of the numbers of people within given noise contours resulting from the forecast aircraft movements, are of course subject to uncertainty, as were those foreseen by Anotec's corrected figures. Around their "probable" forecasts, their "differentiated" and "conservative" scenarios of future movements resulted in a range from plus 6% to minus 38% in the numbers of people within contours. Such wide variations ascribed to external influences are inappropriate to our task of considering policy influences on the "probable" (or central) base case. Since it is just such consideration of change on which we focus, our quantitative work is based on a single central forecast.

7.2.3 Population and the Balanced Approach

We must first re-emphasise that these forecasts are a methodological basis for assessing the effects of stringency scenarios in postulated conditions at the Community level. The results derived from their application are not valid as population noise exposure estimates or forecasts at individual airports.

Although we do discuss the ameliorative effects (and the limitations) of insulation and other measures (in Section 12), we should make it clear that we define exposure to noise as essentially the numbers of residents (excluding transients, workers and so on) within Lden contours, whether or not their homes, schools and so on are insulated. The use of operating restrictions as a final resort within the Balanced Approach is a central theme of the Directive, and it is their effects which we are modelling and discussing. We also consider the amelioration of the impact of that noise upon those people, and the effectiveness of other components of the Balanced

[16] The 27 current members of the European Union, i.e. Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal (Lisbon FIR and Santa Maria FIR), Romania, Slovakia, Slovenia, Spain (and Canaries), Sweden, and the U.K; and Switzerland.

Approach, but our focus remains the potential for various levels of stringency in defining marginal compliance with Chapter 3 to change the area of the contours.

It is also convenient to note here that population change forecasts (whether of natural growth, location or density) are not made, as such factors could have a quite extraneous effect on forecast numbers of people exposed to noise irrespective of noise management action. Thus a "neutral" land use planning regime is effectively subsumed in these assumptions, whereby no net additional numbers of people settle in the vicinity of airports and no net numbers of people move away, within the contour areas at any stage of the 2002-2015 period under review.

7.2.4 Volume Growth and Fleet Mix

We thus produced a fully quantified set of central "business as usual" base case forecasts of aircraft movements in 2010 and 2015 at each of our 70 listed airports, taking account only of volume growth, with no change in fleet mix. The objective is to provide a consistent basis for modelling the contour effects of different levels of marginal compliance stringency at our sample case study airports, and for the grossing up of these modelled results to identify changes in the total population exposed to aircraft noise. These forecasts for each airport – together with the actuals for 2002/3 and 2006 - are summarised overleaf.

Table 7.1 Total IFR Movements Actuals and Forecasts at 70 Airports ('000)

	Airport	2002/03 Database	2006 Database	2010 Forecast	2015 Forecast
Paris CDG	CDG	514.7	541.2	580.7	638.8
Frankfurt/Main	FRA	470.4	488.9	515.2	612.8
London Heathrow	LHR	462.5	477.3	480.0	480.0
Madrid Barajas	MAD	374.7	435.0	534.7	691.6
Amsterdam	AMS	410.1	435.0	485.5	557.2
Muenchen	MUC	344.7	407.5	450.1	518.8
Barcelona	BCN	277.2	327.8	391.2	466.8
Rome Fiumicino	FCO	288.4	315.6	346.5	402.8
London Gatwick	LGW	243.6	263.8	272.0	272.0
Copenhagen	CPH	258.8	258.2	277.4	313.3
Vienna	VIE	204.4	257.4	281.3	325.2
Milan Malpensa	MXP	216.9	251.5	299.9	373.7
Zurich	ZRH	270.6	248.2	279.3	323.8
Brussels	BRU	247.2	247.3	242.7	273.5
Paris Orly	ORY	211.7	233.7	250.8	275.9
Stockholm Arlanda	ARN	239.9	226.7	241.6	261.5
Manchester	MAN	190.0	225.2	281.9	373.1
Duesseldorf	DUS	189.4	214.3	236.6	272.8
Stansted	STN	174.9	205.1	237.3	284.6
Dublin	DUB	170.7	191.2	201.0	233.1
Palma De Mallorca	PMI	163.0	189.9	226.7	270.4
Athens	ATH	156.9	184.9	218.9	268.0
Helsinki Vantaa	HEL	153.0	178.3	197.8	231.2
Prague	PRG	100.4	160.2	208.1	275.9
Geneva	GVA	144.5	158.5	174.8	202.6
Hamburg	HAM	137.2	157.5	173.9	200.5
Koeln-Bonn	CGN	136.1	150.5	166.2	191.6
Stuttgart	STR	130.4	150.2	165.9	191.2
Warsaw	WAW	106.4	144.6	167.0	192.1
Berlin Tegel	TXL	128.0	137.5	151.9	0.0
Nice	NCE	145.4	136.5	146.4	161.1
Lisbon	LIS	114.6	136.4	145.7	173.7
Milan Linate	LIN	110.1	130.0	155.0	193.1
Lyon Satolas	LYS	118.6	128.7	138.1	151.9
Edinburgh	EDI	112.4	124.8	140.1	156.3
Budapest	BUD	75.8	124.8	154.7	201.0
Malaga	AGP	96.7	124.0	148.0	176.6
Birmingham	BHX	121.2	115.8	162.0	189.0
Las Palmas	LPA	94.2	113.1	132.2	159.6
Luton	LTN	76.5	110.3	123.9	138.1
Glasgow	GLA	96.8	104.6	117.3	135.3
Marseille	MRS	92.4	95.5	102.5	112.8
Toulouse	TLS	89.5	90.0	113.0	120.9
Venice Marco Polo	VCE	69.7	82.0	90.0	104.6
Hannover	HAJ	76.6	80.2	88.6	102.1
London City	LCY	55.3	79.4	94.9	118.6
Valencia	VLC	49.8	76.8	91.7	109.4
Alicante	ALC	55.5	75.0	89.5	106.8
Bristol	BRS	53.6	71.5	80.3	89.5
Aberdeen	ABZ	51.9	67.9	68.0	68.2
Nuernberg	NUE	62.1	67.0	77.2	88.0
Gothenborg	GOT	66.7	66.2	71.0	75.2
Basel/Mulhouse	BSL	88.8	64.7	69.4	76.4
Tenerife Sur	TFS	60.7	63.2	74.0	89.3
Bologna	BLQ	61.5	62.9	80.8	92.1
East Midlands	EMA	60.3	62.6	78.0	102.6
Newcastle	NCL	46.9	62.6	70.3	78.4
Naples	NAP	71.6	61.8	67.8	78.8
Luxembourg	LUX	55.1	60.6	62.6	70.6
Berlin Schoenefeld	SXF	25.1	57.9	63.9	288.2
Bucharest	OTP	34.6	56.9	95.2	121.6
Bergamo	BGY	34.8	55.8	61.3	71.3
Catania	CTA	49.1	54.7	60.1	69.8
Bilbao	BIO	38.0	52.5	62.7	74.7
Larnaca	LCA	46.4	46.7	54.7	67.4
Heraklion	HER	40.5	45.7	48.0	50.0
Stockholm Bromma	BMA	38.2	42.7	42.5	49.3
Belfast City	BHD	37.0	37.6	41.2	43.5
Leipzig-Halle	LEJ	32.8	36.2	53.0	61.1
Berlin Tempelhof	THF	36.3	31.0	34.2	0.0
	Total	9859.5	11019.5	12387.0	14391.9
	Other A/p		4701.5	5430.0	6374.3
	EC TOTAL		15721.0	17817.0	20766.2

The modelling and grossing up process is reported upon in Section 8. We then move, in Section 10, to largely qualitative assessments of likely “natural” changes in fleet mix.

The advantages and disadvantages of selecting this approach are evaluated in Appendix. F

In addition, Appendix F describes in some detail the data sources and forecasting methodology which have been employed to produce the movement forecasts shown in Table 7.1 above.

8 Noise Contour Modelling at Case Study Airports

8.1 Case Study Selection

Our preferred approach to selecting the case study airports was given in the study's interim report in April 2007, as follows:

'…the airports will be divided into five categories, each of which will have similar noise characteristics, and we will use a case study in each category to investigate the noise contour area/ATM relationship for that category. There are numerous characteristics that determine the size of an airport's Lden and Lnight noise contours, including; total ATMs, fleet mix (noisiness of aircraft), day/evening/night split, operating procedures, runway configuration/usage etc. These characteristics are being determined from two main sources; the EUROCONTROL data analysis, and airport interviews which are half complete at this stage.

In theory it may be possible to analyse the various characteristics of the airports to produce the five 'best fit' categories. However, we anticipate the derivation of the five categories will be rather more obvious than would result from such an analysis…We shall also try to ensure a reasonable spread of airports in different parts of Europe, but it will be appreciated that much will depend upon finding airports ready to co-operate. The final choice of 5 will inevitably involve an element of compromise.'

From late April to the middle of June we approached airports to seek their assistance in providing information for the case studies. We started with the airports that had responded favourably to question 7.1 of the airport questionnaire that asked if they would be prepared to assists with a case study. As we discussed our data requirements with airports who were interested in helping many explained they would not have time to collate this information and to assist us with our enquiries. As our search went on, it became clear that our expectation that the final choice would be a compromise would prove correct. We gave priority to two key factors; airport size and geographical location. We also endeavoured to select airports with different likely degrees of community noise concern, using the population within Lden 55dB from the ANOTEC study as an indicator. We also aimed to cover a range of airport fleet noisiness by reviewing the fleet mix of airports that appeared willing to help after initial enquiries. We concluded that it was important to study an Accession States airport if possible, because the Directive has a more recent application to them. In this way, we arrived at the following five airports for our case studies.

Table 8-1 Case Study Selection Summary

Case Study Airport	Size	Geographical Location	Expected Degree of community noise concern
Amsterdam	Large	Northern	Large
Lisbon	Medium	Southern	Large
Glasgow	Medium/Small	Northern	Medium
Toulouse	Medium/Small	Southern	Small
Warsaw	Medium	Accession State	Not known

Appendix G gives a simplistic ranking of the noisiness of the fleets operating at all the airports. This ranking is based on the predominance of a selection of the noisiest aircraft types (mainly Band 1; B722, B732, B742, DC9, IL62, T154, YK40, YK42) as derived from the EUROCONTROL operations database for 2006. The resultant ranking can only be indicative of an airport fleet's relative noisiness because this database only gives aircraft type using the ICAO type designator which is insufficient to truly indicate an aircraft's noisiness. However, by analysing aircraft that are highly likely to be noisy based on their ICAO type, this analysis gives a ranking that bears some resemblance to the noisiness of aircraft fleet operating at the various airports. It can be seen that the 5 case study airports are spread across the range of airport fleet noisiness from Warsaw (ranked 3rd), Amsterdam (ranked 8th), Lisbon (ranked 41st), Glasgow (ranked 51st) to Toulouse (ranked 57th).

It was particularly difficult to find one of the large airports (greater than about 200,000 ATMs/yr) who was prepared to share aircraft fleet noise data with us, and in the end a different approach was needed for the large airports, as discussed under the Amsterdam Airport case study section below.

8.2 Modelling methodology

The key aim of the case studies was to model noise contours in sufficient detail to be able to estimate the effect of phasing out marginal aircraft in the 3 noise bands. This necessitated very careful consideration of each airport's aircraft fleet.

The core air traffic data for 2002 and 2006 came from the EUROCONTROL database discussed earlier in Chapter 3, and the future growth forecasts of this traffic discussed in Chapter 7. However, as explained in Section 3.3, although the EUROCONTROL data uses 343 ICAO aircraft codes to identify aircraft types this is not sufficient to determine the noise band of a given ATM. Nor is it always adequate to determine which aircraft to select from the INM database for modelling. Hence, the marshalling of the EUROCONTROL data into a set of ATM data set up in appropriate aircraft types for modelling was a key challenge for the case studies.

Our approach to this challenge was to use detailed ATM data from each airport to study the actual aircraft flying at that airport. In most cases the key data that the airports were able to supply was Air Traffic Control tower logs of individual aircraft flying in the years 2002 and 2006. These logs gave the aircraft registration number of each aircraft using the airport for a sample period (ranging from a typical week to a whole year). In most cases these registration numbers were cross-referenced to the DGAC and EASA databases of certificated noise levels, via the JP Fleets database, to identify the exact noise band of important (including potentially marginal) aircraft types at the relevant airport (as discussed in Section 4). This enabled the movements of certain ICAO types in the EUROCONTROL data to be divided into suitable sub-types for modelling in INM, each accurately reflecting the different noise bands. As a result the INM models were set up with 124 aircraft types.

Cooperation from the airports proved essential to obtaining the necessary fleet details and we are extremely grateful for the people at the five airports that gave up their time to meet us and collate this data. Each airport was visited by the modelling team, and some of the findings from those meetings are mentioned in the following 5 sections that discuss the results of the case study modelling and where necessary some of the finer details of the approach in each case.

For the years 2010 and 2015 three possible marginal aircraft phase out scenarios have been modelled in addition to the Base Case for these two year, as follows:

- Base Case - No change to the Directive and the way it is interpreted and applied by airports, and no change to the fleet mix;
- Scenario 1 - Band 1 aircraft phased out - effective phase-out of marginally compliant Chapter 3 aircraft at Community airports, marginal being defined as in the Directive as Chapter 3 minus a certificated cumulative 5 dB(A);
- Scenario 2 - Band 1 and 2 aircraft phased out - effective phase-out of potentially marginal compliant Chapter 3 aircraft at Community airports, marginal being defined as in the Directive as Chapter 3 minus a certificated cumulative 8 dB(A);
- Scenario 3 - Band 1, 2 and 3 aircraft phased out - effective phase-out of aircraft not meeting Chapter 3 minus a certificated cumulative 10 dB(A), thus permitting only Chapter 4 operations.

In these scenarios each marginal aircraft types was substituted by an appropriate Chapter 4 aircraft so that the number of aircraft remains unaltered from the Base Case in that year.

The final stage of the case study for each airport was to estimate populations within the Lden 55dB and Lnight 45dB contours. Unless stated below, this was done by extrapolation from population data supplied by the airport in previous noise contours studies. No allowance was made for possible changes in population distributions in the future.

8.3 Glasgow Airport

In March 2007 the Environmental Research and Consultancy Department (ERCD) of the UK CAA produced Lden and Lnight noise contours for BAA to meet the requirements of Directive EC 2002/49. Following contact with Brendan Creavin, BAA's Environment Policy Manager, BAA asked the ERCD to assist us in sourcing the data we required. We met with ERCD and runway logs and ERCD's noise contour details were provided.

Table 8.2 gives the numbers of marginal aircraft estimated in 2006. Within each of these ICAO code aircraft types various sub-types may not be marginal and those are not counted in this table.

Table 8-2 Marginal Jet Aircraft Movements at Glasgow Airport, 2006

Aircraft Type	Noise Band	ATMs/yr (approx)
Airbus A310	3	76
Airbus A321	3	95
Boeing B727-200	1	2
Boeing B737-200	1	13
Boeing B737-400	3	2426
Boeing B747-200/300	1	72
DC10	1	17
DC9	1	4
Hawker Siddeley HS125	1	6
Tupolev T154	1	74
Vickers VC10	1	5
Yakolev Yak-42	1	2
Total Marginal ATMs		2792
% All ATMs		2.7%

Analysis of airport control tower logs for a typical week in July.

Whilst a great deal of effort was put into this analysis, as noted in Section 3 and 4, establishing marginality is imprecise, so this table can only provide a best estimate. It is, however, clear that there are very few Band 1 aircraft and B737-400s are the key aircraft in Band 3. At Glasgow no Band 2 aircraft were identified, so Scenario 2 is the same as Scenario 1.

We also analysed the marginal aircraft in the Glasgow fleet in 2002. The data indicated that there may have been approximately twice as many marginal aircraft at that time, but there is less certainty in this statistic because the aircraft characteristic databases used are for aircraft as registered in 2006.

Table 8.3 gives the estimated areas and populations within the Lden 55dB and Lnight 45dB contour. It is not considered helpful to add in data for higher contour levels, because it can be taken that within these two contours the entire population is exposed to noise level that could have some effect, depending on local conditions and circumstances.

Table 8-3 Glasgow Airport Noise Contours

	Lden 55dB Contour Area (km^2)	Lnight 45dB Contour Area(km^2)	Lden 55dB Contour Population	Lnight 45dB Contour Population
2002	31.0	39.8	56,000	70,000
2006	31.6	42.7	57,000	75,000
2010 Base	35.0	46.8	63,000	83,000
2010 Scenario 1	34.0	46.6	61,000	83,000
2010 Scenario 2	As scenario 1		As scenario 1	
2010 Scenario 3	33.6	46.2	61,000	82,000
2015 Base	39.3	52.8	71,000	95,000
2015 Scenario 1	38.3	52.5	70,000	94,000
2015 Scenario 2	As scenario 1		As scenario 1	
2015 Scenario 3	37.9	52.1	69,000	93,000

The population estimates for Glasgow are based on those provided by the ERCD in their work preparing their own Lden and Lnight noise contours for BAA in March 2007. They are based on census data from the year 2001 and have been extrapolated to our noise contours.

The following main trends can be seen in these modelling results:

- The noise contours grow as ATMs increase with time;
- From 2002 to 2006 the growth rate is lower, particularly for the Lden contours, because increasing numbers of ATMs is partly offset by the movement to quieter types;
- Scenarios 1 and 3 deliver only small noise benefits that at best offset approximately 2 years of traffic growth.

8.4 Lisbon Airport

A very cooperative meeting was held with Lisbon Airport Environment staff on 20 June 2007. Lisbon, like all the case study airports, has a Noise and Track Keeping system which monitors the complexity of flight paths over and around the city. Lisbon has produced Lden and Lnight noise contours. It was noted that the local definitions of day and evening are one hour different to the default periods in EC2002/49, being 0700-2000 and 2000-2300 hours respectively, although it is expected this would make little difference to Lden noise contours.

Lisbon airport is quite close to the city and, as a consequence, aircraft noise affects a mixed group of the population. Many of those working within areas affected by noise leave these areas after work, perhaps making night noise less of a concern than might be suggested by general population statistics. Indeed, Lisbon receives only a few noise complaints each year. Given the warm climate people prefer to have windows open, and perhaps have a different cultural attitude towards noise to those in northern Europe. There is no noise insulation scheme at the airport, although there is a statutory limit on night movements (26/night) most of which is freighter traffic.

Lisbon Airport staff explained to us that they felt Lisbon had a quiet fleet mainly because Air Portugal has a modern Airbus fleet. Table 8.4 gives the results of our analysis of Lisbon's 2006 marginal aircraft.

Table 8-4 Marginal Jet Aircraft Movements at Lisbon Airport, 2006

Aircraft Type	Noise Band	ATMs/yr (approx)
Airbus A30B	2 3	162 204
Airbus A306	3	4
Airbus A310	3	34
Airbus A321	2 3	44 4642
Boeing B737-200	1	16
Boeing B737-300	3	394
Boeing B737-400	2 3	88 144
Boeing B737-500	3	64
Boeing B747-200	1	8
Boeing B767-200	2 3	169 18
Boeing B767-300	3	4
Cessna C650	3	14
Falcon FA20	3	16
Falcon FA50	2	321
Hawker Siddeley HS125	2	30
McDonald Douglas MD82	3	12
Tupolev T154	1	10
Tupolev T204	3	50
Yakolev Yak-42	1	58
Total Marginal ATMs		6500
% All ATMs		8.8%

Analysis of airport tower logs of whole year.

Airbus 321s account for 72% of marginal flight, and the majority of these are by just a few A321s certificated as high MTOWs.

Analysis of Lisbon's fleet in 2002 suggested the proportion of marginal aircraft has increased substantially since between 2002 and 2006, but there is less certainty in the 2002 analysis, as noted above.

Table 8.5 gives the estimated areas and populations within the Lden 55dB and Lnight 45dB contours. Populations were estimated from geo-referenced 2001 census data provided by the Institoto Nacional de Estatistica.

Table 8-5 Lisbon Airport Noise Contours

	Lden 55dB Contour Area (km^2)	Lnight 45dB Contour Area(km^2)	Lden 55dB Contour Population	Lnight 45dB Contour Population
2002	33.0	40.8	118,000	149,000
2006	36.0	44.2	132,000	159,000
2010 Base	38.2	46.6	140,000	166,000
2010 Scenario 1	36.9	44.5	135,000	160,000
2010 Scenario 2	36.6	44.5	135,000	160,000
2010 Scenario 3	36.0	43.7	132,000	156,000
2015 Base	44.3	53.8	159,000	195,000
2015 Scenario 1	42.8	51.4	154,000	183,000
2015 Scenario 2	42.7	51.4	154,000	183,000
2015 Scenario 3	41.9	50.7	152,000	177,000

The following main trends can be seen in these modelling results:

- The noise contours grow as ATMs increase with time;
- Scenarios 1, 2 and 3 deliver only small noise benefits that at best offset approximately 3 to 4 years of traffic growth.

8.5 Toulouse Airport

A very cooperative meeting was held on 14th June with Toulouse Airport Environment staff and DAC-sud staff who conduct the airport's noise modelling and analysis.

In March 2007, DAC-sud prepared noise contour forecasts for 2010, 2020 and 2030. Model input data was made available.

Airbus uses the airport for 'constructors' flight, around 6,000 in 2006, but these are not registered to EUROCONTROL as they are local circuit routes.

Landing charges at Toulouse are related to six noise groups that directly relate to cumulative Chapter 3 margin. Flight logs are sent to DAC-sud, who consult their database and return the logs with the Chapter 3 margin added to assist in the charging process. The DAC database is not publicly available, and although this was not commented upon, we noted that our work on such databases was challenging and could not necessarily always give a single definitive marginality level.

DAC-sud subsequently provided us their flight log analysis for 2 weeks in February 2006 which revealed the marginal aircraft listed in Table 8.6.

Table 8-6 Marginal Jet Aircraft Movements at Toulouse Airport, 2006

Aircraft Type	Noise Band	ATMs/yr (approx)
Airbus A300	1 2 3	78 416 182
Airbus A310	3	52
Airbus A321	2 3	104 390
Boeing 727-200	1	130
Boeing 737-200	1	338
Boeing 737-300	2 3	130 1066
Boeing 737-400	2 3	468 728
Boeing 737-500	3	130
Boeing 747-200	2	234
Boeing 757-200	3	26
Boeing 767-200	3	52
BAE 125-700	2	52
DC10	1 2	78 26
Falcon 20	3	78
Falcon 50	3	234
Lockheed L1011 TriStar	2 3	26 156
Raytheon HS125	2	182
Total Marginal ATMs		5356
% All ATMs		12%

The estimated 1066 Boeing 737-300s in Band 3 are generally within 1dB of being non-marginal. Analysis of Toulouse's fleet in 2003 suggested this proportion of marginal aircraft may have increased in recent years, but there is less certainty in this analysis, as noted above.

Table 8.7 gives the estimated areas and populations within the Lden 55dB and Lnight 45dB contour.

Table 8-7 Toulouse Airport Noise Contours

	Lden 55dB Contour Area (km^2)	Lnight 45dB Contour Area(km^2)	Lden 55dB Contour Population	Lnight 45dB Contour Population
2002	26.5	25.2	35,200	43,400
2006	24.7	23.5	32,800	40,500
2010 Base	28.5	26.7	37,900	46,000
2010 Scenario 1	27.3	26.2	36,300	45,100
2010 Scenario 2	27.2	26.1	36,100	44,900
2010 Scenario 3	26.9	25.9	35,700	44,600
2015 Base	29.6	27.8	39,300	47,900
2015 Scenario 1	28.3	27.3	37,600	47,000
2015 Scenario 2	28.2	27.2	37,500	46,800
2015 Scenario 3	28	27	37,200	46,500

In the noise model Airbus construction traffic was taken to be constant from 2006. This may have the effect of providing a constant extent of noise over time which would have a tendency to lessen future growth trends and the effects of the marginal aircraft phase out scenarios.

8.6 Warsaw Airport

A friendly meeting was held on 18th May 2007 with Warsaw Airport's Environment Manager, Witold Piechota. Warsaw airport has been growing rapidly in recent years and there is a feeling that the lack of a national strategy for air traffic has lead to a lack of policy on the airport's expansion including an absence of any clear land use planning in the areas affected by noise.

The airport environment management is well integrated into European practices and runs an advanced noise and track keeping system that produces noise contours. Noise modelling data files were provided to us in mid-June, but no compatible runway log data was available This had made a precise analysis of marginal aircraft at Warsaw impossible.

Since Poland has only recently joined the EU, and given this uncertainty in the detail of its aircraft fleet, we have not carried out INM modelling for 2002 for Warsaw.

Table 8.8 gives the estimated areas and populations within the Lden 55dB and Lnight 45dB contours.

Table 8-8 Warsaw Airport Noise Contours

	Lden 55dB Contour Area (km^2)	Lnight 45dB Contour Area(km^2)	Lden 55dB Contour Population	Lnight 45dB Contour Population
2006	38.5	44.7	34,400	41,000
2010 Base	42.8	49.9	38,200	45,800
2010 Scenario 1	41.3	49.1	36,800	45,000
2010 Scenario 2	41.2	49	36,800	45,000
2010 Scenario 3	41	48.9	36,600	44,900
2015 Base	47.5	55.3	42,400	50,700
2015 Scenario 1	46	54.6	41,000	50,100
2015 Scenario 2	45.9	54.5	41,000	50,000
2015 Scenario 3	45.7	54.3	40,800	49,800

The noise contours grow as ATMs increase with time. Scenarios 1, 2 and 3 offer small noise benefits, at best off-setting about 2 years of ATM growth. Whilst there is some uncertainty in marginal aircraft identification for the other case study airports, for Warsaw this uncertainty is greater because of the lack of any detailed fleet data. This uncertainty means the effects found from the modelling of Scenarios 1, 2 and 3 can only be taken as indicative.

8.7 Amsterdam Airport

A meeting was held with Environmental Capacity Department staff of Schiphol Group on 19th June 2007. Schiphol Group explained how noise, air quality and safety are the main capacity constraints, and the airport works hard in these areas to create a 'licence to grow'. Noise capacity at Schiphol is capped in two ways:

1. Total Noise Volume. This is a theoretical total amount of noise energy produced by all aircraft. It has no geographical reference, but it simply a measure of total noise output.
2. Noise limits at enforcement points; 35 for Lden and 25 for Lnight. Some in populated areas, some in green areas, at different noise levels.

The airport has to manage its annual ATMs using its flight schedules and runway preference so as to keep within these limits each year, else face a €1 million fine. One year a limit was exceeded due to unusual weather, and the CAA made a new rule that 10% of the noise dose has to be kept in reserve up to 2 weeks before the year end.

Schiphol has its own (legally approved) noise model to forecast and demonstrate compliance with these limits, but this does not produce conventional noise contours.

Noise management at Schiphol has been driven by strong objection to noise in the local community over many years, although the size of the population affected by the airport is not one of the highest across Europe. As a result, the system used to enforce noise standards at Schiphol is unique and the most complicated in the world. Schiphol Group is seeking to change this, to free up capacity, and has prepared assessments that the government is considering. Hence, the future noise climate at Schiphol is largely dependent on national aviation policy. If this policy were to resist change to the current noise constraint, then in the future we would expect noise to remain fairly constant (as quantified in the noise limits). If, on the other hand government policy endorses the proposals to grow to 600,000 ATMs/yr, it seems likely noise levels will increase.

The airport was helpful in supplying key reports and noise assessment information, but runway logs giving details of aircraft type and operating parameters were not available. Experience from the other case studies had shown that an assessment of the effect of marginal aircraft types on noise contours would be impossible without details of aircraft type well beyond ICAO type. It has therefore not been possible to do any suitably detailed noise modelling for Schiphol.

Instead, in order to investigate the typical trends in noise contours for the large European airports, we have reviewed available published noise contour data for the large airports; Paris CDG, Frankfurt, London Heathrow, Madrid Barajas, Amsterdam, Muenchen, Barcelona, Rome Fiumicino, London Gatwick, Copenhagen, Vienna, Milan Malpensa and Zurich, as discussed below.

8.8 Noise Contour Trends at Large Airports

Most of the large airports publish noise contours. However, establishing Lden and Lnight contours trends since 2002 is not straightforward for numerous reasons. Firstly, over the years airports have developed their own preferred noise metrics. Harmonisation to Lden and Lnight has only begun since Directive 2002/49 which in most Member States was not enacted for some years, and it has its first reporting requirement in December 2007. As a consequence no airports have produced Lden and Lnight contours from 2002-2006, so far as we could establish.

Not all airports produce contours annually, and if they do, they can be based on differing modelling techniques or assumptions (e.g. runway usage/split). Examples of year on year comparable noise contours were found at London Heathrow and London Gatwick airports for which the UK CAA produce annual LAeq, 16 hr noise contours. Table 8.9 summarises the populations within these contours from 2002 to 2006.

Table 8-9 Large Airport Noise Contour Population Trends (Thousands of residents within LAeq 16 hr 57dB r)

Airport	2002	2003	2004	2005	2006	ATM Growth 2002-2006
Heathrow	257.8	269.2	240.1	254.4	259.0	3%
Gatwick	3.6	4.3	4.6	4.8	4.5	8%

Table 8.9 indicates the variance in year on year population estimates based on highly detailed noise modelling. For these two airports the changes in population affected by daytime noise between 2002 and 2006 have been small. This is largely explained by the fact that ATM growth over the same period was also small at 1-2% /yr. This is common to the majority of the large airports.

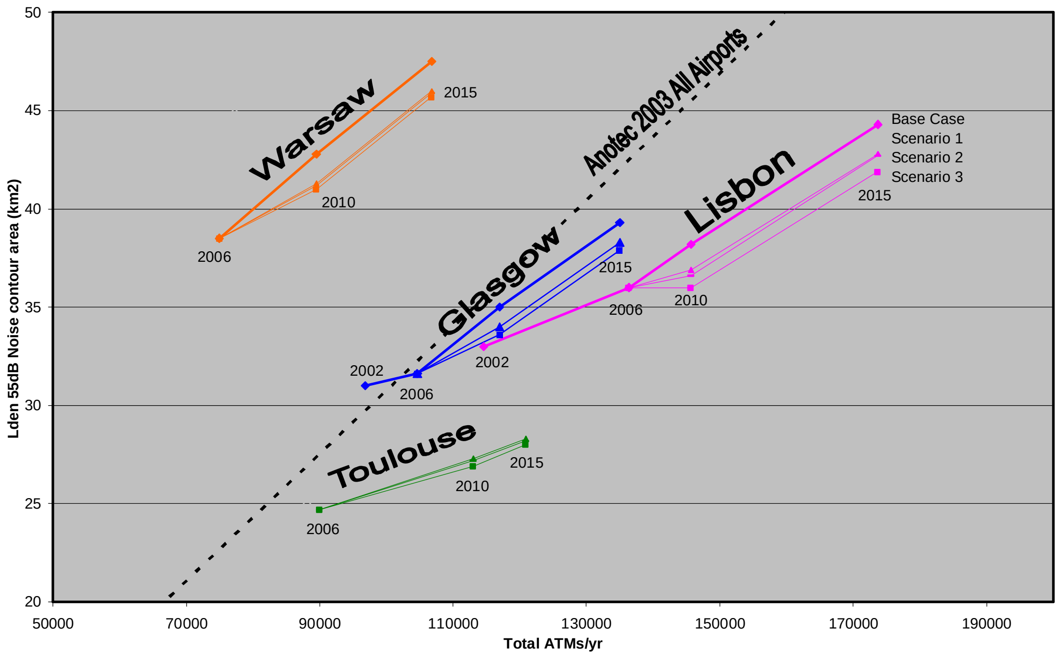
9 Estimation of Population Noise Exposure Across All Airports

9.1 Methodology

The Anotec study in 2003, as summarised in Section 3.1, provided estimated Lden and Lnight noise contours and estimates of exposed populations for 2002 2006 and 2015. This study takes the estimates for 2002 and provides new estimates of population exposure for 2006 and new forecast of population exposure for 2010 and 2015 based on the new ATM predictions discussed in Chapter 7. The Anotec analysis for 2002 is the starting point, after which we have used the following methodology.

Our Case Studies have been used to model the noise changes in details, including the effect of the 3 marginal aircraft scenarios, as described in the previous chapter. From these we have extracted relationships between noise contours areas and aircraft movement (ACM) numbers for the different time periods and aircraft fleet scenarios of interest. The trends for Lden 55dB contours can be seen in Figure 9.1.

Figure 9.1 Lden 55dB Noise Contour Areas v ACMs; 2002, 2006, 2010, 2015



In this Figure, the thick line gives the Base Case (i.e. no fleet change) and Scenarios 1, 2 and 3 are plotted below the Base Case for 2010 and 2015. This illustrates the progressive reduction in contour area predicted under these phase out scenarios. For Glasgow there is no Scenarios 2 because no band 2 aircraft were modelled.

It can be seen that the base case contour area/ACM relationship is similar for the case study airports. The exception is Toulouse which shows a slower growth in contour area probably due to the Airbus construction traffic that is assumed to remain constant as the rest of the fleet grows.

Anotec kindly supplied us with data files of all their noise contours for 2002 from which we analysed the critical contour areas. This data is also represented in Figure 9.1 by the dashed trend line giving the contour area/ACM relationship for all 51 airports modelled by Anotec. This trend line is very similar to the contour area/ACM relationship for the case studies. This constant relationship has been used to interpolate base case contour areas for all 51 airports from 2006 to 2010 and 2015 by applying the ACM forecasts for those years given in Chapter 7. The base case contour area/ACM relationship between 2002 and 2006 is a little flatter, reflecting a slight trend to quieter aircraft fleets following the Chapter 2 ban in 2002.

Similarly, the effect on contour area of applying marginal aircraft phase out scenarios 1,2 and 3, by either 2010 or 2015, is similar for the case study airports (except Toulouse) and has been applied to the cases for all 51 Airports.

An equivalent process was used to develop Lnight 45dB contour areas for all 51 airports.

Estimates of populations within Lden 55dB and Lnight 45dB contours in 2002 are given in the Anotec study. These were necessarily based on geographically coarse population data but nonetheless provide an indication of populations for each airport in 2002. From this, we have estimated the population densities in the region of the outer contours and used these to estimate populations within our forecast contour areas. Population estimation is difficult task for any airport depending on the data available. For the Case Studies we made use of more detailed population data, but in order to remain consistent across airports for estimating populations at all airports here we have in all cases used the Anotec 2002 estimates as our base.

9.2 Results for 51 Airports

The objective of our methodology is to develop a tool for measuring changes at the European level in exposure to noise and how that could change under the policy options studied. It is a standard approach and cannot be expected to give an accurate estimate for any individual airport. Table 9.1 summarises changes in the total populations across all the airports in the different years/Scenario combinations.

Table 9-1 Estimates of Total Population Exposure for All Airports

	Total Population within Lden 55dB (millions)	Total Population within Lnight 45dB (millions)	Comment
2002	2.2	2.7	
2006	2.2	3.0	From 2002 to 2006 Lden 55dB population increases by less than 0.1million
2010 Base	2.4	3.2	From 2006 to 2010 Lden 55dB population increases by 10%
2010 Scenario 1	2.3	3.1	Lden 4% reduction over the base case Lnight 2 % reduction over base case
2010 Scenario 2	2.3	3.1	Lden 5% reduction over the base case Lnight 3 % reduction over base case
2010 Scenario 3	2.3	3.1	Lden 6% reduction over the base case Lnight 4 % reduction over base case
2015 Base	2.7	3.2	From 2010 to 2015 Lden 55dB population increases by 9%
2015 Scenario 1	2.6	3.2	Lden 4% reduction over the base case Lnight 2 % reduction over base case
2015 Scenario 2	2.6	3.2	Lden 4% reduction over the base case Lnight 2 % reduction over base case
2015 Scenario 3	2.5	3.1	Lden 5% reduction over the base case Lnight 3 % reduction over base case

The following broad conclusions can be drawn from these results.

- Base Case contours grew very little from 2002 to 2006;
- Base Case (i.e. constant fleet) contours are expected to grow from 2006 to 2010 with total population exposure increasing by 8-10% over this period.
- Base Case (i.e. constant fleet) contours are expected to grow from 2010 to 2015 with total population exposure increasing with the population within Lden 55dB expected to increase by about 9%, and the population within Lnight 45dB increasing by about 2% (a lower increase due to night restrictions).

- Populations within Lnight 45dB contours are bigger than Lden 55dB, by 25-30%, but given the uncertainty in interpreting Lnight contours, little can be drawn from this.

- Scenario 1 gives small benefits – a reduction in population of about 4% for Lden 55dB and 2% of Lnight 45dB.

- Scenario 2 gives similar benefits to Scenario 1 - a reduction in population of about 4-5% for Lden 55dB and 2-3% of Lnight 45dB.

- Scenario 3 gives similar benefits to Scenario 2 - a reduction in population of about 4-5% for Lden 55dB and 3-4% of Lnight 45dB.

As some of these changes are likely to happen through the natural retirement and replacement of the fleets as discussed in Chapter 10, these should be taken as the maximum benefit from each policy option.

The Base Case 2015 results are in line with Anotec's results, falling between the population estimates for their 'Conservative' and 'Probable' traffic forecasts.

The purpose of this study is focused on the effect of marginal aircraft, rather than obtaining accurate populations exposure estimates. During our airport interviews in Spring 2007 most airports indicated that they had Lden and Lnight contours and population estimates either complete, in progress or planned for later in the year. This was entirely as expected given the requirement of EC Directive 2002/49 to have these contours reported to the European Commission by December 2007. Hence, even as this report is being finalised, further airport noise modelling results are already available. These studies are likely to be based on detailed input data and to provide more accurate population estimates than have been possible for all the airports covered in this study. Hence, whilst this study provides a clear indication of the effects of removing -5, -8 and -10 dB marginal aircraft, analysis of populations exposure to noise across the whole of Europe or at any particular airport will be better informed by the forthcoming results of noise mapping under EC/2002/49.

This study applies a common methodology for ACM forecasting and populations estimation at all airports, which may be more realistic for some airports than others. There may be anomalies that should not be taken as individual airport noise exposure forecasts.

9.3 Other Airports

There are 12 airports that were not covered in the Anotec 2003 study but have been addressed elsewhere in this report; 3 Accession State airports (Warsaw, Budapest and Prague) and 9 others which have, or are soon to grow to have, greater than 50,000 jet ATMs/yr (Bilbao, Basel, Catania, Larnaca, Linate, Newcastle, Nueremburg, Schoenefeld and Valencia).

The results of our Warsaw case study are discussed in Section 8.6 and its noise contours trends are illustrated in Figure 9.1. The results predict population exposure to Lden 55dB to increase by about 23% from 2006 to 2015 due to high forecast growth in ACMs. Budapest and Prague may grow even more rapidly that Warsaw with corresponding rapid increase in population noise exposure. The Warsaw case study population estimates make no allowance for population increase around the airport which could be particularly significant at accession state airports if land use planning restrictions are not in place.

We have not attempted noise predictions or population estimates for the 9 airports that have grown or will soon grow to above 50,000 ATMs/yr. These are required from each relevant airport by December 2007 under EC Directive 2002/49. These are the 9 smallest airports in this study, so their noise contours are likely to be some of the smallest too. Hence population exposure to noise should generally be small too in comparison to the major airports for which this data has been analysed above.

10 Potential Natural Changes in Fleet Mix

10.1 Definition

In this section we consider what might happen to the mix of aircraft using Community airports in practice, without any stringency pressures. As explained in Section 7, we did not prepare forecasts of such changes for modelling a base case as this would have given an inconsistent and inappropriate basis against which to test possible changes in stringency, the prime object of the exercise.

Nonetheless, we have to evaluate, at least qualitatively, whether natural fleet mix changes are likely to complement or to run counter to the objectives of the Directive. It is therefore important to note that this is not a consideration of "substitution" of banned aircraft by alternative types when such bans are predicated in our scenarios for future definitions of marginality, and the implementation of associated stringency. Such substitutions, since we consider a potential "minus 10" marginality (virtually a Chapter 3 non-operation rule), are assumed to be by Chapter 4 compliant aircraft. If they are new, they are likely to be so compliant, as all aircraft with new type certificates after 01 January 2006 must (as decided by the ICAO Council in 2001) comply with Chapter 4 noise limits, which are broadly Chapter 3 cumulatively minus 10 dB(A)[17].

10.2 Evolution

It is of course impossible to determine with certainty how far the general decline in noise output per aircraft movement over the past 40 years or so has been due to stringency, and how much would have occurred anyway, as technological advances including higher engine by-pass ratios have brought enormous increases in power, fuel efficiency, reliability and "quietness". As industry publicists often point out, the noise "footprints" (a given contour area per take off) of today's jets cover areas of the order of 10% of those of the first generation of NNC (non-noise-certificated) civil subsonic jets.

Both economics and regulation drive an underlying "technology bonus" which is sometimes built in to forecasts as a small underlying reduction in noise emissions per aircraft movement, irrespective of stringency. It arises from continuous product improvement by both engine and airframe manufacturers, in competitive markets. We recognise this "technology bonus" qualitatively but hesitate to quantify it, for while it doubtless applies to new engines and perhaps to modification updates during overhaul, much still depends upon how quickly the improvements reach service, and that in turn depends largely upon the rate of replacement of and additions to current fleets.

Another observable trend is the tendency for average aircraft capacity to increase – or at least average load per movement. Congested international hubs in particular tend to be characterised by a relatively high proportion of large long range aircraft, and the increasing value of slots at peak times as it comes close to capacity (infrastructural or restricted) tends to drive up the average aircraft size year by year. At any airport, operators will tend to use the largest aircraft they think they can fill to maximise revenue and fuel efficiency, and to minimise seat cost/price. Thus in general we may expect to see a drift to larger aircraft, although as the growth of the low fare sector has shown, much higher load factors than used to be regarded as

[17] Strictly, not every aeroplane meeting "minus 10" is necessarily Chapter 4 compliant, as there are rules on "trades" when cumulating between the three measurement points, which are ignored by Directive 2002/30 in defining "minus 5" marginality, and similarly ignored by our study for consistency.

achievable can provide for growth without increasing aircraft size, as can higher frequencies and new routes (which also generate growth) where slots are available.

10.3 Generic Classification of Aircraft

The distinction between at least two ways of grouping aircraft in fleets according to their characteristics, effectively providing different definitions of "fleet mix" can be seen in discussing the above considerations :

- noise characteristics; and
- design characteristics.

This distinction is not always clear-cut. There can be noisy small aeroplanes and larger aeroplanes which are quieter in absolute terms at given measuring points; and others which are noisier in absolute terms than smaller types but which are certificated to a greater margin of Chapter compliance, because allowance is made for MTOM and numbers of engines in the standard. Furthermore, in both noise and design terms, definition is not always an exact science.

We have highlighted some historic changes in the noise characteristics of the fleet as it serves our 70 listed airports in the Community and Switzerland, in Section 4, in evaluating the evolution of the noise climate since the Directive came into force. That is our baseline for considering the future, and will be recapitulated in summary, as well as being expressed in design characteristic terms, in this Section.

10.4 Aircraft Noise Characteristics

10.4.1 Significance

In noise terms, the differences between individual aeroplanes which determine their marginality can depend upon engine or nacelle modifications, or even flap settings, which can not be distinguished at the level of detail at which we are working. However, we believe that we have developed a comprehensive picture of the noise characteristics of the aircraft using Community airports, while maintaining operator confidentiality.

This was achieved by assiduous database matching of :

- the database specially prepared by EUROCONTROL for this study, identifying movements[18] by aircraft type, subtype and MTOM, according to local time-bands, at 70 airports for :
  - the 12 months following the disappearance of Chapter 2 aircraft from Community[19] airports and entry into force of Directive 2002/30 at the end of March 2002; and
  - calendar 2006 as a complete "current" year.
- ICAO's 'NoisedB' Noise Certification Database, maintained by the French DGAC, and the European Aviation Safety Agency (EASA) Database of EASA Approved Noise Levels for Jet Aeroplanes TCDSN[20] identifying compliance with Chapter 3 by detailed aircraft subtype, engine type, MTOM, modification status and (where relevant) flap setting. Some of these criteria can not be precisely matched in other databases in which they either differ or are unspecified - at the margin, differences are sometimes, by definition, very marginal indeed.

[18] 9,859,466 in 2002/03 and 11,019,531 in 2006.

[19] The Community of 15 as it was at that time, this date did not necessarily apply to Accession States who have since joined the European Union.

[20] Type certificate data sheets for noise (TCDSN) jets.

- JP 'Airline Fleets' listing the world fleet of individual transport aeroplanes by generic type and sub-type, engine type, MTOM, construction number, year of manufacture, registration, operator, operator nationality and continent, as well as other criteria not relevant here.

The limitations of confidentiality in the EUROCONTROL movements database (non-identification of airlines), and the levels of detail available in the various databases for this matching process meant that, while we could identify particular aeroplanes within a given type or subtype meeting a certain marginality level, we could not always distinguish their movements. Thus in some cases the apparent noise impact of these aircraft may be overstated as some of the subtypes in a given aircraft family may be quieter., On the other hand some may be understated where the possible extra noise of a few individual marginal aeroplanes within a given fleet is ignored in the broader picture. .

Further, in some cases the precise degree of marginality of some sub-types could not be determined, as it spread across (or even beyond) two or more of the noise bands considered. We have, however, been able to set limits to the uncertainties of enumeration in Section 4, for what we believe is the first time in such a study.

10.4.2 Aircraft Fleets and their Marginality

As described in Section 4, the database matching process resulted in the identification of aircraft types using our listed airports at five levels of compliance and confidence. In summarily recapitulating that grouping, and putting it in the total fleet context, we concentrate in this section on jet aircraft as defined by the Directive.

Overall, it is first significant that the total numbers of marginal aeroplanes using Community airports are relatively low - relatively in terms of proportions of total fleets, certainly at the World level. Secondly, we may note that short haul marginal aircraft from overseas continents are probably less likely to use European airports than long-haul types (although they may come from the Community's or Europe's neighbours). Also, some companies use foreign registered aircraft for their European operations.

Nonetheless, to put marginality in context, we feel it useful to show the proportions of generic types which might be defined as marginal. This analysis is at Table 10.1 The fleet totals in this table are from the JP Airline Fleets database, excluding duplicates and stored aircraft.

Table 10-1 Chapter 3 Jets in Fleet Context

Marginality :	Chapter 3 Identified Jet Aircraft -0 to -5	-5 to -8	-8 to -10	-0 to -10 not further allocable	Total Chapter 3	* Unident-ified Aeroplanes	Total Jet Fleets (all types)
EC, EEA & Switzerland	49	151	245	107	552	72	4,676
	1.0%	3.2%	5.2%	2.3%	11.8%	1.5%	100.0%
Europe	376	219	312	135	1042	498	6,143
	6.1%	3.6%	5.1%	2.2%	17.0%	8.1%	100.0%
World	1201	671	1460	806	4138	1132	21,345
	5.6%	3.1%	6.8%	3.8%	19.4%	5.3%	100.0%

* Unidentified aeroplanes of types identified as including significant numbers of Chapter 3 aircraft.

Source : Consultants' analysis of JP Airline Fleets and DGAC & EASA databases.

Bearing in mind throughout that Band U aeroplanes can fall into any of the other Bands, it is noticeable that while clearly identified marginal (Band 1) subsonic jets make up 5.6% of the world fleet overall, in the EC/EEA/Swiss fleet they account for only 1%. At the European level, the presence of some older Russian types raises the proportion to over 6%, world-wide the overseas survivors of the North American and other overseas B737 and older B747 fleets make a further impact.

In the potentially marginal ("-5.1" to "–8") band, the low number of aircraft bears out the Section 4 movements analysis even when restricted to jets. The identified EC/EEA/Swiss Band 2 aeroplanes make up only 3.2% of the corresponding fleet, at European and World levels the proportions are similar at 3.6% and 3.1% respectively. The 737-400 and MD80 family features quite strongly, but Community and other European B767s seem to be largely relatively quiet models compared with those of overseas operators. However, 767 variants are capable of long haul operation into Europe.

We can be less concerned with band 3 ("-8 to –10") Chapter 3 aircraft, and as noted Band U picks up the imprecisely matched cases. There are also a few unidentified aeroplanes of the types known to include significant numbers of Chapter 3 aircraft.

In total, marginality, current or potentially redefined, refers to 200 identified and at most (including all band U and unidentified Chapter 3 aeroplanes) some 380 aeroplanes operated in significant numbers by Community carriers (plus EEA and Switzerland). They seem to be mostly single aisle short to medium range aircraft, although some of twin aisle size are involved. They are also recognisably "older" designs, and may therefore be expected to drop out of service eventually on economic grounds. However, conversion to freighter use is an option for some of them, perhaps particularly the A300 family, as band 2 ("-5 to –8") examples are known to be operating as such in Europe although only identifiable as band U ("-0 to –10") in the databases.

Having seen in Section 4 the trend in turnover from "traditional" types to more modern variants and new aircraft in terms of movements, to reach the noise groupings of the current fleet discussed in this Section, we turn therefore to examining trends in "natural" fleet evolution which may characterise future years.

10.5 Aircraft Design Characteristics

10.5.1 Categories

As noted above, the traditional distinctions between long haul and short haul are somewhat blurred nowadays and in the context of Europe. Reasons include:

- improvements in aircraft engine power and reliability made twin engined over-ocean performance commonplace;
- flexibility of range has helped to change travel habits, using single-aisle aircraft for long-haul travel in high-density holiday mode and generous-pitch business travel;
- twin aisle passenger flights can serve dense short-haul and long-haul routes, for improved fuel and slot-use efficiency; and their wide bodied configuration makes them attractive for freight operations, whether converted or new.
- Furthermore, in the context of this study, short-haul operations are not confined to internal European Union flights. It takes only a short-haul aircraft to serve the Community's airports from its neighbours, be they the rest of Europe, the CIS, or Mediterranean countries; not all of which may necessarily be as concerned as the Commission about degrees of marginal compliance.

We shall nonetheless follow the conventional categorisation of aircraft identification by size and number of engines, because they broadly parallel function and they are retained by the manufacturers, whose long-established and authoritative forecasts of fleet changes are our guide. As in the movement forecasts, our aim is not to generate a new and better view of the future than the specialist companies whose continued existence rests directly upon designing the right aircraft for the market. The goal is rather an acceptable consensus forecast of what might happen, and its impacts on the noise climate.

We may also note that our categorisation is to maximise compatibility with the manufacturers' forecasts, not for use in modelling. Our contour models, at representative case study airports, use specific aircraft types (or INM-acceptable equivalents) as reported in the tower logs or other appropriate sources. The results are grossed up to a large number of airports, rather than modelling representative aircraft groups at a large number of airports.

Our categories of aircraft may be summarised in passenger-related descriptive terms, as :

- Commuter/Regional jets, 19 to +/- 100 seats;
- Single aisle jets, +/-100 to +/-200 seats (generally twin-jets);
- Widebody 2/3 engined jets, +/- 200 to +/- 300 seats;
- Widebody 4 engined jets, +/- 300 seats to very large aircraft (VLA);
- Non jets, which as elsewhere in this Report includes small jets as outside the "civil subsonic jet aircraft" definition of the Directive; and
- Freighters.

The seating capacity definition for each group is somewhat imprecise, due both to various "stretches" of sub-types within families of aircraft, and to operator configuration within sub-types, but we think it is a reasonable classification.

We may note at this point that non-jets (those which do not meet the civil subsonic jet definition of the Directive) account for nearly 20% of the IFR movements in the EUROCONTROL database, but we are not further concerned with them here. It should however be borne mind, as noted elsewhere, that business jet movements in particular are growing fast and the contribution of some of these aeroplanes to the noise climate can give rise to concern at airports. There are also some turboprops (in the HS748 and F27 families) which are, strictly, marginal in Chapter 3 terms.

10.5.2 Fleet Composition

We have analysed historic trends in movements of the major families of jet aircraft at our 70 airports in these design categories, as shown in Table 10.2. However, since the EUROCONTROL database does not permit the identification of freighters (for confidentiality reasons), they are subsumed within the passenger-related groupings.

Table 10-2 Airport IFR Movements by Aircraft Design Category

Aircraft	Movements 2002/3	% Share 2002/3	Movements 2006	% Share 2006	% Change 2002/3 - 2006
BAe-146/RJ	573,836	5.8%	558,699	5.1%	-2.6%
Bombardier City Jet	504,753	5.1%	551,539	5.0%	9.3%
ERJ, Do & YAK40	471,903	4.8%	490,495	4.5%	3.9%
Regional/Commuter Jets	1,550,492	15.7%	1,600,733	14.5%	3.2%
A318, 319, 320, 321	1,764,766	17.9%	2,857,569	25.9%	61.9%
Boeing B-727	33,535	0.3%	835	0.0%	-97.5%
Boeing B-737	2,224,606	22.6%	2,389,750	21.7%	7.4%
Boeing B-757	336,668	3.4%	304,921	2.8%	-9.4%
MD-80/90 & B-717	798,838	8.1%	636,481	5.8%	-20.3%
Other	368,588	3.7%	443,368	4.0%	20.3%
Single Aisle	5,527,001	56.1%	6,632,924	60.2%	20.0%
A300 & A310	180,466	1.8%	131,796	1.2%	-27.0%
A330	81,324	0.8%	134,672	1.2%	65.6%
B-767	182,653	1.9%	199,814	1.8%	9.4%
B-777	89,352	0.9%	128,452	1.2%	43.8%
DC10, MD11, Tristar	76,306	0.8%	53,300	0.5%	-30.1%
Wide-body 2/3 Engines	610,101	6.2%	648,034	5.9%	6.2%
A340	73,186	0.7%	109,170	1.0%	49.2%
A380	0	0.0%	260	0.0%	-
B-747	184,104	1.9%	183,677	1.7%	-0.2%
Other	5,312	0.1%	1,897	0.0%	-64.3%
Wide-body 4 Engines & VL	262,602	2.7%	295,004	2.7%	12.3%
Small Jets	211,513	2.1%	307,003	2.8%	45.1%
Turboprops	964,583	9.8%	897,486	8.1%	-7.0%
Other & Unidentified	733,174	7.4%	638,347	5.8%	-12.9%
"Non-Jet"	1,909,270	19.4%	1,842,836	16.7%	-3.5%
TOTAL	9,859,466	100.0%	11,019,531	100.0%	11.8%

Source : Consultants' analysis of EUROCONTROL database

Our most authoritative guides to future changes in fleet composition are the manufacturers' forecasts. Understandably, they work in terms of generic groups based on design characteristics.

10.6 Airbus and Boeing Fleet Forecasts

10.6.1 Sources

Our sources are :

- Airbus Global Market Forecast 2006 - 2025.
- The Boeing Company 2006 Current Market Outlook

Airbus and Boeing have a history of supplying consensus forecasts for use by ICAO's Committee for Aviation Environmental Protection (CAEP) Forecasting and Economic Support [working] Group (FESG), and their views of world (and regional) aircraft fleet developments are particularly relevant. In their current published work, however, Airbus seems to see a greater need for very large aircraft (VLA) against Boeing's "shifting balance toward smaller twin-aisle airplanes". It is difficult to draw detailed numerical comparisons between the two documents because of nomenclature, but both are useful sources. They deal only with jet aircraft – apparently close to the Directive definition.

We draw from these sources the various views on how quickly different categories of aircraft are likely to be replaced. Numerical forecasts are prepared by the manufacturers of the numbers of new (and in some cases "recycled") aeroplanes needed in each category over a typically 20-year timescale, extending a decade beyond our planning horizon. However, they present only textual comments on variations in the sequence of replacement over time, and rarely are specific aircraft types identified in this context.

Both give particular attention to the conversion of passenger aircraft, withdrawn from "first line" service, to freighters. Utilisation may be expected to fall in these circumstances among short- and medium-haul aircraft, but their usage at night may well increase. In terms of measurement of their impact on the noise climate, their reduced number of movements each carry a 10dB weighting in Lden and Lnight terms.

This exemplifies the dangers of trying to measure numerically the effects of potential stringency policy changes on an uncertain and evolving fleet, and is the underlying reason we selected a "no fleet change" baseline for modelling, in order to test different stringencies. It is, however, just such an uncertain and evolving situation within which the Directive (or a revision of it) will have to be applied in the future. We therefore attach particular importance to this qualitative assessment.

10.6.2 Differences in Definition and Forecasts

There are inevitably differences due to definition, even in identifying the size of the current fleet. The discrepancies seem to be concentrated in the commuter/regional jet category, but since such aircraft have not significantly featured in our identification of marginal or potentially marginal types, this is largely academic. A broad comparison of their views of world fleets and their evolution is at Table 10.3.

Table 10.3 Summary World Jet Fleet Forecasts

	Source	2006	Retired	Converted to Freighter	New	2025
Passenger Aircraft	Airbus	17,153	- 6,748	- 2,777	+ 25,851	33,479
	Boeing	15,540	- 7,360	- 2,220	+ 26,440	32,400
Freighter Aircraft	Airbus	1,644	- 1,109	+ 2,777	+ 803	4,115
	Boeing	1,790	- 1,210	+2,220	+ 770	3,570
Total Jet Fleet	Airbus	18,797	- 7,857	-	+ 26,654	37,594
	Boeing	17,330	- 10,790	-	+ 27,210	33,750

Source : Manufacturers

They also use slightly different categories as a basis for forecasting, particularly in the make–up of groups of twin aisle aircraft, "small/intermediate/VLA" (Airbus), and "small/medium/VLA" (Boeing); and in the freighter definitions, but these are not serious enough to prevent recognition of an overview in each case, although some of the numbers in individual categories look unusual[21]. These differences are dealt with as each generic category is considered below, largely by amalgamation backed by explanation where necessary.

10.6.3 Differences in Forecasts

The differences in forecasts are more significant. Among passenger fleets :

- Commuter or regional jets, 19 to 90 or 100 seats : Airbus has consistently higher numbers than Boeing, starting from 4,477 against Boeing's 2,710; and growing to 6,172 against 5,040; the difference probably lying in the 90 to 100 seat band.
- Single aisle, approximately 100 to 200 seats : Airbus and Boeing closely agree, starting from an average 9,675 aeroplanes, their average forecast is for a fleet of 20,256 in 2025.
- Widebody, 2/3 engines, approximately 200 to 300 seats : Airbus start with a current fleet of 2,982, 522 above Boeing's 2,460 – this is largely due to the next (VLA) category definition discrepancy. By 2025, however, the position is reversed. Boeing see a fleet of 6,490, which is 778 higher than Airbus' 5,712.' partly as matter of definition but also reflecting, we think, Boeing's greater emphasis on a market future in which frequency and direct city-pair growth will have a particular impact.

[21] For example, Airbus identify a current fleet of 25 VLA (by which they mean, broadly, A380's) Boeing put 90 aeroplanes in this group (clearly including some B747s).

- Widebody, 4 engines, approximately 300 seats to VLA : The odd starting points are almost irrelevant in looking at their 2025 forecasts – Airbus see a fleet of 1,263, which is more than double Boeing's forecast of 690. This might be explained as a matter of definition of the previous (broadly 200-300 seat) category, but the fact remains that Airbus see a market for the manufacture of a really very large aircraft, the A380, while Boeing have not chosen to launch one, although they do acknowledge the likelihood of bigger aeroplanes on trunk long-haul routes. This is partly a matter of economically meeting foreseen market demand, and partly a response to slot congestion at hubs. The difference in approach is important, because while all new aircraft are Chapter 4 compliant, the larger ones tend to make more absolute noise.
- Freighters : Both Airbus and Boeing broadly agree on the current fleet, at an average 1,717 aeroplanes, about 10% of the world's jet transport total. Airbus forecast a 2025 fleet of 4,115, which is 545 above Boeing's forecast of 3,570. This difference is accounted for by Airbus' prediction of 2,777 passenger (and combi) conversions to freighter configuration, 557 above Boeing's 2,220. We shall return to this point in more detail in considering the implications of the forecast changes in fleet mix.

The differences between current and forecast fleets by these generic design groups are detailed in the tables accompanying the succeeding paragraphs.

In conclusion, we next examine the significance of the likely changes in each generic category for the future noise climate.

10.7 Implications of Fleet Mix for the Noise Climate

10.7.1 Introduction

In this Section we look at the fleet change forecasts in more detail by generic design characteristics, with particular reference to the significance of marginal and potentially marginal aircraft types in each category. Where the manufacturers' forecasts permit, we give particular attention to the European fleet, especially for traditionally-regarded short- and medium-haul groups, while for the generally larger long-haul aeroplanes we must look at the world. We also identify, where possible, references to specific aircraft types.

10.7.2 Commuter/Regional Jets

We are concerned here with passenger aeroplanes between 19 and about 100 seats, including the Dornier 328J, the Embraer ERJ family, and the Bombardier/Canadair CRJs. Those are all are twin-engined, but YAK40 has three and the BAe146/RJ family has four, unusual for a relatively small jet. The YAK40 is prolific, with over 300 in service world-wide (16 with EC/EEA/Swiss operators, mainly governmental entities), and some have been found in the potentially marginal noise Band 2, but their use of our list of airports is minimal, 2,197 movements in 2006 (averaging 6 per day in total) and has declined from 34,780 in 2002/03.

Boeing and Airbus differ greatly in their baselines and forecasts for this class, as shown in Table 10.4, no doubt a matter of definition.

Table 10.4 Commuter/Regional Jet Fleet Forecasts (19 to +/- 100 seats)

Source	2006	Retired	Converted to Freighter	New	2025
Airbus	4,447	- 2,296	- 0	+ 3,991	6,172
Boeing	2,710	- 1,120	- 0	+ 3,450	5,040

Source : Manufacturers.

None of these commuter jets are forecast for conversion to freighter use. Given the low Community usage of the YAK40 (which would be affected by a "minus 8" marginal ban, their impact on the noise climate is therefore likely to be one of volume growth only, if at all. In that context we must note that Boeing see no increase at all in the European fleet of this category; it will all come, they think, in the Americas, Asia/Pacific and Africa/Middle East.

10.7.3 Single Aisle Jets

This design category covers aircraft from around 100 to 200 seats, and is the most prolific in terms of numbers of aeroplanes and prevalence of use at Community airports. Most are twin-engined, the group being dominated by the Airbus A318, A319, A320 and A321 families, and the Boeing B737-family. Between them they accounted for 47% of total IFR movements at our list of 70 airports, in turn accounting for 70% of all Community and Swiss airport IFR movements in 2006.

Other important single aisle jets are the Boeing B757s and its Russian "equivalent" Tu204, the MD80/90 family (as well as some designated B717 and some surviving DC9s), some Fokker twin-jets, and some surviving three-engined B727s, although these last we think are virtually all now freighters. Also three-engined are the Tu154 and YAK42. Finally there are some surviving four-engined narrow-bodies (re-engined DC8s, probably all freighters, and some Ilyusin 62s) but their frequency in the Community is not significant.

Of all these types, we have found marginal ("minus 5") examples of B727s, B737-200s, DC9s, Il62s, Tu154s and YAK42s. Their use at our listed Community airports has been decreasing, historically, the most prevalent being Tu154s (reducing from 26,478 in 2002/03 to 14,287 in 2006) and the B737-200 (dramatically reducing from 100,416 in 2002/03 to 7,417 in 2006). The withdrawal of 727-200s since 2002/03 by a prominent low-cost operator was remarked upon by airport interviewees as having made a real difference to their noise climate.

We found potentially marginal ("minus 5" to "minus 8") B737-400s, but did not specifically identify any among the older 737-300's, which in 2006 accounted for 570,231 movements at our airport list (714,480 in 2002/03). There are, however, some B737-300s and B737-500s which are not fully Chapter 4 compliant.

There are also a handful of potentially marginal A321s, among a European fleet of over 200. That total fleet accounted for 474,806 movements at our listed airports in 2006, substantial growth on the 2002/03 figure of 327,090.

Most of the MD80/90 aeroplanes, particularly in Europe, are Chapter 4 compliant or almost so, but were remarked upon as relatively noisy in practice during our airport interview programme. Some at least appear from the databases to have been recertificated at lower weights, achieving improved margins of certificated compliance quite legitimately by this means.

Table 10.5 Single Aisle Passenger Aircraft Forecasts (c.100 to c. 200 seats)

Source	2006	Retired	Converted to Freighter	New	2025
Airbus	9,669	- 3,679	- 988	+ 15,330	20,332
Boeing	9,680	- 4,900	- 1,140	+ 16,450	20,180

Source : Manufacturers

Airbus emphasise growth in this fleet in North America, but both manufacturers agree that low cost carrier imperatives of fuel efficiency and high utilisation will keep demand strong in that sector for the newest aircraft. For Europe, Boeing forecast that the total fleet of aircraft in this category will double by 2025, a net average growth rate of the order of 3.5%. The average annual retirement rates for this class of aircraft are forecast as of the order of 200 per annum, which would see nearly 1,000 disappear from the World fleet by 2010 and 2,000 by 2015, but of course they are not likely to be removed at a tidy constant rate. Even if they were, it would not necessarily account for all the marginal and potentially marginal aircraft identified in the world fleet of this sort – retirement could be faster in the early years and it could target the noisiest aeroplanes; it is likely to target the older and less fuel efficient ones. However, this is a popular aircraft class for freighter conversion, with around a thousand aeroplanes forecast for conversion.

Overall our opinion on the future impact of these fleet changes on the European noise climate is that some “natural” net improvement per average movement is likely, and prevalence of marginal aircraft at our listed airports is already declining. However, given the potential for freight use (perhaps at night), we hesitate to suggest dramatic change for the better, and volume growth is likely to be strong.

10.7.4 Widebody 2/3 Engined Jets

This generic group covers the range from about 200 to 300 seats, and includes the Airbus A300 family, A310, and A330. It also covers the Boeing B767 family and the B777. Other members include the Lockheed L1011 Tristar as well as the DC10 family and their MD11 successor, these three-engined aircraft being popular as freighters, as are some of the A300s. All are capable of Transatlantic operations, and examples using European airports are thus likely to include foreign-registered aeroplanes.

Both the A300 and B767 families are notable for their inclusion of potentially marginal (“minus 5” to “minus 8”) subtypes, but there are wide variances across the range of different degrees of compliance. They are both quite prevalent at our listed airports, the B767s increasing from 182,653 in 2002/03 to 199,814 in 2006. The A300s movements at these airports declined slightly from 107,209 to 91,166 over the same period, night use falling almost exactly as much to account for 30% of its total movements in both years.

Table 10.6 Widebody 2/3 Engine Passenger Aircraft (c.200 to c.300 seats)

Source	2006	Retired	Converted to Freighter	New	2025
Airbus	2,982	- 748	- 1,789	+ 5,267	5,712
Boeing	2,460	- 770	- 1,000	+ 5,800	6,490

Source : Manufacturers

Even allowing for differences in definition in this generic category, Boeing appear to put more emphasis on this sector, and foresee a European fleet 2.6 times its present numbers by 2025. They have launched the B787 to complement the B777 in this group, while Airbus look to a future A350. Airbus think that a larger proportion of the existing fleet will be withdrawn from passenger service than Boeing, and it does appear that the future noise climate may benefit from a largely new (and therefore Chapter 4) fleet in the future. How soon in the future is not so evident, and the concomitant is that a high proportion of passenger aircraft are expected to move to freight use. If these are the potentially marginal A300 and B767 types, and they move to night use, the overall noise climate impact could worsen, depending on the aircraft they replace. There will be considerable volume growth among the passenger variants, but we are optimistic that that will be dominated by new quiet aeroplanes.

10.7.5 Widebody 4 Engined Jets

These are traditionally long range aircraft. They all have over 300 seats. At present the group comprises the Boeing B747 and the Airbus A340, and will be joined by the VLA Airbus A380. The Airbus types are Chapter 4 compliant, but the B747 family has a longer pedigree and the older 747-100 and –200 types can be marginal. They are not very prevalent at our listed Community airports, accounting for a nominal 493 and 20,350 respectively in 2006 (down from 675 and 36,046 in 2002/03). There was less than one movement per day on average between all our 70 airports in 2002/03 and 2006 by the widebody 4-engined Ilyushin 96, but we have found marginal examples in the databases.

There are potentially marginal (“minus 5” to “minus 8”) aircraft in the World, if not the European, fleet of B747-400s, and these could be among the 337,901 movements of the type at our listed airports in 2006 (up from 128,577 in 2002/03). However, we believe that most 747-400s are fully Chapter 3 compliant or better.

Table 10.7 Widebody 4 Engined Passenger Aircraft (Over c.300 seats)

Source	2006	Retired	Converted to Freighter	New	2025
Airbus	25	- 25	- 0	+ 1,263	1,263
Boeing	690	- 570	- 80	+ 650	690

Source : Manufacturers

There are clear differences in definition of this class, with Airbus focussing upon its unique A380. While Airbus believe that the ultimate fleet will be double the size

Boeing forecasts, the common feature is that it will be an almost entirely new (and therefore Chapter 4) fleet. We rather think Boeing are right in allowing for some very large aircraft to be converted to freighters, which tends to imply more night use. Also important is that, while certification by Chapter is the Balanced Approach format for protection from operating restrictions, and while a weight-relative regime for a noise metric is logical, large aeroplanes tend to be noisier in absolute terms than small ones (due to aerodynamic noise if nothing else). Thus the noise climate implications of the manufacturers' forecasts range from very high volume growth in the case of Airbus, to the probability of more night noise (QC restrictions permitting) in the Boeing scenario. It is not an optimistic outlook in noise climate terms, particularly since restrictions based on certificated marginality seem unlikely to change the "natural" forecast, although they could speed the demise of potentially marginal aeroplanes in this class.

Even allowing for the differences in outlook between Boeing and Airbus on the future of this aircraft class, there seems to be general agreement that twin-engined wide-bodies are likely to be more prominent than four-engined in the future. We can already see this in the number of secondary Transatlantic routes switching to or being started with such aircraft, like the B777. Broadly, in absolute terms, they tend to be quieter than their 4-engined counterparts. Thus where there is a replacement at a given frequency average noise per movement is going to reduce, but increased frequencies and new services are of course likely to offset this.

10.7.6 Freighters

There are few recognisable purpose-designated civil freight-only aircraft families, except (effectively) such types as the narrow-body twin-jet Antonov An72 and An74, the four-engined widebody Ilyushin Il76/78/82 family, and the huge An124 Ruslan. While they are characteristically marginal or potentially so, they do not account for significant identified frequencies at our listed airports. There are, however, smaller airports in the Community whose traffic is characterised by the prevalence of large Russian freighters.

There are also of course freighter versions of many Western aircraft, but they are not identifiable in databases, for confidentiality and/or technical recognition reasons. However, Airbus point out that current freighter fleets include factory-built A300-600s, converted A300s and A310s, B727-200s and B747s, DC10s and some (probably re-engined) stretched DC8s. Boeing do not specify types, but note the historically growing proportion of widebody rather than narrow-body types in all areas of freighter activity.

Table 10.8 Freighter Aircraft Forecasts

Source	2006	Retired	Converted from Passengers	New	2025
Airbus	1,644	- 1,109	+ 2,777	+ 803	4,115
Boeing	1,790	- 1,210	+2,220	+ 770	3,570

Source : Manufacturers

The manufacturers agree that 62% (Boeing) to 67% (Airbus) of future freighters will be recycled passenger aircraft – tending to be the older and thus, very broadly, likely to be the noisier types, however compliant. This is doubly significant, because freighter operations (particularly express) are often characterised by night operations. Age is, however, by no means an infallible metric. A case in point is the B737 family. The 737-300 was the first of the higher bypass ratio sub-types, the large nacelles being described as "shoehorned on" to the wings while maintaining ground clearance. It preceded the 737-400. Yet it is the latter sub-type which includes potentially marginal ("minus 5" to "minus 8") aeroplanes, the 737–300s all seem to meet at least "minus 8".

There is always a balance to be considered between fixed aircraft ownership costs (notably depreciation and interest, or lease charges) and variable operating costs. The general rule is that utilisation is the element normally leveraging the latter, but this can be modified if not reversed by an operator whose utilisation is constrained by the nature of the business – short-haul night freight for instance.

Within the total freighter forecasts above, definitions are not necessarily compatible. However, both manufacturers agree that "small freighters" (Airbus) and "standard body freighters" (Boeing), retirements and growth will be totally met by conversions from passenger aircraft, Airbus thinks these might be "A320s" and B737s. Among those retired, according to Airbus, will be B727-100s, implicitly by 2010 or so, with B727-200s gone by 2015. Neither type (probably but not certainly all freighters) is very prevalent at our listed European airports, falling from 7,211 and 26,324 movements respectively in 2002/03 to 528 and 7,417 respectively in 2006. Our interviews reported examples of express 727s being returned to the USA from Europe on economic grounds. Because there are so few 727s in Europe, any noise climate impact will be small. . .

In the "regional freighter" (Airbus) and "medium wide-body " (Boeing) segment, Airbus allow for nearly twice as many conversions as Boeing. The surviving DC8s will be the first to disappear, implicitly by 2010, but they are not significantly prevalent at our listed airports. Replacements in this segment will include A321s, B757s, and B767s, according to Airbus – a mixture including potentially marginal Chapter 3 and Chapter 4 compliant types, so the noise climate impact may depend upon which particular aeroplanes are used.

"Large and long range freighters" (Airbus) and "large freighters" (Boeing) make up something under one third of the current World freighter fleet. Airbus expect more conversions and more new freighters in this segment than Boeing, for a larger fleet after 1,100 to 1,200 of current aeroplanes are withdrawn. Airbus expect a smooth retirement pattern of DC10s contrasting with a marked wave of 747-200 freighter retirements, both beginning about 2015 and so having little effect on noise climate to our planning horizon.

Overall, therefore, taking freight operations as often characterised by night flights (but not exclusively so), the forecast of large volume growth as total World freighter fleets double or more over the next 20 years is not encouraging in noise climate terms for the next decade and beyond. There is also the negative implication that most added freighters are forecast to be the aircraft which passenger airlines are ready to withdraw, as long as they are suitable for freight conversion. On the positive side, however, Airbus and Boeing agree that two thirds of the current World freighter fleet is likely to go out of service altogether through natural development by 2025. Again on the general assumption that the oldest aircraft tend to be the noisiest, that implies some improvement in average noise per movement.

10.7.7 Overall Effects by 2015

The results presented in Section 9 and above suggest that the noise contour areas around airports are likely to expand, even if all non-Chapter 4 aircraft were removed. Unlike the case in previous decades, it appears that the reduction in average noise levels is not sufficient to counterbalance the effect of traffic growth.

The average rate of decrease in noise impact per aircraft movement has progressively declined since jets were introduced, but technological improvements to aircraft and engines over the next three to eight years seem unlikely to have the same dramatic impacts as were witnessed in the past.

It seems clear that the average noise level is only likely to reduce a little and that increases in the contour areas can be expected.

As a further check on this conclusion, it is to be noted that very few airports participating in the interview programme mentioned the likelihood of any significant reduction in the populations affected, and several do anticipate an increase.

10.8 Conclusions

This Section has sought to demonstrate that there are 'natural' changes in fleet mix, which have been considered :

- historically in terms of prevalence of movements at airports, largely in Section 4 but also developed here;
- considering authoritative forecasts in terms of design characteristics, and their implications for the noise climate.

Overall the trend for average noise per movement to reduce, observed over the decades since jets were introduced, appears to be continuing and to be expected to go on doing so in the future (although it varies by market segment). The rate at which such natural change is likely to progress tends to be responsive to cyclical external pressures such as fuel price, new products from aircraft and engine manufacturers, and the development of new market demands, so these trends are characteristically looked at long-term, while the forecast horizons of this study are relatively short-term.

More significantly, it is not possible to disentangle such pressures from the impact of stringency, in a demonstrably quantified or useful way. In recent years, the use of marginal aircraft at our listed airports has generally tended to reduce, and from external sources we think the number of marginal aircraft in World fleets has tended to decline. Some of those changes were doubtless due to operating restrictions, and/or the perceived expectation of them; but some would probably have happened anyway, for economic or other reasons. We have not seen historic or forecast evidence quantifying the contribution of each element.

However, it seems clear that if a policy-desirable change in fleet mix appears likely from "natural" causes, a new stringency measure aimed at achieving such a change may encourage or hasten it. Alternatively it may be regarded as superfluous, but the expectation of the sort of "natural" change described in this Section is not a cogent reason for not ensuring it through stringency, in practice. However, when considering the likely impacts of the application of one policy against another in a planning context before the event, it is necessary (as in this study) to have a consistent baseline against which quantified scenario results can be measured.

Authoritative forecasts that movements at our listed airports are likely to increase (on 2006) by over 12% by 2010 and by over 30% by 2015. It is also forecast that the World jet fleet is likely to increase by between 95% and 100% by 2025, with between 42% and 62% - say half – of the current total fleet replaced, and 17% to 22% of the current (non-Commuter) passenger fleet converted to freighters. That is probably going to lead to a reduction in average noise per movement, depending upon the growth in size of the replacement aircraft, and the marginality status of the aircraft replaced and converted.

Chapter 4 compliant aircraft are of course themselves likely be among those retired (some B747-400s will be 25 years old by 2015 for instance), as well as the least

Chapter 3 compliant aircraft ("naturally" or through phase-out). It does seem, however, that even if our predicated, modelled and broadly grossed-up stringency assumption of a complete Chapter 3 phase-out by 2015 is insufficient to outweigh the effects of expected growth in numbers of movements, then turnover among generally quieter (Chapter 4) is unlikely to make a further dramatic difference, particularly in the short time-scale of the next eight years to our 2015 horizon.

Thus, the overall conclusion of our historical, current and forecast analyses of "natural" fleet mix changes must be that volume growth in traffic, reflected in fleet numbers and frequency of movements, is likely to outstrip any reduction in the average noise per movement.

11 Alternatives

11.1 Alternatives based on the balanced approach

11.1.1 Introduction

As explained in section 5.1.1, the Directive requires Member States to "adopt a balanced approach in dealing with noise problems at (their) airports". This imposes a duty on the relevant authorities to consider alternative ways of reducing noise disturbance apart from introducing operating restrictions on carriers. Operating restrictions should be treated as a "last resort", only when alternatives can be shown not to provide any, or sufficient, amelioration of noise problems.

The alternatives comprise:

- reduction of noise at source;
- land use planning and management;
- insulation of properties;
- acquisition of properties;
- noise abatement operational procedures.

In addition economic instruments are also a permitted tool, either in the implementation of those elements, or as stand-alone measures to discourage noisy operations.

In our interview programme we discussed with airport authorities whether they had made use of any of these alternatives, and with what benefit or cost, or whether they planned to do so in the future. Full details are reported on in sections 5.3 to 5.7 above. As a result we offer the following conclusions as to the costs and benefits of alternatives based on the Balanced Approach.

11.1.2 Reduction of Noise at Source

The reduction of noise at source means that aircraft are designed ab initio to be quieter in operation in the air and on the ground. This has in fact been happening over a lengthy period, and there has been a quantum reduction in noise of modern production aircraft versus the original civil jet aircraft of the 1960s and 1970s, or even of aircraft of the 1980s and early 1990s. The Chapter 4 standard, adopted by the ICAO Council in 2001, is applicable to jet aeroplanes for which a type certificate will have been requested since January 2006. The ICAO noise certification standards apply when an aircraft design or type is first approved for operational use. Although they do not prevent the use of existing designs for current aircraft in production, in practice nearly all current jet aircraft in production do meet Chapter 4 limits. Individual airports by themselves would be able to have little influence in encouraging manufacturers to design quieter aircraft, but certainly Europe-wide airports organisations and especially the Commission can lobby for the setting of tougher standards for aircraft noise – including a "Chapter 5". However, implementation would require multilateral discussion and agreement, so the benefits may only manifest themselves in the very long term.

11.1.3 Land Use Planning and Management

A complete ban on all noise-sensitive new building, especially housing, beyond a particular noise contour is already in place at several airports, and at other airports such building is actively discouraged. If a complete ban were to be extended to all airports within the scope of the Directive this could limit the growth of population exposed to high levels of noise. However, it would not affect those already living within houses that were built before any ban came into effect (this might have to be dealt with by acquisition or insulation – see below).

Such a strict ban may well require complex national legislation because of the differing arrangements for the authorisation of planning controls as between national and local authorities within EU States. It would also require, in order to be effective, rigorous enforcement by national and regional authorities – and a number of our respondents reported political difficulties or delays in implementing or enforcing present day building bans.

In general these measures do not involve any financial costs to the airports per se, though there is an economic cost in terms of the opportunity costs for potential developers. Land adjacent to airports is attractive to airport service providers, freight forwarders and others involved in logistics. We found that one EEA country's law requires payment to landowners prohibited from construction on their property, and similar legislation may be attached to any new legal bans in other countries – and unless the airport authority is itself the landowner a contribution from the airports may be required.

Finally it can be noted that in the rare occasions where a new airport is built, this could reduce noise near existing airports.

11.1.4 Insulation of Properties

Insulation of properties in the neighbourhood of airports has become more prevalent across the European airports we have interviewed, but is not yet universally practised. One reason for this may the recognition that although the noise levels inside the insulated properties will decrease which will result in less annoyance, nevertheless people will still be affected by air traffic noise if they are outside. They also have to close the windows of their houses to take advantage of the insulation. It may also be because it can be a costly affair.

For insulation to make a serious contribution to reducing noise annoyance it would have to have the following characteristics:

- All properties, whether private housing or public or commercial buildings, lying within a given Lden and/or Lnight contour should be insulated to meet a given acoustic requirement (e.g. the example quoted to us from the Spanish "Norma Básica de Edificación" - 30 dB(A) Leq inside bedrooms, 40 dB(A) Leq inside other house areas at night time).
- The specification would have to be very generous to include double glazing, doors, wall vents, chimneys and roofs, and to include insulated ventilators to allow fresh air without opening windows – to overcome the problem (especially in summer) of having to close the windows of houses to take full advantage of the insulation.

Such a programme would be more expensive than currently operated at most airports. We estimated (section 5.5) that current average expenditure on insulation, which is usually not to the required standard suggested above, may amount to just under € 4,000 per head.

At the higher standard, and based on the experience at Dublin airport, this figure is likely to double, i.e. € 8000 per head to remove aircraft noise annoyance while inside a dwelling or place of work. There may of course be some variation due to differing costs of labour and materials across the airports within the EU. However, disturbance while outside the property would remain.

11.1.5 Acquisition of Properties

Property acquisition is potentially a more effective method for reducing noise disturbance, by removing people who would be exposed to high levels of noise. This is occasionally offered when new infrastructure is being planned Apart from this, at the moment only a minority of airports either have, or are envisaging introducing, some sort of acquisition policy. It is generally targeted at a small number of residences that are exposed to very high levels of noise. At the lowest level (e.g. at some UK airports) the airport does not offer acquisition as such, but rather a home relocation assistance scheme, whereby financial assistance is provided to current home owners to relocate, thus removing their exposure to noise. Any subsequent purchaser of the property would be deemed to accept the noise disturbance voluntarily – especially if combined with an insulation programme. At other airports homes are acquired for conversion to shops or other commercial purposes. Unless such properties are then insulated, this merely transfers the noise disturbance from domestic to other users.

Acquisition might be able to make contribution to reducing noise annoyance if it included all properties, whether private housing or public or commercial buildings, lying within a given Lden and/or Lnight contour. The costs of such a programme would be considerable, depending on the market value of such properties. The limited evidence from our interviewees suggests that costs may range from €200,000 to € 500,000 per house, i.e. (given an average population per household of 2.6) around € 70,000 – 200,000 per head. Because of the considerable costs, the benefits of acquisition are mainly in the removal of situations of extreme noise exposure and cannot be expected to make a serious contribution in limiting the total number of noise exposed people.

11.1.6 Operational Procedures for Noise Abatement

Nearly all the airports we interviewed already require some form of noise abatement operational procedures to be followed in order to minimise noise exposure to local residents. Evidence from interviewees indicates that such procedures can provide clear and measurable benefits, sometimes up to 25% reductions in contour area.

The effectiveness of such procedures will be maximised if airports apply rigorous noise and track-keeping systems to monitor any infringements. Financial penalties on airlines for infringements may then act as an incentive to airlines to adhere to such procedures.

Although airports and civil aviation authorities incur costs for investment in, and the operation of, monitoring equipment, some of this may be offset initially from the financial penalties for infringements.

11.2 Market based instruments

In this section, a number of economic instruments will be discussed with regard to their potential to contribute to the noise management at Community airports. As presented in section 5.7.6, over 70% of the airports that responded to the particular question indicated that they currently apply market-based instruments to manage noise. Aircraft noise is an external cost imposed on society by airline operations; a market scheme can at least partly internalise those external costs. The instruments vary from penalties to charges and differentiated landing fees.

In this section we will discuss some other potential economic instruments:

- Noise permit trading
- Penalties
- Taxes and charges
- Revenue-neutral incentives

Other potential instruments that might be considered but that are not further discussed are:

- Quota count system at Community level
- Taxes/charges at Community level
- Slot regulation

The reason for not further discussing the first two instruments is that they do not comply with the balanced approach, which seeks to introduce only measures at airports at which there is a particular noise problem. Slot regulation is briefly referred in combination with noise permit trading, but is in itself an instrument to regulate physical capacity.

We will first briefly elaborate on the desirability of harmonising airport noise limits.

11.2.1 Advantages and disadvantages of uniform airport noise limits

Uniform airport noise limits across the EU have several advantages and disadvantages. This section explores them both and sets out to weigh them. This section does not make a full case for or against EU noise limits, as such a case would need to take the subsidiarity principle into account. Also, clearly, it would have to be considered to what extent it would be in line with the balanced approach.

To the extent that airports compete with each other, uniform noise limits could ensure that the competitive market has the same rules everywhere. This could be considered an advantage of uniform noise limits. It need not be, however, if the ultimate objective of noise policy is taken to be the welfare optimisation. The remainder of this section elaborates on this point.

From an economic welfare perspective, it can be shown that welfare is maximised when the marginal social benefits of an activity exceed the marginal social costs. For the last, marginal, activity undertaken, in this case the last flight that is added to the system, marginal social costs and benefits are about equal in the case where welfare is maximised. As far as these costs and benefits are internal (i.e. reflected in the market price), the market will automatically steer towards this optimum. However, if an activity causes external costs and benefits, the total social costs and benefits may not be in balance. In this case, for some of the trips, the marginal social costs could exceed the marginal social benefits and total social welfare may actually decreases if the flight is carried out.

In aviation, an important external benefit is the so-called Möhring effect: an increase in the frequency of air service caused by additional travellers, from which other travellers benefit as well.[22]

The main external cost of aviation to be considered under the scope of this report is the cost of noise exposure[23]. Usually, these costs are estimated by indirect valuation methods, such as revealed and stated preference. An example of a revealed preference method is hedonic pricing, which is commonly used to valuate noise exposure. The (market) prices of exposed houses are compared with similar houses that are not exposed to the noise. Alternatively, asking people what they would be willing to pay for an increase in the chance of success in a medical operation is an example of a stated preference method.

Available studies show that external cost estimates vary widely between airports. Variation cannot always be explained by differences in the number of people exposed to noise. Nor can they be explained by other obvious factors, such as GDP per head. Airports of comparable sizes in countries of comparable economic development still can have very different values of noise costs. Since total external costs vary widely for airports of comparable size, average external costs per aircraft movement also vary widely, and it is most likely that marginal external costs show significant variation as well.

Furthermore, research indicates that noise hindrance (the cause of the social costs) is not only correlated to noise itself as measured, but is to an extent determined by non-acoustic factors including policy factors. On the one hand, airports that have devoted effort to communicate better with the neighbouring community have received lower numbers of complaints, which could be a good indication of lower hindrance. Sydney airport has had very positive experiences with this approach. On the other hand, some research indicates that noise policy itself might increase the awareness of noise exposure and might even increase the perceived nuisance (Broër, 2006).

If marginal external costs for airport noise (i.e. the external cost of an additional amount of noise – be it an extension of the noise contour, an additional person in a noise contour, or an additional noise event) vary significantly throughout the EU, applying uniform limits to all airports would not necessarily lead to an improvement in welfare. For some airports, the limit would be too low to balance costs and benefits, while for others, the limit would be too high. So in fact, a uniform noise limit may even reduce welfare.

11.2.2 Noise permit trading

Tradable permit systems are rapidly gaining acceptance as a method of pollution abatement. This kind of system is, for example, currently used to reduce CO_2

[22] Mohring, Herbert, Optimization and Scale Economies in Urban Bus Transportation, American Economic Review 62, no. 4 (September 1972): 591-604

[23] Other external costs include the impact of aviation on climate change and local air quality.

emissions in Europe (EU Emission Trading Scheme). In 2006 the European Commission has issued a proposal also to include aviation in this trading system (European Commission, 2006). According to the proposal, airlines will have to surrender allowances for CO_2 emissions on flights within the EU (in 2011) and on all flights departing from or arriving at EU airports (from 2012 onwards). The advantage of permit trading over other policy instruments is that it allows for trading between entities such that pollution is abated at the lowest costs possible. Entities that can reduce pollution at relatively low cost will do so and sell excess permits to entities that face higher abatement costs.

It is of interest to see where such a tradable permit system could also be a cost effective instrument to reduce noise emissions around airports. Noise permit trading systems can be designed in a number of ways. They have in common that the total amount of noise is set and divided into noise allowances. These noise allowances are distributed amongst trading entities, potentially by an auction, after which they may be traded. Under certain conditions,[24] a noise cap will be met at minimal costs: trading entities which can take noise reduction measures that cost less than the market price of the allowances will take these measures and sell their allowances to trading entities that are not able to take cheap measures.

Noise permit trading systems can in principle be designed in a number of ways serving different purposes. They can be designed to reduce the noise contours around a number of airports in a certain region, in which case the trading system would have to include more than one airport. Alternatively, they can be designed to minimise the noise contours around one airport at the lowest cost, or to reduce the number of noise affected dwellings. It could even be envisaged that the trading system is designed in a way to minimise external costs. The remainder of this section will be devoted to an analysis of the main design elements.

Design elements of noise permit trading

Noise permit trading can be implemented in different ways. Several important design elements are:

- Definition of a noise permit
- Scope of the system: i.e. the number of airports
- Trading entities
- Link with slot allocation

Below these key elements will be discussed.

Definition of a noise permit

First of all, it should be determined what a noise permit actually allows. A permit could be related to the actual noise energy emitted, or to the certificated noise value of the aircraft. An alternative could be to define noise permits in terms of noise exposure (i.e. the actual amount of noise that a person or area is actually exposed to, expressed as L_{den}, $L_{Aeq,}$ etc.) or the adverse effects of noise, often indicated as noise annoyance (the impact of noise on the exposed population) (CE Delft et al., 2005).

The actual choice of the noise indicator depends on the trading entity and the objective of the trading systems. In some cases, it may be necessary to differentiate

[24] For example, trading costs may not be too high, there should be a substantial number of entities under the scheme, facing different abatement costs.

the indicator with respect to time and location of the noise event. For example, noise at night has a stronger health impact that daytime noise, and if the purpose of the system is to reduce the health impacts, night noise should be treated differently that daytime noise in the trading system.

An advantage of relating the cap to noise emissions is that the value of this indicator can be determined with relative ease. Noise emission data is available from the aircraft's certification process. However, there is no direct link between the objective of the cap (limit the impact of noise on the population) and noise emissions. Therefore, this indicator will not give an incentive for all mitigation measures which contribute to obtaining the objective, such as adjusting flight tracks.

Noise annoyance, on the other hand, is directly linked with the objective of the noise cap, and hence provides incentives for all types of noise mitigation measures. However, the monitoring of noise annoyance is difficult. In addition, annoyance remains an essentially subjective measure on which consensus may be difficult to achieve. Due to the lack of acceptance for this indicator, we recommend not to base the cap on noise annoyance.

Finally, noise exposure has a more direct link with the objective of the cap than noise emission, although the link is less strong than for noise annoyance. A cap based on noise exposure provides also more incentives for a broad range of noise mitigation measures than a cap based on noise emissions does. The determination of noise exposure could be based on measurement and modeling. The measurement of noise exposure on a large scale has high costs and the reliability is questionable (CE Delft et al., 2005; Hullah, 2006). Therefore, exposure levels are usually based on modeling instead of measuring.

In general, the definition of a noise permit is not straightforward. In the existing trading schemes, permits provide the right to emit a number of kilograms of pollutant. Adding the kilograms allowed for by permits gives the total cap. Given the logarithmic relation for noise levels, the specification of a noise permit would be more difficult and would require a lot of attention. In addition, where the location of emission of CO_2 has at most a minor impact on the climate impact, the exact location of the noise emission is important. It will be very difficult to account for this in a permit scheme.

Scope of the system

Two different scopes of the system for noise permit trading can be distinguished (CE Delft et al., 2005). First, there is an multi-airport system, in which there is one market for noise permits at several airports within the European Community, with an overall cap on the number of noise permits for these airports combined. The second system, an one-airport trading scheme, allows trading entities to trade noise permits related to a specific airport. In this case, a noise cap should be defined separately for each airport.

The inter-airport system will in theory be more efficient in reaching a specified total of noise exposure, since there would a larger number of trading entities (be it airlines, airports, air traffic managers or others), adding to the liquidity of the market. Moreover, the trading entities would have a larger number of noise abatement measures at their disposal, at different airports. However, an inter-airport system also has a major drawback: No certainty of noise reduction at a given airport can be guaranteed. Since trading entities are free to choose at which airports they realise the required overall noise reduction, airports where the marginal costs of noise reduction are high will not experience noise reductions. So in fact, there is a real possibility that noise at certain airports will increase relative to the baseline under an inter-airport trading system. This can only be avoided by restricting trade, which will reduce the efficiency of the system.

Furthermore, the multi-airport system may not comply with the Balanced Approach. According to the Balance Approach, only airports with documented noise problems are entitled to take specific measures. If the multi-airport system should include airports without a documented noise problem, it could violate the balanced approach.

Trading entities

Which entity should be responsible for surrendering allowances? Several options are available:

- Aircraft operators could be required to surrender permits according to the noise impact they caused under the scope of the permit trading system. Aircraft operators have some possibilities to reduce noise at source by changing the fleet mix at an airport or by acquiring less noisy aircraft. At uncongested airports, they may also have some influence over the timing of a noise event by adjusting flight schedules. Aircraft operators have no influence over the location of the noise, since in most cases they have to use runways assigned to them by the air traffic managers or the airports, and follow preferential tracks, et cetera.
- Airports; in a multi-airport trading system, it is possible to make airports responsible for the surrendering of permits. Airports have some control over the location of noise by defining preferential tracks. They may also influence the timing of noise events by introducing night curfews or taking other measures to reduce night flights. Moreover, airports may influence the noise characteristics of the fleet mix by introducing noise-differentiated charges.
- Providers of air traffic management (ATM); In this option, providers of ATM would be obliged to surrender allowances for all flights that are covered by the noise permit trading system. The ATM providers, like the airports, would need a mechanism to pass on the costs of purchasing allowances to the aircraft operators, who in turn would implement those mitigation options that are less expensive than the additional charges imposed by the ATM providers.

In addition, parties from outside the aviation sector may be allowed to hold permits, e.g. people living around airports. By buying the permits these parties can reduce the total noise allowed at the airport. In this way they can decide on the noise limit imposed on the airports.

Allocation

In theory, the efficiency of a permit trading system is independent of the choice of design of the allocation of permits (Tietenberg, 2006). However, the allocation of permits determines the financial burden to be borne by the sector as a whole as well as by individual entities. Due to these distributive implications, the allocation of permits is a highly sensitive design element which is crucial for the acceptance of the system (CE Delft et al., 2004; US ITC, 2005).

In general, three main allocation methods can be distinguished:

- Grandfathering, i.e. free allocation on the basis of an airlines historical emissions.
- Auctioning, i.e. no free allocation
- Benchmarking, i.e. free allocation on the basis of an indicator of the output, efficiency, or fleet characteristics.

From an economic perspective, auctioning can be considered the most efficient option. In addition, entrants are treated equally to existing operators and credits are given to airlines which have already implemented noise reduction measures. An important drawback of auctioning is the large financial burden placed on the aviation sector, which undermine the acceptance of the system. Since permits are allocated for free by grandfathering, this allocation method will gain airlines cooperation. However, grandfathering is less cost-effective than auctioning, early action is not rewarded, and it provide a barrier for market access by new entrants. A better option is using a benchmarked allocation, which is more favourable to early movers. However, this option is less cost-effective compared to auctioning.

As mentioned before, from a economic perspective auctioning is the most attractive allocation method. However, if the financial burden on airlines is considered to be too large, a benchmark system could be an alternative.

Link with slot allocation

Noise permits, giving the owner the right to create a certain amount of noise, would in some aspects resemble slots, which gives the owner the right to land, use the terminal and take-off at a certain time. This resemblance would be even stronger if noise permits would be time- and/or location specific, reflecting the annoyance or health impacts created by the noise. The similarity between noise permits and slots leads to the question how noise permit trading would affect slot allocation, and whether noise permits should be integrated in slots. This section deals with these questions, but first it briefly describes slots and slot allocation.

In EC regulation 793/2004, which forms the basis for slot allocation in the EU, a slot is defined as “the permission (…) to use the full range of airport infrastructure necessary to operate an air service at a coordinated airport on a specific date and time for the purpose of landing or take-off”. Slots are allocated to airlines on the basis of historical rights; if an airline has used its slot for over 80% in a certain season, it retains them in the next season. Slots that are not used are aggregated in a slot pool and distributed amongst airlines with some preference given to new entrants. Because of the allocation method, slots are not automatically assigned to airlines that would assign most value to them. Slot allocation in its current form cannot be considered economically efficient.

Introducing a (secondary) slot trading system would result in a more efficient allocation of slots (NERA, 2004). If such a system would be in place, existing slot holders would face an opportunity cost in the form of the revenues they forego if they carry on using a slot that could be sold instead to another airline. In the end, slots are allocated to airlines that value them most. The introduction of a slot trading system, however, may affect aviation noise negatively. Several studies predict that secondary trading will result in more flights at off-peak times, and a shift from short-haul to long-haul movements (with larger and thus more noisy aircraft) (NERA, 2004; Mott MacDonald et al., 2006; SEO, 2007). So, if not accompanied by other policy measures, the introduction of secondary slot trading could result in more airport noise.

By introducing a noise permit trading system next to the system of slot trading these adverse noise effects of slot trading may be prevented. Airlines will take noise-related costs into account, and hence the slots will be allocated to airlines with the lowest total costs (including noise-related costs). The combination of both systems will also provide a better investment climate for noise reducing technologies than in a situation with only slot trading. The financial benefits noise permit trading provides to airlines with quiet aircrafts can be used to buy more slots and make more profits.

Since slots are time specific and noise permits could also be time specific to fulfill some purposes, would it make sense to combine both rights into a single tradable permit? Although this could reduce transaction costs, it would probably not increase efficiency: slots are independent of aircraft type and thus of noise. So, the combined slot-noise permit would either allow to much noise per slot (in which case the number of slots would need to be reduced below the capacity of the airport to safeguard against overexposure to noise), or too little (in which case airlines would not be able to use all their aircraft at a certain slot, thereby reducing the efficiency). Therefore, welfare would be maximized by having separate trading systems for noise permits and for slots, or secondary slot trading in combination with other policy instruments to reduce noise.

Conclusion

The potential of noise permit trading could only be discussed briefly in this study. Although emission trading has proven its worth in other fields of pollution control, it is still very much an open question whether it could be an effective instrument to control noise around airports as well. The analysis above has raised many questions that need to be answered, before a full assessment can take place.

11.2.3 Penalties

Noise penalty schemes can be used to secure compliance with the noise management scheme. A penalty can for example be imposed to airlines for deviations from the designated flight path or if the measured noise level on the ground exceeds the noise level allowed.

In the United Kingdom, several airports (e.g. Manchester, Birmingham, East Midlands) operate this system to control noise. These airports set noise limits, which are mostly differentiated to time of day. For example, the noise limits set at Heathrow, Gatwick and Stansted are 94dB(A) in daytime (0700-2300); 89 dB(A) between 2300-2330 and 0600-0700; and 87 dB(A) in the night period, 2300-0600. These limits relate to noise measurements on the ground. At these three airports, airlines which violate the limits are fined £500 for the offence of exceeding the limit, or £1000 if the aircraft breaches the limit by 3 dB(A) or more. Some airports (e.g. Manchester) also levy penalties for flagrant or persistent deviation from the noise preferred flight path. Several airports reported that penalties were very helpful in ensuring compliance.

There is no general agreement about the way income generated from fines should be spent. Some airports (e.g. London Heathrow) use the income to provide insulation for local schools and community halls. At other airports specific trust funds has been set up, which receive the money raised from fining. These funds provide grants to social and environmental projects in the neighbourhood of the airport.

An advantage of a penalty scheme is the ease of implementation. However, noise and track-keeping systems, which are required to assess violations of noise limits and deviations for noise preferential routes, are potentially costly to install. Therefore it may not be appropriate to apply this instrument at smaller airports. A penalty scheme could provide an additional incentive for airlines to use less noisy aircraft.

In general however, penalty schemes should be seen as measures to ensure compliance with certain procedures or regulations. These procedures and regulations are the primary measure to control noise, penalties are a potentially powerful means to ensure compliance. Penalty schemes for airlines in themselves for airlines are related to particular noise events and cannot control the overall noise at an airport.

11.2.4 Taxes and charges

Taxes and/or charges[25] related to the noise level of aircraft could be used to incentivise airlines to operate quieter aircraft. If airlines act as economic rational actors, they would operate quieter aircraft if the cost of doing so would be less than or equal to the cost of paying the charge. The costs of operating quieter aircraft are determined by a large number of factors, including the investment in new aircraft, the operating costs of alternative aircraft, the potential and costs of re-engining, et cetera. These costs cannot be evaluated here.

Of the 26 airports that answered the question on differentiation of charges, 8 responded that there were net revenues of the differentiated charges. These revenues were generally used for noise related measures, such as noise insulation and noise monitoring systems. This increases the effectiveness of such charges. On the one hand, they provide an incentive to airlines to deploy less noise aircraft, on the other hand, with the revenue from the charges, noise abatement measures such as insulation may be financed.

The charge level is related to the noise emissions of the aircraft, either through the certificated noise values, or through measurements on the ground. Potentially, the time of day could be factored in as well, for example by differentiating between day, evening and night, so to provide incentives in line with the Lden noise level at the airport.

At most airports the charge is based on a stepwise classification scheme. These schemes can be based on the certificated noise level of the aircraft, on actual noise

[25] ICAO defines a conceptual difference between taxes and charges, as follows (see Resolutions adopted by the Assembly, provisional edition December 2004, at: http://www.icao.int/icao/en/assembl/a35/a35_res_prov_en.pdf, consulted January 12, 2006): 'a charge is a levy that is designed and applied specifically to recover the costs of providing facilities and services for civil aviation, and a tax is a levy that is designed to raise national or local government revenues which are generally not applied to civil aviation in their entirety or on a cost-specific basis'. Although we are aware of the different definitions of taxes and charges, we will use the word 'charge' for both, as their economic implications are identical.

measurements or some other classification is in use. In general, aircraft are categorized in several classes according to their noise classification. The number of classes as well as the boundaries between classes differs for different airports. If the classification only distinguishes between a few classes, the incentive is very rough. From a theoretical perspective, the more classes are distinguished, or the more directly the charge level is related to the actual noise emitted or measured, the more effective the incentive is.

However, practical considerations are also important. Airlines may want to know beforehand the charge they will have to pay, which is not possible if the charge is based on the actual noise level measured. In addition, the difference between 1 or 2 dB(A) is often not perceivable by the human ear, so a very detailed classification scheme may make things overly complicated.

11.2.5 Revenue-neutral incentives

As an alternative to introduce a tax or a charge, existing charges may be differentiated on the base of some noise indicator. This could be done on a revenue-neutral basis, potentially increasing the support for the noise management measures under the airport users.

Revenue-neutral incentives share many features with charges. The main difference is that charges may truly internalize an external cost, whereas revenue-neutral incentives do no raise the average cost level. As such, they do provide incentives for airlines to invest in less noisy aircraft, but are unlikely to lead to a fall in passenger demand due to internalization of external costs. In addition, by definition, revenue-neutral incentives do not raise revenues and cannot contribute to the financing of noise abatement measures on the ground.

Apart from these differences, revenue-neutral incentives can be designed in much the same way as charges. They are widely applied at Community airports, particularly in the form of differentiated LTO charges. They may provide incentives to the operators to deploy less noisy aircraft, while not imposing net costs to the operators as a whole. Such incentives are in line with ICAO guidance.

As discussed elsewhere in this report, the basis of the differentiation of LTO charges differs considerably between European airports. The differentiation may be based on the aircrafts margin with Chapter 3 requirements, but quite often a MTOW component is included and at a substantial number of airports the differentiation is related to the absolute noise level of the aircraft.

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12 Policy issues

12.1 Introduction

In this chapter we discuss several policy issues related to a potential revision of the Directive. This chapter relates in particular to the fourth objective of this study, namely to analyse how likely the Community is to achieve its objective of limiting aviation noise at and around Community airports under existing legislation and to identify possible improvements to that legislation.

First, in section 12.2 we discuss the findings from the case study airports. These are mainly discussed in terms of changes to the contour size. Impacts on population are slightly different, due to the assumptions on population density. See also chapters 8 and 9.

Next, in section 12.3 we discuss the objectives of the Directive. Section 12.4 discusses to what extent alternative measures under the balanced approach and economic instruments may achieve similar results. In 12.5 we discuss several remaining policy issues.

12.2 Analysis of findings from case study airports

The analysis in chapter 8 indicates that the fleet that is not chapter 4 compliant[27] at the case study airports for which information is available, composes only a relative small share of the total fleet at these airports. At Glasgow airport, only 2.7% of all ATMs are accounted for by civil subsonic jet airplanes that have a cumulative margin of chapter 3 minus 10 dB or less. For Lisbon airport, this share is estimated at 8.8%. The third case study airport for which this information is available is Toulouse, where the share is estimated at 12%.

This numbers indicate that even if all aircraft with a cumulative Chapter 3 margin of less than 10 dB were no longer allowed, this would only affect a relatively small share of total ATMs, and hence, may be expected to have only a relatively small impact on noise exposure.

In chapter 8 the impact on the noise contour area of replacing these aircraft by Chapter 4 compliant aircraft has been analysed. The analysis for Glasgow indicates that for 2010 such a scenario might reduce the growth of the Lden 55 contour area from 10.7% with an unchanged fleet mix to 6.3 %. Note that replacement of all jets with a margin of 5 dB or less with chapter 4 by 2010 would already reduce the underlying growth of the contour area by 7.6%. For 2015, the underlying growth in contour area could be reduced by about one fifth, if all chapter 3 aircraft were replaced by chapter 4 aircraft. For the Lnight 45 contour, the impact of replacing the chapter 3 aircraft is much lower, both for 2010 and 2015. Note that these figures are not surprising, given that only 2.7% of the ATMs were carried out by chapter 3 minus 10db aircraft at Glasgow airports.

The results for Lisbon differ somewhat. For 2010, with an unchanged fleet mix, growth in contour area is about 6% for the Lden 55 contour, and 5.5% for the Lnight contour. Replacing the marginal chapter 3 aircraft (cumulative margin of 5dB or less), would reduce the contour area growth to 2.5% and 0.7%, respectively. If all chapter 3 aircraft were replaced in 2010 by chapter 4 aircraft, the Lden 55 contour area would be similar to the 2006 area, and the Lnight 45 contour area would even decrease over this period.

[27] Based on the cumulative margin with Chapter 3, and no account has been taken of the measuring point trade-off limitations.

Considering 2015, the impact of the autonomous traffic growth at Lisbon airport on the contour area cannot be neutralised by replacing all chapter 3 aircraft. The Lden 55 contour area is expected to grow by 23%, whereas the night contour area is expected to increase by about 21.5%. Replacement of marginal chapter 3 aircraft would reduce these growth projections by about 5 percentage points and replacement of all chapter 3 aircraft by about 7 percentage points.

For Toulouse airport[28], the Lden 55 contour is projected to increase significantly with a constant fleet mix, up 15% and 20% in 2010 and 2015 respectively, compared to 2006 levels. Similarly, the expected growth in Lnight 45 contour is 14% to 2010 and 18% to 2015. Replacing marginal or all chapter 3 aircraft would cut the growth for the Lden contour by about 5 to 6.5 percentage points, respectively. The growth in the Lnight contour could be reduced by up to 3.5 percentage points.

Finally, the results for Warsaw are in line with the results for Toulouse. There is significant growth in contour area of around 11% for 2010 and 23% for 2015 both in the Lden 55 contour and Lnight 45 contours. Replacing marginal or all chapter 3 aircraft reduces the growth in the Lden contour area by about 4.5 percentage points (compared to business as usual increase), and the Lnight contour growth by about 2.5 percentage points. The growth in contour area in 2015 would still be around 20% even if no chapter 3 would visit the airport.

There are two issues that underlie the case study results as discussed above and need to be remembered when looking at these figures indicating the potential impact of operating restrictions on chapter 3 aircraft. First, the Base Case forecasts assume an unchanged fleet mix, and this overstates likely noise exposure, since some natural replacement of old and relatively noisy aircraft would take place anyway, as discussed in chapter 10. The natural replacement, and the growth accommodated by new aircraft would tend to reduce the growth in contour area as estimated in the case studies.

Second, at many airports initiatives have already been implemented to encourage airlines to deploy less noisy aircraft. Such incentives can vary widely from differentiated LTO charges to informal discussions between airport and airlines. Most of these incentives have been directed at discouraging the most noisy aircraft, being the marginally compliant chapter 3 aircraft. The results of such initiatives are already taken account of in the business as usual projections, thus reducing the potential impact of operating restrictions on chapter 3 aircraft.

Having in mind these two notions, we redirect attention to the results of the case studies. The results for the case study airports assuming an unchanged fleet mix indicate:

- All airports show an increase in contour area with an unchanged fleet mix. This growth is 5 to 15% for the coming 4 years (2006 to 2010) and 18 to 24% for the period 2006 – 2015.
- Even if all chapter 3 aircraft would be replaced, the Lden 55 contours are estimated to grow by between 13 to 20% up to 2015. The growth in Lnight 45 contours under such a scenario lies between 14 and 22%.
- For each airport, the development in Lden 55 contour area is very similar to the development of the Lnight 45 contour area at that airport

[28] The results for Toulouse are influenced by the 'constructors flights' by Airbus, which are forecast to stay constant.

- A replacement of all chapter 3 aircraft by chapter 4 aircraft would reduce the Lden 55 contour growth by about 4.5 to 6.5 percentage points.
- The impact of a replacement of all chapter 3 aircraft by chapter 4 aircraft on the Lnight 45 contour differs considerably between the case study airports. Results vary between a reduced growth of 1.5 to 7.0 percentage points, depending on the current night time regime in place.
- The difference in contour area between replacing all aircraft with a margin < 5 dB with chapter 3 requirements, and all aircraft with a margin < 8 dB is less than half a percentage point.

In short, contour areas are expected to grow considerably, with natural fleet replacement lowering the estimates. In addition, if the fleet would be composed of chapter 4 aircraft only, this would significantly reduce contour growth.

12.3 Objectives of the Directive

12.3.1 Objectives and aims

To be able to evaluate whether the Directive achieves its aims and the more general aims of the Commission with regard to noise around European airports, we first need to be clear about those aims.

The objectives of the Directive are given in article 1:

- to lay down rules for the Community to facilitate the introduction of operating restrictions in a consistent manner at airport level so as to limit or reduce the number of people significantly affected by the harmful effects of noise;
- to provide a framework which safeguards internal market requirements;
- to promote development of airport capacity in harmony with the environment
- to facilitate the achievement of specific noise abatement objectives at the level of individual airports
- to enable measures to be chosen from those available with the aim of achieving maximum environmental benefit in the most cost-effective manner.

The specific environmental aim of the Commission is not quite clear from these five objectives. Objective 1 refers to the limitation or reduction of the number of people significantly affected by the harmful effects of noise. Objective 4 clearly allows for particular objectives as individual airports.

In the preambles in the text of the Directive the following lines are included with regard to the Commission's aims:

- (1)[29] 'a key objective of the common transport policy is sustainable development'
- (2) 'sustainable development of air transport necessitates the introduction of measures aimed at reducing the noise nuisance from aircraft at airports with particular noise problems'
- (3) The new noise certification standard defined within ICAO 'will contribute to an improvement in the noise climate around airports in the longer term'
- (4) 'The Chapter 4 standard has been established for certification of aircraft and not as a basis for the introduction of operating restrictions.'

[29] The numbering refers to the 'whereas' preambles as included in the Directive.

- (5) 'new measures will be required to prevent a deterioration in the noise climate after 2002, assuming continued growth of air transport in Europe'
- (7) 'a common framework of rules and procedures for the introduction of operating restrictions at Community airports, as part of a balanced approach on noise management, will help safeguard internal market requirements by introducing similar operating restrictions at airports with broadly comparable noise problems.'
- (10) ICAO Resolution A33/7 introducing the 'balanced approach' includes 'international guidance for the introduction of operating restrictions on an airport-by-airport basis.'
- (11) '[I]f effective and sustainable noise-reduction is to be achieved, more stringent technical standards, such as more stringent noise standards for aircraft combined with action to take noisy aircraft out of service, will also be necessary.'
- (18) 'It is necessary to allow for the continuation of existing airport-specific noise management measures and for certain technical changes to operating restrictions of a partial nature.'
- (23) 'The introduction of operating restrictions can contribute to the objective of preventing a worsening of the noise climate around airports, but there is a possibility of introducing distortions of competition. The objective can therefore be more effective achieved by the Community by means of harmonized rules on the introduction of operating restrictions as part of the noise management process. The Directive confines itself to the minimum required in order to achieve this objective and does not go beyond what is necessary for that purpose.'

In some preambles, the aims of the Commission are specified somewhat beyond the objectives in article 1 of the Directive. First of all, the aim of the common transport policy is sustainable development. But this is too general an aim to determine the impact on the Directive. It is also mentioned that ICAO noise standards will contribute to an improvement in the noise climate around airports in the longer term, and that new measures (apart from a Chapter 2 phase out) will be required to prevent a deterioration in the noise climate. Finally, (23) refers to the objective of preventing a worsening of the noise climate around airports.

From these preambles and the first objective in Article 1, we conclude that the aim of the Commission is to prevent a worsening of the noise climate, and even contemplate an improvement.

12.3.2 Achievement of environmental objective

There are many factors that will determine whether the population exposed to noise around a particular airport will increase or decrease in the future to 2010, 2015 and beyond. These factors can be broadly grouped as follows, when considered in the context of this study:

- the rate of overall growth in air traffic;
- distribution of that growth over the day/evening/night periods;
- the extent to which Chapter 3 aircraft are phased out;
- the extent to which noisier Chapter 4 aircraft are replaced by quieter types;
- the benefit of improved operational procedures; and
- changes in population distribution (neighbouring land-uses).

Specific airport forecasting and noise modelling studies are used to predict future changes in population noise exposure around airports. These cannot be definitive, and their predictions become increasingly uncertain as the time horizon increases. Such studies are usually required when an airport is planning new airport infrastructure. This infrastructure is usually associated with air traffic growth, and the predictions in these studies commonly forecast increases in population exposure to noise. These studies also identify mitigation measures to minimise this. For an airport that is fairly 'young' and historically has been subject to little 'environmental pressure' from stakeholders, improved noise management (departure procedures, CDA, track-keeping, runway preference etc as well as committed operational restrictions) may offer significant benefits. For a mature airport, there may be little more benefit to gain with current technologies.

Hence, the prospect of population noise exposure growth is different for each of the 70 airports of relevance to this study. Some of the smaller airports have capacity for substantial traffic growth, but the younger ones may be able to offset this by improved noise management. Mature airports with substantial projected growth will almost certainly have increasing populations affected.

We have shown that Chapter 3 fleet retirements will off-set traffic growth to reduce population exposure by a few percent. Changes to the Chapter 4 compliant fleet up to 2015 will add to this. Whether or not all these off-setting factors will be enough to avoid actual year on year noise exposure increasing will, we suspect, vary greatly from airport to airport. It seems likely that at the largest, most mature, airports the changes will be small unless environmental policy shifts to ease environmental capacity constraints and/or new infrastructure is permitted. Since these large airports account for the majority of Europe's overall population exposure to aircraft noise, changes in the overall population exposed to noise is also likely to be small.

The analysis in chapters 8 and 9 together with the discussion of developments in the fleet in Chapter 10, indicate that the number of people exposed to aircraft noise within the Lden 55 contour has as shown, a slight increase between 2002/3 and 2006, and is likely to grow by 2010 and 2015.

With regard to night time noise, the number of people exposed to Lnight of 45 dB(A) or more has changed by 11% since 2002/3. A further increase is expected between 2006 and 2015.

Substitution of marginally compliant chapter 3 aircraft by chapter 4 aircraft, would have minimal effect and even a substitution of all chapter 3 aircraft, is not expected to bring about such changes that the contour area or the number of exposed people will stabilise.

Thus, the concept of permitting airports to control the operation of marginally compliant Chapter 3 aircraft, however marginality is defined, will not be sufficient to achieve the Directive's objectives.

12.3.3 Options under Directive 2002/30

Our conclusion that greater use of the power to restrict marginally compliant aircraft will have little effect, should not prevent a re-consideration of the definition. In the short to medium term, some airports might be able to make use of a wider limit to contain the growth of noise exposure, albeit the natural retirement of noisier aircraft may reduce the value of those restrictions in time.

It thus appears that consideration will have to be given to greater use of the other partial restrictions permitted by the Directive, namely:

- Night restrictions – which will have a direct impact on the Lden measure given the additional weighting given to night flights.
- Quotas or noise budgets – already in use at some airports. We discuss below the merits of combining quotas with a noise permit trading scheme.
- Partial restrictions which are not linked to Chapter 3 standards – but could include some Chapter 4 aircraft on an objective basis.

In this context, it should be remembered that Directive 2002/49 requires Member States to publish action plans to limit or prevent the growth in exposure to aircraft noise.

12.4 Discussion of alternatives

Part of our task was to determine to what extent alternative measures may achieve the same results as operating restrictions on marginally compliant Chapter 3 aircraft. In chapter 11 an overview is given of alternative measures, both under the balanced approach and economic instruments.

Operational measures in the past have had much larger impacts at some airports, up to 25% in some cases. In general, operational measures may be introduced at relatively low cost to the aircraft operators. Such measures have now been implemented at most airports, and the potential of further improvements to operational procedures are limited. Several airports have reported positive experiences using penalty schemes related to track keeping, to ensure that aircraft follow the operating procedures closely.

Similarly, land use planning to prevent encroachment may have had huge impacts on the number of exposed people. Land use planning is a long term policy. It can control the population density around the airport, thus making future airport expansion more difficult. Land use planning should mainly be implemented to prevent the noise climate from worsening, indeed it is hard to see how land use planning could improve the noise climate, given an airport's fixed footprint and a projected number of operations[30].

Insulation and acquisition can reduce the exposed population at an airport. Typically, acquisition will target the people in the highest noise contours and is a relatively expensive measure. Nonetheless, it may well be advocated for the most severe cases. In general, the analysis in this report only considers the number of exposed people in the Lden 55 and Lnight 45 contour and does not consider the actual noise level people are exposed to.

Insulation on the other hand is more widely practiced but is less effective. It is cheaper than acquisition, but provides a less effective solution. For this reason, we feel that insulation cannot be relied on as the solution to increased aircraft operations and widening noise contours.

Seventy percent of the airports that responded answered that market based instruments are considered effective tools to manage noise. Nonetheless, several

[30] Note that the analysis on the number of exposed in this report has assumed a constant population density at airports. Therefore the impact of future land use planning measures is not reflected in our figures. The same holds for the impact of acquisition and insulation.

airports indicated that environmental aims will always need to be balanced against financial aims. With the introduction of environmental policy measures, airports aim to strike a balance between giving incentives in the right direction, while at the same time trying not to scare airlines away. This holds in particular for economic instruments, where the balance between environment and economy becomes most explicit. Airports will try to avoid imposing such large disincentives that airlines relocate to other airports (in potentially less densely populated surroundings). This is very understandable and makes sense from the airport's perspective.

In general, it is our view that these measures should not be regarded as alternatives to restrictions on (marginally compliant) chapter 3 aircraft. They should be regarded as complementary. Business as usual projections indicate that the Lden 55 and Lnight 45 contour area will increase in the coming period. This development is despite all the efforts in the field of land use planning, operational procedures, encouragement of less noisy aircraft through differentiated LTO charges, and despite the Chapter 4 requirements on newly produced aircraft.

Note that it is sometimes put forward, with good reason, that airport specific noise objectives and management may induce a relocation of services to other airports. Such a relocation may be regarded as a relocation of the nuisance from one area to another. However, it may be that the aircraft operations cause less nuisance at the new location.

The particular environmental objectives at each airport may be subject to national or local government regulations. If the elected politicians do not take account of the population around the airport and do not protect them enough by imposing environmental restrictions to the airport, they may not be re-elected. Relocation may hence be the desirable outcome of the local democratic processes. At the airport where the population considers the operations to cause the least nuisance, environmental regulation will be least strict. Similarly, in a densely populated area, stringent environmental rules may gain more votes than in a low density area, where operations will also lead to lower exposure figures. Clearly, this line of reasoning does assume a correctly functioning democratic process. Nonetheless, it also indicates that a relocation of operations may well be a cost effective way to reduce noise exposure.

12.5 Other policy issues

There are a number of other policy issues that have come up during the course of this study and warrant discussion.

12.5.1 Other aircraft than civil subsonic jets

First of all, the Directive relates to civil subsonic jet aeroplanes, defined as 'aeroplanes with a maximum certificated take-off mass of 34.000 kg or more, or with a certified maximum internal accommodation for the aeroplane type in question consisting of more than 19 passenger seats, excluding any seats for crew only'. In our discussions with the airports, a few have indicated that the Directive does not say anything about aircraft that are not included in this category. Nonetheless, at some airports the number of ATMs of such aircraft are rapidly increasing and they may contribute to the noise climate. It may be appropriate to develop policies for this class of aircraft as well. Or to put it a different way, it may be necessary to consider whether operators of such aircraft should receive the same kind of protection against operating restrictions as the Directive provides for operators of civil subsonic jets.

12.5.2 Transcription

Another point to be raised arises from the transcription of the Directive into national law. It has been brought to our attention that in some instances the national law implementing the Directive differs slightly from the Directive itself. For instance, we were told that in Italy the law applies to airports with over 50.000 air traffic movements instead of subsonic jet aeroplane movements. Also in the UK transcription we were told some of the nuances of article 6 of the Directive may be different from national law. The national legislation says that if it is required for environmental objectives, airports shall introduce operating restrictions. This is somewhat more direct than the formulation in article 6. The potential solution offered by EEA was the possibility of issuing an amended Directive as a Regulation, so to avoid inconsistencies in interpretation during transcription. We have not assessed to what extent this would be legally practical.

12.5.3 Partial operating restrictions

At many airports, the partial restrictions hold only for a limited period of the night, not directly in line with the definition of night as used for the calculation of Lden and Lnight contours. This makes the assessment of the success of this Directive, as measured in Lnight and Lden contours more difficult. Even if airports have introduced partial night time restrictions on chapter 3 aircraft, there may still be marginal Chapter 3 aircraft that fly during the 8 hour night time period.

In addition there are some airports where partial operating restrictions are related to the chapter 3 margin, such as Amsterdam. However, this does not apply generally. In the UK partial operating restrictions are often related to the aircraft noise quota count (based on a combination of the certification values at approach, sideline and flyover) which is a proxy for the absolute noise level, (see Appendix I for details). Similarly, in Germany many partial operating restrictions are related to the Bonus list (see Appendix I)

However, some further clarification as to what is allowed under the Directive may be required. For example, at Stansted airport, aircraft with a quota count of 4 or higher are subject of a scheduling ban within the night quota period. Although it is not an operating ban it only permits aircraft movements within this period when aircraft are delayed and it does impose limitations on the use of some aircraft that are chapter 4 compliant. Whether the Directive allows this is not quite clear to all stakeholders.

Another point that may be clarified is the status of operating restrictions that relate to the withdrawal of marginally compliant aircraft at night. It appears that for partial operating restrictions, no withdrawal process is required. If the requirements of Annex 2 are met, they may be introduced provided a prior notice is provided.

12.5.4 Harmonisation of aircraft classifications

As discussed above, different airport categorisations are in use in different countries. Such categorisations may form the basis for partial operating restrictions, or for differentiated LTO charges. One airport called for a further harmonisation of the aircraft categorisations in use in different countries. This could streamline and enforce the demand from operators to aircraft manufacturers to develop less noisy aircraft. However, ACI EUROPE responded by commenting 'not to fix what is not broken'. Noise classifications in place at airports are often the result of time consuming deliberations between airport, operators and local authorities. To change the schemes in place could entail substantial costs to the operators at a particular airport that have already adapted their fleet to the particular classification in place. Having said that, the Commission might want to consider to what extent further harmonisation may be a long term objective.

12.5.5 Clarification of the Directive

Several airports have indicated that a further clarification of the Directive is desirable. This call relates partly to Annex 2 and its exact requirements. Article 5.1 states that '[w]hen a decision on operating restrictions is being considered, the information as specified in Annex 2 shall, as far as appropriate and possible, for the operating restrictions concerned and for the characteristics of the airport, be taken into account' (emphasis added). It leaves room for discussion what information is appropriate and possible. As discussed before, it may be very difficult to isolate the effects of a particular measure on the overall exposure to noise.

In addition to these points raised by the airports, the study team note that the Directive actually does not prohibit airports from going beyond operating restrictions on marginally compliant aircraft. Clearly, article 6.2 allows city airports to introduce measures, other than a complete ban, that are more stringent than operating restrictions on marginally compliant aircraft. But the Directive does not state anywhere that other airports may not do so. Article 6.1 states that if a full assessment demonstrates that the introduction of restrictions aimed at phasing out marginally compliant aircraft is required, the following rules should be applied. The Directive does not say what should be done if a full assessment would indicate that the phasing out of all chapter 3 aircraft (or aircraft with a cumulative chapter 3 margin of 8 dB or less) would be required[31].

If this is not in line with the Commission's intensions, a reformulation stating that restrictions of marginally compliant chapter 3 aircraft only are permitted, but not required by the Commission. Operating restrictions on aircraft with a larger margin may only be introduced at city airports, under particular specified conditions.

[31] In fact, one might even argue that whereas operators are somewhat protected from the sudden implementation of operating restrictions for marginally compliant aircraft (rules from article 6.a and 6.b apply), they have less protection for operating restrictions on chapter 3 aircraft in general, since no rules as specified for this.

13 Conclusions and recommendations

Based on the analysis and modelling results in the previous chapters, we conclude the following.

13.1 Noise climate

The development in the noise climate at EU airports has worsened and is projected to worsen further. At most airports the number of movements has grown and has outpaced improvements in fleet. We estimate that the number of exposed people has increased by 3% in the period between 2002/3 and 2006.

For the coming years, we project a continued growth in air traffic movements and expect the noise climate to deteriorate. In the period up to 2010, it is projected that the number of exposed people in the Lden 55 dB(A) contour will grow by about 10%. Between 2010 and 2015, the number of exposed is projected to grow by another 10%. The number of exposed people in the Lnight 45 dB(A) contour is estimated to grow by 7.5% and 9% for 2010 and 2015 respectively, compared to 2006 levels.

It should be noted that these estimates and projections calculations are based on the fleet forecasts that do not incorporate natural fleet replacement.

Obviously, the Directive in itself cannot ensure that the noise climate around European airports will remain stable or even improve in Europe. It is an enabling Directive, not prescribing particular noise objectives, and leaving it open to the individual airports whether they assess the situation as such that measures need to be introduced. Moreover, it has been in place for only a few years and could not be expected to have resulted in widespread application yet.

13.2 Experiences with the Directive

Airports indicate mixed experiences with the Directive. These reactions should be seen in light of the limited period the Directive has been in use. The majority of airports indicate the Directive so far has had no direct impact on the instruments in place. Instruments were either already in place or planned before the Directive, and/or were made possible under pre-existing national law. The restrictions that were in place before the coming into force of the Directive are not very consistent between countries, especially with regard to partial night time restrictions that are based on different aircraft categories in different countries.

Some airports indicate the Directive had some indirect impact, for example by raising awareness for the noise problems or by discouraging potential objectors to the measures being introduced. A few airports report that the Directive was of direct influence, by encouraging individual airport action, or by enabling night restrictions.

A number of airports indicated the Directive has made it more difficult to introduce restrictions. In their view, Annex 2 is overly restrictive and some airports in fact fear legal action by airlines based on Annex 2.

It is the consultant’s opinion that the requirements posed by Annex 2 of the Directive are indeed substantial, and may be impractical in some cases. Isolating the specific impact of a particular instrument on noise exposure is very difficult. Business as usual development can be hard to predict, especially given that the noise instrument is generally part of a larger package.

13.3 Revision of the Directive

In the interview program, about 60% of the airports favoured a revision of the Directive. Thirty percent of these airports suggested a total ban on marginally compliant aircraft, for competitiveness concerns. Many airports also suggested that more stringent standards for new aircraft should be introduced. In contrast, three airports called for clarification of the Directive and a substantial number of airports (including all German airports) called for a relaxation of the requirements under Annex 2.

Seventy five percent of the airports that responded indicate they currently have sufficient powers under national and international legislation to manage aircraft noise. In general, few airports showed interest in tightening the definition of marginally compliant aircraft to chapter 3 minus 8 dB. Such a tightening would not allow them to manage noise better around the airport. One airport indicated that further stringency may even make it more difficult to introduce restrictions, because more aircraft would be affected, hence increasing the negative impact on competitiveness.

This result is corroborated by the analysis of the case study airports. An increase in the stringency of the definition of marginally compliant aircraft would only reduce contour area by about 0.4%.

13.4 Recommendations

We have examined a number of ideas which could repay further study and have benefits for the longer term. These include:

- Criteria for a possible Chapter 5
- Possible restrictions on Chapter 4 aircraft
- Greater use of differentiated airport charges
- A noise permit trading scheme (though we believe this is impractical)

Based on the extensive interview program and the modelling work at case study airports we come to the following recommendations for minor revisions to the Directive:

- Further clarify the Directive to make clear what exactly it permits and prohibits;
- Reconsider the formulation in Article 5.1 and the requirements posed in Annex 2;
- Change the definition of marginally complaint aircraft by increasing the margin by which Chapter 3 standards have to be exceeded
- Consider achieving further consistency of aircraft categorisation in the long term;
- Consider widening the scope of the Directive to apply to smaller aircraft types as well.

Moreover, going beyond this particular Directive, the Commission may want to consider the contribution of the underlying Directive to the Commission's aims of limiting or reducing the number of people significantly affected by the harmful effects of noise. In particular, based on the modelling results and the results on exposure around EU airports as will be delivered under Directive 2002/49 in the coming years, the Commission may want to consider the need for complementary measures

Appendix A Project Specifications

TENDER SPECIFICATIONS
ATTACHED TO THE INVITATION TO TENDER
Invitation to tender No. TREN/F3/15-2006 concerning
Study of Aircraft Noise Exposure at and around Community Airports:
Evaluation of the effect of measures to reduce noise

TABLE OF CONTENTS

1. SPECIFICATIONS

1.1. Introduction

Strong growth of aviation leads to an increased exposure of citizens living around airports to aviation noise.

The variety of situations at Community airports in terms of traffic volume and local land-use rules make it difficult to implement uniform rules across the board. There is need however for a harmonized uniform approach, with possibilities to take action at local level within an appropriate framework.

Assuming continued growth in air transport in the medium and long term, and without further actions to limit noise around airports, the number of people in the Community which is exposed to excessive noise from aeroplanes is expected to increase in the future, although a number of Community initiatives made it possible to limit the genitive impacts on society:

Since 1 April 2002, aeroplanes certificated to the ICAO “Chapter 2” noise standard have been completely phased out in the Community.

Directive 2002/30/EC - OJ L085 published 28/3/2002 - establishes rules and procedures with regard to the introduction of noise-related operating restrictions. It does so in the framework of a “balanced approach” to noise management which implements and develops further at Community level the ICAO guidance on noise management as endorsed by the 33rd ICAO Assembly in 2001 and reaffirmed in 2004 in Assembly Resolution A35/5 “Consolidated statement of continuing ICAO policies and practices” (in particular Appendices C “Policies and programmes based on a balanced approach to aircraft noise management” and E “local noise-related operating restrictions at airports).

Under the provisions of the Directive, subject to assessment requirements, airports with a problematic noise situation are allowed to gradually remove aeroplanes that have a cumulative margin of no more than 5 decibels in relation to the cumulative Chapter 3 certification limits.

To analyse the effectiveness of the harmonisation measures the Commission has now to evaluate the results from the application of the Directive. As it stands, the Directive enables airports to adopt measures which address a specific noise situation. However the Directive does not include either an obligation to take any measures, or any reference to or obligation to respect noise emission limits.

In parallel, the Directive relating to the assessment and management of environmental noise (2002/49/EC – OJ L189 published 18/7/2002), requires competent authorities to draw up action plans to address noise issues around inter alia the major European airports across the Union. These action plans must be based on strategic noise maps established using common indicators, but their content (i.e. the measures to address noise) is left to the discretion of the competent authorities. In particular, although this Directive defines the notion of limit value for noise, it does not require authorities to set any such limits.

This study is required to determine the current aircraft noise climate in the European Community and to make an assessment of present and future action to limit or reduce the noise from aviation. Article 14 Directive 2002/30/EC requires that

"No later than five years after the entry into force of this Directive the Commission shall report to the European Parliament and to the Council on the application of this Directive. The report shall be accompanied, where necessary, by proposals for revision of the Directive. It shall contain an assessment of the effectiveness of this Directive, in particular the need to revise the definition of marginally compliant aircraft as laid down in Article 2(d) in favour of a more stringent requirement."

The Directive sets out its objectives in Article 1 as follows:

(a) to lay down rules for the Community to facilitate the introduction of operating restrictions in a consistent manner at airport level so as to limit or reduce the number of people significantly affected by the harmful effects of noise

(b) to provide a framework which safeguards internal market requirements;

(c) to promote development of airport capacity in harmony with the environment

(d) to facilitate the achievement of specific noise abatement objectives at the level of individual airports

(e) to enable measures to be chosen from those available with the aim of achieving maximum environmental benefit in the most cost-effective manner

In order to assess how well these objectives have been achieved, it will be important to assess how the noise climate has changed over the last five years and to what extent the regulatory framework provided by the Directive has contributed to those changes. It will therefore be necessary to make a detailed inventory of the measures which have been taken at airport level under the Directive and what is currently already planned for the future.

More particularly, it will be necessary to determine to what extent the definition of marginally compliant aircraft as laid down by the Directive is still relevant. In the light of the increased number of complaints at a number of Community airports about noise during the night, the study should give particular attention the use of partial operating restrictions.

1.2. Purpose of the contract

General

The study will need to make an assessment of the noise climate on a European scale. There will be four outputs (weighting of each in brackets):

an assessment of the changes in the total impact of aircraft noise within the European Union since the entry into force of Directive 2002/30/EC (30%);

an inventory of measures to mitigate that noise at and around Community airports, taken into accordance with the provisions of the Directive since its entry into force (20%);

an inventory of already planned actions to mitigate aircraft noise with respect to gradual withdrawal of marginally compliant aircraft and to night flight restrictions (20 %);

a detailed analysis of the above with a view to establishing how likely the Community is to achieve its objective of limiting aviation noise at and around Community airports under existing legislation and to identify possible improvements to that legislation, inter alia by examining more stringent phase out options (above 5 dB)(30%).

The study should be supplemented by case studies of at least 5 airports which are particularly noise sensitive.

Detail

Impact of aircraft noise

This part of the analysis will be based on a compilation of data about airports within the European Community. It will build further on the analysis that was made in the ANOTEC Study “Study on current and future aircraft noise exposure at and around Community airports”(http://ec.europa.eu/transport/air/environment/studies_en.htm) ensuring that it is brought up-to-date, preferably by using different bands of values expressed in Lden and Lnight (definitions described in Directive 2002/49/EC).

The assessment of the change in the noise climate will need to define the total number of people affected by aircraft noise. Whenever necessary for the consistency of the results, data from different models should be obtained.

The inventory of current practices to mitigate noise should include historic information about the growth of the airport, the change in fleet mixes over time and the changes in environmental noise impact since the entry into force of the Directive. The inventory should also include information about operating restrictions (day/night, weekend, seasonal) currently in place, when they were introduced and what effect they have had. The responses to these questions should include references to the development of land-use planning and noise management policies both at local and national level and how, and for how long, they have been applied to airports and their surroundings.

Planned actions/future development

The study should assess the plans airports might have to contain any projected increase from larger airport types or from growth in numbers of aircraft. It should ask whether airports have plans that would allow for an increase in movements as well as about possible measures to reduce the number of people within the relevant contours. For the purpose of the study time horizons of 2010 and 2015 should be used.

Report on the implementation of Directive 2002/30/EC

A detailed report must be prepared on all the airports that have used the noise Directive for reducing or limiting noise or which are preparing such actions. The report should mention why those airports have undertaken such action, and give a detailed description of the measures and the results obtained or expected. The report should also mention possible problems that have been encountered in applying the procedures that are prescribed by the Directive. In addition the report should draw conclusions about how useful the Directive has been for following a "balanced approach to noise" as described in ICAO Resolution A35-5.

Analysis

Further to the assessment of the different data collected and the forecasts prepared on the basis of existing legislation, the effects of a number of alternative stringency scenarios will be quantified. To that end the study will estimate the impact of an increase in the stringency definition of marginally compliant aircraft from 5 dB to 8 dB as well as the impact of a total phase out of all aircraft that do not have the noise characteristics to be certificated or re-certificated to the current ICAO noise standard (Chapter 4). For each of the stringency levels alternative instruments under the balanced approach should be studied (e.g. insulation of dwellings) which could ascertain the same level of perceived noise improvement, with indications about the relative costs of the different solutions.

The study should examine also whether there is likely to be an increase in the use of secondary airports (which are not covered by the Directive) – where local populations may currently be less disturbed by aircraft noise – which might face an environmental impact which is not significantly large to bring new numbers into the "seriously annoyed" noise contours.

In order to illustrate the possibilities and problems faced by airports the study should use case studies of airports in different situations. The airports selected should include small, medium and large airports in different member states so as to provide pointers to the problems that might arise and how they might be overcome.

Summary
The study needs to provide a detailed inventory of the number of people currently seriously affected by aircraft noise and how that number has changed since the entry into force of the Directive. The study should also determine how this number would be likely to change over the next 4 and 9 years with and without the implementation of airport noise mitigation measures developed under Directive 2002/30/EC. The study will also analyse the "natural" phase out of marginal aircraft at airports which have not implemented the Directive.
The study should also examine the effects to be expected from increases in the stringency of noise standards, their environmental benefits and costs, as well as possible ways and means to obtain the same environmental effect by making use of other elements of the balanced approach to noise.

1.3. Reports and documents to produce - Timetable to observe
Execution of the tasks begins after the date on which the Contract enters into force.

A kick-off meeting will take place in Brussels, at the latest 15 days following the signature of the contract, in order to settle all the details of the study and to discuss the action plan.
A second meeting will be held following the reception of the interim report in order to discuss the first results of the study and further action.
A third meeting will follow the submission of the draft final report describing the work carried out, to discuss the Commission's comments on the report.

1.3.1. Interim reports
The interim report showing progress of the work shall be submitted to the Commission at the latest 3 months after the date of signature of the contract.
The Commission shall have 45 days from receipt to approve or reject this report. Within 20 days of receiving the Commission's observations, the Contractor will submit additional information or anther report.

1.3.2. Final report
The contractor will submit a draft final report to the Commission at the latest 7 months after the signature of the contract.
Within 45 days after the submission of this draft final report the Commission will provide the contractor with its comments on the draft final report and a date for a meeting in Brussels in order to discuss the Commissions observations. After this meeting the Contractor shall have 20 days in which 1to submit additional information or a new final report.

1.3.3 Report format and publication
25 copies of the reports shall be supplied in paper form and one copy in electronic form, either in MS Word or in HTML format.
The Commission may publish the results of the study. For this purpose, the tenderer must ensure that there no restrictions based on confidentiality and/or intellectual property rights are expected from the third party. Should he intend to use the study data, which cannot be published, this must be explicitly mentioned in the offer.

1.4. Duration of the tasks
The duration of the tasks shall not exceed 9 months. This period is calculated in calendar days.

1.5. Place of performance
The tasks will be performed on the Contractor's premises. However, meetings between the contractor and the Commission may be held on Commission premises in Brussels.

1.6. Estimate of the amount of work involved
The amount of work involved to carry out this contract is assessed at 350 man-days.

Appendix B Pro Forma Questionnaire used for interviews

Interview Summary

1. Background

We have been asked by the EC to evaluate the effectiveness of aircraft noise reduction measures introduced as a result of Directive 2002/30[32]
We are therefore seeking your assistance in a telephone interview programme to help us measure changes in the aircraft noise climate since the introduction of the Directive.

We would therefore very much appreciate an appointment for a telephone interview to collect some facts and figures, and to seek your expert opinions on the issues outlined below.

2. Basic Airport Data

Confirmation of runway layout

Current split of current operations between different runways

Number of ATMs, Number of Passengers, Volume of Cargo for :
2002 or 2003 or April 2002 to March 2003 (this is the preferred period), and 2006

Forecast ATMs for 2010, 2015

3. Quantified Noise Data

We are interested in seeing noise maps using Lden contours
(Note: Directive 2002/49 requires Lden and Lnight noise maps to be prepared for major airports by 30 June 2007)

4. List of Restrictions already imposed under Directive 2002/30

We would like to learn about any changes in your noise management systems since April 2002, particularly restrictions imposed under Directive 2002/30.

5. List of Other Measures used to control noise

We would like to learn about other Balanced Approach measures that you may have used including:
Land Use Planning, Operational Procedures, Noise Insulation of Properties

6. Policy Issues

We would like to explore with you your experience of noise related problems, and whether you have sufficient powers under current Community legislation to achieve your noise policy objectives.

[32] ref: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2002/l_085/l_08520020328en00400046.pdf

Interview Framework

APT	EAPT	AIRPORT NAME
IATA code	ICAO code	

Checklist

Interviewee name	
Position	
Telephone number	
Email	
Interviewer	
Date	
Language	

Explanation

We have been asked by the European Commission, as you will have seen from Mr. Salvarani's letter, to evaluate the effectiveness of noise-reduction measures permitted under Directive 2002/30, and to find out whether airports need more powers to restrict noise. Existing powers of course include the ability to ban marginally 'Chapter 3 compliant' aircraft, and to impose night flight restrictions; as well as airport action in other areas of the Balanced Approach such as land use planning and insulation schemes. ACI-Europe supports this study.

We will be making an inventory of what airports have already done and are planning to do under the Directive. We also have to quantify how effective these actions are in practice. To do this we have to measure the aircraft noise climate in terms of population within past, present and forecast **Lden** and **Lnight** contours.

Your help will be greatly appreciated, in providing the necessary information, and your expert opinions. I have to tell you that under the terms of the Study specified by the Commission, we can not promise confidentiality in using the factual data you supply, but the facts we are requesting are not normally confidential anyway. We can promise anonymity, if you wish and tell us so, regarding any opinions you express. Please alert us at any point if what you tell us is confidential and thus "off the record".

This interview framework is split in two parts. The first part relates to basic statistics that are required for the quantification of the aircraft noise climate. We have filled in this part for as far as our information reaches. Please check the data already filled in and supplement it with the missing data. (If sent to interviewee *ex ante* and/or when sent for interviewee review *ex post*)

THE SECOND PART OF THE INTERVIEW FRAMEWORK IS MORE QUALITATIVE AND DEALS WITH THE NOISE MANAGEMENT AROUND THE AIRPORT AND YOUR OPINION WITH REGARD TO THE DIRECTIVE. WITH REGARD TO THE CURRENT NOISE MANAGEMENT, WE HAVE ALREADY FILLED IN SOME OF THE QUESTIONS. PLEASE BE SO KIND TO CHECK THESE ANSWERS. WE (WOULD) APPRECIATE THE OPPORTUNITY TO DISCUSS THE OTHER QUESTIONS WITH YOU OVER THE PHONE.

Part 1: Statistics

1 Runways and use

Pre-researched from Boeing website Orientation TORA	Confirmed	Percentage use for take off

1.1 Are there any preferential tracks or standard procedures, SIDS, STARS, etc?
Yes/no [encircle], ……………………………………………………………………………..
…………………………………………………………………………………………………
1.2 Are any particular aircraft types restricted to particular runways?
…………………………………………………………………………………………..
…………………………………………………………………………………………..
1.3 Are there any runway extensions or new runways planned to become operational before 2015? (Note details)
....

2 Traffic data

	Period	Jets	Turboprops	Total
Air transport movements				
April 2002/March 2003				
2006				
Forecast 2010				
Forecast 2015				
Number of Passengers				
April 2002/March 2003				
2006				
Forecast 2010				
Forecast 2015				
Cargo (in tonnes)				
April 2002/March 2003				
2006				
Forecast 2010				
Forecast 2015				

[For comparability with other data, we have a preference for the pre-typed periods. If data for the preferred time period are not available, see what data are available for years as close as possible to the preferred period. This may especially be relevant for the forecasts. ATMs refer to the number of movements (both landings and take-offs). Jet movements are most interesting, turboprops if available. Data on passengers (total number of yearly passengers) and cargo (freight + mail in tonnes transported) only totals required.]

2.1 Can the data be split into day/evening/night?
[Preference for ATM data for jets, if these are not available, but others are, please fill in these.]

Please encircle, data relate to:

Jet / Total	ATM / PAX / Cargo	Exact / Approximation

	Day	Evening	Night
Definition day/evening/night			
April 2002/March 2003			
2006			
Forecast 2010			
Forecast 2015			

[In the first line, please fill in how the day, evening and night period are defined at your airport.]

Part 2: Qualitative data

3 Noise Quantification
As you know, Directive 2002/49 requires Lden and Lnight strategic noise maps and populations impacted around major airports to be prepared by 30 June this year, and reported to the Commission by the end of the year. These maps are of interest to us to be able to analyse the change in noise around the EU airports as required under our Terms of Reference.

Have you already produced noise maps using Lden and Lnight contours?
[Most important are 55 dB Lden and 45 dB Lnight]
3.1 Yes / no (encircle), and please fill in table below.

Contours available

	Exact period	Lden	Lnight
Past			
Present			
Future			

[Fill in under the Lden and Lnight the contour levels that are available. For future years we have a preference for 2010 and 2015, but also for the most recent (up to date) forecasts.]

3.2 Can you make those contour maps available to us (or are they accessible on Internet)?
[Fill in the arrangements made.]
……………………………………………………………………………………………..
……………………………………………………………………………………………..

3.3 Can you give us, or guide us toward, population data within the noise contours?
[Fill in the arrangements made.]
……………………………………………………………………………………………..
……………………………………………………………………………………………..

3.4 If these maps have not yet been prepared, can you say when they will be available? We would like to include them in our analysis, is there be any possibility of doing so?
[Study runs until end of August]
……………………………………………………………………………………………..
……………………………………………………………………………………………..
3.5 Are you aware of a noise action plan for your airport? The competent authorities are required to draft such a plan by Directive 2002/49 before the end of 2008? If so, could we see it?
Yes / No [Fill in arrangements made.]
……………………………………………………………………………………………..
………………………………………..…………………………………………………………………
3.6 If there is no data available, please provide your opinion on the following questions:

- Have your noise contours changed since 2002?
- How do you measure this? (Percentage area, or number of people affected, or what)
- Do you expect your noise contours to change between now and 2010 or 2015?
- How do you measure this? (Percentage area, or number of people affected, or what)
- Why? (Traffic growth, new runway, quieter aircraft, restrictions, or what)

……………………………………………………………………………………..
……………………………………………………………………………………………
……………………………………………………………………………………..
……………………………………………………………………………………………
.

4 Inventory of Restrictions Already Imposed Under 2002/30

The study requires us to prepare an overview of the noise management measures that have been imposed under Directive 2002/30. Therefore we now proceed to several questions on the noise management system around the airport. We will first ask you some general questions and will then, depending on your first answers, discuss the specifics.

The emphasis here is on generic restrictions on access to the airport by aircraft with particular certificated noise characteristics, imposed under 2002/30 since April 2002. However, we are also interested in your total noise management system, including noise monitoring, rules and penalties to control track-keeping, actual monitored noise limits by individual flights, etc. We will come to those in the next Section [5 (b) and (e)], as they relate rather to Operational **Procedures** than **Restrictions.**.

4.1 Have there been any changes in the noise management system since April 2002 when Chapter 2 aircraft were finally excluded from Community airports?
………………………………………………………………………………………..
………………………………………………………………………………………..
4.2 Have consultations taken place on the measures taken?
………………………………………………………………………………………..
………………………………………………………………………………………..
4.3 To what extent has Directive 2002/30 been of influence on the noise management system?
………………………………………………………………………………………..
………………………………………………………………………………………..

4.4 Have any measures been introduced that could not have been introduced without the Directive?
a) Ban on marginally compliant aircraft (ch3 – 5 dB) [yes/no]
b) Ban on other Chapter 3 aircraft [yes/no]
c) Night restrictions [yes/no]

Can we just run through the specifics of any restrictions you may have imposed or plan to impose under the Directive?

a) and b) Banning Marginal Chapter 3 aircraft
4.5.1 Is a ban of marginal chapter 3 aircraft applied or considered?
Yes / No [please encircle]

If yes, please proceed:
4.5.2 It is applied since / planned for: …..
4.5.3 We might do so, if
………………………………………………………………………………………..
………………………………………………………………………………………..
4.5.4 The ban is / would be defined as :
………………………………………………………………………………………..
………………………………………………………………………………………..
4.5.5 What particular aircraft types were/would be affected (e.g. B737-300)?
………………………………………………………………………………………..
………………………………………………………………………………………..
4.5.6 The expected / achieved noise reduction is [also note how this is measured]:
………………………………………………………………………………………..
………………………………………………………………………………………..
4.5.7 Would a possible ban of Chapter 3 minus 8 enable you to manage noise more effectively?
………………………………………………………………………………………..
………………………………………………………………………………………..
4.5.8 Under what circumstances would you consider introducing such a ban?
………………………………………………………………………………………..
………………………………………………………………………………………..

If so, please proceed:
4.5.9 When would you like to introduce it? ……………………..
4.5.10 How would you prefer to define the ban? [e.g. partial or total ban]
…………………………………………………………………………………………..
…………………………………………………………………………………………..
4.5.11 What aircraft types would be affected?
…………………………………………………………………………………………..
…………………………………………………………………………………………..
4.5.12 Do you expect such a ban to make a significant difference? [e.g. in noise / operations / would it affect many airlines / aircraft]
…………………………………………………………………………………………..
…………………………………………………………………………………………..
4.5.13 What noise reduction would you expect from it? [also note how this is measured]

…………………………………………………………………………………………..
…………………………………………………………………………………………..

c) Night Restrictions
4.6.1 Are night time restrictions imposed or considered?
Yes / No [please encircle]

If yes, please proceed:
4.6.2 It is applied since / planned for: …..
4.6.3 We might do so, if
…………………………………………………………………………………………..
…………………………………………………………………………………………..
4.6.4 The restriction is / would be defined as [summary description, no details needed]:
…………………………………………………………………………………………..
…………………………………………………………………………………………..
4.6.5 Was it part of a wider package (e.g. more day flights, new runway etc.)?
…………………………………………………………………………………………..
…………………………………………………………………………………………..
4.6.6 The expected / achieved noise reduction is [also note how this is measured]:
…………………………………………………………………………………………..
…………………………………………………………………………………………..
4.6.7 Are any other partial operating restrictions possible / under consideration?
…………………………………………………………………………………………..
…………………………………………………………………………………………..
4.7 For the restrictions we have been discussion, how the airlines reacted and how has this helped to reduce noise? [E.g. substitution of quieter aircraft on services affected, relocation of flight to other airports, loss of frequencies / services]
…………………………………………………………………………………………..
…………………………………………………………………………………………..

5 Inventory of Other Noise management Measures
Apart from the measures discussed so far, have (are) any other noise management measures been implemented (planned for) at your airport?

Land use planning and management	Yes / No	Since / planned for
Operational procedures		
Insulation of properties		
Acquisition of properties		
Market based instruments / pricing measures		

If so, please proceed to fill in details.

a) Land Use Planning & Management
5.1.1 Outline policy
…………………………………………………………………………………………..
…………………………………………………………………………………………..

5.1.2 Any quantifiable economic or financial costs?
……………………………………………………………………………………………..
……………………………………………………………………………………………..
5.1.3 Costs borne by?
……………………………………………………………………………………………..
……………………………………………………………………………………………..
5.1.4 Noise reduction achieved [how measured]?
…………………………………………………………………………………………..
…………………………………………………………………………………………..

b) Operational Procedures (e.g. tracks, noise abatement climb etc.)
5.2.1 Please elaborate briefly
…………………………………………………………………………………………..
…………………………………………………………………………………………..
5.2.2 Any quantifiable economic or financial costs?
…………………………………………………………………………………………..
…………………………………………………………………………………………..
5.2.3 Costs borne by?
…………………………………………………………………………………………..
…………………………………………………………………………………………..
5.2.4 Noise reduction achieved [how measured]?
…………………………………………………………………………………………..
…………………………………………………………………………………………..

c) Insulation of Properties
5.3.1 Please quantify (e.g. number of houses, schools, hospitals, etc) insulated until now.
………………………………………………………………………………………..
………………………………………………………………………………………..
5.3.2 Can you estimate the total costs of the programme up to now?
………………………………………………………………………………………..
………………………………………………………………………………………..
5.3.3 What is the quantified aim of the insulation. [e.g. - 10 dB inside]?
………………………………………………………………………………………..
………………………………………………………………………………………..
5.3.4 What does it cost to insulate a house to that level?
…………………………………………………………………………………………..
…………………………………………………………………………………………..
5.3.5 Who bears the costs?
…………………………………………………………………………………………..
…………………………………………………………………………………………..
5.3.6 Do you have any indication of the impact on the number of exposed people [how measured]?
…………………………………………………………………………………………..
…………………………………………………………………………………………..

d) Acquisition of properties
5.4.1 Please quantify (e.g. number of houses, other property or land) acquired.
………………………………………………………………………………………..
………………………………………………………………………………………..

5.4.2 Can you estimate the total costs of the programme up to now?
………………………………………………………………………………………………..
………………………………………………………………………………………………..
5.4.3 What is the quantified aim of the acquisition [e.g. removing how many people from what contour]?
………………………………………………………………………………………………..
………………………………………………………………………………………………..
5.4.4 Who bears the costs?
………………………………………………………………………………………………..
………………………………………………………………………………………………..

e) Market based instruments / pricing measures

5.5.1 Are the Airport User charges (such as landing fees) differentiated by :

- certificated noise emission of aircraft [yes/no]
- and day / night [yes/no]

5.5.2 What is the reason for the differentiation? (E.g. noise management / regulating congestion / other)
………………………………………………………………………………………………..
………………………………………………………………………………………………..
5.5.3 Are there net revenues and if so, what are they used for?
………………………………………………………………………………………………..
………………………………………………………………………………………………..
5.5.4 Can the noise benefits be quantified [how measured]?
………………………………………………………………………………………………..
………………………………………………………………………………………………..

5.6 Any other noise management measures in place, planned or considered? [Please pay attention to year of introduction, achieved noise reduction, costs and who bears the costs]
………………………………………………………………………………………………..
………………………………………………………………………………………………..

6 Policy Issues

6.1 Does your airport in fact have a "noise problem"?
………………………………………………………………………………………………..
………………………………………………………………………………………………..

6.2 If so, please discuss:

- What is it? (Night noise, particular aircraft or operator, what?)
- Is capacity restricted by such a noise problem (e.g. noise budget, restricted night utilisation or runway use)?
- Are the total noise emissions restricted by some sort of noise or movements budget and if so, does this affect capacity?
- If not, do you expect it to do so in the future?

………………………………………………………………………………………………..
………………………………………………………………………………………………..
………………………………………………………………………………………………..

6.3 Does the airport determine its noise limits or are they imposed by local, regional or national authorities?

……………………………………………………………………………………………..

……………………………………………………………………………………………..

6.4 Does your airport have a quantified noise policy objective? [e.g. shrink 55 dB Lden contour population by what percentage over how many years]

……………………………………………………………………………………………..

……………………………………………………………………………………………..

6.5 Do you have sufficient powers to achieve objectives? Yes / no (encircle)
If not, what extra powers would be required?

……………………………………………………………………………………………..

……………………………………………………………………………………………..

6.6 Would revision of 2002/30 or a new Directive help you to manage noise more effectively? What new legislative measures would you recommend? [E.g. enable ban on chapter 3 -8 dB]

……………………………………………………………………………………………..

6.7 If you were able to do more (greater stringency, better land use planning) what would the effects on your noise climate be ? (Specifically - which aircraft excluded, how many people moved out of 55dB Lden contour, etc.).

……………………………………………………………………………………………..

6.8 What is your airport's viewpoint (or your own professional opinion if no formal policy) with regard to market-based instruments for noise management (e.g. differentiated charging, noise penalties to aircraft that do not follow procedures or make too much noise, noise permit trading, etc)?

……………………………………………………………………………………………..

……………………………………………………………………………………………..

6.9 What is your airport's viewpoint (or your own professional opinion if no formal policy) with regard to "indirect" operational restrictions for managing noise (e.g. by using the Community Slot Regulation to noise levels of aircraft or their operators)?

……………………………………………………………………………………………..

6.10 Do you think the 50k jet movement threshold for applicability of Directive 2002/30 should be reduced/increased/unchanged ?

……………………………………………………………………………………………..

7 Follow up

7.1 We shall be conducting some more detailed case studies at a few airports, modelling actual and forecast contours for various scenarios. The results will be part of our report and may be publicised by the Commission. If invited, would your airport be prepared to participate in such a case study?

Yes / no, on the condition of ……………………………………………………………..

7.2 Are there any other matters **you** would like to raise in this context?

………………………………………………………………………………………………..

7.3 Was there anything confidential we can not use in our report ?

………………………………………………………………………………………………..

7.4 I hope I may contact you again if any problems arise?
Yes / no

Thank you sincerely for your time and effort!

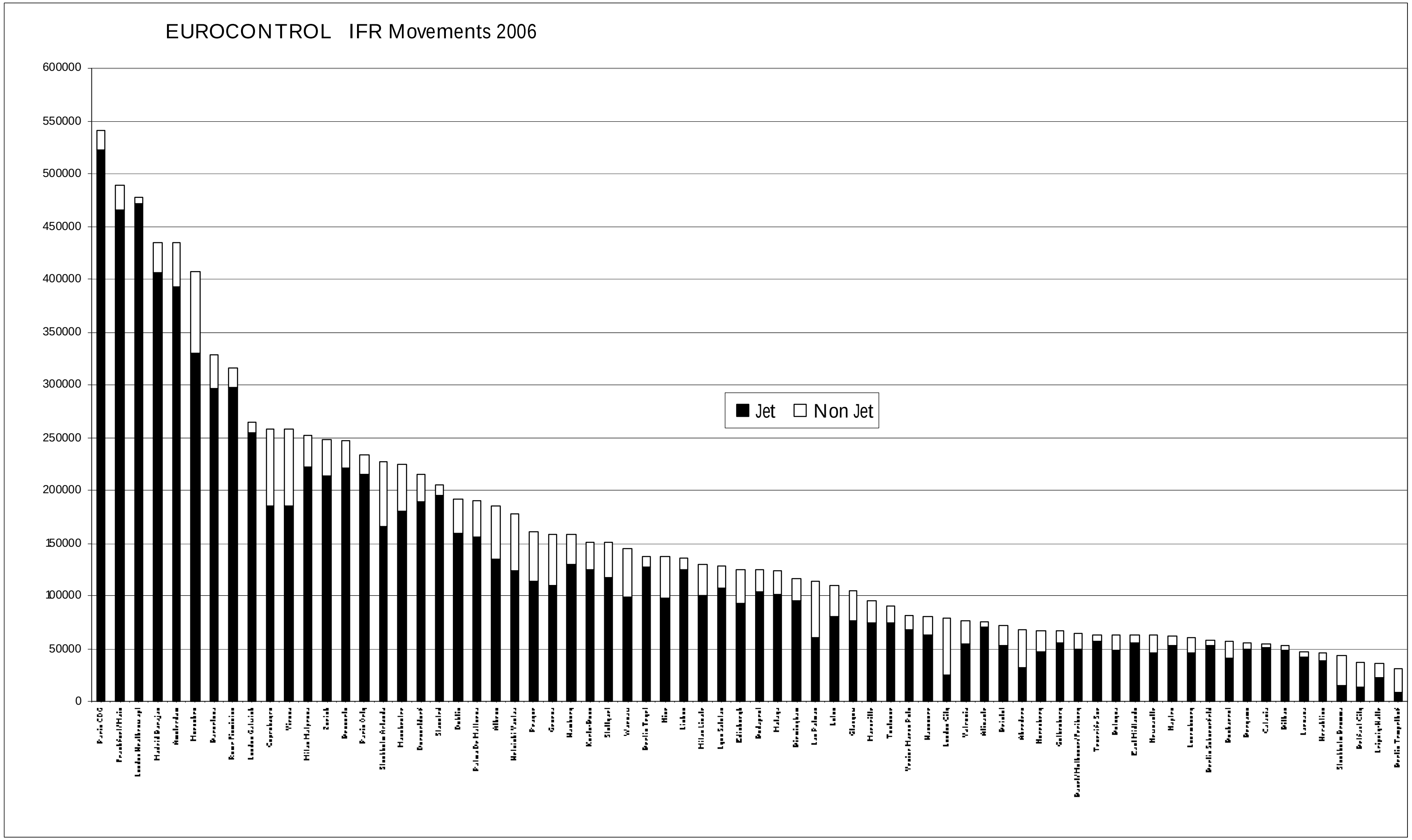
Appendix C 2002/3 and 2006 jet and total movements at airports

Airports Studied (Ranked by 2006 IFR Movements '000)

	2002/03			2006			
	Jet	Non-Jet	All A/c	Jet	Non-Jet	All A/c	
Paris CDG	490.4	24.3	514.7	521.8	19.3	541.2	CDG
Frankfurt/Main	432.6	37.8	470.4	465.1	23.8	488.9	FRA
London Heathrow	457.3	5.3	462.5	471.8	5.5	477.3	LHR
Madrid Barajas	339.4	35.3	374.7	406.0	29.0	435.0	MAD
Amsterdam	351.4	58.7	410.1	392.6	42.3	435.0	AMS
Muenchen	264.6	80.1	344.7	329.7	77.9	407.5	MUC
Barcelona	234.7	42.5	277.2	296.1	31.6	327.8	BCN
Rome Fiumicino	269.0	19.4	288.4	297.0	18.6	315.6	FCO
London Gatwick	225.0	18.6	243.6	254.0	9.7	263.8	LGW
Copenhagen	184.5	74.3	258.8	184.9	73.3	258.2	CPH
Vienna	150.0	54.4	204.4	185.6	71.8	257.4	VIE
Milan Malpensa	192.0	24.9	216.9	222.8	28.7	251.5	MXP
Zurich	211.5	59.0	270.6	213.2	35.0	248.2	ZRH
Brussels	224.5	22.8	247.2	221.3	26.1	247.3	BRU
Paris Orly	193.4	18.3	211.7	214.7	19.0	233.7	ORY
Stockholm Arlanda	162.9	77.0	239.9	165.5	61.2	226.7	ARN
Manchester	158.9	31.1	190.0	180.6	44.6	225.2	MAN
Duesseldorf	162.1	27.3	189.4	188.7	25.5	214.3	DUS
Stansted	157.4	17.5	174.9	195.6	9.5	205.1	STN
Dublin	133.9	36.8	170.7	159.1	32.0	191.2	DUB
Palma De Mallorca	125.7	37.3	163.0	155.1	34.8	189.9	PMI
Athens	111.9	45.0	156.9	134.7	50.1	184.9	ATH
Helsinki Vantaa	101.1	51.8	153.0	123.7	54.6	178.3	HEL
Prague	66.2	34.2	100.4	114.1	46.1	160.2	PRG
Geneva	103.3	41.2	144.5	109.8	48.6	158.5	GVA
Hamburg	107.2	30.0	137.2	129.8	27.7	157.5	HAM
Koeln-Bonn	93.5	42.6	136.1	125.1	25.4	150.5	CGN
Stuttgart	88.3	42.1	130.4	117.1	33.1	150.2	STR
Warsaw	70.8	35.6	106.4	98.7	45.9	144.6	WAW
Berlin Tegel	117.6	10.4	128.0	127.7	9.9	137.5	TXL
Nice	112.5	32.9	145.4	98.1	38.4	136.5	NCE
Lisbon	104.1	10.5	114.6	124.6	11.8	136.4	LIS
Milan Linate	88.8	21.3	110.1	100.1	29.9	130.0	LIN
Lyon Satolas	100.1	18.6	118.6	107.8	21.0	128.7	LYS
Edinburgh	83.9	28.5	112.4	92.3	32.5	124.8	EDI
Budapest	60.7	15.1	75.8	104.1	20.7	124.8	BUD
Malaga	77.5	19.1	96.7	101.3	22.7	124.0	AGP
Birmingham	103.0	18.2	121.2	95.6	20.2	115.8	BHX
Las Palmas	49.7	44.5	94.2	60.7	52.3	113.1	LPA
Luton	58.3	18.2	76.5	80.1	30.2	110.3	LTN
Glasgow	73.5	23.3	96.8	76.7	28.0	104.6	GLA
Marseille	70.9	21.5	92.4	74.5	21.1	95.5	MRS
Toulouse	70.0	19.5	89.5	74.5	15.4	90.0	TLS
Venice Marco Polo	57.0	12.7	69.7	67.9	14.1	82.0	VCE
Hannover	54.1	22.5	76.6	63.2	17.0	80.2	HAJ
London City	12.8	42.5	55.3	24.5	54.9	79.4	LCY
Valencia	22.4	27.4	49.8	54.1	22.7	76.8	VLC
Alicante	50.5	4.9	55.5	70.2	4.7	75.0	ALC
Bristol	36.2	17.4	53.6	53.7	17.8	71.5	BRS
Aberdeen	25.2	26.6	51.9	32.0	35.9	67.9	ABZ
Nuernberg	33.2	28.9	62.1	46.5	20.5	67.0	NUE
Gothenborg	52.5	14.1	66.7	55.7	10.5	66.2	GOT
Basel/Mulhouse	45.8	43.0	88.8	49.9	14.8	64.7	BSL
Tenerife Sur	53.3	7.4	60.7	56.3	7.0	63.2	TFS
Bologna	46.9	14.6	61.5	48.3	14.6	62.9	BLQ
East Midlands	49.9	10.5	60.3	55.5	7.1	62.6	EMA
Newcastle	27.8	19.1	46.9	45.9	16.7	62.6	NCL
Naples	51.7	19.9	71.6	53.4	8.3	61.8	NAP
Luxembourg	36.7	18.4	55.1	46.1	14.5	60.6	LUX
Berlin Schoenefeld	17.5	7.5	25.1	52.5	5.4	57.9	SXF
Bucharest	25.1	9.5	34.6	41.2	15.8	56.9	OTP
Bergamo	26.5	8.3	34.8	49.6	6.2	55.8	BGY
Catania	42.8	6.3	49.1	50.3	4.5	54.7	CTA
Bilbao	31.2	6.8	38.0	48.5	3.9	52.5	BIO
Larnaca	42.9	3.5	46.4	42.3	4.4	46.7	LCA
Heraklion	35.3	5.2	40.5	38.2	7.5	45.7	HER
Stockholm Bromma	16.3	21.9	38.2	15.2	27.5	42.7	BMA
Belfast City	18.7	18.3	37.0	13.8	23.9	37.6	BHD
Leipzig-Halle	17.4	15.3	32.8	22.5	13.7	36.2	LEJ
Berlin Tempelhof	5.0	31.3	36.3	8.6	22.4	31.0	THF
TOTAL	7968.7	1890.7	9859.5	9198.3	1821.2	11019.5	Total
	Average rate of change per annum			3.9%	-1.0%	3.0%	

Note 1: "Non Jet" means jet aircraft <19 seats or <34 tonnes, as well as turboprop/piston aircraft.

Note 2: City airports specified the Directive are identified by shading


EUROCONTROL IFR Movements 2006
600000
550000
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Jet
Non Jet

Appendix D Percentage Growth in movements at European airports

Percentage Growth in movements at European airports

All Aircraft types (Jet & Non Jet)	
Airport	% Growth 2006 v 2002/3
Berlin Schoenefeld	131%
Bucharest	65%
Budapest	65%
Bergamo	60%
Prague	60%
Valencia	54%
Luton	44%
London City	44%
Bilbao	38%
Warsaw	36%
Alicante	35%
Newcastle	33%
Bristol	33%
Aberdeen	31%
Malaga	28%
Vienna	26%
Las Palmas	20%
Lisbon	19%
Manchester	19%
Barcelona	18%
Muenchen	18%
Milan Linate	18%
Athens	18%
Venice Marco Polo	18%
Stansted	17%
Palma De Mallorca	17%
Helsinki Vantaa	17%
Madrid Barajas	16%
Milan Malpensa	16%
Stuttgart	15%
Hamburg	15%
Duesseldorf	13%
Heraklion	13%
Dublin	12%
Stockholm Bromma	12%
Catania	11%
Edinburgh	11%
Leipzig-Halle	11%
Koeln-Bonn	11%
Paris Orly	10%
Luxembourg	10%
Geneva	10%
Rome Fiumicino	9%
Lyon Satolas	9%
London Gatwick	8%
Glasgow	8%
Nuernberg	8%
Berlin Tegel	7%
Amsterdam	6%
Paris CDG	5%
Hannover	5%
Tenerife Sur	4%
Frankfurt/Main	4%
East Midlands	4%
Marseille	3%
London Heathrow	3%
Bologna	2%
Belfast City	2%
Larnaca	1%
Toulouse	0%
Brussels	0%
Copenhagen	0%
Gothenborg	-1%
Birmingham	-4%
Stockholm Arlanda	-6%
Nice	-6%
Zurich	-8%
Naples	-14%
Berlin Tempelhof	-15%
Basel/Mulhouse/Freiburg	-27%
Total	12%

Appendix E Night movements as a proportion of total movements

Jet night movements 2002/3 and 2006 as proportion of total movements, and growth

Aircraft type: Jets

Name	2002/3 Night proportion	2006 Night proportion	2006 v 2002/3 Night growth
Koeln-Bonn	28.4%	24.9%	17%
East Midlands	27.3%	30.8%	25%
Bergamo	24.0%	19.2%	50%
Leipzig-Halle	23.3%	26.1%	44%
Berlin Schoenefeld	23.3%	13.1%	69%
Nuernberg	21.4%	14.7%	-4%
Larnaca	20.8%	21.2%	1%
Athens	18.4%	16.0%	4%
Tenerife Sur	16.6%	14.8%	-6%
Heraklion	16.6%	18.4%	20%
Hannover	14.4%	16.6%	35%
Las Palmas	14.0%	15.6%	35%
Luton	13.8%	12.1%	17%
Newcastle	13.0%	11.5%	46%
Bucharest	12.9%	14.6%	85%
Palma De Mallorca	12.6%	10.2%	-1%
Gothenborg	12.3%	11.8%	2%
London Gatwick	11.5%	12.2%	20%
Brussels	11.3%	14.0%	22%
Bologna	11.2%	12.9%	18%
Marseille	10.8%	11.1%	9%
Manchester	10.7%	11.1%	18%
Stansted	10.5%	13.7%	61%
Helsinki Vantaa	10.4%	11.5%	35%
Valencia	10.0%	7.8%	89%
Frankfurt/Main	9.9%	9.3%	1%
Malaga	9.8%	8.0%	7%
Alicante	9.3%	7.3%	8%
Glasgow	9.3%	10.4%	17%
Stuttgart	9.2%	9.2%	32%
Toulouse	9.1%	8.7%	2%
Paris CDG	9.0%	8.6%	2%
Stockholm Arlanda	8.8%	8.4%	-4%
Prague	8.7%	8.2%	63%
Basel/Mulhouse/Freiburg	8.7%	10.9%	36%
Edinburgh	8.3%	8.0%	6%
Luxembourg	8.3%	10.0%	51%
Bristol	8.2%	8.7%	58%
Catania	7.8%	9.7%	45%
Budapest	7.8%	10.6%	132%
Dublin	7.8%	12.0%	82%
Lisbon	7.8%	7.0%	7%
Madrid Barajas	7.6%	9.0%	42%
Birmingham	7.5%	8.9%	10%
Amsterdam	7.2%	8.1%	26%
London Heathrow	6.5%	6.4%	2%
Vienna	6.4%	8.3%	60%
Duesseldorf	6.4%	7.3%	34%
Hamburg	6.3%	6.8%	30%
Warsaw	6.3%	8.9%	98%
Berlin Tegel	6.2%	7.3%	27%
Rome Fiumicino	6.2%	5.7%	1%
Barcelona	5.9%	7.4%	56%
Lyon Satolas	5.8%	6.7%	24%
Naples	5.4%	4.2%	-19%
Muenchen	5.2%	5.8%	38%
Copenhagen	5.2%	6.1%	19%
Aberdeen	5.1%	6.3%	57%
Nice	4.9%	4.3%	-25%
Milan Linate	4.9%	6.8%	55%
Venice Marco Polo	4.6%	6.9%	80%
Bilbao	4.3%	4.9%	80%
Geneva	4.1%	4.9%	27%
Milan Malpensa	4.0%	5.8%	68%
Belfast City	3.8%	2.0%	-61%
Zurich	3.7%	4.1%	11%
Paris Orly	2.5%	2.5%	12%
Stockholm Bromma	1.4%	0.4%	-73%
Berlin Tempelhof	0.5%	3.0%	946%
London City	0.0%	0.9%	*
TOTAL	8.6%	9.1%	23%

Appendix F Forecasting Methodology and Approach

1. Sources and their Uses

1.1 Sources and their Uses : Introduction

We start of course from the EUROCONTROL database produced specifically for this study at the request of the Commission, identifying numbers of IFR movements by aircraft type and MTOM[33] by hourly time bands at each of our 70 specified airports, for the two years April 2002 – March 2003 and calendar 2006. Individual aeroplanes and operators may not be identified for confidentiality reasons.

In seeking acceptable consensus for forecasts to apply to that baseline, we have sought authoritativeness, consistency, and relevance in existing forecasts, from which we have borrowed and which we have adapted (not always for purposes envisaged by the original authors) to give us a basis for quantified assessments of future aircraft noise exposure in various stringency scenario circumstances. The source forecasts on which we have particularly concentrated for the volume growth forecasts for modelling, presented in this Section, are :

- EUROCONTROL (STATFOR) Medium-Term Forecast: IFR Flight Movements 2007-2013 edition number v1.0, volume 1 (6/3/2007) and volume 2 (22/2/07).
- EUROCONTROL (STATFOR) Long-Term Forecast: Flight Movements 2006-2025 edition number v1.0 (01/12/06).
- Our airport interview programme, while primarily concerned with noise management, also requested airports' own forecasts of future growth of movements, and of any quantifiable (existing or expected) restrictions on capacity, thus collecting data based on detailed local knowledge at source.

1.2 Sources and Their Uses : EUROCONTROL (STATFOR)

The EUROCONTROL Statistics and Forecast Service (STATFOR) material has the particular virtue of consistency of source and definition, as the data for our base years was also supplied by EUROCONTROL, it is also specific to Europe. It is particularly relevant to this study as it forecasts IFR <u>flights</u> by country (or FIR region), which we have translated into airport <u>movements</u>.

It is this STATFOR material, together with airports' own forecast growth rates, which are the basis of our forecasts of movements in the base case. These provide the numbers of movements for modelling the different stringency scenarios at the case study airports in 2010 and 2015, and for grossing up the results of that base case to the groups of airports of which the case studies are broadly representative.

At each airport, the determined growth rates to 2010 and 2015 are applied to the EUROCONTROL database for 2006. The 2006 data is arranged by day, evening and night, and the appropriate overall growth rate for each airport is (initially) applied to each time period. The objective is to provide a "base case" future in which only traffic volume, determined by (in this context) "disinterested" sources, differs from the present situation.

We thus start, in effect, from a somewhat artificial "worst case". This postulates that the 2006 fleet mix, including marginal Chapter 3 aircraft, remains in operation until 2010 and 2015, and even the marginal aircraft manage to increase their numbers of movements (in the same time periods as they flew in 2006) without breaching ICAO's rule, whereby all new types certificated since 2006 must be

[33] MTOM : Maximum take off mass.

Chapter 4 compliant (Chapter 3 minus 10 dB(A)). It is this "worst case base case" against which the effects of different definitions of marginality, and thus corresponding degrees of stringency, are consistently measured.

The main disadvantage of this approach is that the base case is indeed artificially pessimistic. However, this is in our view outweighed by the consistency of the results in terms of the changes resulting from application of various policy options. They are neither skewed by, nor dependent upon, judgemental predictions of what might or might not happen to the fleet mix by way of "natural change". Such "natural change", addressed in Section 8, includes all sorts of extraneous reasons among the myriad of other drivers of particular aircraft replacement such as fuel efficiency, passenger preference, interest rates, and so on.

If, at the opposite "best case, base case" extreme, all "minus 8" aircraft were forecast to disappear from service by 2015 for example, the result of a change in the definition of marginality from "minus 5" to "minus 8" (and its adoption by airports as a basis for restrictions) would be forecast as zero. This would be of no help in assessing the effectiveness of such a redefinition. It could be a basis for policy advice ranging from "do nothing, greater stringency is unnecessary" to "do it anyway, restriction imposes no cost", neither providing a measured basis of the effect of such a policy, for comparison with alternative strategies.

The likelihood in practice is of a situation somewhere between the two extremes. Its assessment requires the application of judgement, which we reserve to the later qualitative rather than quantitative element of our forecasts. For this too we shall look at other, also authoritative, but somewhat conflicting sources.

2 Central Forecasts : Overview

These are baseline "business as usual" forecasts of growth of IFR movements at European airports. They focus upon the calendar years 2010 and 2015, applying national growth rates derived from STATFOR Medium- and Long-Term forecasts to our list of airports covered by (or expected to be covered by) Directive 2002/30/EC. They thus are essentially national forecasts, cumulating to an authoritatively-based and impartial cumulative picture for the European Union plus Switzerland, with our EUROCONTROL database airports' movements accounting for 70% of the STATFOR 2006 overall total of movements for the same group of countries.

The STATFOR forecasts already take account of individual current and future airport and airspace capacity restrictions known to, but not disclosed by, EUROCONTROL, who treat this information as confidential. For calculation purposes, however, in order to present a coherent and consistent (albeit somewhat artificial) base against which to measure the effects of stringency scenarios, we have initially assumed uniform growth at national rates over all the airports within each country, unless the resultant forecasts are at significant variance with :

- any known limits on capacity at individual airports, as declared to us without confidentiality constraints during our interview programme, particularly overall infrastructural or operational limits on the number of movements that can be accommodated;
- existing environmental limits on numbers of total movements, at night for instance, of which airports have informed us, although we have assumed that current limits on numbers of movements by particular aircraft types, or QC budgets, do not necessarily affect future growth in numbers of movements, as a QC total can be made up by many different aircraft combinations;

- airports' own forecast growth rates in total movements within which airports have told us they are planning as a matter of local market knowledge;
- recent historic growth rates, where there appear to be good reasons to expect future changes to them to be unlikely.

The distribution of movements at each airport by time (day, evening, night) and number of movements are taken at this stage to change at uniform rates by aircraft type, so the proportions of aircraft (small to large, passenger to freighter, quiet to noisy) remains constant until different levels of stringency are applied.

We do not of course have the same confidential details on capacity constraints for the whole of Europe as are available to EUROCONTROL. Conversely, we are aware of some plans by airports to increase capacity; but these are generally subject to Planning, financial and/or other constraints, and neither we nor the airports can predict the outcome of such plans or their timing. Exceptions (major projects already under way like Heathrow's Terminal 5), are taken into account by airports' own forecasts, or effectively subsumed in STATFOR country totals within which our distribution will be inevitably imperfect. In addition, there are (generally confidential) marketing plans by operators, as to where and when they will increase or decrease numbers of movements.

Some of these constraints and changes are within the context of "natural" aircraft fleet changes, whereby the general trend (through technological development and modernisation) is for aircraft to become quieter. It is to eliminate dependence upon such uncertainties that we have initially postulated uniformly distributed rates of change within countries for modelling, unless we see good reason to apply the exceptions noted above, but keeping within an authoritative cumulative 'control total' envelope.

3 Source Details

3.1 Flights and Movements

It is first necessary to recognise that the STATFOR forecasts are of IFR movements enumerated in terms of <u>flights</u>, because flights are what EUROCONTROL deals with; while we are concerned with IFR <u>movements at airports</u> enumerated in terms of take-offs and landings. We have used two sets of STATFOR forecasts, described below.

3.2 Medium-Term 2007-2013

At the national level, the Medium-Term forecasts of flights comprise :

- "internal" (domestic) flights, each of which generates two airport movements within that country;
- "arriving/departing" flights, each generating an arrival or a departure at an airport within that country – while the same flight will be counted again as an arrival or departure in the country of its origin or destination if that is within Europe, so these flights are equivalent to airport movements within each country;
- "overflights", important for EUROCONTROL charging and en-route facilities planning, but, whether they arrive at or depart from airports in other European countries (in which case they have already been counted as airport movements there) or outside Europe, numbers of overflights are irrelevant to our forecasts.

At the EUROCONTROL Statistical Reference Area (ESRA) level; "internal" means flights within the ESRA area (each generating two airport movements within that area; "arriving/departing" flights are those flight sectors whose origin/destination is outside ESRA, and "overflights" are those (relatively) few which cross any part of the Area without landing. Thus country totals of flights and of the airport movements deduced from them can not be added directly to ESRA totals. We have however taken care to check that our deduced country-by-country airport movements match those appropriately deduced on an ESRA basis.

Medium-Term forecasts cover the period 2007 to 2013. They derive from modelled airport-pair traffic flows, constrained by (confidential) airport capacities, driven by economic and industry trends. They take account of trends in load factors, ticket prices, and observed factors like rapid growth in Accession markets, continued growth of low-cost carriers, high speed train development, and open skies agreements. Thus both supply-side and demand-side effects are modelled, to produce high, low, and baseline "scenario" forecasts. We have worked on the "baseline" numbers, extracting absolute annual movement numbers and deriving percentage growth rates :

- to produce our 2010 forecast for modelling; and
- to have the latest possible (2013) consistent base for our 2015 forecast.

3.3 Long-Term 2006-2025 (to cover 2014 and 2015)

We used these forecasts as a guide to extrapolation from the 2013 Medium-Term to our second snapshot year, the 2015 forecast for modelling. STATFOR regards 2015 as falling in a Long-term timescale, and beyond 2013 displays only total flight numbers for each country – single-counted internal, normally counted arriving/departing, and overflights added together. The particular difficulty with overflights is that they can comprise the great majority of a country's flights (as can be seen from the Medium-Term details for, for instance, Austria or Belgium/Luxembourg); or in some cases a small minority (e.g. Canary Islands), or in others accounting for very roughly half (e.g. Denmark and France). Thus total flight growth rates are not necessarily wholly appropriate for forecasting airport movements. However, since we have used these percentage growth rates only for the final two years of an uncertain future, we think this known danger is preferable to "second-guessing".

The STATFOR Long-Term forecasts adjust for the loss of between 0.2 and 0.6 million arrivals/departures for ESRA as a whole in 2015 due to capacity shortages, without apparent redistribution of unaccommodated movements within countries. These capacity shortages will be concentrated at the larger airports which are included in our studied list (although resultant movement losses can affect uncongested origin/destination airports) and the traffic losses could affect the total forecast movements in Table 7.1 by around 2%. Thus our forecasts are not totally unconstrained at least as we approach the planning horizon, but such discrepancies are, we think, within the limits of conservative estimation.

We should further note that the STATFOR forecasts reflect a series of "scenarios" (A, B, C and D), but the term "scenario" is used rather differently from its use in the Medium-Term[34]. Here, they are defined by different quantitative (but unquantified) inputs to a matrix of 13 factors across the four "scenarios". The factors include different tourism destination trends, the relative strengths of different free trade agreements, fuel price trends, security costs, hub and spoke or point-to-point emphasis (network effects), and business jet developments. STATFOR recommend consideration of all four scenarios, and warn that they represent different views of

[34] And of course quite differently from our "scenarios", which describe various levels of stringency in noise management.

aviation in the future, so they are nor necessarily "mixable". However while hopefully not being lulled, as STATFOR puts it, into a "simplistic one-size-fits-all solution", we keep in mind that we are seeking an "acceptable" forecast within an authoritative range, and we have arithmetically averaged the growth rates of the four STATFOR "scenarios" for our 2013 to 2015 results[35].

4 Methodology

(a) STATFOR historic and Medium-Term forecast numbers of IFR flights were first converted to airport IFR movements for each Community Member State, for 2003 (total 14.3 million), 2006 (15.7 million), 2010 (17.8 mn), 2012 (19.0 mn) and 2013 (19.6 mn).

(b) Average annual growth rates of airport IFR movements were calculated for each country for the periods 2003 to 2006 (3.3% per annum overall) and 2006 to 2010 (3.2% p.a. overall), as well as 2010 to 2012 (3.3% p.a.) and 2012 to 2013 (3.0%).

(c) The STATFOR Long-Term forecast IFR average annual flight growth rates for the period 2012 to 2015 (total 4.3% p.a.) were applied to the Medium-Term 2013 airport IFR movements to give forecast numbers of airport IFR movements for 2015 for each country (total 20.8 million).

(d) The resultant average annual growth rates of airport IFR movements for the period 2010 to 2015 (3.1% overall) was calculated and compared with those for 2003 to 2006, 2006 to 2010, 2010 to 2012, 2012 to 2013, and 2013 to 2015, for overall reasonableness and consistency.

(e) The 2006 STATFOR-derived airport IFR movement totals for each country were compared with the sums of the 2006 EUROCONTROL database IFR movements for each listed airport in each country, and the differences labelled as "other" airports. The proportion of 2006 STATFOR movements identified, at our EUROCONTROL list of airports studied, is 70% overall in the Community plus Switzerland.

(f) The average annual growth rates derived in preceding steps for each country for the periods 2006 to 2010 and 2010 to 2015 were then applied across the board to individual listed airports' IFR movements, and to the "other" airports within each country's 'control total'.

(g) Each identified airport was then considered to see if adjustment was warranted on grounds of capacity limitations, airports' own forecast growth rates, or other known factors, and any redistribution of traffic between airports was made to remain within the STATFOR-derived country 'control totals'.

(h) Movements at each airport were then allocated to day/evening/night time bands, pro rata to the 2006 distribution, failing interview notification of significant time-related (generally night) limits on total numbers of movements.

(i) The forecasts for our listed airports are thus ready to be added to grouped totals, of which the selected case study airports are reasonably representative in terms of stated characteristics, particularly size, for grossing up of modelled noise-exposed population estimates.

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35 It may also be noted that the STATFOR Long-Term forecasts were prepared before the Medium-Term, from a 2005 base, and display growth rates only to 2012, 2015, 2020 and 2025 milestones. This results in slight differences from the 2013 Medium-Term " working base, but for use over a couple of years at this time perspective we do not treat this as significant in the context of overall acceptability.

5 Country Forecasts

The country by country forecasts are summarised in Table 5.1.

The largest, generally mature markets show generally lower growth rates than those of recent Accession States, but because of their size they contribute the highest growth in absolute volume of traffic. Taking the five largest markets in each group over the 2006 to 2015 period :

- France, Germany, Italy, Spain and the U.K. show overall average growth of 3% *per annum* in adding 2.8 million IFR airport movements, but their share of the Community[36] total falls from 65% to 63%; while
- Bulgaria, the Czech Republic, Hungary, Poland and Romania grow at an annual average 7%, but add only 600,000 IFR airport movements in growing their share of the total from 5% to 7%.

Note that the only redistribution of STATFOR-forecast traffic between countries is the movement of an estimated 13,000 night movements from Belgium / Luxembourg to Germany by 2010, to account for an expected relocation of express operations from Brussels to Leipzig-Halle.

[36] plus Switzerland

Table 5.1 IFR Airport Movement Forecasts by Country (Thousands)

Listed Airport Coverage[37]	"Countries"	2003	2006	Change p.a. '03 – '06	2010	Change p.a. '06 -'10	2015	Change p.a. '10 - '15
70%	Austria	320	370	5.0%	418	3.1%	490	3.2%
80%	Belgium & Luxembg	376	383	0.6%	383	0.0%	431	2.4%
0%	Bulgaria	46	69	14.5%	101	10.0%	127	4.7%
50%	Canaries	313	354	4.2%	414	4.0%	500	3.8%
73%	Cyprus	69	64	(2.5%)	75	4.0%	92	4.3%
87%	Czech Republic	125	184	13.8%	239	6.8%	317	5.8%
74%	Denmark	346	351	0.5%	377	1.8%	426	2.5%
0%	Estonia	42	41	(2.4%)	52	6.1%	74	7.3%
63%	Finland	268	282	1.7%	313	2.6%	366	3.2%
65%	France	1960	1999	0.7%	2145	1.8%	2360	1.9%
84%	Germany	2161	2356	2.9%	2615	2.6%	3014	2.9%
49%	Greece	423	467	3.4%	553	4.3%	677	4.1%
97%	Hungary	87	129	14.0%	160	5.5%	208	5.4%
65%	Ireland	258	293	4.6%	366	5.7%	460	4.7%
64%	Italy	1473	1584	2.5%	1739	2.4%	2022	3.1%
0%	Latvia	29	42	20.3%	62	10.2%	95	9.0%
0%	Lithuania	39	43	5.0%	59	8.2%	83	7.0%
0%	Malta	27	28	1.2%	31	2.6%	37	3.8%
82%	The Netherlands	495	533	2.5%	595	2.8%	683	2.8%
53%	Poland	184	273	14.1%	362	7.3%	488	6.2%
53%	Portugal ex Azores[38]	222	257	5.0%	303	4.2%	361	3.6%
47%	Romania	80	122	15.1%	188	11.4%	250	5.8%
0%	Santa Maria FIR	35	37	1.9%	40	2.0%	48	3.5%
0%	Slovakia	28	39	11.7%	51	6.9%	66	5.2%
0%	Slovenia	26	36	11.5%	47	6.9%	59	4.8%
75%	Spain ex Canaries[39]	1430	1705	6.0%	2035	4.5%	2428	3.6%
58%	Sweden	589	576	(0.7%)	628	2.2%	729	3.0%
90%	Switzerland	446	451	0.4%	488	2.0%	555	2.6%
76%	U.K.	2362	2653	3.9%	2978	2.9%	3321	2.2%
70%	Total	14257	15721	3.3%	17817	3.2%	20766	3.1%

Source: Consultants' application of STATFOR Medium- and Long- Term Forecasts

[37] Percentage of each country's 2006 IFR movements accounted for by our list of airports studied
[38] For Portugal read Lisbon FIR, see also Santa Maria FIR
[39] See also Canary Islands

6 Application of Country Forecasts to Airports

For these forecasts, the STATFOR-derived country-wide growth rates were applied across the board to IFR movements at all airports in each country (or other identified region), for 2010 and 2015. Keeping within country totals, individual airport forecasts were adjusted as necessary for capacity restrictions or more immediate knowledge bases. However, the 2006 baseline for our list of individual airports is sourced from our EUROCONTROL database of movements by aircraft type and by time (the Directive 2002/49/EC default-defined day, evening and night). Table 7.1 showed the percentage "coverage" of country total movements by the airports studied to be reasonably comprehensive.

From 2006 onward, the IFR movements at "other" (unidentified) airports in each country could also be arithmetically derived, as the difference between the STATFOR-based country total IFR airport movements and the sum of the individual (identified) airports' IFR movements (EUROCONTROL actuals for 2006, forecasts for 2010 and 2015).

We also have comparable EUROCONTROL airport data for the April 2002 to March 2003 period, the first year after completion of Chapter 2 phase-out. Actual historic changes in individual IFR airport movements are thus recorded accurately. STATFOR does not provide country totals for that precise period, so growth at "other" airport and in country totals can not be shown for the 2002/03 to 2006 period. The STATFOR growth rates by country were shown in Table 7.1 for 2003 to 2006, but we have no EUROCONTROL database of IFR airport movements for calendar 2003, since our emphasis is on the impact of Directive 2002/30/EC since completion (at least in the Community of 15 of that time) of the Chapter 2 phase-out at the end of March 2002.

Table 7.2 (in three parts, to accommodate our list of 70 airports) reflects the historic and forecast IFR individual airport movements and growth rates. It also confirms the "coverage " of our list of 70 airports studied, as actually or probably shortly to be subject to the Directive. Further work will only deal with the identified airports for which we have detailed base data.

The STATFOR country total forecasts remain intact (apart from the Belgium-Germany BRU-LEJ transfer of night flights), with the "other airports" in each country acting as a balancing factor to absorb adjustments to the identified airport forecasts. This process has however been subjected to a "common sense" check, particularly where the absolute numbers involved appear significant. In some cases, however, quite small absolute changes, "fortuitously" arising from application of our methodological rules, can give apparently big parentage variances.

Where an airport has notified a numerical limit on the number of movements it expects to be able to handle (overall or at defined periods) these limits have been accepted. The most notable are the declared movement limits at Gatwick and Heathrow, forecast to be reached by 2010. Bearing in mind that the STATFOR forecasts already take account of (without identifying) capacity limitations, we have stopped their growth there. Some hub traffic might be lost to competing hubs across the Channel in such a situation, but UK airports' own individual forecasts (particularly Birmingham, Manchester and to an extent Stansted) do seem to "take up the slack" of displaced traffic, resulting in only minor adjustment to the "other airports" balance in the UK.

Where an airport has provided its own forecasts for 2010 – often seeming to stem from a differently defined forecasting baseline than our consistently authoritative 2006 EUROCONTROL database, we have accepted it, or calculated the airport's own forecast growth rate and applied it to our 2006 base. For 2010 to 2015, the same process has been followed, using the adjusted 2010 forecast as a base.

Table 6.1 Part 1 Individual Airport IFR Movement Forecasts (Thousands)

Airports	Actual 2002/03	Actual 2006	Change p.a. '02/03 – '06	Forecast 2010	Change p.a. '06 – '10	Forecast 2015	Change p.a. '10 – '15
VIE Vienna	204	257	6.3%	281	2.2%	325	2.9%
Other Austria	-	113	-	137	5.0%	164	3.7%
BRU Brussels	247	247	0.0%	243	(0.5%)	273	2.4%
LUX Luxemburg	55	61	2.6%	63	0.8%	71	2.4%
Other Belgium/Lux	-	75	-	78	0.8%	87	2.4%
Bulgaria	-	69	-	101	10.0%	127	4.7%
LPA Las Palmas	94	113	5.0%	132	4.0%	160	3.8%
TFS Tenerife Sur	61	63	1.1%	74	4.0%	89	3.8%
Other Canaries	-	178	-	208	4.0%	251	3.8%
LCA Larnaca	46	47	0.2%	55	4.0%	67	4.3%
Other Cyprus	-	17	-	20	4.0%	25	4.3%
PRG Prague	100	160	13.3%	208	6.8%	276	5.8%
Other Czech Rep	-	24	-	31	6.8%	41	5.8%
CPH Copenhagen	259	258	(0.1%)	277	1.8%	313	2.5%
Other Denmark	-	93	-	100	1.8%	113	2.5%
Estonia	-	41	-	52	6.1%	74	7.3%
HEL Helsinki	153	178	4.2%	198	2.6%	231	3.2%
Other Finland	-	104	-	115	2.6%	135	3.2%
LYS Lyon	119	129	2.2%	138	1.8%	152	1.9%
MLH Mulhouse	89	65	(8.1%)	69	1.8%	76	1.9%
MRS Marseille	92	96	0.9%	103	1.8%	113	1.9%
NCE Nice	145	136	(1.7%)	146	1.8%	161	1.9%
CDG Ch. de Gaulle	515	541	1.3%	581	1.8%	639	1.9%
ORY Orly	212	234	2.7%	251	1.8%	278	1.9%
TLS Toulouse	90	90	0.1%	113	5.9%	121	1.4%
Other France	-	709	-	744	1.2%	822	2.0%
SXF Schoenefeld	25	58	25.0%	64	2.5%	288	35.2%
TXL Tegel	128	138	1.9%	152	2.5%	0	(100%)
THF Tempelhof	36	31	(4.2%)	34	2.5%	0	(100%)
CGN Koeln/Bonn	136	150	2.7%	166	2.5%	192	2.9%
DUS Duesseldorf	189	214	3.3%	237	2.5%	273	2.9%
FRA Frankfurt	470	489	1.0%	515	1.3%	613	3.5%
HAM Hamburg	137	157	3.7%	174	2.5%	200	2.9%
HAJ Hanover	77	80	1.2%	89	2.5%	102	2.9%
LEJ Leipzig/Halle	33	36	2.7%	53	10.0%	61	2.9%

Table 6.2 Part 2 Individual Airport IFR Movement Forecasts (Thousands) - Continued

Airports (Contd)	Actual 2002/03	Actual 2006	Change p.a. '02/03 – '06	Forecast 2010	Change p.a. '06 – '10	Forecast 2015	Change p.a. '10 – '15
MUC Munich	345	408	4.6%	450	2.5%	519	2.9%
NUE Nuernberg	62	67	2.0%	77	3.8%	88	2.6%
STR Stuttgart	130	150	3.8%	166	2.5%	191	2.9%
Other Germany	-	377	-	438	3.8%	487	2.1%
ATH Athens	157	185	4.5%	219	4.3%	268	4.1%
HER Heraklion	40	46	3.3%	48	1.2%	50	0.8%
Other Greece	-	236	-	286	4.9%	359	4.6%
BUD Budapest	78	125	14.2%	155	5.5%	201	5.4%
Other Hungary	-	4	-	5	5.5%	7	5.4%
DUB Dublin	171	191	3.1%	201	1.3%	233	3.0%
Other Ireland	-	102	-	165	12.8%	227	6.6%
BGY Bergamo	35	56	13.4%	61	2.4%	71	3.1%
BLQ Bologna	61	63	0.6%	81	6.5%	92	2.6%
CTA Catania	49	55	2.9%	60	2.4%	70	3.1%
LIN Linate	110	130	4.5%	155	4.5%	193	4.5%
MXP Malpensa	217	251	4.0%	300	4.5%	374	4.5%
NAP Naples	72	62	(3.9%)	68	2.4%	79	3.1%
FCO Fiumicino	288	316	2.4%	346	2.4%	403	3.1%
VCE Venice	70	82	4.4%	90	2.4%	105	3.1%
Other Italy	-	570	-	578	0.3%	635	1.9%
Latvia	-	42	-	62	10.2%	95	9.0%
Lithuania	-	43	-	59	8.2%	83	7.0%
Malta	-	28	-	31	2.6%	37	3.8%
AMS Schiphol	410	435	1.6%	486	2.8%	557	2.8%
Other Netherlands	-	98	-	109	2.8%	126	2.8%
WAW Warsaw	106	145	8.5%	167	3.7%	192	2.8%
Other Poland	-	128	-	195	11.0%	296	8.7%
LIS Lisbon	115	136	4.7%	146	1.7%	174	3.6%
Oth. Portugal ex Az	-	121	-	157	6.9%	188	3.6%
OTP Bucharest	35	57	14.2%	95	13.7%	122	5.0%
Other Romania	-	65	-	93	9.3%	128	6.6%
Santa Maria FIR	-	37	-	40	2.0%	48	3.5%
Slovakia	-	39	-	51	6.9%	66	5.2%
Slovenia	-	36	-	47	6.9%	59	4.8%

Table 6.3 Part 3 Individual Airport IFR Movement Forecasts (Thousands) - Continued

Airports (Contd)	Actual 2002/03	Actual 2006	Change p.a. '02/03 – '06	Forecast 2010	Change p.a. '06 – '10	Forecast 2015	Change p.a. '10 – '15
ALC Alicante	55	75	8.4%	90	4.5%	107	3.6%
BCN Barcelona	277	328	4.6%	391	4.5%	467	3.6%
BIO Bilbao	38	52	9.0%	63	4.5%	75	3.6%
MAD Madrid	375	435	4.1%	535	5.3%	692	5.3%
AGP Malaga	97	124	6.9%	148	4.5%	177	3.6%
PMI Palma	163	190	4.2%	227	4.5%	270	3.6%
VLC Valencia	50	77	12.3%	92	4.5%	109	3.6%
Other Spain ex Can.	-	424	-	491	3.7%	532	1.6%
GOT Gothenburg	67	66	(0.2%)	71	1.8%	75	1.1%
ARN Arlanda	240	227	(1.5%)	242	1.6%	262	1.6%
BMA Bromma	38	43	3.0%	42	(0.1%)	49	3.0%
Other Sweden	-	240	-	273	3.2%	343	4.7%
GVA Geneva	144	158	2.5%	175	2.5%	203	3.0%
ZRH Zurich	271	248	(-2.3%)	279	3.0%	324	3.0%
Other Switzerland	-	44	-	34	(6.5%)	29	(3.1%)
ABZ Aberdeen	52	68	7.4%	68	0.1%	68	0.1%
BHD Belfast City	37	38	0.4%	41	2.3%	44	1.1%
BHX Birmingham	121	116	(1.2%)	152	7.0%	177	3.1%
BRS Bristol	54	72	8.0%	80	2.9%	90	2.2%
EMA East Midlands	60	63	1.0%	78	5.6%	103	5.6%
EDI Edinburgh	112	125	2.8%	140	2.9%	156	2.2%
GLA Glasgow	97	105	2.1%	117	2.9%	135	2.9%
LCY London City	55	79	10.2%	95	4.6%	119	4.6%
LGW Gatwick	244	264	2.1%	272	0.8%	272	0.0%
LHR Heathrow	463	477	0.8%	480	0.1%	480	0.0%
LTN Luton	77	110	10.3%	124	2.9%	138	2.2%
MAN Manchester	190	225	4.6%	267	4.3%	353	5.8%
NCL Newcastle	47	63	8.0%	70	2.9%	78	2.2%
STN Stansted	175	205	4.3%	237	3.7%	285	3.7%
Other U.K.	-	644	-	756	4.1%	823	1.7%
Identified Airports	9859	11020	3.0%	12362	2.9%	14360	3.0%
Other Airports	-	4701	-	5455	3.8%	6406	3.3%
Total	-	15721	-	17817	3.2%	20766	3.1%

Source : Consultants' adaptation and application of STATFOR and airports' rates of change

Among further airports where restrictions and local knowledge-based forecasts significantly influenced our final figures were :

- Berlin Schoenefeld, which is expected to absorb traffic from Tegel and Tempelhof as Berlin Brandenburg by 2015;
- Heraklion, which is already "at capacity", where we have merely rounded up the 2006 traffic over the next 8 years to reach the Directive's threshold;
- Linate and Malpensa, which apparently expect to maintain their recent historic above-average growth rates compared with much of the rest of Italy;
- Warsaw, apparently less optimistic than STATFOR is for Poland overall, perhaps due to provincial growth by low-cost-carriers;
- Madrid, where we have derived growth rates from the average of the airport's forecasts for different hub development scenarios;
- Zurich (and to a lesser extent Geneva) where recovery is apparently predicated from the a-typical recent historic effects of major airline restructuring (also evident at Basel/Mulhouse).

It may also be noted that Amsterdam Schiphol provided (from an earlier study) a more optimistic forecast of movements for 2010 than STATFOR's Netherlands average, but this appeared to conflict with environmental constraints implying a much lower forecast to be achievable. We therefore let the quite modest STATFOR average apply. This put Amsterdam, as well as Madrid, and Munich (joining the current ranking of Frankfurt and Paris CDG) above Heathrow in terms of movements in 2015, with Barcelona and Rome Fiumicino not far behind.

Overall, the result is a Community airport growth rate in movements of between 3% and 4% per annum, with an overall tendency to be slightly faster at the relatively small ones than at the largest, where slot constraints and perhaps moves to larger aircraft rather than higher frequency are to be expected. The consistent 3% growth rate shown for the sum of our 70 listed airports is the coincidental result of a "bottom-up" process, not a pre-judged 'control total'.

While repeating that :

- this project is not primarily a traffic-forecasting exercise (although it uses authoritative "outside" forecasts); and that
- our methodology and approach are designed to reduce dependency on judgemental forecasts in assessing the potential effectiveness and/or amendment of the Directive and its application;

this does not seem to be an unreasonable outcome.

The next step in the forecast process was to allocate the traffic to time bands (day, evening, night).

7 Airport Time Bands

For each identified airport, IFR movements in 2002/03 and 2006, and forecasts for 2010 and 2015, were grouped into time bands defined by the defaults in Annex I to Directive 2002/49/EC :

- day 0700-1900 local;
- evening 1900-2300 local; and
- night 2300-0700 local.

At this point, adjustments were expected to be necessary for known significant time-related (generally night) limits on total numbers of movements at individual airports.

In the event, although several airports imposed such limits, none of them quite matched our consistent definition of "night" as 23:00 to 07:00 local. It was not felt practicable or necessary to further adjust for lesser restrictions on numbers of flights during shorter 'core' periods, by particular aircraft, or for QC budgets, when working at this scale. Not only can QC budgets be met by various numbers of aircraft movements, but the absence of already banned aircraft types would be subsumed in the EUROCONTROL historic data bases.

The historic and forecast time band distribution of the forecast traffic at our 70 identified airports was thus a largely mechanical exercise for contour production and grossing up purposes. The consolidated results can be found in Table 7.3., in which the above-average rate of growth of night movements in recent years is seen to be modestly maintained by our forecast methodology.

The forecast percentage growth rates to 2010 and 2015 for each sample case study airport are applied by time band to its detailed 2006 movements for each aircraft type identified in our EUROCONTROL database has, to provide a basis for contour modelling; and the modelling of the effect of various levels of marginal compliance-based stringency. The forecasts at other airports provide a basis for the grossing up of those sample modelled contour areas and associated populations exposed to noise, in Section 9, in order to provide a quantified assessment of the "base case worst case" noise climate and the future effectiveness of the Directive fully applied as it stands, or with redefinition.

The forecasting process continues to the qualitative assessment, in Section 10, of the "natural" fleet changes which may form the context of future noise management.

Table 7.1 Part 1 Individual Airport IFR Movement Forecasts by Time Period (Thousands)

	2002/03			2006			2010			2015		
Airport	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Aberdeen	42.9	6.9	2.1	53.0	10.8	4.1	53.1	10.8	4.1	53.3	10.8	4.1
Alicante	36.9	13.6	5.0	51.9	17.6	5.4	62.0	21.0	6.5	74.0	25.1	7.7
Amsterdam	310.3	72.9	26.9	316.5	85.2	33.2	353.3	95.1	37.1	405.5	109.2	42.6
Athens	100.0	29.5	27.4	121.7	33.3	29.9	144.1	39.4	35.4	176.4	48.3	43.4
Barcelona	189.8	66.3	21.1	226.5	73.8	27.5	270.3	88.0	32.9	322.5	105.0	39.2
Basel/Mulhouse	61.2	21.5	6.1	45.3	13.5	6.0	48.6	14.4	6.4	53.5	15.9	7.1
Belfast City	28.9	7.1	1.1	30.1	6.4	1.1	33.0	7.0	1.2	34.8	7.4	1.3
Bergamo	17.7	9.5	7.5	28.0	17.2	10.6	30.7	18.9	11.7	35.7	22.0	13.6
Berlin Schoenefeld	15.2	4.6	5.2	37.4	12.7	7.7	41.3	14.0	8.5	186.5	63.3	38.4
Berlin Tegel	93.1	27.2	7.6	98.7	29.4	9.5	109.0	32.5	10.5	0.0	0.0	0.0
Berlin Tempelhof	28.2	7.7	0.4	24.7	5.4	0.9	27.3	6.0	0.9	0.0	0.0	0.0
Bilbao	26.9	9.8	1.4	37.0	13.0	2.5	44.2	15.5	3.0	52.7	18.5	3.6
Birmingham	90.4	22.2	8.5	85.0	21.8	9.0	111.6	28.6	11.8	130.3	33.3	13.8
Bologna	42.9	12.4	6.2	43.2	12.0	7.8	55.5	15.4	10.0	63.2	17.5	11.4
Bristol	37.0	10.2	6.5	54.0	12.1	5.5	60.6	13.6	6.1	67.5	15.1	6.9
Brussels	170.6	50.0	26.6	163.7	50.8	32.8	169.3	52.5	20.9	190.7	59.2	23.6
Bucharest	26.5	4.6	3.5	40.3	10.2	6.5	67.4	17.0	10.8	86.0	21.8	13.8
Budapest	56.6	13.5	5.7	90.4	21.6	12.8	112.2	26.7	15.8	145.7	34.7	20.5
Catania	34.7	10.7	3.7	36.7	12.1	5.9	40.3	13.3	6.5	46.8	15.5	7.6
Koeln-Bonn	77.7	23.9	34.5	84.7	29.4	36.3	93.6	32.5	40.1	107.9	37.4	46.3
Copenhagen	192.6	54.1	12.1	189.9	54.4	14.0	204.0	58.4	15.0	230.4	66.0	17.0
Dublin	124.1	31.8	14.7	133.8	35.7	21.6	140.7	37.6	22.8	163.2	43.6	26.4
Duesseldorf	138.7	38.0	12.7	154.0	45.1	15.1	170.1	49.9	16.7	196.1	57.5	19.3
East Midlands	30.9	11.6	17.8	30.5	13.5	18.6	38.0	16.8	23.2	50.0	22.1	30.5
Edinburgh	78.6	22.8	10.9	87.7	26.9	10.3	98.4	30.2	11.5	109.7	33.7	12.9
Frankfurt/Main	326.4	98.9	45.0	339.7	103.7	45.5	358.0	109.3	47.9	425.8	130.0	57.0
Geneva	108.7	30.2	5.6	119.4	32.6	6.5	131.7	36.0	7.1	152.6	41.7	8.3
Glasgow	71.4	17.3	8.1	76.1	19.6	8.9	85.3	21.9	10.0	98.4	25.3	11.5

Table 7.1 Part 2 Individual Airport IFR Movement Forecasts by Time Period (Thousands) Continued

	2002/03			2006			2010			2015		
Airport	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Gothenborg	47.3	11.9	7.5	47.3	11.4	7.5	50.8	12.3	8.0	53.7	13.0	8.5
Hamburg	100.8	28.9	7.5	113.5	34.1	9.8	125.4	37.7	10.9	144.5	43.4	12.5
Hannover	52.8	14.8	9.0	53.4	15.2	11.6	59.0	16.8	12.8	68.0	19.3	14.8
Helsinki Vantaa	104.5	30.3	18.2	122.8	34.5	21.0	136.3	38.2	23.3	159.3	44.7	27.2
Heraklion	25.7	7.8	7.0	26.5	10.4	8.8	27.8	11.0	9.2	29.0	11.4	9.6
Larnaca	27.5	9.4	9.5	27.1	10.2	9.4	31.7	12.0	11.0	39.1	14.7	13.6
Las Palmas	62.7	18.9	12.6	74.2	24.2	14.7	86.8	28.3	17.2	104.8	34.1	20.7
Leipzig-Halle	21.0	6.8	4.9	21.3	7.7	7.2	23.6	8.5	20.9	27.2	9.8	24.1
Lisbon	85.4	20.5	8.7	102.4	24.7	9.3	109.4	26.4	9.9	130.5	31.5	11.8
London City	45.5	9.5	0.2	64.8	14.0	0.7	77.4	16.7	0.8	96.7	20.9	1.0
London Gatwick	176.9	39.3	27.4	186.8	45.2	31.8	192.6	46.6	32.8	192.6	46.6	32.8
London Heathrow	341.4	91.0	30.2	347.8	98.7	30.8	349.8	99.3	30.9	349.8	99.3	30.9
Luton	51.1	14.9	10.5	76.5	21.5	12.3	85.9	24.1	13.8	95.8	26.9	15.4
Luxembourg	39.9	11.0	4.2	44.2	11.3	5.1	45.7	11.7	5.3	51.4	13.2	6.0
Lyon Satolas	83.8	27.2	7.6	88.7	31.0	9.0	95.2	33.2	9.7	104.7	36.6	10.7
Madrid Barajas	260.9	82.1	31.7	299.4	94.2	41.5	368.0	115.8	51.0	475.9	149.7	66.0
Malaga	66.9	21.5	8.2	88.5	26.7	8.8	105.7	31.8	10.5	126.1	38.0	12.6
Manchester	141.5	30.0	18.5	164.9	38.8	21.6	195.3	45.9	25.5	258.5	60.7	33.8
Marseille	62.2	21.0	9.2	61.9	23.2	10.5	66.4	24.8	11.2	73.1	27.3	12.3
Milan Linate	78.9	25.9	5.3	92.0	29.4	8.6	109.7	35.0	10.3	136.7	43.6	12.8
Milan Malpensa	159.5	48.7	8.7	179.7	58.3	13.5	214.3	69.5	16.1	267.0	86.7	20.0
Muenchen	256.3	72.2	16.2	301.5	84.5	21.5	333.0	93.4	23.7	383.9	107.6	27.3
Naples	53.3	14.7	3.5	45.6	13.0	3.1	50.1	14.3	3.5	58.2	16.6	4.0
Newcastle	33.6	8.4	4.9	42.8	13.3	6.5	48.1	14.9	7.3	53.6	16.7	8.1
Nice	109.5	29.1	6.8	104.2	26.3	5.9	111.9	28.3	6.3	123.1	31.1	6.9
Nuernberg	41.4	11.5	9.2	45.7	13.2	8.1	52.7	15.2	9.4	60.0	17.3	10.7
Palma De Mallorca	104.9	35.0	23.1	126.3	41.2	22.4	150.7	49.2	26.8	179.8	58.7	31.9

Table 7.1 Part 3 Individual Airport IFR Movement Forecasts by Time Period (Thousands) : Continued

Airport	2002/03 Day	2002/03 Evening	2002/03 Night	2006 Day	2006 Evening	2006 Night	2010 Day	2010 Evening	2010 Night	2015 Day	2015 Evening	2015 Night
Paris CDG	357.1	102.4	55.2	382.3	103.6	55.3	410.3	111.1	59.3	451.3	122.2	65.2
Paris Orly	154.7	52.0	4.9	170.7	57.6	5.4	183.1	61.8	5.8	201.5	68.0	6.4
Prague	72.9	19.7	7.8	114.2	33.2	12.7	148.4	43.2	16.5	196.7	57.3	21.9
Rome Fiumicino	209.0	61.0	18.3	225.3	71.8	18.5	247.3	78.8	20.3	287.5	91.6	23.6
Stansted	117.9	36.8	20.1	135.7	40.8	28.5	157.0	47.2	33.0	188.3	56.7	39.6
Stockholm Arlanda	168.7	48.0	23.2	161.4	44.1	21.2	172.0	47.0	22.6	186.2	50.8	24.4
Stockholm Bromma	32.3	5.5	0.3	35.8	6.7	0.2	35.6	6.7	0.2	41.3	7.8	0.2
Stuttgart	94.2	25.3	10.9	109.1	28.1	12.9	120.5	31.1	14.3	138.9	35.8	16.5
Tenerife Sur	37.3	11.6	11.9	38.9	12.9	11.5	45.5	15.1	13.4	54.9	18.2	16.2
Toulouse	63.5	18.0	8.0	62.1	20.0	7.9	78.0	25.2	9.9	83.4	26.9	10.6
Valencia	35.5	10.7	3.7	53.8	16.9	6.1	64.2	20.2	7.3	76.6	24.1	8.8
Venice Marco Polo	51.8	14.7	3.3	59.5	17.3	5.2	65.4	19.0	5.7	76.0	22.1	6.6
Vienna	148.2	43.4	12.8	180.7	57.4	19.4	197.4	62.7	21.2	228.2	72.5	24.5
Warsaw	74.8	22.8	8.9	99.4	30.7	14.6	114.7	35.4	16.9	132.0	40.7	19.4
Zurich	205.7	55.6	9.3	186.3	51.9	10.0	209.7	58.4	11.2	243.1	67.7	13.0
Listed A/p	7017.7	1998.6	843.1	7764.8	2268.7	986.0	8705.4	2546.0	1110.5	10087.9	2961.6	1310.8
Proportion	71.2%	20.3%	8.6%	70.5%	20.6%	8.9%	70.4%	20.6%	9.0%	70.3%	20.6%	9.1%
Growth Rate				2.7%	3.4%	4.3%	2.9%	2.9%	3.0%	3.0%	3.1%	3.4%

Source : Consultant's distribution of forecast totals based on STATFOR and airports' growth rates

Appendix G Prevalence of noisy flights at studied airports

This appendix gives a simplistic ranking of the noisiness of the flights operating at all the studied airports. This ranking is based on the predominance of a selection of the noisiest aircraft types (mainly Band 1; B722, B732, B742, DC9, IL62, T154, YK40, YK42) as derived from the EUROCONTROL operations database for 2006. The resultant ranking can only be indicative of an airport's relative noisiness because the EUROCONTROL database only defines aircraft type using the ICAO type designator which is insufficient to indicate precisely an aircraft's noisiness. However, by analysing aircraft that are highly likely to be noisy, this gives an approximate ranking of the noisiness of aircraft flights operating at these airports.

Prevalence of "Noisy Aircraft" Flights by Airport based on EUROCONTROL IFR Flight Data 2006

Ranking	Name	B722	B732	B742	DC91	DC92	DC93	DC95	IL62	T154	YK40	YK42	Total "Noisy" flights	Total all flts (excl mil)	%"Noisy" flights
1	Luxembourg		6	2162					2	14	16	4	2204	60559	3.64%
2	Larnaca	47	121	54	2			8	1	778	8	236	1255	46421	2.70%
3	Warsaw		16	7			2	20	6	1421	1477	14	2963	144625	2.05%
4	Catania		709							44	2		755	54717	1.38%
5	Rome Fiumicino		3025	16			3		6	1063		11	4124	315601	1.31%
6	Naples		345		2	1	219	73		21	6	127	794	61553	1.29%
7	Hannover	2	6	12				5		833		50	908	80146	1.13%
8	Amsterdam	4	4	4296					2	16	2	22	4346	434947	1.00%
9	Frankfurt/Main	2	10	3436			4			892		143	4487	488871	0.92%
10	Berlin Schoenefeld	2	1					2		470		27	502	57850	0.87%
11	Heraklion		30				4			340	2	12	388	45283	0.86%
12	Budapest	5	30	43	2			2	11	794	32	6	925	124732	0.74%
13	Brussels	6	442	1273			6		4	30	40	20	1821	247232	0.74%
14	Paris CDG	1	203	3298					6	426			3934	541117	0.73%
15	Prague	2	24				2		10	990	86	26	1140	160192	0.71%
16	Manchester		98	1139						143			1380	225198	0.61%
17	Hamburg	2	6	14						914		4	940	157465	0.60%
18	Duesseldorf		6	22				43		1016	2	12	1101	214247	0.51%
19	Venice Marco Polo	4	120	50						206		7	387	81988	0.47%
20	Athens	18	19	148			4		15	440	5	200	849	184736	0.46%
21	Bucharest	10	11	2						189	26		238	56392	0.42%
22	Madrid Barajas	7	32	1659	1		1		6	44		71	1821	435029	0.42%
23	Stansted	40	287	433	16		4			28		16	824	205072	0.40%
24	Birmingham		371							87		2	460	115777	0.40%
25	Gothenborg		6	208			2			4		2	222	66165	0.34%
26	Tenerife Sur		163	32						13		4	212	63238	0.34%
27	Helsinki Vantaa		6	32					10	209	322	13	592	178246	0.33%
28	Bristol		223							2			225	71520	0.31%
29	Barcelona	2	12	185					2	808		8	1017	327784	0.31%
30	East Midlands		8	97						69			174	62563	0.28%
31	Muenchen	2	8	278					5	672	6	132	1103	407542	0.27%
32	Las Palmas	98	10	14	1		6		27	18		130	304	112775	0.27%
33	Basel/Mulhouse/Freiburg	54	6	96			2			6		4	168	64692	0.26%
34	Malaga	12	18	42					2	184		4	262	124017	0.21%
35	Palma De Mallorca	1	249	32						51		28	361	189832	0.19%
36	Lyon Satolas	3	92	39						50		22	206	128698	0.16%
37	Vienna	4	6	10			2		4	72	101	183	382	257387	0.15%
38	Leipzig-Halle			28				2		14	2	6	52	36214	0.14%
39	Paris Orly	5		279					2	18		2	306	233657	0.13%
40	Bologna		72	2						6		2	82	62921	0.13%
41	Lisbon	1	19	37			14		34	10		60	175	136087	0.13%
42	Nice	50	35	8					4	18	2	54	171	136436	0.13%
43	Geneva	39	44	2					6	32	3	67	193	158413	0.12%
44	Alicante		62	1			2			20		4	89	74991	0.12%
45	Stockholm Arlanda	2	41	123			4	9	2	80	2	2	265	226540	0.12%
46	Newcastle		2							71			73	62594	0.12%
47	Luton	34	66									24	124	110335	0.11%
48	Bergamo	4	29	1						20		8	62	55831	0.11%
49	Milan Malpensa		16	140						99		12	267	251434	0.11%
50	London Heathrow apt	38	9	393					8	22			470	477281	0.10%
51	Glasgow	2	14	4			4			74		2	100	104614	0.10%
52	Edinburgh		22				2			89			113	124790	0.09%
53	Berlin Tegel	1	8				10		12	54	26	10	121	137528	0.09%
54	Marseille		28	16						34	2	2	82	95367	0.09%
55	London Gatwick	11	56	16						131		2	216	263784	0.08%
56	Koeln-Bonn		14	28				2		16	15	24	99	150447	0.07%
57	Toulouse		10	29	2	2				8			51	89945	0.06%
58	Zurich	8	5	44					2	37		43	139	248173	0.06%
59	Nuernberg		10	2	2		6	4		2	4		30	66968	0.04%
60	Milan Linate	2	51									4	57	129950	0.04%
61	Stuttgart		4	12			34			7		7	64	149895	0.04%
62	Copenhagen	1	2	46			4			44	6	3	106	258237	0.04%
63	Valencia	2	13	2						4		6	27	76790	0.04%
64	Dublin		38	8						20			66	191135	0.03%
65	Bilbao		18										18	52488	0.03%
66	Berlin Tempelhof										2	2	4	30972	0.01%
67	Aberdeen													67891	0.00%
68	Belfast City													37622	0.00%
69	Stockholm Bromma													42713	0.00%
70	London City														

Appendix H Bonus List for less noisy aircraft in Germany

Bonus List for less noisy aircraft in Germany

The German Federal Ministry of Transport, Building and Houses has developed a Bonus List for Chapter 3 Annex 16 aircraft. This list provides a further classification of aircraft within Chapter 3. Aircraft on the Bonus List have an advantage over aircraft not on the List, as to having less flight restrictions and/or getting charged lower LTO fees.

In order to enable this "quieter aircraft differentiation", all aircraft are classified according to the number of engines and maximum takeoff gross weight (MTOGW). The maximum takeoff limits are determined so that comparable aircraft types fall into one class even though their individual MTOGWs may differ. This has resulted in 5 weight classes differentiated to number of engines. Within these classes (1) the logarithmic average of measurements for all aircraft in the class (Total Average Value) is calculated separately for landings and takeoffs, as well as (2) the average of each aircraft type (Type Average Value). Aircraft for which the Type Average Value is below the Total Average Value for both landing and takeoff, are included in the Bonus List. The bonus list categorisation is thus based on actual noise measurements and not directly on the type approved certification values.

The bonus list aims to *enable* a more harmonised noise management system. Airports are not obliged to use the Bonus List. However, if they apply it, they are not allowed to use only a selection of The Bonus List. Nonetheless, airports are free to extend the Bonus List with additional aircraft types, based on their own judgement. Such extended Bonus List is to be used for an airport´s individual use only. This has resulted in a range of Bonus List variants. Two examples:

The Düsseldorf List (DUS)

All types with MTOW below 25 tonnes, plus:		
A300	B727-100 re-engined(3 Tay re-engined)	DC8-70
A310	B737-300 to 800	DC10
A319	B747-400	MD11
A320/A321	B757	MD90/95
A330	B767	Grumman Gulfstream IV
A340	B777	BAe 146/AVRO RJ
Lockheed Tristar L1011	Fokker 100/70	

The Koln-Bonn List (CNG):

All types with MTOW below 25 tonnes, plus:		
A300	B727-100 reengined(3 Tay reengined)	DC8-70
A310	B737-300 to 900	DC10-30
A318	B747-400	MD11
A319	B757	MD90
A320/A321	B767	Grumman Gulfstream IV
A330	B777	BAe 146/AVRO RJ
A340	TU 204+	Fokker 70
A380	CRJ-700	Fokker 100
EM 170/175	CL90+	

Individual airports may use the Bonus List to base differentiated charging on, and may also use it to define runway operations/restrictions In general, if an airport chooses to apply the Bonus List, it is an integrated part of the airport´s charging method, often existing next to a basic charge that either is or is not differentiated to noise category and/or time of day. A few examples (only the main features described):

§ *Düsseldorf airport*: scheduled takeoffs and landings of aircraft not included in the Bonus List are not permitted at all during a defined night time period. Aircraft on the Bonus List have slightly milder nighttime restrictions: scheduled landings are permitted during a part of the defined nighttime period, as are delayed landings and takeoffs. Aircraft not on the Bonus List must pay a higher charge, both during daytime and nighttime.

§ *Koln-Bonn airport:* Aircraft not on the Bonus List are not allowed at all during night time (whereas aircraft on the Bonus List are restricted during night time but still allowed at one dedicated runway).Aircraft not on the Bonus List must pay a higher charge, both during daytime and nighttime.

§ *Munich airport:* Take-offs and landings during night time are only permitted for aircraft included in the Bonus List. There are 3 charges: (1) “Basic Charge” based on noise category. (2) Second charge is an “LTO Charge”, differentiated to day/night for airplanes both on and not on the Bonus List. (3) “Surcharge” (also differentiated to day/night) for aircraft types not on the Bonus List.

Appendix I Noise Quota Count System in UK

Noise Quota Count System in UK

General Description

In the UK, many airports make use of the Quota Count (QC) system developed in 1995 by the UK Government. It was originally developed to help manage the noise generated by aircraft night operations at the three designated London airports - Gatwick, Heathrow and Stansted. Later, several other UK airports also adopted the system. For this scheme, aircraft are grouped into 'QC' bands dependent on their noise performance measured during certification. The QC classification is intended to reflect the contribution made by an aircraft to the total noise impact around an airport.

The quota count for an aircraft may differ for arrival and departure. The quota counts are based on the certification values as determined under Annex 16 of ICAO. The quota count for takeoff is determined by the average of the certification values for take off and sideline. For approach, the quota count is based on the approach certificated value minus 9 EPNdB. The correction factor for approach reflects the idea that arrivals contribute less to the total noise impact than departures for the same certificated EPNLs.

The following quota counts apply:

Quota Count Scheme

Certificated Noise Level (EPNdB)	Quota Count
Greater than 101.9	16
99-101.9	8
96-98.9	4
93-95.9	2
90-92.9	1
87-89.9	0.5
84-86.9	.25

Hence, the noisier aircraft fall into the higher QC bands. For each reduction of 3 EPNdB (decibels of effective perceived noise), the QC is halved. Halving the quota count for each 3 EPNdB reduction, is based on the fact that noise is expressed logarithmically, such that doubling of noise energy results in an increase of 3dB, e.g. 80dB + 80dB = 83dB.

In many instances, the quota counts are related to a noise quota at the airport. The quota can be applied for the night time movements in a particular season. If for example aircraft rated at 96 EPNdB were replaced with aircraft rated at 95 EPNdB, twice as many could be flown during the restricted period. At the UK airports with a quota, the quota count system is combined with a limit both on movements during the 'Night Quota period'. Both movement limits and noise quota are differentiated to season (summer and winter).

In addition, some airports have introduced a (partial) night time ban on noisy aircraft by QC classification. A few examples:

§ *London Heathrow, Stansted and Gatwick*: (1) Any aircraft which has a quota count of 4, 8 or 16 may not be scheduled to take off or land during the night quota period; (2) any aircraft which has a quota count of 8 or 16 may not be scheduled to take off or land during the night period; (3) any aircraft which has a quota count of 8 or 16 may not take off in the night period, except in the period 2300 hours to 2330 hours under certain defined circumstances.

- *Manchester:* QC 16 & QC 8 movements banned are banned 2300-0600, QC 16 and QC 8 take offs banned 0600-0700, QC 4 take-offs can not be scheduled 2330-0700.
- *East Midlands*: QC 8 and QC 16 movements are banned during nighttime, fines for late running from day.
- *Aberdeen*: QC4 movements are banned during nighttime.
- *Birmingham*: The partial ban (during night time) is defined as No QC 8 or QC 16 movements 2300-0600 local, except delayed take-off allowed to 2330 local.
- *London Luton:* is considering a QC8 ban at night.

Further, although the QC system was not developed as a basis for differentiated charging, some airports have (partly) integrated the QC rating into their charging system. A few examples:

- *London Luton:* Currently, Luton airport has a Night Operating Charge and is considering to introduce graduations by QC rating.
- *London Stansted:* aircraft are charged a lower fee if they are Chapter 3 Minus or Chapter 4 aircraft, *or* if they have a quota count, on both departure and arrival, of 1, 0.5 or 0.25.
- *Manchester*: charges are partly differentiated to QC rating.

More information can be found in:

(Boeing 2007) Boeing website for airport noise regulations for individual airports, like: http://www.boeing.com/commercial/noise/heathrow.html

(BA 2007) *Quota Count (QC) night restrictions classification scheme,* http://www.britishairways.com/travel/crnoise/public/en_gb

(ERCD 2002) *Review of the Quota Count (QC) System: Re-analysis of the differences between arrivals and departures*, J B Ollerhead, H Hopewell, ERCD, Prepared on behalf of the Department for Transport by the Civil Aviation Authority,
London, November 2002

(NATS 2007) London Heathrow, London Gatwick and London Stansted Airports Noise Restrictions Notice 2007, NATS Limited, London, 2007, Published on behalf of the Department for Transport