AIRCRAFT NOISE EXPOSURE AROUND EUROPEAN AIRPORTS: FUTURE TRENDS AND THE INFLUENCE OF AIRCRAFT CERTIFICATION

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1 INTRODUCTION

Air traffic in Europe is forecast to grow as consumers choose to travel more in the coming years. In the past, new aircraft have been progressively quieter than older ones, and this has offset much of the increase in airport noise that might otherwise have taken place. This paper reports a quantification of how many people are currently affected by aircraft noise across Europe, and how we can expect this to change in the near future, under current legislation governing aircraft noise emission levels.

In December 2006 the Transport and Energy Directorate of the European Commission let a contact entitled *Study of Noise Exposure at and Around Community Airports: Evaluation of the Effect of Measures to Reduce Noise* [(1)] to a consultancy consortium lead by the MDP Group and assisted by Environmental Resources Management (ERM) in the UK and CE Delft in the Netherlands. The study looked closely at the certificated noise levels of the current European aircraft fleet, and, based on industry air traffic forecasts, predicted how the populations exposed to noise around airports might change between 2006 to 2015. The noise exposure forecasts considered more than 50 major European airports.

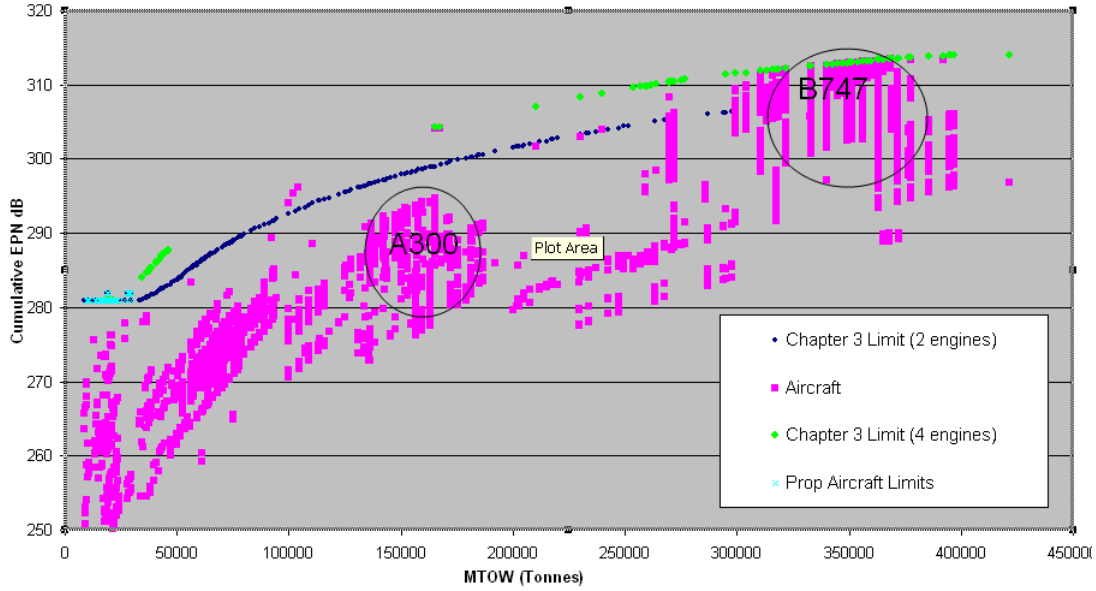
The study was undertaken to assist the Commission in its review of EC Directive 2002/30 [(2)] and included extensive consultation on noise control measures in the context of the 'balanced approach' advocated by that directive. This paper focuses on the noise exposure aspects of the study rather than the policy and mitigation elements. It addresses the generic question: '*Are airports getting noisier ?*'

This paper presents the views of the author, and in no way reflects the views of the European Commission.

2 AIRCRAFT NOISE EMISSIONS

Under rules laid down by the International Civil Aviation Authority (ICAO) [(3)] noise emissions from new aircraft types are measured 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 standards. 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 of an aircraft compared to the Chapter 3 standard (i.e. with no limit on trading). The cumulative Chapter 3 limit increases with aircraft weight and with the number of engines as shown in Figure 1 [(4)].

Figure 1 Cumulative Chapter 3 Noise Certification Levels



This figure shows how the noise levels vary for a given aircraft type, even at a given maximum take off weight (MTOW). eg a Boeing 747 with a maximum take of weight of 350 Tonnes may have a cumulative (ie flyover, sideline and approach) noise emission level between 301 and 313 dB. In this case the cumulative range of 12 dB translates to an actual range of, on average 1/3 of this at any particular location on the ground, ie 4dB. The range of levels can be due to jet nacelle variants, varying flap and aircraft configurations during departure, and the range of landing weights at which the aircraft may operate.

EC Directive 2002/30 gives procedures to be adopted if an airport wishes to introduce operational restrictions whereby certain noisier aircraft cannot fly in certain circumstances. The Directive refers to certificated noise levels when defining such restrictions, and in particular to the margin by which an aircraft passes the current Chapter 3 certification standard. In this study 3 levels of marginality were considered, and the effect of banning each under three future scenarios, as listed in Table 1, was modelled.

Table 1 Aircraft Noise Certification Margins

Aircraft Noise Band	Cumulative Margin within Chapter 3 (EPN dB)	Noise Modelling Phase Out Scenario	Other Names Used
Band 1	0-5dB	Scenario 1	Chapter 3 High
Band 2	5-8dB	Scenario 2	
Band 3	8-10dB	Scenario 3	
Band 4	>10dB		Chapter 4 compliant, subject to meeting measurements point trade-off limitations

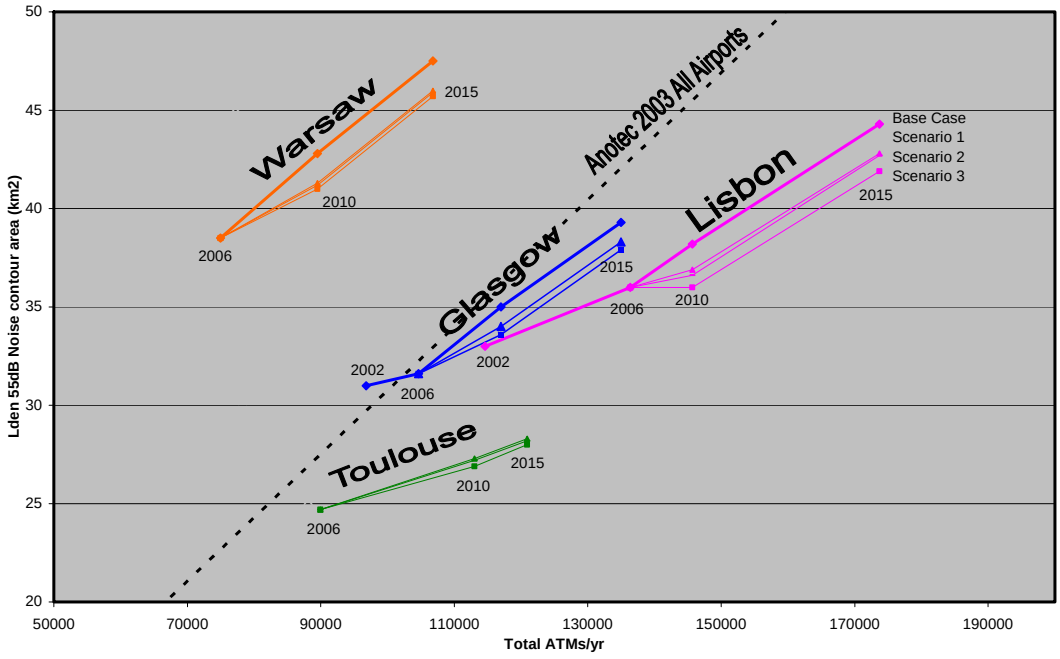
3 EUROPEAN AIRCRAFT FLEET

The study looked in great detail at the aircraft operating within European airspace in order to consider how any future tightening of operating restrictions might affect the industry. A database of all air traffic movement in 2006 was supplied by EUROCONTROL for the analysis. It was found that of the 4,600 jet aircraft register in the Community (EU, EEA and Switzerland) that come under the Directive (jets over 34 tonnes or 19 seats) only 600 (12%) or so did not meet Chapter 4 standards and only 49 were less than 4 dB marginal (Band 1). Overall, it was estimated that in 2006, at the 70 airports considered, only 0.4% of movements were by less than 5dB marginally compliant (Band 1) aircraft, and 88% were by aircraft meeting Chapter 4 standards. Nonetheless, it was appreciated that although the numbers of these noisier aircraft are small, their noise emissions may have a disproportionate influence on overall noise experienced around airports.

4 AIRPORT NOISE EXPOSURE

In 2002/3 Anotec reported to the Commission estimates of Lden and Lnight noise contours and estimates of exposed populations around 51 airports for the years 2002, 2006 and 2015 [(5)]. 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 air traffic movement (ATM) predictions. The Anotec analysis for 2002/3 was the starting point, after which the following methodology was used. 4 case studies were undertaken to model the noise changes in details using the Integrated Noise Model (INM), including the effect of the 3 marginal aircraft scenarios, as described above. From these we derived relationships between noise contours areas and air traffic movement (ATM) numbers for the different time periods and aircraft fleet scenarios of interest. The trends for Lden 55dB contours can be seen in Figure 2. The author would like to thank officials from Glasgow, Warsaw, Toulouse and Lisbon airports for their assistance in collating the necessary modelling data.

Figure 2 Lden 55dB Noise Contour Areas v ATMs; 2002, 2006, 2010, 2015

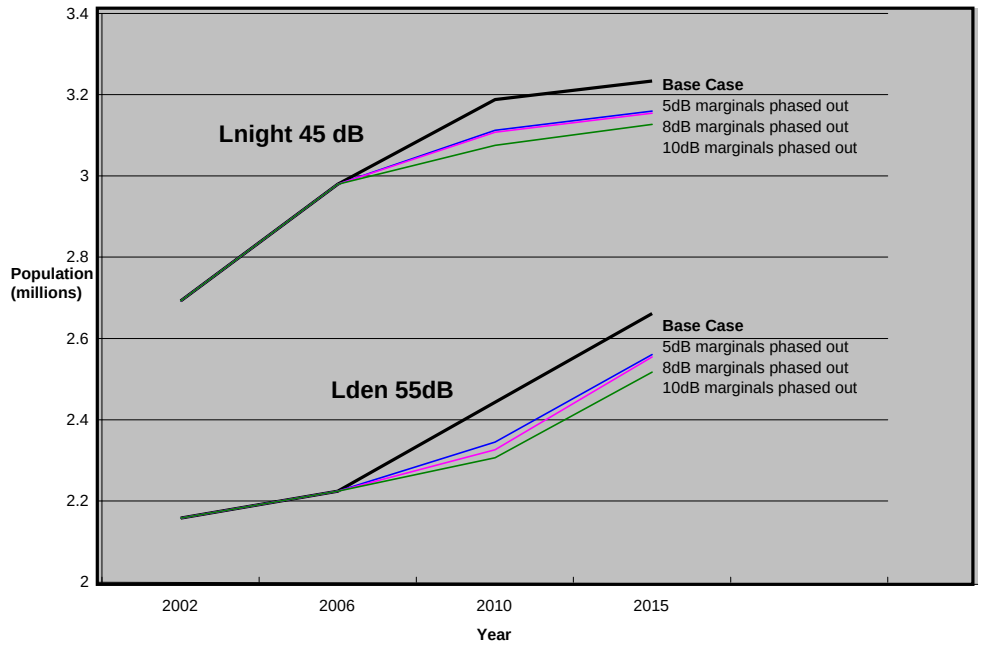


In this Figure, the thick line gives the base case (i.e. no fleet change) and Scenarios 1, 2 and 3 are plotted below the Base Case for 2010 and 2015. This illustrates the progressive reduction in Lden

55dB contour area predicted under these phase out scenarios. It can be seen that the base case contour area/ATM relationship is similar for the case study airports, and to the relationship found from an analysis of the Anotec 2002/3 results (the dotted line in Figure 2). 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.

These relationships were used to interpolate base case contour areas for all 51 airports from 2006 to 2010 and 2015 by applying the revised ATM forecasts for each airport. An equivalent process was used to develop Lnight 45dB contour areas. The resulting totals for all airports are shown in Figure 3.

Figure 3 Estimates of Total EU Population Exposure for All Airports



The general expected upward trends in the base (constant fleet) case up to 2015 is clear, but it is important to appreciate that aircraft fleets will change and this study was focused on the potential benefits of phasing out 5, 8 and 10dB marginal aircraft. These benefits were found to be reductions of 2 and 5% in the total populations exposed.

During the 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 as result of the requirement of EC Directive 2002/49 [6] to have these contours reported to the European Commission by December 2007. Those airport noise mapping 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 results of noise mapping under EC/2002/49.

5 FURTHER ANALYSIS OF FLEET EFFECTS AT LISBON AIRPORT

In order to better understand the effect of changes to the aircraft fleet that are not within the 10dB margin of Chapter 3, further analysis was undertaken for the fleet operating at Lisbon Airport. This looked closely at particular Chapter 4 aircraft that could be replaced, substituting these for their likely replacements including new types such as the Boeing 787 and Airbus 350, and summing up the net effect to overall Lden noise levels. The analysis was done using the INM aircraft database and estimated noise levels on the ground at the Flyover and Approach certification points.

In 2006, 9% of ATMs at Lisbon were by aircraft within a 10dB margin of Chapter 3. Airbus 321s accounted for 72% of marginal flight, and the majority of these were just a few A321s certificated at high MTOWs. The results of the sensitivity analysis of retiring the older Chapter 4 aircraft yielded the following conclusions.

The effect of the Chapter 4 replacements in the likely proportions (17-23% by 2015) is small, reducing Flyover departure noise by about 0.2-0.3dB, with an even smaller effect of Approach noise.

For Flyover noise in 2015 Scenario 3 (all aircraft marginal within 10dB banned) to be no higher than in the 2006 base would require the Chapter 4 replacement proportions to be about 40%.

The effect of Chapter 4 replacements on Approach noise is less than for Flyover noise. This is because new aircraft are developed to be quieter primarily through reduction in engine noise, and so yield better noise reductions on departure than on approach (when engine noise is less dominant). This trend has been evident for several years now and has already raised the prospect of approach noise becoming increasingly dominant in the future. The result of this sensitivity analysis is consistent with this expectation, in that it shows that even if 100% of the Chapter 4 aircraft types considered were replaced, Approach noise would still go up by 2015 compared to the 2006 base.

Unfortunately combining the Approach and Flyover results is not straightforward. But considering them together it can be concluded that even if 40% of the Chapter 4 types considered were replaced by 2015, as well as Scenario 3 implemented to phase out marginal Chapter 3 aircraft, then we would still expect Lisbon's Lden contours to be at least as big as in the 2006 base. This result of course assumed that no other noise management techniques are applied, and it may be that if they are a different result will be obtained.

It is important to appreciate that this result is specific to Lisbon airport's fleet, and each airport will show its own characteristics. Each airport has its own approach to noise management through encouraging aircraft operational procedures, routing aircraft, land use planning, compensation measures etc. Many airports could improve these measures to help offset noise increase.

6 CONCLUDING COMMENTS

Under current European aircraft noise emission regulations, ignoring other improvements in airport noise management, and on the basis of the aviation industry's current growth forecasts, it is likely that Lden and LNight noise contours will, in general, not be reducing up to 2015. Each airport will be different, but over the whole of Europe (including the Accession States) it is expected that population exposure to noise, as measured using conventional Leq based metrics, will be increasing. Whether or not this has a negative impact on health will depend on how each airport acts to manage its noise output locally and how the local population responds to that noise.

7 REFERENCES

1. Study of Aircraft Noise Exposure at and around Community Airports; Evaluation of the Effect of Measures to Reduce Noise, MPD Group in Association with ERM and CE Delft, for European Commission DG TREN ref TREN/F3/15-2006.

2. EC 2002/30/EC on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports, 2002.

3. International Civil Aviation Authority (ICAO); Convention on International Civil Aviation, Annex 16 Environmental Protection, Volume 1, Aircraft Noise, third edition, amendment 7, March 2002.

4. Direction Générale de L'Aviation Civile (GDAC) NoisedB database.

5. ANOTEC Consulting SLL Study on current and future aircraft noise exposure at and around Community airport, Final report and update corrections 2002/4.

6. EC 2002/49/EC relating to the assessment and management of environmental noise, 2002.