Study on Current and Future Aircraft Noise Exposure at and around Community Airports

- Final Report –

Prepared for the European Community (DG-TREN) under Contract nº B2002/B2-7040B

Doc nº : PAN012-4-0
Date : 10-11-2003

Executive Summary

The European Community Directive 2002/30 EC of 26 march 2002 states, that within 5 years after the entry into force of this Directive, the Commission shall assess the present and future aircraft noise climate in the EC, the effectiveness of the measures defined in the Directive and the present and future actions planned and required to limit or reduce the noise from air transport around airports.

Anotec was pleaded to provide the “Study on current and future aircraft noise exposure at and around Community airports” with the aim to assess the noise situation and its evolution at all EU airports potentially affected by the Directive for the scenario 2002 up to 2015.

Starting at the ‘Baseline Year’ 2002, the study calculates the number of people affected by noise from aircraft and how it will change over time, the so-called ‘Baseline Trend’, for the scenario where the Directive 2002/30/EC is not applied. A second exercise is then performed in which an assessment will be made of the introduction of the measures proposed by the Directive or other further actions is assessed, with special interest in application of restriction to so-called marginally compliant aircraft, and how this application will reduce the number of people affected by noise in comparison with the baseline trend.

The methodology applied is based on the use of a single, harmonised software model (SONDEO), capable of predicting with sufficient accuracy the noise contours around airports and the number of people affected. Model validation has been made by the comparison with the MAGENTA results and detailed data available from several European airports.

A total number of 53 airports, all of them with more then 50.000 civil jet movements per year, has been analysed in detail to estimate the number of people affected by noise in the years 2002, 2007 and 2015. Noise contours for L_{den} values of 55, 60, 65 and 70 dB(A) and L_{night} values of 45, 50, 55, 60 and 65 dB(A) have been calculated for the different scenarios, together with noise response parameters.

The analysis of the various scenarios considered indicates that at Community level the total number of people exposed to aircraft noise will increase in the period up to 2015. The number of people highly annoyed (HA) will increase at a rate of 1 to 4% per year, depending on the scenario considered. This means that in 2015 the number of people seriously affected will have increased between 10 and 50% with respect to the current situation. The margin is directly in relation with the assumptions of growth considered (growth scenarios), ranging from conservative to high growth for the aviation sector.

The assessment of future actions that can be considered so as to be able to reach the Directive objective “to limit or reduce the number of people significantly affected” indicate that its application has the potential to maintain or slightly improve the Community noise climate on the short term (2007). On the longer term (2015) the benefits of all actions will have been almost or even fully offset by the increase of noise exposure due to traffic growth. In summary no single action will be able to guarantee a stable noise climate in the 2015 horizon.

The concept of the ‘Airport/Noise Mitigation Matrix’ is introduced to assist in determining the most appropriate measures to be taken within the framework of the balanced approach.

Table of contents

APPENDIX

Table of contents

1. Introduction

In March 2002 the European Parliament and Council approved on the Directive 2002/30/EC on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports [1]. The main objective of the Directive is to respond to the need for a common framework of rules and procedures for the introduction of operating restrictions, as part of a balanced approach on noise management. This includes the assessment of the noise impact at an airport and evaluation of the measures available to alleviate that impact.

According to article 14 of the Directive, the Commission shall report to the Parliament and Council on the application and effectiveness of measures taken under the Directive within 5 years after the entry into force. In order to be able to do so, the starting point, indicated as the "baseline", with respect to current noise climate and current regulatory framework shall be assessed. The baseline includes:

- detailed information on the current noise climate around airports
- detailed information on the nature, effectiveness and amount of measures that have currently been taken at airport level
- detailed information on planned measures, including their effectiveness and amount
- expected noise climate if no further action would be taken.

In order to be able to estimate whether or not the Directive will be able to meet its objectives, an assessment has been made of the effects on the noise climate of the actions, induced by its introduction.

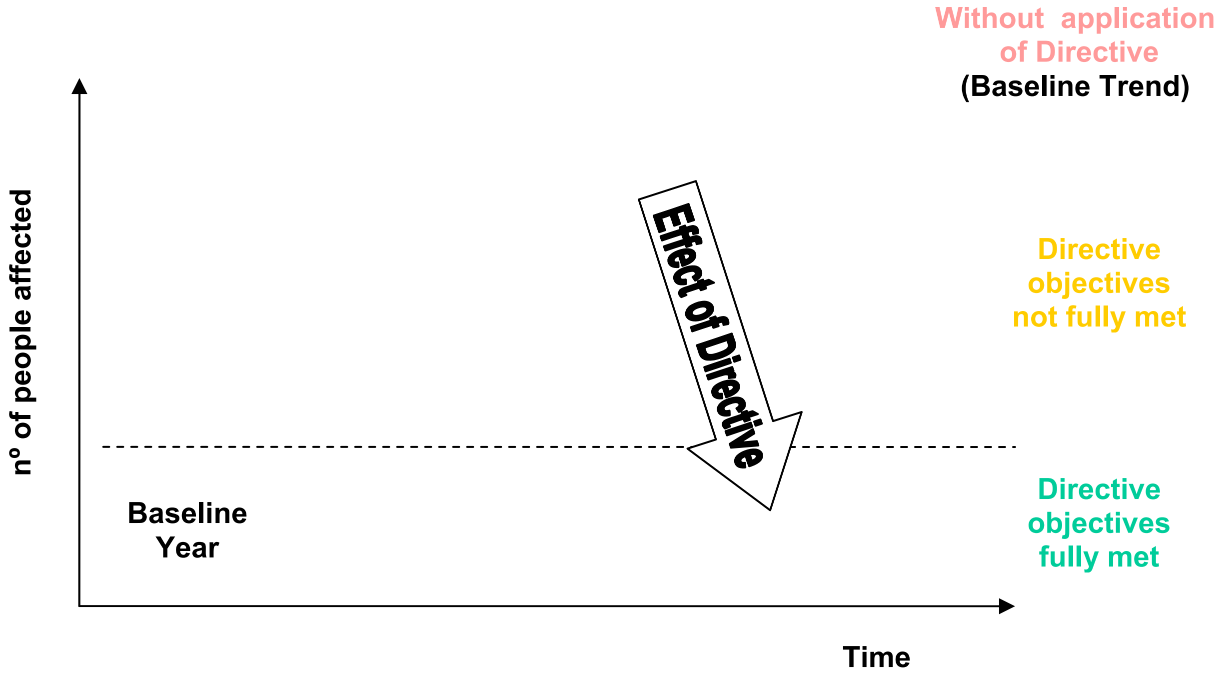
This final report describes the results of the work that Anotec has carried out in the above framework.

The Appendix to this report contains the main results obtained during the study.
A CD-ROM has been prepared containing all results for the Baseline scenarios, which may be presented with the tool supplied on the same disk.

2. Methodology

2.1 Objectives

The main objectives of the study can be summarised as indicated in the following chart.



Starting at the 'Baseline Year' the number of people affected by noise from aircraft will change over time according to the 'Baseline Trend', if the Directive 2002/30/EC (hereafter called 'the Directive' or 'ORD' (Operational Restrictions Directive)) would not be applied. Introduction of the measures proposed by the ORD will reduce the number of people affected by noise. Depending on a multitude of factors, this reduction will be more or less pronounced.

One of the main objectives of the present study is to determine whether this reduction will be sufficient to reach the objective, stated in Article 1.a) of the ORD ("….. to limit or reduce the number of people significantly affected by the harmful effects of noise"). In other words, the various trends indicated will have to be quantified.

As can be deduced from the abovementioned, one of the main purposes of the study is the determination of the baseline noise climate, which will be used as a reference for the evaluation of future actions, such as the introduction of the ORD. This baseline is defined by two parts:

- The 'Baseline Year'
- The 'Baseline Trend'

For the purpose of this study the 'Baseline Year' is defined as the status when the ORD was introduced, i.e. 2002. Since information for 2002 on important items such as population are not available or not considered as representative (see section 4.3.1), it had to be decided to extend the concept of Baseline Year to those years closest to 2002 for which representative data are available. Hereafter Baseline Year 2002 has to be interpreted in these terms.

The ‘Baseline Trend’ is defined as the evolution in time of the noise climate, without taking into account actions induced by the introduction of the ORD. To establish this trend the noise climate will be assessed for the years 2007 and 2015, taking as a reference the Baseline Year.

In order to obtain a correct baseline the following characteristics has been considered as critical elements throughout the present study:

- Be homogeneous in the criteria used for the airports under study
- Allow objective analysis of common actions with the results obtained
- Introduce the option of modifications in order to create a useful tool for future studies
- Link with the balanced approach concept and its application
- Be flexible to allow modifications in the assumptions considered

2.2 Applied methodology

At first sight, the most convenient way to determine this baseline noise climate seems the compilation of existing data on noise contours and people affected by noise around European airports. However, the use of existing information as a sole source to determine the noise climate has the following disadvantages:

- Existing information may be outdated (e.g. an important part of the Magenta database was collected before 1997) and the effect of 11th September 2001 or the more recent SARS epidemic has obviously not been included
- Noise data from different airports will differ in:
    - noise metrics used
    - noise model used
    - future scenarios envisaged
- Not all airports have available or will provide the necessary information
- Data usually not compatible with the Environmental Noise Directive 2002/49-EC [2] (hereafter called “END”)
- The majority of existing studies has been made before the final phase-out of Chapter 2 aircraft and do not take into account the gradual phase-out of marginally compliant aircraft as a result of Community Directive 2002/30 EC, nor the effect of the introduction of Chapter 4.
- Not all data will be publicly available

This situation might be improved somewhat by correcting the available data to standard conditions (same year, same noise unit) but apart from the error introduced by these corrections, various parameters can not be corrected (e.g. noise model).

For the present study it is of utmost importance to dispose of harmonised, consistent reference databases (both for the ‘Baseline Year’ as well as for the ‘Baseline Trend’), since the result of all future actions will be judged relative to this baseline.

For the above mentioned reasons Anotec concluded that the only practical way in which the results of the present study would have the required quality, is by means of a single, harmonised software, capable of predicting with sufficient accuracy the noise contours around airports and the number of people affected. Using the same model for all airports and all scenarios will guarantee data consistency. It is recognised that in some cases the methodology used might not reach the same precision as studies performed at detailed individual airport level due to the assumptions to be made. However, the possibility to compare harmonised datasets will allow for an accurate determination of trends, both at airport as well as Community level.

The software used is an adapted version of the noise model Anotec already developed under private funding. The 'engine' of this model was used to calculate noise contours around all airports relevant to the present study. This noise model is fully compatible with ECAC Doc.29, calculates L_{den} and L_{night} noise contours and has been updated to include the most recent recommendations made by the EC [3] (and thus guarantees compatibility with END). The noise and performance databases used are those provided by INM, since these are one of the few globally accepted datasets publicly available.

A pre-processor has been developed in such a way that the required input can directly be obtained from the airport, traffic, population and action databases described hereafter. This minimises the preparation time for the calculations (normally the most laborious part of this type of noise calculations).

Conventional INM-like computations to obtain the noise contours around a large number of airports used to be unacceptably long. Therefore former studies like Magenta applied a simplified approach, based on the use of an appropriate reduced fleet mix for each airport, limiting the number of different aircraft types to a minimum. Experience obtained from Magenta indicated that results obtained in this manner are in sufficiently close agreement with those obtained by means of a full 'classic' analysis. In its initial proposal Anotec also opted for this simplified approach. During the first Phase of the project however, a parallel action was undertaken to optimise the noise model 'engine' for speed. In combination with the power available with latest generation computers, the execution of some test-cases showed a considerable reduction in computation time. It was therefore decided that the calculations required in Phase 2 would be performed with the actual fleet mix rather than with a simplified one. The only simplification made is the substitution of any aircraft/engine combination for which no data are available, by an acoustically equivalent combination, taking into account the recommendations given for the INM noise model.

A post-processor has been developed, containing tools to analyse the results obtained in order to fulfil the requirements of the Terms of Reference of the present contract.

The input and output of the software is by means of databases. The following databases are considered:

a. 'Airport database' (containing airport related data relevant for the current study)
b. 'Traffic database' (containing data on air traffic: nº of movements, fleet mix, etc)
c. 'Population database' (containing data relevant for calculating the population affected by noise from the airport)
d. 'Baseline noise climate databases' (describe the noise climate in the 'Baseline Year' 2002 and the 'Baseline Trend' for the years 2007 and 2015)
e. 'Further action noise climate databases' (describe the noise climate for 2007 and 2015, applying further actions required to meet EC objectives)

The calculations are controlled by so-called "scenario indicators". With these indicators the input for different scenarios is generated, simulating for example noise mitigation actions or traffic forecasts.

Databases mentioned under a thru c are fed by data supplied by airports and other relevant sources. Databases d thru f contain the results of the calculations performed with the software.

For further details one is referred to the corresponding Tasks in the following sections.

In addition to the advantage of avoiding the problems indicated at the beginning of this section, the proposed methodology has the big advantage of providing a tool, with which it is very easy to evaluate the different scenarios analysed during the study. The model developed by Anotec easily allows for changing the input with the new hypothesis (on an airport by airport basis) and yields the affected population under the new conditions.

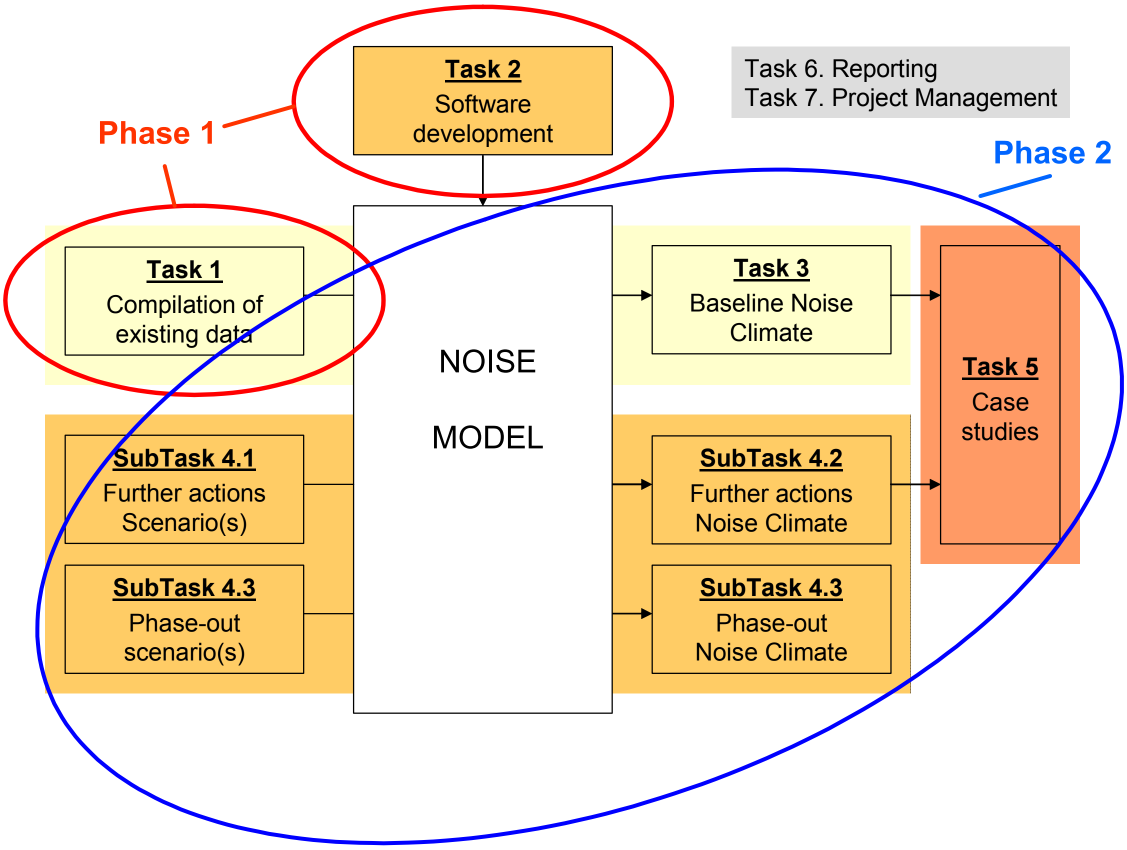
As an example, an adjustment to the traffic growth factor (a generic factor applied to all airports) or constraints on the airport capacity could be applied easily.

2.3 Project structure

To be able to manage the project, the work has been split into various Tasks:

Task 1: Compilation of existing data
Task 2: Adaptation of existing noise model software to current study
Task 3: Assessment of current and future noise climate without further actions
Task 4: Assessment of further actions required
Task 5: Case studies
Task 6: Reporting
Task 7: Project Management

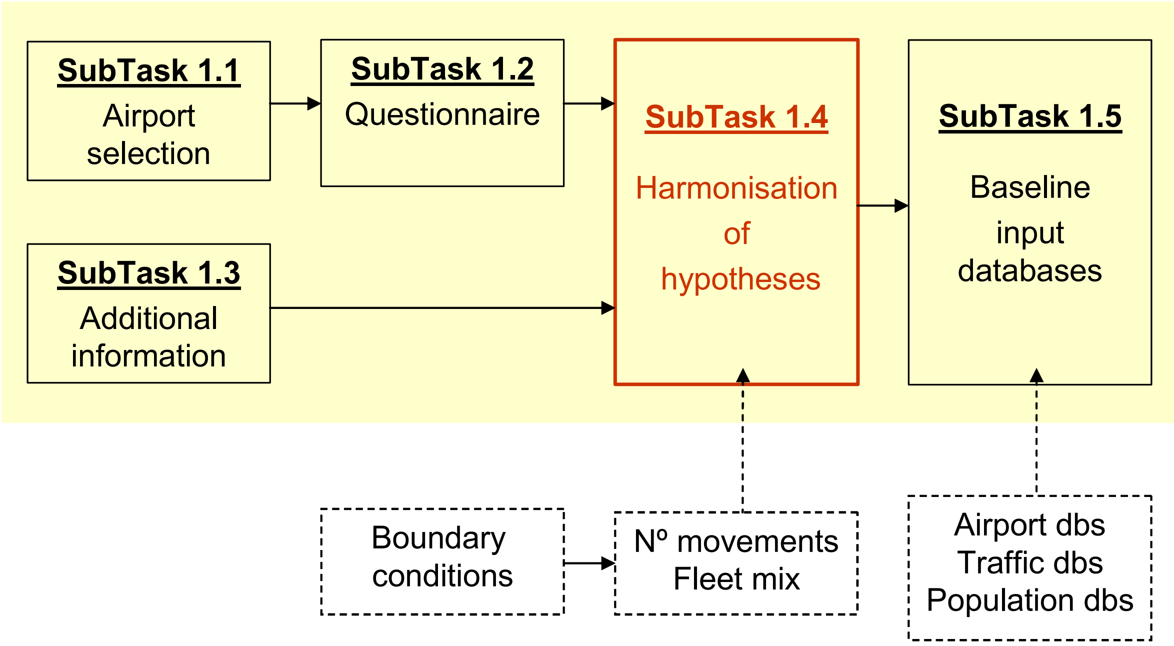
In the following chart the project structure is presented. In the following sections each item will be further detailed.



The project can be subdivided in two phases:
- Phase 1, mainly dedicated to the preparative tasks (Tasks 1 and 2)
- Phase 2, in which the actual assessments have been performed (Tasks 3, 4 and 5)

Tasks 6 and 7 are not relevant for the present report and will therefore not be discussed.

3. Compilation of existing data (Task 1)



The data, information and assumptions required to develop the study have been assembled from the following SubTasks:

1.1 Selection of airports

A two-step approach has been followed: First data has been obtained for all airports within the community, mainly directed to contacts information and preliminary traffic data, so as to determine the airports potentially affected by the Directive (i.e. having more then 50.000 jet movements per year). Based on this analysis, the questionnaire mentioned hereafter was sent. After this initial analysis a final selection was made of the airports to be assessed in Phase 2 of the study.

1.2 Airport Questionnaire

The information required for the calculations in Phase 2 of the study can be obtained from various sources, among which the airports under study by means of a questionnaire. Two versions of the questionnaire were developed and sent to the airports. A full version was sent to those airports which (based on the initial analysis of SubTask 1.1) potentially could be affected by the Directive and to those not affected but having noise problems. A reduced version was sent to those airports not affected by the Directive. Due to the low response on this first questionnaire, a second attempt with an adapted questionnaire was made with help of ACI Europe.

1.3 Additional information

From the very beginning it was anticipated that, in case the response to the questionnaire would be too low, the required information should be obtained from other sources. Part of this information has been obtained directly from those sources, while other data were developed through analysis, using assumptions and criteria not always quantifiable.

Since part of the data to be used will be based on assumptions and hypotheses from various sources, a harmonisation exercise was performed, so as to obtain a coherent basis for the calculations (SubTask 1.4). Since the final result of these calculations depends on the hypotheses used, it was important that all relevant parties involved in this study, agree with the assumptions made. This agreement was obtained during the project mid-term meeting held on 17/06/03 in Brussels.
All relevant data have been stored in databases for further processing (SubTask 1.5).

3.1 Selection of airports (SubTask 1.1)

As mentioned above, a two-step approach has been followed. The objective of the first step was to obtain sufficient information on all airports within the EU so as to be able to determine which airports were potentially affected by the ORD to be able to send the questionnaire. The second step was dedicated to the final selection of the airports to be studied in the Phase 2 of the study.

3.1.1 Preliminary selection for questionnaire purposes

The initial step was to create a database containing all Community airports and the necessary information to contact the persons in charge of noise issues. A second objective of this initial step was to perform a first analysis of the number of movements and types of operations at the airport, allowing for a pre-selection of those airports potentially affected by the European Directive.

This database contains the following information (if available) for each airport:

- Country
- Airport by name or city
- Airport IATA code
- E-mail of the Noise Specialist, Operations Department, Director or other contact
- Phone and Fax number
- Total number of movements (take-off plus landing) for all types of airplanes
- Observations, containing any important remark related to the type of operations and airplanes (military, percentage of turbopropeller airplanes, light aviation, etc.), number of passengers and cargo in relationship with the number of movements, etc. This field has only been completed when a further analysis was required in order to determine the potential application of the ORD.

The sources used in this analysis were: OAG Worlds Airways Guide, available information from airports, airport's web pages, Boeing airport web page, ICAO airport traffic information and ITA World Air Transport Data Guide.

The data on movements gathered were those for the years 2000 and 2001, since no data was available for 2002 for many airports. In addition the year 2002 is not considered as a representative year, due to the general reduction in traffic at the mayority of the European airports. However, the objective of this first database was only to serve as an initial filter for airport selection at an early stage in the project, for which purpose these data are good indicators. For this analysis it is important to bear in mind the definitions established in the ORD (Article 2):

> For the purpose of this Directive:
> (a)'Airport' shall mean a civil airport within the Community which has more than 50 000 movements of civil subsonic jet aeroplanes per calendar year (a movement being a take-off or landing),taking into consideration the average of the last three calendar years before the application of the rules of this Directive to the airport in question;
> (b)'City airport' shall mean an airport in the centre of a large conurbation, of which no runway has a take-off run available of more than 2 000 metres and which provides only point-to-point services between or within European states, where a significant number of people are objectively affected by aircraft noise and where any incremental increase in aircraft movements represents a particularly high annoyance in the light of the extreme noise situation.
> These airports are listed in Annex I. That Annex may be amended in accordance with the procedure laid down in Article 13(3);
> (c)'Civil subsonic jet aeroplanes' shall mean 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.

Based on the data gathered in the database, the airports potentially affected by the ORD were then selected. All airports with less than 40.000 movements per year were rejected. This limit was taken as a conservative measure to take into account fluctuations in air traffic such as the downturn over the recent years due to e.g. the September 11th events and possible growth in coming years and to account for any non-scheduled flights, not available from the sources consulted.

Whenever possible the total number of movements for the remaining airports was then corrected for the following types of traffic:

- Private airplanes
- Training flights
- Military flights
- Business jets
- Turboprop operations

Based on the available information, several of these airports clearly fall outside the scope of the ORD, due to the type of traffic prevailing. An example is the Gotenborg City Airport (GSE) in Sweden, where 70208 movements were registered in 2001, but only 95175 passengere were handled. In cases were the figures were not so clear, the airport was maintained in the 'potentially affected' list.

In Annex I-1 the database with airports potentially affected by the ORD is given. The full version of the questionnaire was sent to these airports (see section 3.2). Annex I-2 presents the other airports studied, but which failed to pass the first filter described above. The reduced questionnaire was sent to these airports (see section 3.2).

3.1.2 Determination of the airports to be studied in Phase 2.

It was hoped that the final selection of the airports to be studied in Phase 2 of this study could be based on the response of the airports to the questionnaire. Due to the very low response, however, an alternative method had to be used. This method is described below.

The OAG 'Max historical' database for 2003 was acquired (the 2002 database was considered not to be representative due to e.g. the presence of Chapter 2 aircraft). This database contains detailed information on all scheduled (passenger and cargo) flights from and to all European airports. For each flight, departure and arrival airport and - times, effective period, flight duration, aircraft type, number of seats, distance, etc. are given. Software was developed so as to be able to extract the required data from this database. For each airport within the European Community the total number of movements was determined, together with the number of flights operated with jet aircraft, in line with the above definition. The results are given in Annex I-3, ordered by decreasing number of jet movements.

All airports with more than 50.000 movements of civil subsonic jet aircraft (as by the ORD definition) were automatically selected. Also the city airports defined in Annex 1 to the ORD were included. It should be noted that the resulting list is based on the number of scheduled flights only. Since at various airports the number of non-scheduled flights is important (e.g. tourist destinations with charters) and at some even superseeds the number of scheduled flights, a further analysis was performed to detect at which airports the total number of jet operations (both scheduled and non-scheduled) would superseed 50.000 movements per year. This analysis was mainly based on ICAO airport traffic reports [4]. The resulting list of the 53 airports selected for detailed analysis in Phase 2 of the study is given in Table 1.

Country	Airport	
	IATA	Name
Austria	VIE	Vienna International Airport
Belgium	BRU	Brussels National
Germany	CGN	Koln-Bonn (Cologne-Bonn)
	DUS	Dusseldorf
	FRA	Frankfurt
	HAJ	Hannover
	HAM	Hamburg
	MUC	Munich
	STR	Stuttgart
	THF	Tempelhof (Berlin) *
	TXL	Tegel (Berlin)
Denmark	CPH	Copenhagen(Kastrup)
Spain	AGP	Málaga
	ALC	Alicante
	BCN	Barcelona
	MAD	Barajas (Madrid)
	PMI	Son San Juan (Palma)
	LPA	Las Palmas de Gran Canaria
	TFS	Tenerife Sur Reina Sofia Airport
Finland	HEL	Vantaa (Helsinki)
France	CDG	Charles de Gaulle(Paris-Roissy)
	LYS	Lyon-Sain-Exupéry
	MRS	Marseille-Provence International Airport
	MLH	Basel-Mulhouse (Euroairport)
	NCE	Cote D'Azur (Nice)
	ORY	Orly(Paris)
	TLS	Toulouse(Blagnac)
United Kingdom	BHD	Belfast City Airport
	BHX	Birmingham
	EMA	East Midlands Airport
	EDI	Edinburgh
	GLA	Glasgow
	LCY	London City Airport
	LGW	Gatwick Airport
	LHR	Heathrow
	LTN	London Luton
	MAN	Manchester
	STN	Stansted Airport
	ABZ	Aberdeen
Greece	ATH	Athens(Athens)
Ireland	DUB	Dublin(Ireland)
Italy	CTA	Catania
	FCO	Fiumicino(Rome)
	LIN	Linate Airport (Italy)
	MXP	Malpensa Airport
	NAP	Napoli
	VCE	Venice Marco Polo Airport
Luxemburg	LUX	Luxembourg International Airport
Netherlands	AMS	Schiphol(Amsterdam)
Portugal	LIS	Lisbon International
Sweden	ARN	Arlanda (Stockholm)
	BMA	Bromma(Stockholm)
	GOT	Landvetter (Gotenburg)

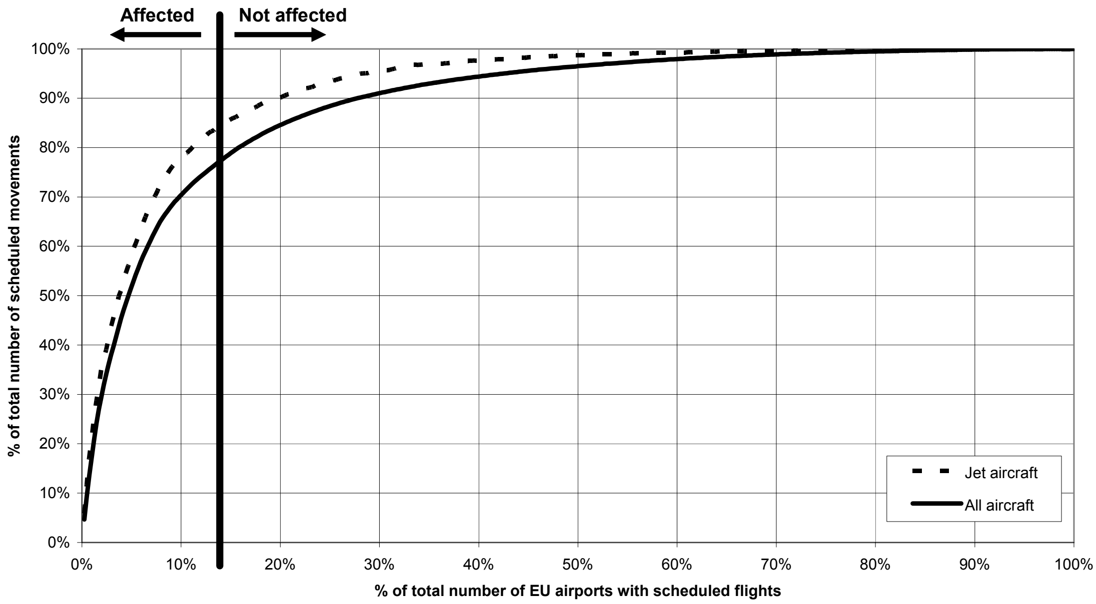
* Although it is anticipated that Berlin-Tempelhof will close to commercial traffic in the near future due to the inauguration of Schonefeld, it was maintained in the present study so as to simulate the latter as a first estimate.

Table 1. Airports selected for further analysis in Phase 2

Assumption 1. Airports selected for Phase 2.

The calculations of the noise climate in Phase 2 of the present study, have been performed only for those airports listed in Table 1. These airports have been selected on the criterion of handling more than 50.000 scheduled and non-scheduled jet operations in 2003 (with the definition of 'jet' according to the ORD)

An additional analysis was made, based on the available data in the OAG database. The cumulative number of movements was plotted against the number of airports, resulting in the following graph. Only 13% (53) of all EU airports with scheduled flights seem to be affected by the ORD. However, these airports handle 83% of all scheduled jet aircraft operations and 76% of all scheduled movements within the EU.



3.2 Questionnaire (SubTask 1.2)

3.2.1 Contents of the questionnaire

One of the manners in which data required for the calculations in Phase 2 was supposed to be gathered, was by means of a questionnaire to the airports.

Initially, two versions were developed:

- Complete version
  This version was sent to 135 airports with more than 40,000 movements (as listed in Annex I-1). It was also sent to those airports which replied on the abbreviated version, indicating noise problems (finally only Farnborough).
- Abbreviated version
  Sent to all 285 airports with scheduled flights which are not potentially affected by the ORD (see Annex I-2).

The questionnaires were sent in PDF format by e-mail to the noise specialist or the contact person determined in SubTask 1.1. The format of the questionnaire was designed so as to take a minimum of time in filling in the answers.
The full version of the questionnaire is given in Annex I-4. The abbreviated version consists of the first page of the full version (containing only the sections "General" and "General description of the noise situation" as described below).

The questionnaire is divided into various sections with the objective to obtain the following information:

General
The main purpose of this section is to gather up-to-date contact data

General description of the noise situation
The questionnaire requests information whether the airport is affected by aircraft noise, the characteristic of the problem and the type of airplanes that cause the major annoyances (e.g. cargo, heavy airplanes, hush-kitted)

Noise monitoring and calculation
Identification of noise monitoring systems, if installed, and characteristics of the system. In addition information is requested on the noise modelling performed at the airport (if any).

Airport details
Geographical information on the airport and runways. Future plans.

Traffic details
In this section, detailed information is requested concerning the number of movements, passengers, cargo, and number of movements by category of aeroplane and stage length of flights from or to the airport.

Noise abatement practices
Requests information about current and projected practices at the airport and if the airport plans to introduce additional restrictions in the framework of European Directive 2002/30

Population details
Information on affected areas and population. This section was considered the most problematic one due to the sensibility of the information and the probability that airports would not provide details.

Fleet mix for a representative day
This section asks for information about the fleet mix distributed by generic class in the years 2002, 2007 and 2015.

Due to the low response on this initial questionnaire (see section 3.2.2), a second attempt was made by sending a revised version to the airports which did not respond to the first one. This second questionnaire was sent through ACI-Europe with the hope this would improve response rate. A copy of this second questionnaire is also given in Annex I-4.

3.2.2 Results of the questionnaire

Anotec was aware upon sending the questionnaires that most likely not all the information requested from the airports would be available or could not be provided due to the sensibility of the data. Likewise, Anotec was also aware from previous experience with other questionnaires, that probably not all airports would reply.

The response received, however, was even less than anticipated. Only 13 of the 53 Phase 2 airports (~25%) and 6 of the 280 other airports (~2%) replied, as shown in the next table.

Responded to Questionnaire 1	
Full version	**Abbreviated version**
BHX (Birmingham, UK)	FAB (Farnborough, UK)
LTN (London Luton, UK)	ANE (Angers-Marce, France)
FRA (Frankfurt Rhein Main International, Germany)	CHR (Chateauroux, France)
LCY (London City Airport, UK)	KLU (Klagenfurt, Austria)
THF (Berlin Tempelhof, Germany)	ODE (Odense, Denmark)
TXL (Berlin-Tegel, Germany)	KSD (Karlstad, Sweden)
BRU (Brussels, Belgium)	
HEL (Helsinki Vantaa, Finland)	
EDI (Edinburgh, UK)	
GLA (Glasgow, UK)	
EXT (Exeter, UK) – not included in Phase 2 -	

Responded to Questionnaire 2	
HAM (Hamburg, Germany)	
AMS (Amsterdam Airport Schiphol)	
LIS (Lisbon, Portugal)	

The main reason for this low response seems to be the huge amount of questionnaires on environmental issues received by the airports (as indicated by various of them in different occasions). Another reason might be the type of data requested, which possibly could not be responded by a single person/department due to the distributed internal responsibilities with respect to these items.

The low response made it necessary to base the major part of the required input for Phase 2 on the additional information gathered under SubTask 1.3 (see section 3.3)

In the following the replies on the questionnaires will be analysed. Details on traffic flow, SIDs etc. are not included in this analysis, since they are considered relevant only for the calculations in Phase 2.

3.2.2.1 General description of the noise situation

The following table gives an overview of the answers on the questionnaire section related to the general noise situation at the airports and detection of any problems.

Airport		AMS	BHX	BRU	EDI	FRA	GLA	HAM	HEL	LCY	LIS	LTN	THF	TXL
Type of surroundings	*Industrial*				x		x	x		x		x		
	Residential	x	x	x	x	x	x	x	x	x		x	x	x
	Rural		x		x		x	x			x			
Noise problems	*Yes*	x	x	x	x	x	x	x	x		x	x	x	x
	No									x				
Future problems	*Yes*	x	x	x	x	x	x	x	x		x	x		x
	No									x			x	
Period of day causing problems	*Day*	x	x	x	x	x	x	x	x		x		x	x
	Night	x	x	x	x	x	x	x	x		x	x	x	x
	Depending on runway configuration				x		x	x	x					
Problems exist for	*Departure*	x		x	x	x	x	x	x		x	x	x	x
	Landing	x			x	x	x	x	x		x	x	x	x
	Beneath flight path	x	x		x		x	x	x		x			
	Sideline	x					x		x		x			
	Taxiing		x								x			
	Terminal area												x	
Types of aircraft which are considered to produce mayor problems	*Cargo*				x				x		x			
	Intercontinental						x		x					
	Hush-kitted		x	x	x		x	x	x		x			
	Marginally compliant Chapter3		x		x		x	x	x		x	x	x	x
	All types	x				x								
	Other				x	x	x				x			

From this table the following conclusions can be drawn:

- All airports, except Lisbon, are surrounded by residential areas, in some cases mixed with industrial zones.
- All airports report to have noise problems. Only London City airport reports no problems, but this is most probably due to the fact that they already have taken a variety of noise abatement measures (see below).
- All airports with current noise problems expect that these problems will persist in the future (except Berlin Tempelhof, due to the expected closure to commercial operations in the near future)
- All airports with noise problems report that these occur both at day and night (except Luton, where problems only seem to occur during the night). In some cases the problems depend on the runway configuration in use
- In general noise problems exist for both departures and landing.
- Only 3 airports (Birmingham, Lisbon and Berlin-Tempelhof) report problems related to ground operations
- The vast majority of the airports report that hush-kitted and marginally compliant Chapter 3 aircraft are the main cause of the noise problems encountered. Amsterdam-Schiphol reports that “Noise limitations are based on cumulative noise levels and therefore all types contribute to the noise problem. However, marginally compliant Chapter 3 aircraft are by far the least efficient in terms of ‘noise capacity consumption’ per aircraft movement”. Other types causing problems are military aircraft at Frankfurt and Glasgow. Intercontinental flights are a problem only at Glasgow and Helsinki airports.

Apparently all airports experience more or less the same problems.

3.2.2.2 Noise monitoring and modelling

The following table gives an overview of the answers on the questionnaire section related to monitoring systems and modelling the airports use.

Airport		AMS	BHX	BRU	EDI	FRA	GLA	HAM	HEL	LCY	LIS	LTN	THF	TXL
Monitoring system	*Yes*	Question not included in Questionnaire 2	x	x		x	x	Question not included in Questionnaire 2	x	x	Question not included in Questionnaire 2	x	x	x
	No				x									
Monitoring system installed used for	*Information*		x	x		x	x		x	x		x	x	x
	Reporting		x			x	x		x	x		x	x	x
	Enforcement of regulations		x				x			x		x	x	
	Public dissemination		x				x			x		x	x	x
Flight track monitoring	*Yes*		x	x					x	x		x		
	No						x						x	x
Noise metrics used	*LAE*			x						x			x	x
	SEL			x			x			x		x		
	LAmax		x	x			x		x	x		x	x	x
	Lden			x			x		x					
	Lnight			x			x		x					
	EPNL													
	PNL(T)max													
	Other			x	x		x							
Calculation model	*None*		x											
	INM			x					x			x		
	DANSIM								x					
	ECAC Doc 29				x		x							
	Other									x			x	x

No information is available for Amsterdam, Hamburg and Lisbon, since they responded to the second questionnaire, in which this information was not asked for. These airports are thus excluded from the following analysis.

Based on the information provided, the following conclusions can be drawn:

- All airports, except Edinburgh, have noise monitoring systems installed. Some of these are tailor made, whereas the majority of the systems is equally shared between Lochard and B&K.
- These systems are used for both information and reporting. Only Brussels airport does not use the system to report (see also [18]).
- At 50% of the airports these systems are also used for enforcement of regulations. At the same airports they are also used for public dissemination, probably related to the latter use.
- At 50% of the airports a flight track monitoring system is installed. It is noted that only at 3 airports where the monitoring system is used for enforcement of regulations, also a flight track system is available.
- With respect to the noise metrics, a variety of parameters is being used. However, all parameters used are based on dB(A). It is noted that none is using EPNL-related parameters. This is noteworthy, since the latter is the parameter obtained from noise certification, and it is used at several airports (a.o. Brussels) as a basis to apply operational restrictions and/or noise taxes. Since no direct relationship exists between A-weighted levels and EPNL derivatives, some incongruity seems to exist between noise contour calculations and operations related items.
- For noise modelling, several methods are used. The sample size is too small to draw any conclusion on which method prevails.

The main conclusion based on the above is that no 'standard' can be found in the way noise monitoring and modelling is treated at the airports analysed.

3.2.2.3 Noise abatement practices

Information on the noise abatement practices applied at the airports is gathered in the following table, and graphically represented in the graph below.

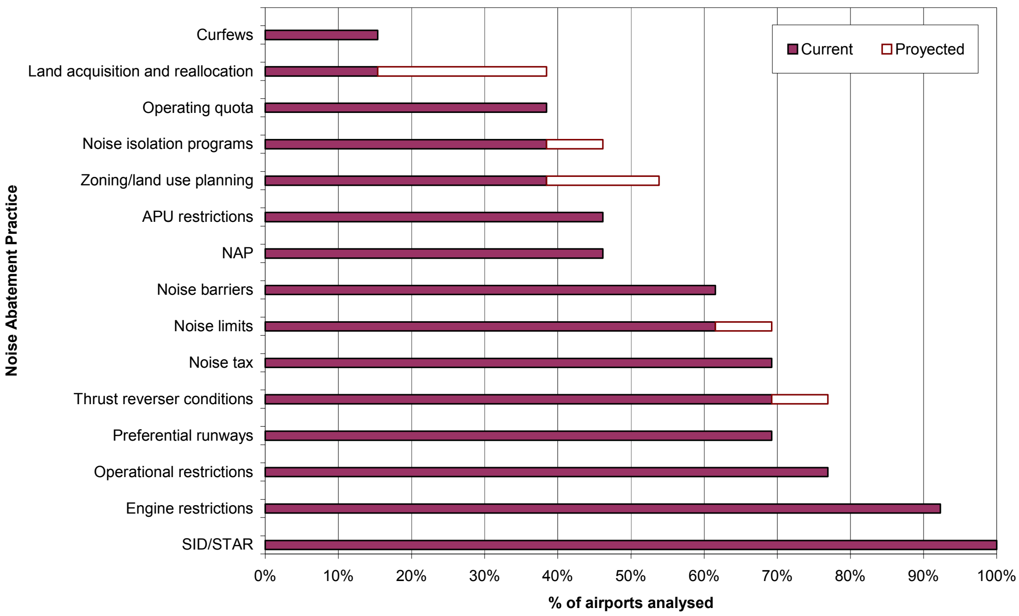
Since a detailed analysis of the noise abatement practices is part of the definition phase within Task 4, in order to define possible further action scenarios, no attempt is made here to analyse the results of the questionnaire. One is referred to Section 8.1 for more details.

In the current context only the projected practices are of interest, together with any plans the airports might have to introduce further restrictions in the framework of Directive 2002/30.

Analysing the table, only Brussels and Luton appear to already have plans for further actions. For both airports these actions are related to land use management. In addition, Brussels is projecting the introduction of noise limits and restrictions on the use of thrust reversers. Since no further details are available on these plans, their effect could not be incorporated in the calculations of the Baseline Trend in Task 3.

With respect to actions planned within the framework of the ORD, only Edinburgh, Glasgow and Luton reported their intention to implement restrictions in this manner. According to their indications, these actions would mainly deal with applying further restrictions to marginally compliant Chapter 3 aircraft.

Airport			AMS	BHX	BRU	EDI	FRA	GLA	HAM	HEL	LCY	LIS	LTN	THF	TXL
Noise Abatement Practices	Curfews	*Current*							x			x			
		Projected													
	Preferential runways	*Current*	x	x	x		x		x	x			x	x	x
		Projected											x		
	Operational restrictions	*Current*	x	x	x	x	x	x		x	x			x	x
		Projected													
	SID/STAR	*Current*	x	x	x	x	x	x	x	x	x	x	x	x	x
		Projected											x		
	NAP	*Current*	x				x	x			x	x	x		
		Projected											x		
	Operating quota	*Current*	x	x	x			x			x				
		Projected													
	Thrust reverser conditions	*Current*	x	x			x	x	x	x			x	x	x
		Projected			x								x		
	Engine restrictions	*Current*	x	x	x		x	x	x	x	x	x	x	x	x
		Projected											x		
	APU restrictions	*Current*	x	x					x		x	x			x
		Projected													
	Noise barriers	*Current*	x	x	x		x		x		x		x		x
		Projected											x		
	Noise limits	*Current*	x	x				x	x		x	x	x		x
		Projected			x										
	Noise tax	*Current*	x	x	x		x	x	x	x			x		x
		Projected											x		
	Noise isolation programs	*Current*	x	x			x		x		x				
		Projected			x										
	Zoning/land use planning	*Current*	x					x	x	x	x				
		Projected			x								x		
	Land acquisition and reallocation	*Current*	x					x							
		Projected			x		x						x		
	Other	*Current*													
		Projected													
Additional restrictions 2002/03-EC?		*Yes*				x		x					x		
		No		x	x					x	x			x	x



3.3 Additional information (SubTask 1.3)

To reduce project risk, a dedicated SubTask was defined from the very beginning so as to explore alternative methods to obtain the required information to develop the study. In the following these alternatives are described in more detail, using the same structure as the questionnaire. It is noted that the sections General", "General description of the noise situation" and "Noise monitoring and calculation" of the questionnaire are not relevant for the analysis in Phase 2 and thus no alternative method is needed.

3.3.1 Airport details

Details on airport location (longitude, latitude, elevation) and runways (ID, orientation, length, etc.) are easy to find on the internet and in Jeppesen and therefore no assumptions are necessary for these parameters.

The following assumption is made for meteorological conditions at the airport.

Assumption 2. Meteorological conditions at the airport

The temperature to be used in the calculations will be the yearly average temperature indicated by the airport or by default 15ºC.
The ambient pressure will be that corresponding to the former temperature and the airport elevation, according to ISA.
A headwind will be assumed with an average speed of 8 kts. This is in line with the performance coefficients given in the INM database.

With respect to future changes in the airport configuration, the following assumption is made.

Assumption 3. Future changes in the airport configuration

For the airports who indicated the construction of a new runway or other changes in the configuration that might result in a mayor change in the noise climate, these changes will be incorporated in the Baseline Trend study (Task 3). Information will be requested from the airports so as to be able to obtain the required information for the calculations. If this information is not available, the new configuration will only be taken into account in terms of the resulting increased capacity i.e. allowing more movements.

3.3.2 Traffic details

Traffic forecast and fleet composition are key items in every study on noise impact around airports. To be able to arrive at a harmonised hypothesis a comprehensive study was performed, based on reliable sources and taking into account all possible boundary conditions which might influence the previsions. A special section has been dedicated to these items, so as to be able to fully describe the process used to arrive at the harmonised hypotheses for both traffic growth and evolution of fleet composition (see section 4).

Another important parameter is the distribution of flights among the various tracks available (SIDs and STARs). Detailed information can usually only be given by the airports. In those cases where the airport did not provide this information, a best estimate has been made based on other available data, such as knowledge on preferential runways, noise contours indicated main routes, etc. The following assumption will be applied so as to determine the distribution over the tracks.

Assumption 4. Distribution of flights among the tracks available

The distribution of flights among the tracks as provided by the airports will be used. In its absence, a best estimate is made, taking into account preferential runway use, operational restrictions during certain time periods, and flow distribution obtained from different sources such as environmental impact assessment studies, airport master plans, noise maps, airport web pages, Jeppesen[23], etc.

With respect to the evolution of the routes served by the airports it is important to establish the following assumption.

Assumption 5. Changes in routes served by the airport

It is assumed that for the years 2007 and 2015 the airports continue to serve the same routes (city pairs) as established in the Baseline Year and the traffic growth will be maintained in the same routes. This implies that the traffic growth will be applied equally to all Generic Classes.

It should be noted that future developments, such as the growth in traffic to and from the new EU Member States are taken into account by means of an increase in the number of movements. It is assumed that these developments do not have any effect on the fleet mix.

3.3.3 Noise Abatement Practices

Current noise abatement practices can be found for many airports on the Boeing "Airport noise" web page [5]. In addition information can be found on the airports web sites and in the annual environmental reports issued by the airports. These practices are usually not used directly in the calculations. They will mainly be used to define future actions scenarios (Task 4) and/or in the case studies (Task 5).

The only item important for the calculations in the current scope is the take-off procedure the aircraft will fly (i.e. the vertical profile). To be able to run the model for the amount of airports considered in this study the following assumption is made. It is noted that at the majority of the airports this assumption is common practice.

Assumption 6. Flight procedures used in the calculations

It is assumed that for all airports and all years, the take-off procedure used is the so-called ICAO-B procedure. For all modern aircraft data for this procedure are available in the performance database. When this data is not available, the 'standard' INM take-off procedure will be used. This procedure is similar to ICAO-B and it is estimated that the error introduced is negligible, also due to the fact that the majority of the movements at the airports studied are performed with those aircraft for which the ICAO-B procedure is available.
For approach a standard 3º glide slope will be used for all airports.

3.3.4 Population details

Publicly available population data has been found for all countries, usually from their national statistics institutes or similar. In some cases this information is available from local or regional authorities. In general the information is directly given as number of inhabitants per village or town. With this information the population database has been generated.

Assumption 7. Determination of population

Since the only available data is that of the most recent census performed, the year for which the data are valid may vary, but information in general will not be older than 4 years. It is assumed that the latest census is representative for the status in the Baseline Year.
For the years 2007 and 2015 it is assumed that no growth in population will take place. Changes will only be taken into account when stated by the corresponding authority or when it forms part of a further action in Task 4 (see section 7.3). In these cases it is assumed that the growth will take place by means of a corresponding change in density, not in area, since on the latter no information will be available.

It is recognised that this assumption is in fact freezing the land use. Effects like urban development and encroachment are not taken into account, and thus might result in an underestimation of the population affected.

Cartography was purchased for all Phase 2 airports, except CTA (Catania) and LIN (Linate), due to unavailability of recent maps. In practice this means that, although noise contours will be determined for these airports, no data will be available on population affected.

All maps were scanned at an appropriate scale and residential areas were indicated and assigned their corresponding population, according to the census data acquired.

3.3.5 Fleet mix

As mentioned in 3.3.2 above, this item is described in detail in section 4.

Some remarks can be made here on the use of noise and performance data for existing aircraft and the introduction of new aircraft.

Assumption 8. Use of noise and performance data of existing aircraft

For each aircraft type the corresponding noise and performance data will be used as provided by the INM databases. If for any aircraft type various engine types are available, the most representative one for the EU fleet will be used. If for any aircraft type no data are available, this aircraft will be substituted by an acoustically similar one, according to the recommendations given by INM.

Assumption 9. Evolution of noise and performance of existing aircraft

It is assumed that, if the same aircraft/engine combination will exist in both current and future scenarios, its noise and performance parameters will not change.

Assumption 10. Introduction of new aircraft

New aircraft are being developed which will enter service in the short or medium term (A-380, 7E7, etc.) Since no data are available for these models, they will be introduced into the fleet mix table by equal redistribution of the number of new aircraft envisaged among the existing aircraft in the same Generic Class. In the noise model they will thus be substituted by these aircraft. Depending on available noise predictions, this substitution might be adjusted by means of a conversion factor so as to account for any improvements in terms of acoustic performance of this new generation aircraft with respect to the existing ones.

3.4 Harmonisation of hypotheses (SubTask 1.4)

One of the main characteristics and advantages of the methodology applied in the present study is the use of harmonised hypotheses for all airports. Some of the assumptions that have to be made to be able to perform the study, are affecting key parameters, with a major influence in the final results. It is thus of utmost importance that these assumptions are acceptable for all parties involved in this study. All important assumptions made in this study are clearly indicated and agreement on their use has been reached by approval of the Interim Report [6], by representatives of DG-TREN, DG-ENV, Eurocontrol and ACI-Europe.

Since the assumptions presented throughout this report were elaborated taking into account the global context, their definition can be considered part of the harmonisation exercise to which SubTask 1.4 is dedicated. It is thus considered not necessary to repeat these assumptions here. A complete overview of all assumptions is given in Section 6.4 for easy reference.

4. Traffic and fleet composition forecasts

Traffic forecast and fleet composition are key items in every study on noise impact around airports. The objective of this section is to arrive at a harmonised hypothesis, acceptable for all parties involved in the current study. The hypothesis developed is based on a comprehensive study of reliable sources and taking into account all possible boundary conditions which might influence the previsions.

4.1 Traffic forecast

4.1.1 Current economic context

In relation with the object of the study, the existing economic context worldwide and at European level is directly affecting current and future noise exposure at and around European airports. The factors or effects motivating such influence are the following:

- Traffic volume and growth according to the demand
- Interrelation between economic growth and increased demand for air transportation
- Fleet renewal capacity depending on the company's financial capacity and the economic situation in general. The companies are inclined to replace their aircraft in times of growth and profits, while in times of economic regression, the aircraft's use is expanded and the company's fleet renovation is postponed.
- Fuel prices with regard to direct operating costs

On worldwide level in 2001 air traffic fell by 4% and growth levels for the years 2002 and 2003 remain negative. This is caused by the economic unsteadiness, the international crisis related to the dramatic terrorist events of September 11th, 2001, the war in Iraq and the high oil prices [7]. Ultimately, the effect on the demand in several important areas due to the SARS epidemic seriously damaged the number of flights and passengers to important destinations such as Asia.

In this context, with the mentioned negative factors, the weak financial situation of the airline companies for the year 2003 and with regard to the findings of this study, the current situation can be summarized as follows:

- Decrease in the demand
- Increase in the number of inactive aircraft
- Decrease of orders for new aircraft
- General delay in planned fleet renewal programmes by the majority of the European and worldwide companies

It is however important to report that the actual crisis is yielding an important fleet renewal due to high number of aircraft available at low price in the leasing market. Most of these aircraft are almost new models and with state-of-the-art technology. The direct effect is the company's search for more efficient aircraft whose actual market price is clearly lower than two years ago and whose DOC, compared with older aircraft are clearly more favourable.

The above general trends are reflected in the following data for 2001 and 2002 [7]:

- Loss of scheduled airlines in ICAO states: 12 billion US$
- Load factor reduction: -2%, down to 70.2%
- TKT Total Scheduled flights: -4%
- TKT Total Non-Scheduled flights: -5%

4.1.2 Airline industry forecasts

Despite the present downturn, the long-term forecast of the industry will remain unchanged and it is foreseen that once confidence is regained, the same growth levels as in previous forecasts will be reached worldwide (i.e. about 5% on Passengers-Km-transported).

In the following the forecasts from different sources are analysed.

Boeing forecast [7]

20-Year Outlook—Airplanes

- Major projections for the 20-year period 2002 to 2021 are as follows:
  - Worldwide economic growth will average 2.9% per year
  - Passenger traffic growth will average 4.9% per year
  - Cargo traffic growth will average 6.4% per year
- Worldwide demand for commercial airplanes, 2002–2021
  - The world fleet will grow to 32,495 passenger and cargo jets in 2021
  - The composition of the world fleet in 2021 will be
    - 17% smaller regional jets
    - 22% intermediate-size airplanes.
    - 57% single-aisle airplanes
    - 4% 747-size or larger airplanes.
- Total market potential is 23,930 new commercial airplanes worth $1.8 trillion in 2001 US dollars.
  - Airlines will take delivery of
    - 4,240 smaller regional jets
    - 4,980 intermediate-size airplanes
    - 13,765 single-aisle airplanes
    - 945 747-size or larger airplanes.

ICAO forecast [8]

The forecast estimated by the Forecast Economic Study Group (FESG), group pertaining to the CAEP, for the years 2002-2020 are as follows:

- Load factor: Upper limit 75%
- 17500 additional aircraft on the period 2002-2020
- In the horizon 2002- 2020 the following composition is anticipated:
  - 7600 retained in service
  - 4717 Replacement
  - 12667 Growth
- Worldwide Growth in RPK: 4.7%

Airbus forecast [9]

The main data from Airbus global market forecast in the period 2002-2020 are the following:

- Worldwide Growth in RPK: 4.7%
- Europe growth in RPK: 5%
- Growth in cargo: 5.5%
- Increase in number of movements: 3.2%
- A tendency to larger, twin-aisle aircraft is envisaged.

Eurocontrol [10]

The estimations of Eurocontrol (STATFOR) in number of IFR movements are the following for the period 2002-2010

- High: 4.7%
- Baseline: 3.6%
- Low: 2.5%

4.1.3 Proposed scenarios for traffic growth

Given the possibilities of the model developed to calculate the effect of different scenarios in an easy manner (see section 5), it has been considered convenient to establish 3 scenarios for this study. These scenarios take into account different hypotheses to establish the growth factors.

Three growth scenarios have been developed: “Probable” Scenario, “Conservative” Scenario and “Differentiated” Scenario. With these scenarios the whole range from low to high air industry forecasts is covered. It is unlikely that the growth will be higher than that foreseen in these scenarios due to the actual capacity problems of airspace, as well as at airports, in most European countries.

4.1.3.1 “Probable” Scenario

This first scenario gathers the growth forecast adopted from the different air industry sources (Boeing, Airbus, ICAO, Eurocontrol). This scenario is considered a prosperous scenario with a stable economic and traffic growth, similar to that of the previous decade.

Element	2002-2007	2007-2015
GDP	2% (< 2005) 3% (≥ 2005)	3%
Traffic passenger growth	4.7%	4.7%
Load factor	72%	75%
Movement growth	3.6%	3.6%

4.1.3.2 “Conservative” Scenario

It has been considered convenient to carry out a more conservative scenario that could evaluate the effects of a lower growth on noise around the airports, depending on minimizing potential functions of the growth factor or on an economic situation similar to the existing one (2002-2003). Based on the forecasts of the low growth scenario established by Eurocontrol and taking into account the factors that could reduce the annual growth rate (see section 4.2), the following scenario has been developed:

Elements	Considerations		2002-2007	2007-2015
GDP			2% (< 2005) 3% (≥ 2005)	3%
Traffic pass. growth			3%	3%
Load factor			72%	75%
Movement growth	Hub airports	Low cost carriers Ultra High Capacity Increase in size Airport constraint	2%	2%
	Intra-Communita-rian airports	Low cost carriers Increase in load factor Airport constraint	2.5 %	2.5%
	Local airports	Competition from HST	1%	1%

4.1.3.3 “Differentiated” Scenario

In addition to the more general scenarios described above, it has been considered convenient to assess also a scenario which takes into account differences in development of traffic among the various EU regions, e.g. due to the enlargement of the EU and due to differences in economical development. This so-called “Differentiated” Scenario is based on the regional development foreseen by Eurocontrol [11] and takes into account differences in growth between the various flight types (domestic, long-haul, short-haul) served by the airports, as shown in the following table.

Country	Airport type	Average annual growth 2002-2007	Average annual growth 2002-2010	Country	Airport type	Average annual growth 2002-2007	Average annual growth 2002-2010
Austria	Local	1.58%	1.63%	Greece	Local	4.66%	5.08%
	IntraCom	3.75%	4.11%		IntraCom	4.92%	5.59%
	Hub	3.75%	4.11%		Hub	4.96%	5.61%
Belgium	Local	0.87%	1.36%	Ireland	Local	9.86%	11.16%
	IntraCom	3.78%	3.90%		IntraCom	5.72%	5.84%
	Hub	3.74%	3.85%		Hub	5.63%	5.73%
Germany	Local	2.44%	2.54%	Italy	Local	3.12%	3.26%
	IntraCom	3.60%	3.85%		IntraCom	4.19%	4.53%
	Hub	3.60%	3.86%		Hub	4.29%	4.60%
Denmark	Local	1.12%	1.21%	Luxemburg	Local	0.87%	1.36%
	IntraCom	3.51%	3.80%		IntraCom	3.78%	3.90%
	Hub	3.52%	3.82%		Hub	3.74%	3.85%
Spain	Local	3.65%	3.62%	Netherlands	Local	1.02%	2.03%
	IntraCom	4.04%	4.13%		IntraCom	3.44%	3.46%
	Hub	4.01%	4.10%		Hub	3.46%	3.48%
Finland	Local	3.45%	3.80%	Portugal	Local	3.95%	3.97%
	IntraCom	4.33%	4.71%		IntraCom	4.48%	4.69%
	Hub	4.33%	4.70%		Hub	4.44%	4.64%
France	Local	2.82%	2.84%	Sweden	Local	1.35%	1.54%
	IntraCom	3.49%	3.58%		IntraCom	2.78%	3.01%
	Hub	3.47%	3.56%		Hub	2.80%	3.03%
UK	Local	3.00%	2.98%				
	IntraCom	3.98%	3.90%				
	Hub	3.93%	3.86%				

Assumption 11. Forecast for growth in number of movements until 2015

The Baseline Trend of the noise climate (i.e. for the years 2007 and 2015) will be determined for three different growth scenarios: “Probable”, “Conservative” and “Differentiated”.

The yearly growth in total number of movements for these scenarios is as follows:

Airport type	Probable	Conservative	Differentiated
Hub	3.6 %	2.0 %	See Table in 4.1.3.3
Intra-Communitarian	3.6 %	2.5 %	
Local	3.6 %	1.0 %	

4.2 Boundary conditions at airports, influencing traffic growth

The aircraft noise and its incidence on persons living around the airports has become one of the main factors limiting the airport's growth capacity. At present in Europe, a great number of airports experience difficulties to construct new runways or other installations required to increase their capacity, due to their effect on the noise impact. As a result of these constraints various effects will influence the traffic at these and other airports, as will be explained in this section.

4.2.1 Airport capacity constraint

As described above, various airports will reach their "constraint point" at one point in time and will thus be unable to grow further. The problem is further increased by the congestion during the most economically profitable hours where the existing slots prevent the entry of new competitors. The abovementioned "probable" forecast for traffic growth implies that air traffic will increase with about 60% over the 2002-2015 period, which would mean that various major airports within Europe would reach their maximum capacity. Based on an analysis of data obtained from Eurocontrol [12], various airports with more than 50,000 movements could see their growth limited sometime between 2002 and 2015. In the following table the airports affected are presented. It should be noted that the capacity indicated is an estimate, derived from [12] and is mainly based on limitations due to runway capacity, taking into account night curfews and known future developments in terms of number of runways, stands, terminals and ATM improvements. At some airports this theoretical maximum might not be the practical capacity, due to e.g. environmental capacity constraints (as -qualitatively- indicated by AMS airport). However, no quantitive data are available on the latter, due to the lack of response from the airports on this matter.

Airport	Max. capacity*	
	2007	2015
AMS (Amsterdam-Schiphol)	528000	528000
DUS (Dusseldorf)	210240	210240
FCO (Rome-Fiumicino)	490560	490560
FRA (Frankfurt-Main)	554800	554800
LHR (London-Heathrow)	683280	683280
MUC (Munchen)	478880	478880
STN (London-Stansted)	221920	221920

* theoretical or (if available) as indicated by airport

Airports not indicated in the table are assumed not to reach their maximum capacity until 2015.

In Task 3 (see section 7) of the study a first calculation has been performed assuming no constraints. In a second dedicated run, the noise climate at the constraint airports has been re-calculated, taking into account the indicated capacity constraint as indicated in the table and the consequences of this constraint as described below.

4.2.2 Consequences of airport saturation

The constraint on airport growth will have both positive and negative effects on the noise climate around the airport. When calculating the effect of constraint in Phase 2, these consequences are also taken into account according to the assumptions described hereafter.

4.2.2.1 Increase in aircraft size

Constraining any increase in airport capacity would sharply increase competition for, and the implicit price of, slots at the major airports. This would increase the pressure on airlines to maximize their revenues from the slots available. It would intensify the pressure already being felt and would results in a shift from domestic and short-haul flights towards the medium- and long-haul trips which generate greater income. This would lead to changes in the fleet mix at the airports with a trend towards larger aircraft and therefore higher noise levels.

While it is true that data shows a gradual rise in the size of aircraft being ordered and that some capacity constrained airports are seeing a rise in seat numbers, it is also true that there is an "efficiency ceiling" in aircraft size and load factor due to the actual designs of aircraft being manufactured or projected for the next fifteen years and its relationship capacity/accessibility.

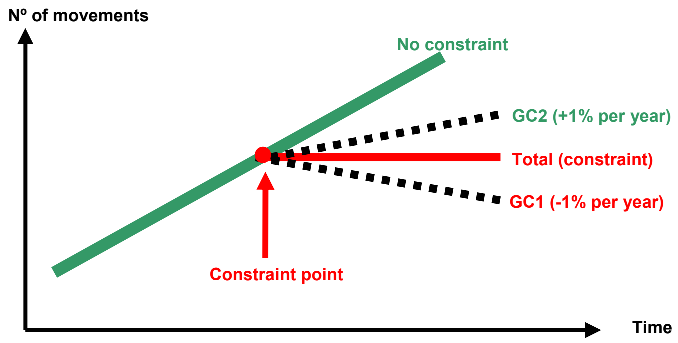
At airports where a capacity constraint is detected, the foreseen effect of increase in individual capacity per aircraft is considered and will result in a shift of operations from one Generic Class to the next one (see section 4.3). The capacity increase considered will mainly depend on the type of the airport (Intercontinental hub, Intra-Communitarian or Local, see section 6.3) and is estimated as follows:

Assumption 12. Increase in aircraft size due to airport capacity constraints

Starting from the year in which constraint is reached, a shift of 1% per year will be assumed from one Generic Class (GC) to the next higher, depending on the type of airport:

- Intercontinental hub: From GC4 to GC5 and from GC5 to GC6
- Intra-Communitarian and local airports: From GC1 to GC2

As an illustration, this effect is presented for a local airport in the following graph. It is noted that the total number of movements at the airport will not change from the constraint point onwards.



4.2.2.2 Shift in operating hours

In another context the airport's saturation could influence the timetable, since saturation will usually first be noticed in the peak hours. Therefore the traffic increase might be engrossed during hours where the noise inconvenience is greater. For example, shifting hours from day to evening or evening to night by delaying departure hours, or time shift to the early morning hours. This effect might result in an increased noise impact due to the higher penalisation of operations during these time periods.

The actual shift will depend on many factors and a harmonised hypothesis can not be given. Therefore this effect will not be taken into account when calculating the effect of airport capacity constraint.

Assumption 13. Shift in operating hours

The shift of operations to noise-wise less favourable periods of the day is not taken into account in this study, due to the difficulties encountered to establish a harmonised hypothesis.

4.2.2.3 Constant number of movements

After the constraint point the total number of movements at the airport will remain constant. Due to market induced fleet modernisation the noise would decrease. This effect is taken into account in the establishment of the fleet composition as developed in section 4.3, and thus no additional exercise is required here.

4.2.2.4 Shift towards secondary airports and competition between airports

Although competition among airports has been and is limited, there are factors that seem to have opened that possibility, e.g. the introduction of low-cost carriers and the existing saturation in main European airports during peak hours. So, while some large airports have suffered a decrease in number of passengers due to the economic downturn, others under similar circumstances have sustained notable growth, as can be seen from the following table, derived from [13]:

Primary airport	Alternative airport	Change in nº movements [%]		
		2000	2001	2002
London LHR+LGW		+3.6	-1.5	-0.8
	Stansted STN	+6.9	+4.2	+0.5
	Luton LTN	+6.7	+3.7	-3.3
Frankfurt FRA		+4.5	-0.5	+0.4
	Hahn HHN	+18.8	-1.8	+11.5
Brussels BRU		+3.9	-6.3	-15.9
	Charleroi CRL	N.A.	+0.3	+31.9

From the general noise viewpoint, the competitive incidence may vary depending on each case and depending on whether the alternative airport is free of noise problems produced by the airplanes or if the noise problem is transferred from one airport to the other.

From the airport's noise viewpoint, it seems to be clear that an extension in restrictions or limitations in certain airports could transfer certain traffic proportions to airports with fewer problems. This could reduce the problem in certain airports, but it could also transfer the problem to other airports and even carry the problems to airports where these were non-existent.

Since at the moment the increase in operations at secondary airports like Charleroi and Hahn is mainly due to the introduction of a single low-cost carrier and, in terms of absolute number of movements, does not (yet) represent a significant amount of the number of movements at the corresponding primary airports, it was agreed during the mid-term meeting that this effect would not be further investigated within the scope of the present study.

Assumption 14. Shift of operations towards secondary airports

The noise climate at the primary airports at which a shift of operations towards alternative airports was detected, will be assumed not to be affected by this shift, due to the limited number of movements involved compared to the total number of movements at the primary airport. The assessment of the noise climate at the secondary airports, due to its complexity, is considered outside the scope of the present study.

4.3 Current and future fleet composition

As expected, not all necessary data was available or has been provided by the airports to run the program. On the other hand, the traffic forecasts obtained from the airports are generic and in the majority of the cases, limited to an estimated number of movements or passengers for future years, based on unknown assumptions, which will vary from one airport to the other.

Therefore additional information has been gathered to allow the use of comparable and homogeneous hypothesis in the analysis of the data for its subsequent use in the noise model software.

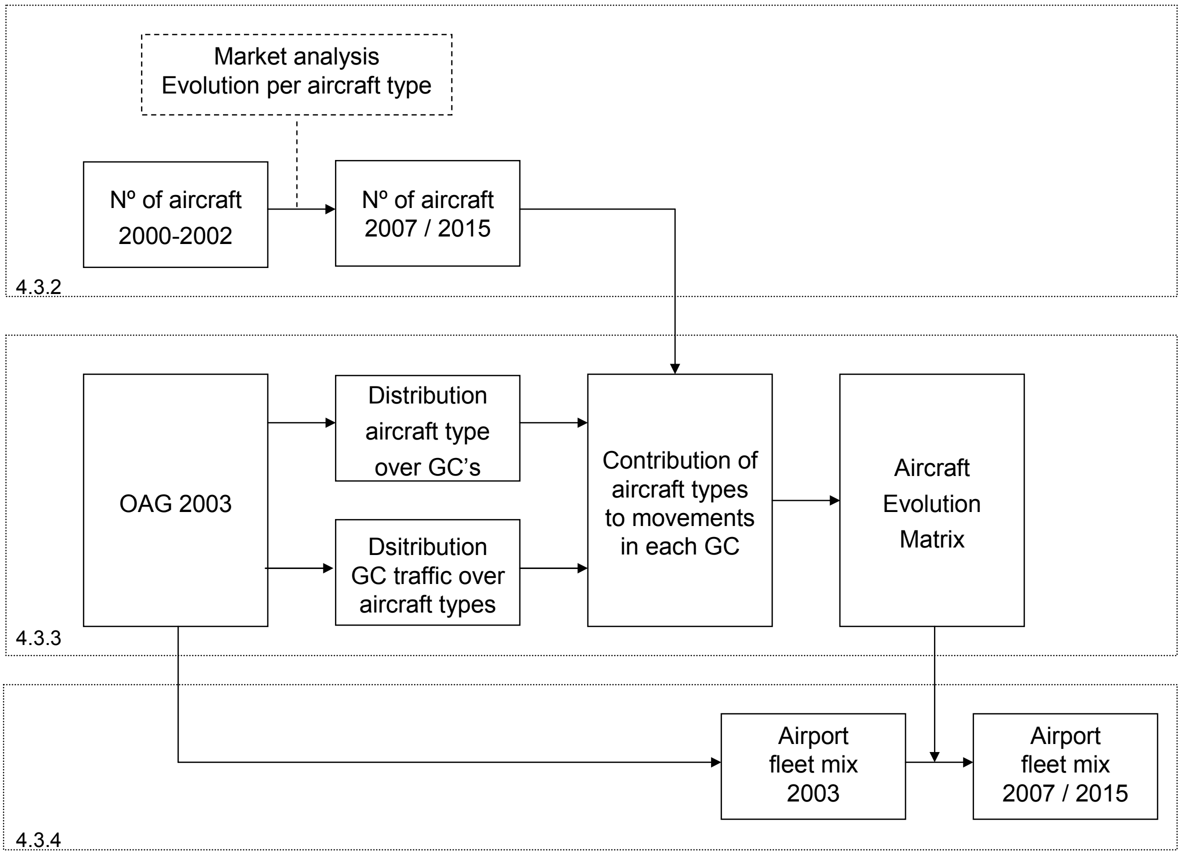
In this section the method to determine the future fleet composition is developed.

4.3.1 Methodology

The final objective of the methodology to be developed is to predict the future fleet composition at each of the airports studied for the years 2007 and 2015.

As mentioned in section 3.1.2 it was decided to purchase the OAG “Max historical” database for 2003. It was decided to take the year 2003 rather than 2002, since it is considered a more representative year for the fleet mix, mainly due to the fact that the Chapter 2 phase-out was completed in 2002. The evolution of the fleet mix is based on this database.

Since this database obviously only gives information on current traffic and fleet mix, a method was developed to obtain the future fleet composition, taking into account the current status. The methodology followed is presented graphically in the following chart.



GC = Generic Class

The following steps can be distinguished:

1. Determination of number of aircraft in current European fleet
   Analysis of European fleet composition, orders and average fleet in the years 2000 to 2002

2. Analysis of market and evolution by aircraft type in the horizon 2003-2015
   Analysis of the quantitative and qualitative factors that will affect the evolution of the fleet composition for each type of airplane

3. Forecast of number of airplanes by type in the years 2007 and 2015
   Based on the data from step 1 and step 2, quantification of number of airplanes in years 2007 and 2015

   Steps 1 to 3 are described in section 4.3.2.

4. Analysis of the distribution over Generic Classes for each aircraft type
   Various aircraft types operate in several Generic Classes, due to differences in the number of seats available

5. Analysis of the distribution of the traffic volume over the aircraft types within a Generic Class
   Within each Generic Class the traffic is distributed over several aircraft types.

6. Determination of the “Aircraft Evolution Matrix”
   Describes the evolution of each aircraft type until 2015 by means of a factor, to be applied to the Baseline Year data.

   Steps 4 to 6 are described in section 4.3.3.

7. Determination of the future fleet composition for each airport
   Adjust the OAG 2003 data for each airport by means of the evolution factor so as to obtain the fleet mix in the years 2007 and 2015 for each individual airport.

   Step 7 is described in section 4.3.4.

4.3.2 Current and future number of aircraft in Europe

The following items have been considered in the assessment of the current and future European fleet mix in terms of number of aircraft. These data are required for the determination of the Aircraft Evolution Matrix as described in section 4.3.3.

- Current and historical data
- Classification by generic Seat category at all EU airports
- Trend in market-orders
- Fleet mix
- Fleet mix forecast

4.3.2.1 Current and historical data

Table 2 reflects the composition of the European aircraft fleet at the moment of the study and for most recent years. This reveals the actual situation with regard to fleet composition and allows the evaluation of the trends shown for the years 2007 and 2015.

The following data are presented:

- Aircraft types: The most representative aircraft models being used at present as well as certain models that have been flying even during the year 2002, but that due to the removal of Chapter 2 aircraft, will not be operative in the following years.
- Generic Class: Classification by number of seats for the standard aircraft configuration provided by manufacturers:

Generic Class	Nº of seats
1	0-80
2	81-150
3	151-210
4	211-300
5	301-400
6	401-500
7	> 500

- Number of aircraft: In European registers, including non-EU.
- Percentage in European fleets: percentage over the total European fleet.
- European share: Indicates the percentage of aircraft pertaining to a specific class in comparison with the rest of the world. The analysis of this data in conjunction with the orders per manufacturers has shown its importance given the fact that it indicates the trends of the fleet composition regarding each model.
- Average age: Average age of the total fleet of the referenced model.
- Firm orders: Worldwide firm orders for the stated model.

NOTE: Given the actual situation of the sector, the number of orders and the forecasted fleet renewals have suffered very important changes. Because of this, the data could vary depending on the date the request was placed. In any case, the data obtained shows the growth trends with regards to mix of future fleets; hence, the total number of orders should be considered from a relative point of view.

Aircraft	*Generic*	*Number of aircraft in*			*% of total EU fleet in*		*EU share*	*Average*	*Firm orders*
type	*Class*	*2000*	*2001*	*2002*	*2001*	*2002*	*(%World)*	*age*	*World (EU)*
A-300-B2	4	56	64	55	1.5	1.3	16.7%	22	0
A-300-600	4	10	12	15	0.28	0.35	28%	9	85
A-310	3	52	74	69	1.5	1.3	28.2%	14	45
A-320	2	258	296	339	5.8	6.6	33.8%	9	370 (166)
A-321	3	108	135	145	2.6	2.8	65.6%	3	155 (68)
A-319	2	81	118	141	2.3	2.7	34.6%	3	190
A-330	5	44	58	58	1.1	1.1	28.2%	4	150
A-340	5	75	99	110	1.9	2.2	52.4%	4	107
B-707	4	?	5	5	0.1	0.1	2.4%	29	0
B-727	2	81	86	70	1.7	1.3	5.8%	27	0
B-737-200	2			15		0.2		25	0
B-737-3/4/5	2	824	938	558	18.4	11.2	24.8%	11	0
B-737-6/7/8/9	2			372		7.2		1	579
B-747-200	5			63		1.2		23	0
B-747-300	5	263	261	15	5.1	0.3	23%	17	0
B-747-400	6			178		3.5		7	0
B-757	3	191	207	201	4.1	3.9	20.5%	10	40
B-767	4	143	145	131	2.8	2.5	15.5%	12	
B-777	5	45	60	70	1.2	1.1	18.6%	2	212
DC-8	4	6	7	7	0.1	0.1	3%	35	0
B-717	2	5	25	34	0.2	0.4	20%	2	44
MD-80	2	329	345	335	6.8	6.6	24.2%	15	0
DC-10	5	34	35	27	0.7	0.1	8.2%	25	0
MD-11	5	59	63	62	1.2	1.2	31.8%	9	0
L-1011	5	9	12	13	0.2	0.1	8.8%	24	0
Bae 146	2	115	226	232	4.4	4.5	61.7%	13	0
F 100/70	2	65	105	97	2.1	1.9	30.2%	9	0
CRJ	1		120	148	2.4	2.9	24.4%	4	561
ERJ	1		107	142	2.1	2.8	27.8%	2	596
Il 96	4		14	14	0.3	0.2	100%	5	0
Tu-154 M	3			175		3.5		12	0
Tu-204	3		18	16	0.4	0.3	80%	5	20
A-318		0	0	0	0	0			84
A-380	7	0	0	0	0	0			95
Chapter 2 aircraft									
BAC 111*	2	19	21	12	0.4		9.6%		0
IL 62*	3	400	172	137	3.4	2.6	77%	21	0
IL 86	4	72	91	74	1.8	1.4	75.5%	16	0
Tu-134	1	340	398	388	7.8	7.6	83.4%	25	0
Tu-154	3	488	599	408	7.5	11.4	84.9%	23	0
Yak-42*	2		138	131	2.7	2.5	81%	13	14

Table 2. Current and historical data on number of aircraft in European registers [7,9,14]

4.3.2.2 Analysis of market and evolution by type of airplane

To define the fleet composition in future years, the following factors and assumptions have been taken into consideration:

- Boeing, Airbus and ICAO growth forecasts for new aircraft in the 2002-2020 horizon
- Growth rate of 4.5% in the total number of airplanes worldwide
- Combination of renewal/growth and retained airplanes in the horizon 2002-2020 (Boeing, Airbus, ICAO)
- Service life of 25 years for passenger airplanes in European fleets
- Service life of 35 years for cargo airplanes
- Trend in fleet composition established in Table 2 for years 2000, 2001 and 2002
- Peak on orders for a model 10 years from its' entry into service
- Reduction in fleet after 20 years average age.
- Growth per Generic Class for 2002-2015 (Airbus, Boeing, ICAO)

In addition to the growth forecasts obtained from Boeing [7], Airbus[9] and ICAO (FESG) [8], information with regard to actual composition, the life of airplanes, average fleet age and orders was mainly obtained from Airclaims [15]. Orders have been confirmed with data from the manufacturers.

The following general trends have been observed, based on the sources used in this analysis:

- In Generic Class 1, relevant trends to modification in the fleet mix from turboprop to light jet such as Embraer 145 family and Canadair RJ. Notable increase in the total number of jet airplanes with corresponding increase in the share in the total fleet.
- Based on the information from recent years and the analysis of fleet evolution, an increase in the number of airplanes under Generic Class 1 has been detected in co-ordination with an increase in the airplane's size under Class 2 and 3. A moderate decrease occurs in the volume of airplanes of the lower part of "Generic Class 2".
- In general and for all categories, the airplanes that are no longer in production have a faster withdrawal (with regard to fleet percentage) in the 2002-2015 horizon. This is the case for MD-80, F-100, MD-11 and others. This is independent of the fleet's age.
- In Generic Class 2 the forecast indicates the early retirement of MD-80. The examples analysed show a great portion of its withdrawal from the European fleet within the coming years. The search for airplanes with more capacity and commonality with the superior Generic Class fleet (commonality within Boeing or Airbus family justified by its maintenance and crew versatility) was a detected factor in the cases analysed. (Data gathered from the analysis of the company's fleet renewal plans and purchase orders).
- The matter of commonality within the fleet is substantial regarding the total composition of the European fleet because of its importance when contemplating future forecasts. The data shows that in the 2002-2015 horizon, a reduction in aircraft diversity is seen and a concentration of an important part of the fleet towards Airbus and Boeing aircraft for Classes 2 to 6.
- The analysis performed indicates that in the year 2015, there will be a dominating airplane for each type, for each of the leading manufacturer's families and these will probably mark the acoustics levels that will exist at the airports.
- There is an increasing trend in the different categories for twin-engined planes with a reduction of the three- or four-engined planes. This has a positive effect on the total noise levels received on the ground due to their improved performance.
- Many of the existing withdrawal plans of the airlines for aircraft that do not comply with the noise requirements established in the ORD, were recently revised because of the actual crisis and the great amount of possible options to purchase new or almost new airplanes at a low price.

Individual consideration for each type of aircraft, taking into account the above general considerations, are described in the following Table 3.

Aircraft Type	Evolution
Turboprop	Growth less than average for total fleet and Generic Class 1. Loss of quota in Generic Class 1.
Jets <80 seats	Due to reduction, in relation with turboprops, of operative cost for light jet and based on passenger demand/preference, these airplanes will present an increasing part in Generic Class 1. Two models will be the representatives for period 2003-2015 Embraer 135/145 and Canadair Regional jet. Higher growth than average for Generic Class 1 in the period 2002-2015 (Boeing, Airbus, ICAO forecast).
A-319	Average fleet age 3 years. Alternative airplane for renovation of B-737-200/300 MD-80 and older DC-9 and 727 in the seat range of 120 seats. Growth higher than average. Commonality with Airbus family. General increase in Generic Class 2 for the period 2002-2015 (Boeing, Airbus, ICAO forecast).
A-320	Average fleet age of this model is 9 years. Growth higher than average based on number of orders. Its commonality with the rest of the Airbus family and its versatility for European routes are one of the justifications for the growth increase in the period of the study. Replacement of older aircraft of the category in mayor European airlines (BA, Air France, Lufthansa, Iberia, SAS, etc) General increase in Generic Class 2 for the period 2002-2015 (Boeing, Airbus, ICAO forecast).
A-321	Average fleet age 3 years. Biggest version of the A-320. Similar characteristics to those described for A-320. Growth higher than average.
B-727	Marginally compliant airplane in the European fleet with majority of operations as cargo airplane. Due to its age and potential restrictions in the horizon 2007 only a small number will remain in activity. Not considered in the scenario 2015.
B-737	Average fleet age 25 years for series –200 and 13 years for series –300. An important proportion of this airplane fleet will be retired in period 2002-2007. Family from series –200 to -900, covering from 109 seats to 220 seats. Retired models will partly be replaced by models of the 'Next Generation' series. The number of orders confirms that the growth maintains in the next years. Alternative airplane for renovation of MD-80 and older DC-9 and 727. Most popular airplane for low cost airlines with more than 200 orders for period 2002-2015. General increase in Generic Class 2 for the period 2002-2015 (Boeing, Airbus, ICAO forecast).
MD-80	Average fleet age is 15 years. Airplane not in production. Higher DOC compared to new airplanes due to fuel consumption. Accelerated retirement from European register. Plan of renewal in the coming years for the main operators in Europe of this airplane (SAS, IBERIA, Spanair, Austrian).
BAE-146	Airplane not in production. Average age 13 years. Higher DOC compared to new airplanes due to 4 engines. Gradual reduction in the European register
F100/70	Airplane not in production. Average fleet age 9 years. Will maintain in some frequent connections between cities but the prevision is a gradual and slow reduction in years 2007 and 2015.
B-757	Average fleet age 10 years. No orders at present from European airlines. The forecast is that the number will be maintained during all the period with a small reduction in 2015 due to reaching retirement age. Very versatile aircraft, used in Europe for flights from 1 hour up to intercontinental operation due to ETOPS capacity.
A-300	The average fleet age for older version –B2 is 22 years. Maintaining the number during the period 2002-2015 with a natural reduction for period 2015. Cargo version with extended life for these airplanes. Version A-300-600 average fleet 9 years. Number increases at average rate.
B-707	Airplane totally retired in the year 2007
B-767	In production from 1981, there are several series with different average fleet age. The progressive retirement of older models will be substituted by new models with more capacity. Maintaining the number for the period 2002-2015
DC-8	Only version –70 re-engined, will maintain for the years 2007 and 2015 as cargo airplane. Average fleet age for this version 16 years (After re-engining, the original airplane was manufactured in the 60's)
A.330	Average fleet age 4 years. Substitute for older B-747 and DC-10. Growth higher than average.
A-340	Average fleet age 4 years. Substitute for older B-747 and DC-10. Growth higher than average. Actually it is the most popular airplane in its class among the major European airlines (Orders and deliveries).
B-747	Average fleet age for series –100 y –200 25 years. For –300 17 years. Natural reduction during the period 2002-2015. Possibility for conversion to cargo version.
B-777	Average age 2 years. Candidate for substitution of older DC-10 and B-747. Growth at average rate
DC-10	Average fleet age 25 years. Not in production. Probable retirement from passenger service. Natural reduction slow due to potential capability to cargo conversion.
MD-11	Average fleet age 9 years. Cargo and passenger version. Not in production. Slow reduction in European fleets during the period 2002-2015. Potential cargo version
B-747-400	Average fleet age 7 years. Cargo and pax. version. Natural substitute of older B-747. Competition with B-777 and A-340 family. No retirement in period 2002-2015. Growth at average rate.

Table 3. Considerations for evolution of individual aircraft types

4.3.2.3 Forecast for future number of aircraft in Europe

The following table gives the forecast for the European fleet composition for the years 2007 and 2015. This forecast is based on the current composition, described in section 4.3.2.1 and taking into account the considerations on the evolution of the various aircraft types according to 4.3.2.2.

Aircraft type	*Generic Class*	*Number of aircraft in*	
		2007	*2015*
Turbop	1	393	427
CRJ	1	306	459
ERJ	1	272	409
A-320	2	440	666
A-319	2	230	565
B-727	2	15	0
B-737-3/4/5	2	530	380
B-737-6/7/8/9	2	485	679
MD-80	2	241	103
Bae 146	2	158	56
F 100	2	66	50
A-318	2	80	300
A-310	3	60	30
A-321	3	202	310
B-757	3	140	120
A-300-B2	4	50	10
A-300-600	4	30	40
B-707	4	0	0
B-767	4	131	131
DC-8	4	3	0
A-330	5	78	110
A-340	5	160	224
B-747-2/3	5	15	9
B-777	5	110	154
DC-10	5	16	0
MD-11	5	60	60
L-1011	5	0	0
B-747-400	6	222	311
A-380	7	0	100

Note 1: The classification of the aircraft types in Generic Classes in this table is based on their maximum capacity and did not take into account other seat arrangements by individual airlines. Since in reality the number of seats may vary considerably among the airlines (see section 4.3.3) a single type may belong to various classes. Based on this, the Generic Class in this table is given for information purposes only.

Note 2: The total number of aircraft determined here will not correspond exactly with the number expected when applying the world fleet growth rate of 4.5%. This is mainly due to the type of analysis performed to arrive at the fleet mix, taking into account individual aircraft types and their evolution, based on many different sources. It is understood however, that the relative distribution over the various aircraft types within the Generic Classes is correctly determined. Since the data given here is only used to arrive at the evolution matrix given in section 4.3.3, and not in the calculations to be performed in Phase 2 (these will be based on actual traffic data expressed in number of movements, see section 4.3.4), the error introduced here will be small.

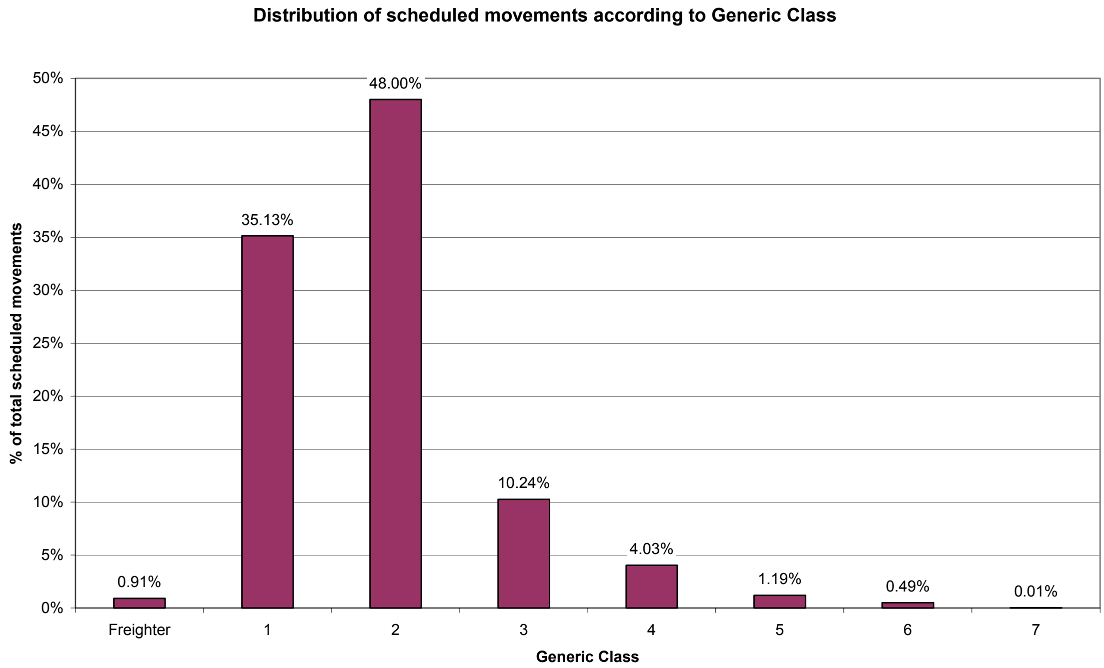
4.3.3 Determination of the Aircraft Evolution Matrix

The OAG database acquired provides detailed data for all scheduled flights from and to all Community airports. For the analysis the following data has been used:

- Movements per aircraft type
- Number of seats for each movement
- Stage length for each movement
- Timetable

The following chart gives an overview of the distribution of all scheduled flights among the various Generic Classes. It can clearly be seen that more than 90% of the movements is performed in Generic Classes 1 to 3.

During an initial analysis of the OAG database, it was found that the distribution of aircraft among the various Generic Classes was not as straight forward as anticipated. Due to the fact that airlines change seat configurations according to service needs, a single aircraft type might cover a range of 3 or even 4 Generic Classes. Since the determination of future fleet composition is based on Generic Class considerations, an additional analysis became necessary. In this section this analysis is described.



4.3.3.1 Analysis of the distribution over Generic Classes per aircraft type

All movements in the OAG database for each aircraft type were distributed over the Generic Classes, based on the number of seats, given for each movement. The following table shows the distribution of airplanes in percentage for each of the Generic Class categories.

Aircraft type	% contribution over Generic Class								
	Cargo	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Fokker 100	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
BAe 146-100/RJ 100	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
Airbus A310	0.0%	0.0%	0.0%	69.6%	30.4%	0.0%	0.0%	0.0%	100%
Airbus A318 /319 /320 /321	0.0%	0.0%	80.6%	19.4%	0.0%	0.0%	0.0%	0.0%	100%
Airbus A330	0.0%	0.0%	0.0%	0.0%	45.3%	54.7%	0.0%	0.0%	100%
Airbus A340	0.0%	0.0%	0.0%	0.0%	93.5%	6.5%	0.0%	0.0%	100%
Boeing 737	0.1%	0.0%	84.5%	15.4%	0.0%	0.0%	0.0%	0.0%	100%
Boeing 747-400	13.4%	0.0%	0.0%	0.0%	6.1%	36.7%	43.8%	0.0%	100%
Boeing 747-300 /200 /100	32.5%	0.0%	0.0%	0.0%	17.1%	38.6%	10.1%	1.7%	100%
Boeing 757	4.0%	0.0%	0.0%	84.8%	11.2%	0.0%	0.0%	0.0%	100%
Boeing 767	0.0%	0.0%	0.0%	31.2%	68.8%	0.0%	0.0%	0.0%	100%
Boeing 777-200 /300	0.0%	0.0%	0.0%	0.0%	85.4%	14.6%	0.0%	0.0%	100%
Airbus A300B2 /B4 /C4	25.9%	0.0%	0.0%	0.0%	74.1%	0.0%	0.0%	0.0%	100%
Airbus A300-600	0.0%	0.0%	0.0%	0.0%	100%	0.0%	0.0%	0.0%	100%
DC10	11.8%	0.0%	0.0%	0.0%	83.7%	0.5%	0.0%	0.0%	100%
MD-11	50.4%	0.0%	0.0%	0.1%	47.5%	0.0%	0.0%	0.0%	100%
MD-80/87/90	0.0%	0.0%	88.0%	12.0%	0.0%	0.0%	0.0%	0.0%	100%
Turboprops	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
Jet<80 seats	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
Rest of models*	22.6%	0.0%	54.3%	19.6%	0.0%	0.0%	0.0%	0.0%	100%

*Tu-154M, IL-62, L-1011, DC-8, B-707, B-727, DC-9. All are marginally compliant aircraft

4.3.3.2 Analysis of the distribution of aircraft types within each Generic Class - 2003

Another important parameter for the determination of the future fleet composition is the share of each aircraft type in the movements within each Generic Class. Based on the same OAG data the following table gives this classification for the Baseline Year.

Aircraft type	% share in Generic Class – 2003							
	Cargo	1	2	3	4	5	6	7
Fokker 100	0.0%	0.0%	4.3%	0.0%	0.0%	0.0%	0.0%	0.0%
BAe 146-100/RJ 100	0.0%	0.0%	10.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Airbus A310	0.3%	0.0%	0.0%	2.8%	3.0%	0.0%	0.0%	0.0%
Airbus A318 /319 /320 /321	0.9%	0.0%	31.8%	33.5%	2.5%	0.0%	0.0%	0.0%
Airbus A330	0.0%	0.0%	0.0%	0.0%	7.0%	29.3%	0.0%	0.0%
Airbus A340	0.0%	0.0%	0.0%	0.0%	17.6%	4.4%	0.0%	0.0%
Boeing 737	2.6%	0.0%	38.6%	34.5%	0.0%	0.0%	0.0%	0.0%
Boeing 747-400	13.4%	0.0%	0.0%	0.0%	1.4%	29.3%	83.9%	0.0%
Boeing 747-300 /200 /100	28.5%	0.0%	0.0%	0.0%	4.7%	25.3%	16.1%	100%
Boeing 757	8.0%	0.0%	0.0%	15.1%	5.1%	0.0%	0.0%	0.0%
Boeing 767	0.0%	0.0%	0.0%	3.8%	21.3%	0.0%	0.0%	0.0%
Boeing 777-200 /300	0.0%	0.0%	0.0%	0.0%	18.5%	11.1%	0.0%	0.0%
Airbus A300B2 /B4 /C4	15.4%	0.0%	0.0%	0.0%	9.9%	0.0%	0.0%	0.0%
Airbus A300-600	0.0%	0.0%	0.0%	0.0%	2.9%	0.0%	0.0%	0.0%
DC10	1.8%	0.0%	0.0%	0.0%	2.9%	0.5%	0.0%	0.0%
MD-11	15.9%	0.0%	0.0%	0.1%	3.2%	0.0%	0.0%	0.0%
MD-80/87/90	0.0%	0.0%	14.7%	9.5%	0.0%	0.0%	0.0%	0.0%
Turboprops	3.4%	61.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Jet<80 seats	0.0%	39.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rest of models	9.8%	0.0%	0.4%	0.8%	0.2%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

4.3.3.3 Distribution of aircraft types within each Generic Class – 2007/2015

Based on the information given in the former sections the following tables have been elaborated, indicating the share each aircraft type will have in the movements within each Generic Class for the years 2007 and 2015.

Aircraft type	% share in Generic Class -2007							
	Cargo	1	2	3	4	5	6	7
Fokker 100	0.0%	0.0%	3.5%	0.0%	0.0%	0.0%	0.0%	0.0%
BAe 146-100/RJ 100	0.0%	0.0%	8.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Airbus A310	0.3%	0.0%	0.0%	3.2%	3.1%	0.0%	0.0%	0.0%
Airbus A318 /319 /320 /321	0.8%	0.0%	37.5%	37.5%	2.6%	0.0%	0.0%	0.0%
Airbus A330	0.0%	0.0%	0.0%	0.0%	9.2%	31.0%	0.0%	0.0%
Airbus A340	0.0%	0.0%	0.0%	0.0%	23.3%	5.8%	0.0%	0.0%
Boeing 737	2.6%	0.0%	40.5%	36.3%	0.0%	0.0%	0.0%	0.0%
Boeing 747-400	13.4%	0.0%	0.0%	0.0%	2.1%	32.7%	91.9%	0.0%
Boeing 747-300 /200 /100	28.5%	0.0%	0.0%	0.0%	2.5%	17.4%	8.2%	100%
Boeing 757	8.0%	0.0%	0.0%	13.0%	3.5%	0.0%	0.0%	0.0%
Boeing 767	0.0%	0.0%	0.0%	4.7%	17.7%	0.0%	0.0%	0.0%
Boeing 777-200 /300	0.0%	0.0%	0.0%	0.0%	21.3%	12.7%	0.0%	0.0%
Airbus A300B2 /B4 /C4	15.4%	0.0%	0.0%	0.0%	7.2%	0.0%	0.0%	0.0%
Airbus A300-600	0.0%	0.0%	0.0%	0.0%	3.4%	0.0%	0.0%	0.0%
DC10	1.8%	0.0%	0.0%	0.0%	1.2%	0.3%	0.0%	0.0%
MD-11	15.9%	0.0%	0.0%	0.1%	2.8%	0.0%	0.0%	0.0%
MD-80/87/90	0.0%	0.0%	10.4%	4.0%	0.0%	0.0%	0.0%	0.0%
Turboprops	3.5%	41.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Jet<80 seats	0.0%	59.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rest of models	9.8%	0.0%	0.2%	1.2%	0.1%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Aircraft type	% share in Generic Class -2015							
	Cargo	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Fokker 100	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%
BAe 146-100/RJ 100	0.0%	0.0%	4.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Airbus A310	0.3%	0.0%	0.0%	3.2%	1.5%	0.0%	0.0%	0.0%
Airbus A318 /319 /320 /321	0.8%	0.0%	44.9%	40.6%	3.9%	0.0%	0.0%	0.0%
Airbus A330	0.0%	0.0%	0.0%	0.0%	14.1%	32.4%	0.0%	0.0%
Airbus A340	0.0%	0.0%	0.0%	0.0%	28.9%	11.0%	0.0%	0.0%
Boeing 737	2.6%	0.0%	43.9%	41.7%	0.0%	0.0%	0.0%	0.0%
Boeing 747-400	13.4%	0.0%	0.0%	0.0%	3.0%	34.0%	100%	0.0%
Boeing 747-300 /200 /100	28.5%	0.0%	0.0%	0.0%	1.7%	2.5%	0.0%	55.0%
Boeing 757	8.0%	0.0%	0.0%	9.0%	3.0%	0.0%	0.0%	0.0%
Boeing 767	0.0%	0.0%	0.0%	3.5%	15.6%	0.0%	0.0%	0.0%
Boeing 777-200 /300	0.0%	0.0%	0.0%	0.0%	24.8%	19.8%	0.0%	0.0%
Airbus A300B2 /B4 /C4	15.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Airbus A300-600	0.0%	0.0%	0.0%	0.0%	3.4%	0.0%	0.0%	0.0%
DC10	1.8%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%
MD-11	15.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MD-80/87/90	0.0%	0.0%	5.3%	2.0%	0.0%	0.0%	0.0%	0.0%
Turboprops	3.5%	33.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Jet<80 seats	0.0%	67.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
A380	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	45.0%
Rest of models	9.8%	0.0%	0.2%	0.0%	0.1%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

4.3.3.4 Aircraft Evolution Matrix

Based on the data presented in the former sections the evolution with time of each specific aircraft type has been determined. This evolution takes into account both the growth in number of aircraft and the natural replacement of the fleet, which are based on current data of airplanes registered in Europe, orders, retirement age and previsions of the manufacturers and airlines. This evolution is expressed as a factor, with which 2003 movement data should be multiplied so as to obtain the fleet composition for 2007 and 2015 (see section 4.3.4). The resulting “Aircraft Evolution Matrix” can be considered the final result of the analysis described in this section 4.3.

Aircraft Evolution Matrix

	Specific Aircraft				Factor 2007-2015				
Code	Model	Cargo	1	2	3	4	5	6	7
100	(Fokker 100)	0	0	1.0-0.9	0	0	0	0	0
146	(BAe 146 Passenger)	0	0	0.6-0.3	0	0	0	0	0
AR1	(Avro RJ100)	0	0	0.6-0.3	0	0	0	0	0
AR8	(Avro RJ85)	0	0	0.6-0.3	0	0	0	0	0
AB3	(Airbus A300 Passenger)	0	0	0	0	0.9-0.2	0	0	0
AB4	(Airbus A300B2 /B4 Passenger)	0	0	0	0	0.9-0.2	0	0	0
AB6	(Airbus A300-600 Passenger)	0	0	0	0	2-2.5	0	0	0
ABF	(Airbus A300 (Freighter))	1.2	0	0	0	0	0	0	0
310	(Airbus A310 Passenger)	0	0	0	0.85-0.45	0.85-0.45	0	0	0
312	(Airbus A310-200)	0	0	0	0.85-0.45	0.85-0.45	0	0	0
313	(Airbus A310-300 Passenger)	0	0	0	1.0	1.0	0	0	0
32S	(Airbus A318 /319 /320 /321)	0	0	1.6-2.4	1.6-2.4	0	0	0	0
319	(Airbus A319)	2.0	0	1.8-2.5	0	0	0	0	0
320	(Airbus A320)	0	0	1.4	1.2	0	0	0	0
321	(Airbus A321)	1	0	0	1.5-2.5	1.5-2.5	0	0	0
330	(Airbus A330)	0	0	0	0	1.4-2.0	1.4-2.0	0	0
340	(Airbus A340 (all Series))	0	0	0	0	1.5-2.0	1.5-2.0	0	0
70F	(Boeing 707-320B /320C (Freighter))	0	0	0	0	0	0	0	0
717	(Boeing 717)	0	0	1.1-1.0	0	0	0	0	0
72F	(Boeing 727 (Freighter))	0.8-0.0	0	0	0	0	0	0	0
732	(Boeing 737-200 Passenger)	0	0	0	0	0	0	0	0
733	(Boeing 737-300 Passenger)	0	0	0.9-0.6	0	0	0	0	0
734	(Boeing 737-400)	0	0	1.0-0.8	1.0-0.8	0	0	0	0
735	(Boeing 737-500 Passenger)	0	0	1.0-0.8	1.0-0.8	0	0	0	0
736	(Boeing 737-600 Passenger)	0	0	1.5-2.5	0	0	0	0	0
737	(Boeing 737 all Series Passenger)	0	0	1.5-2.3	0	0	0	0	0
738	(Boeing 737-800 Passenger)	0	0	1.5-2.5	1.5-2.5	0	0	0	0
73A	(Boeing 737-200 /200C Advanced (Pax))	0	0	0	0	0	0	0	0
73F	(Boeing 737 (Freighter))	1.3	0	0	0	0	0	0	0
73G	(Boeing 737-700 Passenger)	0	0	1.5-2.5	1.5-2.5	0	0	0	0
73S	(Boeing 737 Advanced all Series)	0	0	0	0	0	0	0	0
742	(Boeing 747-200 (Passenger))	0	0	0	0	0	0.8-0.5	0	0
743	(Boeing 747-300 /747-100 /200 Sud (Pax))	1.0-0.8	0	0	0	0	0.9-0.6	0.9-0.6	0
744	(Boeing 747-400 (Passenger))	1.2-1.5	0	0	0	0	1.75-2.0	1.75-2.0	0
747	(Boeing 747 (Passenger))	1.0-0.8	0	0	0	0.9-0.6	0.9-0.6	0.9-0.6	0
74D	(Boeing 747-300 /747-200 Sud (Mxd Config)	1.0-0.8	0	0	0	0.9-0.6	0.9-0.6	0	0
74E	(Boeing 747-400 (Mixed Configuration))	1.2-1.5	0	0	0	1.2-1.5	0	0	0
74F	(Boeing 747 (Freighter))	1.0-0.8	0	0	0	0	0	0	0
74L	(Boeing 747SP)	1.0-0.8	0	0	0	0.9-0.6	0	0	0
74M	(Boeing 747 (Mixed Configuration))	1.0-0.8	0	0	0	0.9-0.6	0	0	0
74Y	(Boeing 747-400F (Freighter))	1.2-1.5	0	0	0	0	0	0	0
75F	(Boeing 757-200PF (Freighter))	1.1-1.2	0	0	0	0	0	0	0
752	(Boeing 757-200 Passenger)	0	0	0	0.9-0.8	0.9-0.8	0	0	0
757	(Boeing 757 (Passenger))	0	0	0	0.9-0.8	0.9-0.8	0	0	0
762	(Boeing 767-200 Passenger)	0	0	0	1.0-0.8	0	0	0	0
763	(Boeing 767-300 Passenger)	0	0	0	1.0-0.8	1.0-0.8	0	0	0
764	(Boeing 767-400 Passenger)	0	0	0	1.0-1.2	1.0-1.2	0	0	0
767	(Boeing 767 Passenger)	0	0	0	1.0-0.8	1.0-0.8	1.0-0.8	0	0
772	(Boeing 777-200 Passenger)	0	0	0	0	1.5-2.2	1.5-2.2	0	0
773	(Boeing 777-300 Passenger)	0	0	0	0	0	1.5-2.2	0	0
777	(Boeing 777 Passenger)	0	0	0	0	1.5-2.2	1.5-2.2	0	0
D8F	(Boeing (douglas) DC8 Freighter)	0.8	0	0	0	0	0	0	0
D95	(McD-Douglas DC9-50)	0	0	0	0	0	0	0	0
D9S	(McD-Douglas DC9 30 /40 /50)	1.0	0	0	0	0	0	0	0
M80	(McD-Douglas MD-80 all Series)	0	0	0.7-0.4	0.7-0.4	0	0	0	0
M82	(Boeing (douglas) MD-82)	0	0	0.7-0.4	0.7-0.4	0	0	0	0
M83	(Boeing (douglas) MD-83)	0	0	0.7-0.4	0.7-0.4	0	0	0	0
M87	(Boeing (douglas) MD-87)	0	0	0.7-0.4	0	0	0	0	0
M88	(Boeing (douglas) MD-88)	0	0	0.7-0.4	0	0	0	0	0
M90	(Boeing (douglas) MD-90)	0	0	0.7-0.4	0	0	0	0	0
D10	(Boeing (douglas) DC10 Passenger)	0	0	0	0	0.6-0.0	0	0	0
D11	(Boeing (douglas) DC10-10 /15 Passenger)	0	0	0	0	0.6-0.0	0	0	0
D1C	(Boeing (douglas) DC10-30 /40 (Pax))	0	0	0	0	0.6-0.0	0	0	0
D1F	(McD-Douglas DC10 (Freighter))	1.2-1.0	0	0	0	1.0-0.95	0	0	0
M11	(Boeing (douglas) MD-11 Passenger)	0	0	0	0	1.0-0.95	0	0	0
M1F	(Boeing (douglas) MD-11 (Freighter))	1.0-1.2	0	0	0	0	0	0	0
M1M	(McD-Douglas MD-11 (Mixed Config))	0	0	0	1.0	0	0	0	0
L10	(Lockheed L1011 Tristar Passenger)	1.0-0.0	0	0	0	0	0	0	0
L15	(Lockheed L1011 Tristar 500 Passenger)	0	0	0	0	0	0	0	0
IL6	(Ilyushin Il-62)	0	0	0	0.5-0.0	0	0	0	0
IL9	(Ilyushin Il-96 Passenger)	0	0	0	0	1.0	0	0	0
T20	(Tupolev TU-204 /tu-214)	0	0	0	1.0	0	0	0	0
TU5	(Tupolev TU154)	0	0	0.8-0.5	0.8-0.5	0	0	0	0

4.3.4 Calculation of current and future fleet composition at airport level

4.3.4.1 Calculation of fleet composition and number of movements for Baseline Year

Although the forecasts, developed in the former sections are valid at Community level, on individual airport level different fleet compositions will exist, mainly based on the type of traffic served by the airport. To account for these differences, the calculations to be performed in Phase 2 are based on the actual traffic of each airport.

Although initially the OAG database was planned to be used for this purpose, at a late stage in the project data from the Eurocontrol PRISME database became available. Since these data cover all actually performed flights (both scheduled and non-scheduled) from 01/09/2002 until 31/08/03, it was considered more adequate using these data. From the database provided all military operations were removed, so as to cover only commercial operations. A check was made so as to compare OAG and Eurocontrol scheduled flight data. In general a very good agreement was found (for 85% of the airports the difference was within ±10%), although at some airports OAG underestimated quite substantially the number of scheduled flights.

All movements for each individual airport have been extracted, together with the corresponding aircraft types, stage lengths and timetable. A representative day was then determined for each airport, based on the following definition. It should be noted that this definition is in compliance with [3].

Assumption 15. Definition of representative day

The representative day consists of two parts:

- Number of movements for each Generic Class
  This will be taken as the total number of movements within each Class per year divided by 365
- Fleet mix for each Generic Class
  The total number of movements within each Class per year and per aircraft type, divided by 365

In the Interim report [6] Assumption 16 was introduced in order to handle non-scheduled flights, for which no information is available in the OAG database. Since the now used PRISME database of Eurocontrol also covers these flights, this assumption has been withdrawn.

The resulting representative day has been used to calculate the noise climate for the Baseline Year.

4.3.4.2 Calculation of fleet composition and number of movements for 2007 and 2015

The calculation of the noise climate for future years will equally be based on the concept of representative day, obviously with the data corresponding to the future situation.

In the determination of the future traffic, both traffic growth and change in fleet composition are taken into account by means of the following procedure:

- Traffic growth
  For each Generic Class the number of movements on the representative day of the Baseline Year is increased with the growth factor according to the scenario

under study (see section 4.1.3). The share of each Generic Class in the total airport traffic is thus maintained constant, in line with assumption 5.

- Change in fleet composition
  For each aircraft type within each Generic Class the contribution determined for the representative day of the Baseline Year is corrected with the corresponding factor derived from the Aircraft Evolution Matrix
- The total number of movements within each Generic Class is then distributed over the aircraft types within this Class, according to their share, determined in the former step.

By using the above procedure, possible inaccuracies in the evolution matrix will be compensated by the equal distribution between the airplanes operating in each particular Generic Class.

Mathematically the procedure can be written as follows:

1. Total number of movements in year X for Generic Class Y ($N_{X,Y}$):

   $N_{X,Y} = N_{2003,Y} * (1+F_{tot})^{(X-2003)}$

   Where:
   $N_{2003,Y}$ = number of movements in Baseline Year for Generic Class Y (from PRISME)
   F_{tot} = yearly growth factor for total number of movements according to the studied scenario

2. Change in fleet composition:

   For each aircraft type i within Generic Class Y, the share in year X ($S(i)_{X,Y}$) will be:
   $S(i)_{X,Y} = (S(i)_{2003,Y} * (F(i)_{X,Y}) / \Sigma(S(j)_{2003,Y} * (F(j)_{X,Y})$ (j=1 to $N_{ac,Y}$)

   Where:
   $S(i)_{2003,Y}$ = Share of aircraft i in Generic Class Y for Baseline Year (from PRISME)
   $F(i)_{X,Y}$ = factor from Aircraft Evolution Matrix for aircraft i, year X and Generic Class Y
   Σ = sum of corrected shares in year X for all aircraft in Generic Class Y

3. Number of movements in future year

   Number of movements for aircraft i in Generic Class Y and year X ($N(i)_{X,Y}$):

   $N(i)_{X,Y} = S(i)_{X,Y} \cdot N_{X,Y}$

This apparently complex procedure can easily be understood with the following example:

From the PRISME database the following fleet mix at the representative day for a certain airport has been determined for Baseline Year 2003 and Generic Class 2:

Aircraft type	Nº movements in GC 2	Share in GC 2
A-320	80	40%
B-737-400	80	40%
MD-80	40	20%
Total	**200**	**100%**

The “Probable” scenario is used, so the number of movements will increase at a rate of 3.6%/year.

With these data the number of movements in 2007 can be determined for each aircraft type within the same Generic Class:

1. Total number of movements in 2007 in Generic Class 2

   $N_{2007,2} = 200 \cdot (1.036)^4 = 230$

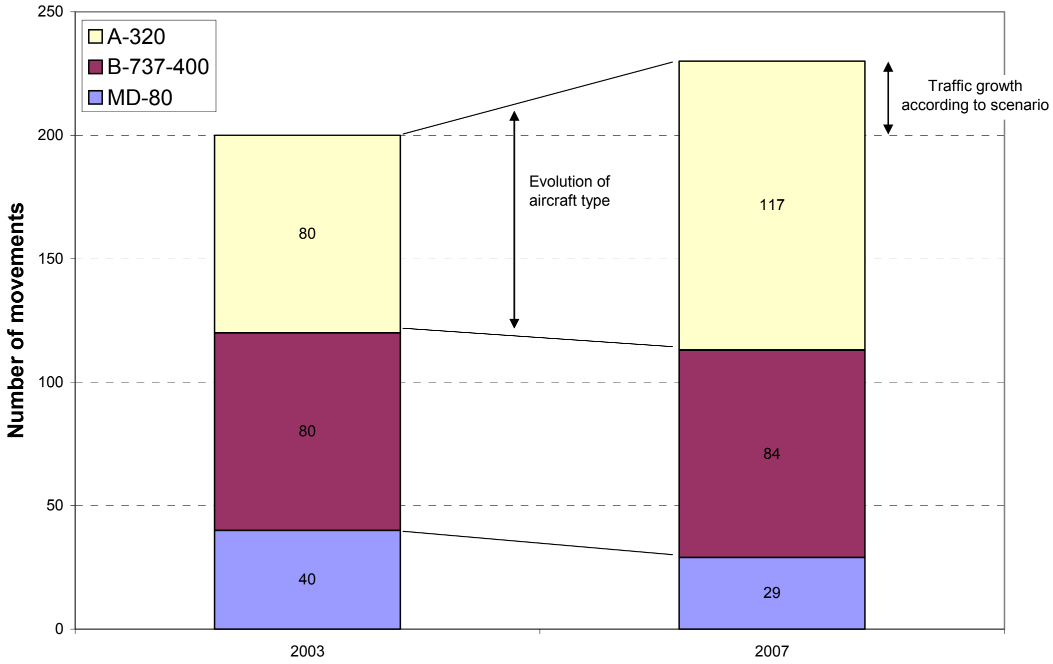
2. Change in fleet composition

Aircraft type	$S(i)_{2003,2}$	$F(i)_{2007,2}$	$S(i)_{2003,2} \cdot F(i)_{2007,2}$	$S(i)_{2007,2}$
A-320	40%	1.4	56	50.9%
B-737-400	40%	1.0	40	36.4%
MD-80	20%	0.7	14	12.7%
Total	**100%**	**-**	**110**	**100%**

3. Number of movements in 2007 in Generic Class 2

Aircraft type	$S(i)_{2007,2}$	$N_{2007,2}$	$N(i)_{2007,2}$
A-320	50.9%	230	117
B-737-400	36.4%		84
MD-80	12.7%		29

This can also be represented graphically:



Assumption 17. Calculation of number of movements and fleet mix at individual airports

For the determination of the number of movements and fleet composition necessary for the calculations in Phase 2, the method outlined in section 4.3.4 is used.

4.4 Boundary conditions, influencing number of movements and fleet composition

Various factors might influence the forecasted number of movements and/or fleet composition. Usually these effects will be limited to some airports, due to their sensitivity to these factors. Hereafter the following factors will be analysed:

- Competition with High Speed Train
- Introduction of Ultra High Capacity aircraft
- Exemptions for noisy airplanes from developing countries
- Russian airplanes
- Marginally compliant aircraft and possibility of re-certification

4.4.1 Competition with High Speed Train

The development of the High Speed Train (HST) lines connecting various European cities, offering competitive travel times compared to airplane routes, makes it necessary to bear this element in mind as a potential cut down in air traffic or expansion of some airports.

The effect of intermodality on the various transport systems involved is currently being studied by some of the stake-holders (e.g. Eurocontrol).

Although it is clear that HST, by offering a competitive service on some city pairs, will certainly draw passengers from air to rail, it may be expected that any slots becoming available due to this, will immediately be used for other routes. The net effect on the noise climate around the airport will thus be very limited. In addition it should be noted that the HST system will also have an environmental impact.

During the mid-term meeting it was agreed that the influence of HST on the noise climate around airports, originally to be assessed in Phase 2 of the present study, will not be taken into account as a special scenario of the Baseline Trend, due to the expected limited net effect.

Assumption 18. Effect of the competition of High Speed Trains

It is assumed that the net effect of HST on the noise climate around airports will be very limited due to substitution of the free slots by other operations. Therefore this effect is not taken into account in Phase 2.

4.4.2 Ultra High Capacity Aircraft

The information of both main manufacturers of commercial airplanes in the world, Airbus and Boeing, is contradictory with respect to the forecasted demand of very large airplanes with capacity higher than 500 seats (UHCA). The sources consulted have been the market forecast of both manufacturers [7,9]. According to Boeing the projected requirement in the period 2002-2020 for UHCA is estimated at only 334 passenger jets. For Airbus the demand in the period 2000-2020 for this type of airplanes will be 1147 with concentration of the demand in the second decade of the period.

Assumption 19. Effect of the introduction of Ultra High Capacity Aircraft (UHCA)

It is assumed that UHCA will enter into service after 2007, so that they will be taken into account for the 2015 horizon only. It will be considered that only major hubs can be affected by the introduction of this type of aircraft. At these airports 5% of the movements of Generic Class 6 will be transferred to Generic Class 7, decreasing the number of movements in this Class by 20%. With respect to the noise generated by this kind of aircraft Assumption 10 applies.

4.4.3 Exemptions for noisy airplanes from developing countries

For the analysis on the effect of the airplanes pertaining to developing countries, it is necessary to bear in mind that Article 9 of the Directive establishes a set of exemption rules during the period of 10 years after the entry into force of the Directive. A “Study on the impact on developing nations from the effect of European Community aircraft noise legislation” was presented in the year 2002. For the current analysis, the most relevant information has been taken from this study:

- Marginally compliant and Chapter 2 aircraft: 119 aircraft
- The number of flights is 0.15% of the total flights into EU

The estimated numbers and proportions of non-compliance flights by developing nation’s airlines at principal EU airports are:

Country	Airport	Marginally compliant and Chapter 2 aircraft	
		Number	% of flights
Belgium	Ostende	417	18.5
France	Paris Le Bourget	45	16.9
UK	Manston	145	16.7
Italy	Montichiari	104	16.5
France	Châteauroux	70	15.1
Netherlands	Maastricht	278	8.5
Italy	Forli	52	6.2
France	Chalons	5	5.4
Italy	Brindisi	192	4.8
Germany	Hahn	110	3.6
Austria	Vienna	42	0.06
Belgium	Brussels	441	0.32
Denmark	Copenhagen	358	0.36
Finland	Helsinki	0	0.00
France	Paris CDG	612	0.27
Germany	Frankfurt	559	0.27
Greece	Athens	7	0.01
Ireland	Dublin	7	0.01
Italy	Rome	441	0.33
Luxembourg	Luxembourg	0	0.00
Netherlands	Amsterdam-Schiphol	182	0.11
Portugal	Lisbon	257	0.51
Spain	Madrid	144	0.09
Swden	Stockholm	45	0.05
UK	London LHR	1075	0.48

The conclusion reached from the results obtained was that, as an average, the proportion of noisy airplanes (i.e. marginally compliant and Chapter 2 aircraft) for the larger European airports that are probably affected by the ORD, totals 0.19 of the airport's total flights. This airplane average is lower than the actual fleet licensed in the EU. Therefore it has been estimated that the impact is negligible with regard to the study. In the case of cargo type airports, the figures of the flight proportions for these noisy aircraft are significant with respect to the total number of flights. However, these airports will not be subject to ORD regulations and judging this, the effect of the ORD is negligible.

Assumption 20. Effect of noisy airplanes from developing countries

Based on the analysis described in this section, the study will not take into account as a differentiating element the effect of the airplanes pertaining to developing countries, with the understanding that it has already been considered in the fleet mix forecast.

4.4.4 Russian airplanes

The capability of the Russian aviation to adapt to new environmental and safety requirements is an issue difficult to estimate, considering the required input for the noise model. However, main Russian airlines are introducing western manufacturer airplanes for flights to European destinations, whereas the more noisy Russian aircraft are operated inside Russia and CIS nations. The main new development is the Russian Regional Jet (RRJ), which is planned to enter service in 2010. Western companies like Boeing and Snecma are actively participating in the design of this aircraft. Although no data exist on this aircraft, it can be expected that the noise and performance will be at western levels. The data show that an important part of the Russian fleet has been affected by Chapter 2 retirement and actually only some versions can operate in connections with European airports (Tu-154 M, YAK 42, Tu-204). The share in Generic Class movements of Russian airplanes obtained from the OAG database for 2003 is the following:

Aircraft type	GC 2	GC 3	GC 4
Ilyushin Il-62	0.00%	0.01%	0.00%
Ilyushin Il-96 Passenger	0.00%	0.00%	0.05%
Tupolev TU-204 /TU-214	0.00%	0.03%	0.00%
Tupolev TU154	0.11%	0.71%	0.00%
Yakovlev Yak-42 /142	0.04%	0.00%	0.00%
Yakovlev Yak-40	0.00%	0.00%	0.00%

See assumption 21 hereafter for further studies on these types of aircraft.

4.4.5 Marginally compliant aircraft and their potential recertification

Marginally compliant aircraft according to the definition of the Directive are shown in the following table. Several of these types are liable to being recertified so as to obtain sufficient margin with Chapter 3 limits. This re-certification may be obtained either through technical modifications of the aircraft and engine (hush-kits) or by reducing its maximum weight or optimizing the procedures used during the certification process. Although technically possible, in practice it seems to be feasible only if the aircraft's age is not too high and/or the cost implied to accomplish the modification is cost-effective. Based on the former considerations an indication is given of the probability that the aircraft type will be re-certified.

Aircraft	Engines	Re-certification		
		Probable	Improbable	Partial
B-707-320	All Hk-Ch 3		X	
B-727	All Hk- CH 3		X	
B-737HK	All Hk Ch 3		X	
B-747-100	All models		X	
B-747-200	JT9D / CF6-50E2		X	
B-747-300	JT9D-series RB211-524C2/DX CF6-50/E/E2/E1			X
B-747SP	JT9D-7FW			X
B-767-200	JT9D-7R4E			X
DC-8-62	All Hk-Ch 3		X	
DC-9	All Hk-Ch 3		X	
DC-10-30	CF6-50C1		X	
IL-62M	D-30KU			X
TU-154M	D-30KU			X
YAK-42	LO D-36	X		
A-300 B4		X		

Depending on the manner in which re-certification would be obtained, the effect on the noise climate around airports may vary. If the re-certification is obtained by means of a reduction of maximum weight or optimised take-off procedures, the effect under practical conditions will be negligible, due to the fact that no change will occur in operations at airports (standard take-off procedure, less than maximum weight). Only re-certification by means of hush-kits will have a notable effect on operational noise levels. This leads to the following assumption:

Assumption 21. Marginally compliant aircraft and re-certification (incl. Russian aircraft)

Since it is quite difficult to determine which method will be chosen to re-certify the marginally compliant aircraft, the effect of re-certification will not be assessed in the baseline study. However, a dedicated study is performed for marginally compliant aircraft in Task 4 of Phase 2. In this study also the Russian aircraft mentioned in section 4.4.4 are included.

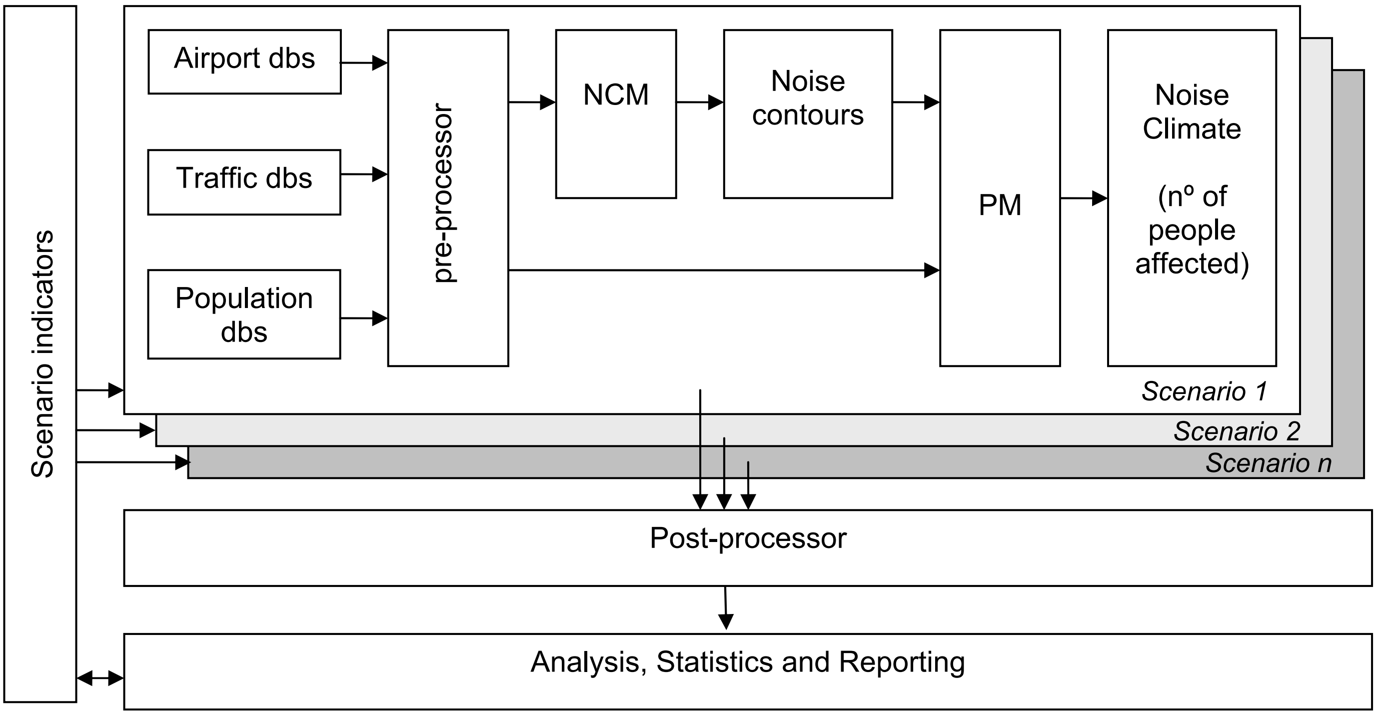
5. Adaptation of existing noise model software (Task 2)

The software developed consists of a pre- and post-processor for the existing noise model software, already developed by Anotec under private funding.

The contour module (NCM) calculates noise contours of L_{den} and L_{night} according to ECAC Doc.29 (including the latest recommendations, issued by the EC [3]). The noise and performance databases used are those provided by INM (Version 6.1), since these are one of the few globally accepted datasets publicly available.

The population module (PM) is capable of overlaying the noise contours from NCM on population maps, so as to determine the number of people affected by noise. From the total number of people affected, the percentage of highly annoyed people will be derived using the dose-effect relations developed by Miedema [16].

A schematic overview of the software ("SONDEO" model) is given in the following chart. A more detailed scheme is presented in Annex I-5.



5.1 Development of a pre-processor (SubTask 2.1)

In order to significantly reduce the time required for an otherwise laborious exercise, a pre-processor has been developed in order to automate tasks. In the original plan separate pre-processors were envisaged for the NCM and PM modules. During development, however, it was decided to combine those in a single processor. Consequently, the original SubTasks 2.1 and 2.2 are thus also combined in this new SubTask 2.1.

The concept of scenario indicators has been introduced in this processor. These indicators are used to simulate any hypothesis by applying the appropriate values for the relevant parameters. A hypothesis might be the introduction of a certain noise mitigation action in the framework of the Balanced Approach. Based on these indicators, the pre-processor directly uses the airport, traffic and population databases to generate the required input to NCM and PM, thus avoiding the time consuming task of input preparation.

5.2 Development of a post-processor (SubTask 2.2)

In addition to the above developments, mainly directed towards minimising the total time required for running the various scenarios envisaged in the present study, new functionality has been added to the programme by means of a post-processor.

The tools developed enable the analysis of the data stored in the various databases in a suitable manner so as to obtain, in an easy manner, classifications, regressions, deltas, etc., according to the needs of the study.

Several of the tools developed are made available through the presentation tool, distributed on CD-ROM together with the Baseline noise climate databases (see section 7).

6. Description of the calculation procedure

In this section the calculation procedure used in this study is described in such a manner that a similar future study could be performed by third parties, without having access to the Anotec software.

As described in the former section, pre- and post-processors have been developed and have been used to facilitate input and output generation to and from the actual calculation modules (Noise Contour Module – NCM and Population Module – PM). Since these processors are relatively simple utilities which convert data from several sources and formats into a harmonised dataset, without calculation capability, their description is not considered relevant for the present study. The only interesting calculation procedure integrated in the pre-processor is the one described in section 4.3.4. In the following sections the main modules will be described.

To be able to perform the study according to the adopted methodology, various assumptions had to be made. Some of these affect key parameters like traffic forecast, which might have a mayor influence in the final results. Whenever an assumption had to be made for any of the parameters or methods described in this report, it has clearly been indicated. Approval of these assumptions was obtained through the approval of the Interim report [6]. The key assumptions are summarised in the table in section 6.4.

The scheme presented in Annex I-5 might result helpful when reading the following sections.

6.1 Noise Contour Module

The NCM is an existing noise model engine, developed by Anotec under private funding. It is fully compatible with ECAC Doc.29 and uses segmentation to describe the flight profiles. Minor changes were included so as to obtain full compatibility with the recommendations issued by the EC [3]. For details on the calculation method of ECAC one is referred to the corresponding, publicly available, document [17]. The noise and performance databases used are those provided by INM (Version 6.1), since these are one of the few globally accepted datasets publicly available. The module calculates contours for a variety of noise metrics. For the present study contours for constant L_{den} and L_{night} are calculated, so as to be compatible with the END.

Assumption 22. Definition of 'Day', 'Evening' and 'Night' for calculation of L_{den} and L_{night}

In the current study the following definitions are used, in line with the default values, proposed in Annex 1 to the END. These values are assumed valid for all countries.

	Period	Weighting
Day	07:00 – 19:00	0
Evening	19:00 – 23:00	+5 dB
Night	23:00 – 07:00	+10 dB

The NCM requires the following input data:

- Airport data (Location, elevation, meteorological conditions)
- Runway data (ID, location, orientation, length, thresholds)
- Tracks (ID, SIDs, STARs)
- Traffic (Aircraft type, nº of movements per track, runway, stage length and period of day)

These data were stored in their corresponding databases in SubTask 1.5. Traffic data have been determined according to the method described in section 4.3.4, taking into account any relevant scenarios indicators (which will depend on the scenario to be simulated).

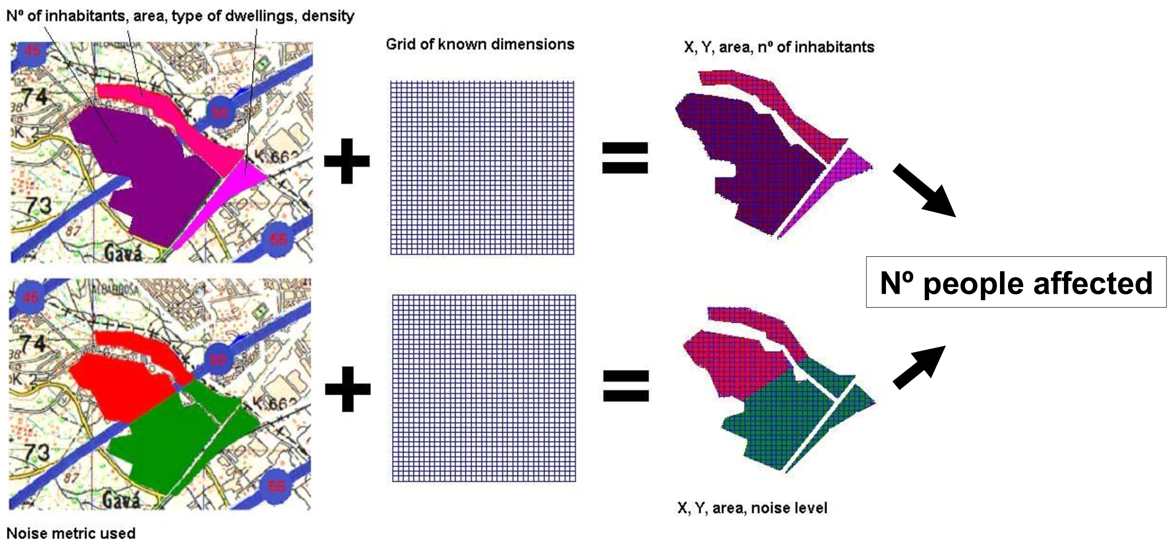
Based on these input data, the NCM will calculate the noise contours of 55, 60, 65 and 70 dB(A) for L_{den} and 45, 50, 55, 60and 65 dB(A) for L_{night}.

6.2 Population Module

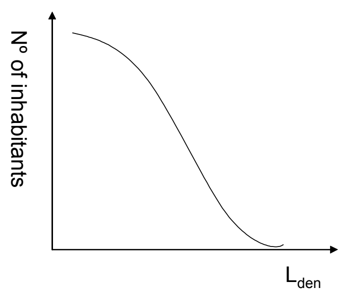
The noise contours as calculated in the former section are passed to the Population Module (PM), together with scaling information. This information is necessary in order to link the noise contours with the map of the affected area around the airport, previously digitised at a convenient scale. The link is made by means of the coordinates of 2 points (i.e. the thresholds of the principle runway), together with the known distance between these points (i.e. the runway length). From this data the coordinate system used in the NCM module can thus be reconstructed by the PM and the scale of the digitised map can be deduced.

All residential areas with know population (nº of inhabitants, density + area, etc.) were previously indicated on the digital map and stored in the Population database.

The PM is capable of combining the noise contours with this population map in the manner as presented in the following graph.



For a grid of points within each populated area the corresponding noise level is calculated by the NCM. With this information the relationship between number of inhabitants exposed and the relevant noise metrics can be determined:



Based on this relationship the number of people above a certain threshold value can be determined. With the dose-effect relations developed by Miedema [16] the number of highly annoyed people is then determined. The equation used is:

$\% = A \cdot (L_{den}-L_0)^3 + B \cdot (L_{den}- L_0)^2 + C \cdot (L_{den}- L_0)$

where:

A,B,C, L_0	coefficients according to the following table
%	percentage of affected population: %LA : Little Annoyed %A : Annoyed %HA : Highly Annoyed

	A	B	C	L_0
%LA	$-6.158 \cdot 10^{-4}$	$3.410 \cdot 10^{-2}$	1.738	32
%A	$8.588 \cdot 10^{-6}$	$1.777 \cdot 10^{-2}$	1.221	37
%HA	$-9.199 \cdot 10^{-5}$	$3.932 \cdot 10^{-2}$	0.2939	42

It is noted that this relationship is only valid for L_{den}. No response curves are available for L_{night}. Therefore in Phase 2 annoyance data will only be presented for L_{den}.

6.3 Analysis of resulting data

The calculations performed yield a huge amount of data for various scenarios. In order to be able to handle these data, a post-processor was developed. In general this processor can be seen as a data extractor for the various databases resulting from the calculations. The interesting part, however, is the way these data will be presented.

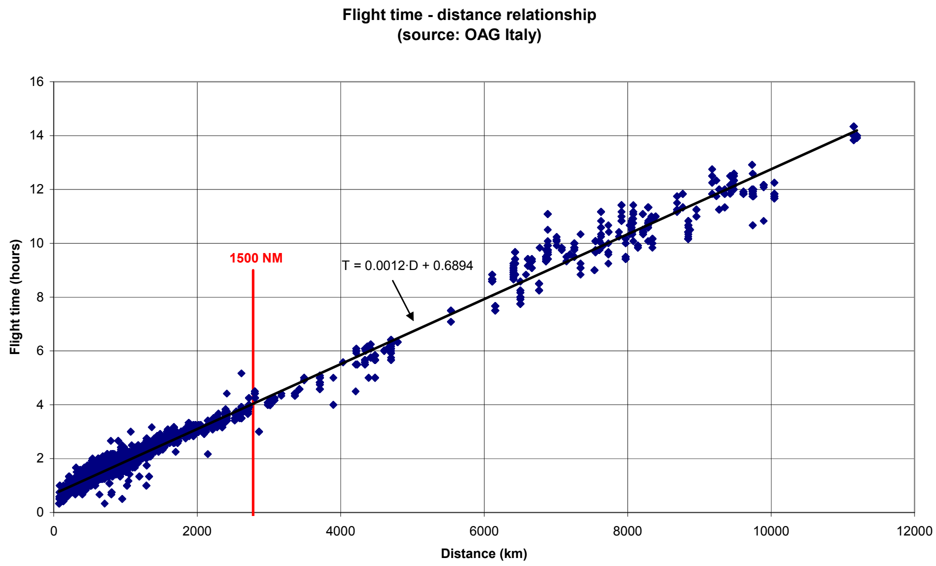
A basic method to present e.g. the Baseline Trend is by means of a graph, similar to the one given in section 2.1.

In order to extract more relevant information from the data available, however, another method has been developed. This method is based on the so-called Airport Classification Matrix.

Basically this matrix can be considered as a way of classifying airports according to the main service they provide. Key indicators for this service are:

- the percentage of flights with a stage length higher than 1500 NM
- the yearly number of jet operations at the airport

It has been verified by means of data from the OAG database that 1500 NM corresponds to flights of 4 hours. Flights with a higher duration will be usually intercontinental and this parameter is thus a good descriptor of the type of traffic handled at the airport.

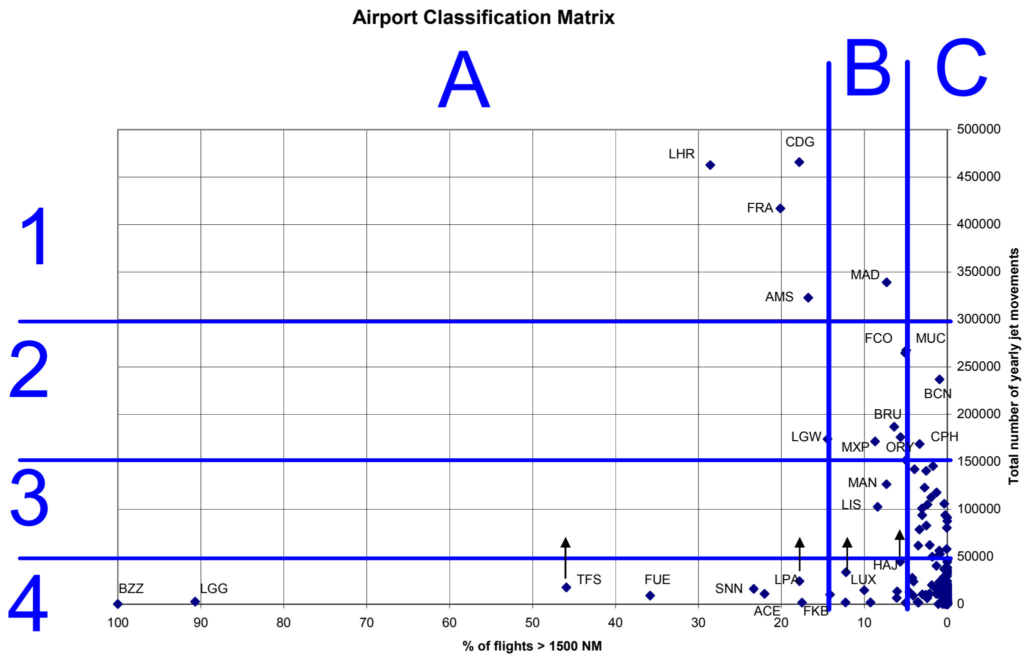


The number of jet operations is a clear indicator for the airport size.

Based on these parameters the following classification can then be made:

		% of total flights > 1500 NM		
		> 15%	5 – 15%	< 5%
Nº of yearly jet operations (x 1000)	> 300	A1	B1	C1
	150 - 300	A2	B2	C2
	50 – 150	A3	B3	C3
	< 50	A4	B4	C4

Based on this classification a first analysis was made with the data available from the OAG database for scheduled flights in 2003. From this database the required information was extracted so as to arrive at the following representation of the airport matrix, taking into account all EU airports with jet operations.



It is not the intention to analyse this matrix here. It is given here only to explain its use in the data analysis performed in Phase 2.

It is understood that the noise situation at airports within each group is comparable. Therefore similar actions can be assessed group-wise rather than individually. This simplifies the analysis to be performed in Task 4.

The number of people affected by noise at each airport can be added to the matrix as a third dimension (e.g. coloured). In a similar manner the Baseline Trend can be represented (e.g. an increase in number of people in red and a reduction in green). It will thus be very easy to detect where exactly the main problems exist (i.e. at which airport group(s)). Further actions in the framework of Task 4 can thus be directed to these groups only.

This matrix has also been used in the case studies of Task 5 (section 9).

6.4 Overview of key assumptions

The following table gives an overview of all key assumptions made in this study and a reference to the applicable section. These reflect the simplifications to the model, necessary to be able to determine the number of people affected by noise for the 53 airports to be evaluated and all this for various scenarios.

Assumption	Subject	Section
1	Selection of airports	3.1.2
2	Meteorological conditions at the airport	3.3.1
3	Future changes in the airport configuration	3.3.1
4	Distribution of flights among the tracks available	3.3.2
5	Changes in routes served by the airport	3.3.2
6	Flight procedures used in the calculations	3.3.3
7	Determination of population	3.3.4
8	Use of noise and performance data of existing aircraft	3.3.5
9	Evolution of noise and performance of existing aircraft	3.3.5
10	Introduction of new aircraft	3.3.5
11	Forecast for growth in number of movements until 2015	4.1.3
12	Increase in aircraft size due to airport capacity constraints	4.2.2
13	Shift in operating hours	4.2.2
14	Shift of operations towards secondary airports	4.2.2
15	Definition of representative day	4.3.4
16	*Withdrawn*	4.3.4
17	Number of movements and fleet mix at individual airports	4.3.4
18	Effect of the competition of High Speed Train	4.4.1
19	Effect of the introduction of Ultra High Capacity Aircraft	4.4.2
20	Effect of noisy airplanes from developing countries	4.4.3
21	Marginally compliant aircraft and re-certification	4.4.5
22	Definition of “Day”, “Evening” and “Night” for L_{den} calculation	6.1

The above assumptions were approved during the project mid-term meeting held in Brussels (17/06/03).

6.5 Model validation

In order to verify if the results of the calculations performed in this study are representative for the actual situation at the airports, a validation exercise was performed for the SONDEO model.

Since sufficient data were only available for Brussels airport and London Stansted, the model validation could only be performed for these cases. Brussels airport has 3 runways and a much more complex SID structure than Stansted with its single runway. Therefore these airports can be considered representative for the different airport layouts encountered in this study.

It is noted that the comparison with MAGENTA, described in more detail in section 7.5, can also be considered part of the model validation.

6.5.1 Brussels airport (BRU)

Brussels International Airport Company (BIAC) provided the annual noise contour report of the airport for the year 2002 [18]. This report contains detailed information on all relevant aspects with respect to the noise levels around the airport (runway usage, distribution among SIDs, population affected per village, etc.). The data provided on page 35 of [18] was used to compare with the predictions made by the model described above. The results of this comparison are given in the following table.

L_{den} [dB(A)]	Number of people within L_{den} interval		
	BIAC	Model	Model-BIAC
55-60	80040	58499	-21541 (-27%)
60-65	16235	23004	+6769 (+42%)
65-70	7160	7157	-3 (0%)
>70	2596	2532	-64 (2%)

It can clearly be seen that for lower levels the predictions are less accurate than for the higher levels. This is logical, bearing in mind that the lower levels are found further away from the airport where the influence of exact traffic behaviour becomes more apparent.

Analysing in more detail the data, it can be seen that the underprediction at 55-60 dB(A) is mainly due to an underestimation of the flights passing close to the city of Grimbergen and Vilvoorde. This underestimation is due to the fact that BIAC used actual trajectories based on radar tracking, while the current model only is capable of allowing for a limited dispersion around the SIDs. The overestimation at 60-65 dB(A) is due to the same effect. When combining both intervals, a total underestimation of 15% is found. The error for higher noise levels is very small.

6.5.2 London Stansted (STN)

This second test case uses the annual noise contour report for London Stansted airport for 2002 [19], issued by the British CAA. This report contains contour areas and population affected above certain noise levels. The following table presents the comparison between the information given on page 4 of [19] and the results obtained with the current model. It should be noted that the noise metric used is Leq(16h), which can also be calculated with the model.

$L_{eq(16h)}$ [dB(A)]	Contour area [km^2]			Number of people above threshold		
	CAA	Model	Model-CAA	CAA	Model	Model/CAA
>57	31.7	32.0	+0.3 (+1%)	2000	1982	-18 (-1%)
>63	11.3	11.4	+0.1 (+1%)	300	328	+28 (+10%)
>69	3.4	4.1	+0.7 (+21%)	<100	164	>64(+64%)

It can be seen that for this smaller airport with simpler trajectory structure, the predictions are very close to the actual data. The differences found in number of people at higher noise levels are mainly due to the cell size used to simulate populated areas. The error in absolute number of people, however, is considered well within allowable margins for this type of studies.

6.5.3 Conclusion on model validation

Based on this limited validation exercise it was concluded that the SONDEO model is capable of predicting the noise climate around airports with sufficient accuracy for the scope of the current study.

7. Determination of the Baseline Trend (Task 3)

In this section the noise climate at each of the selected airports is determined for the baseline scenarios by means of the calculation procedures described in section 5.

- 'Baseline Year' (2002)
- 'Baseline Trend' (2007 and 2015)
    - Probable scenario
    - Conservative scenario
    - Differentiated scenario

The baseline scenarios only take into account the noise mitigation actions currently in force or already planned and the forecasted changes in fleet-mix and number of movements, as described in section 3.3. Any further actions which might be taken due to the introduction of the Directive are not considered here. It should be noted that in the currently planned actions also those, implemented as a consequence of the introduction of END, are incorporated.

Noise contours for L_{den} values of 55, 60, 65 and 70 dB(A) and L_{night} values of 45, 50, 55, 60 and 65 dB(A) are calculated for the different scenarios. These values are required by Annex VI to the END and in addition maintain compatibility with former studies like Magenta. Based on these contours the number of people affected is calculated according to the procedure described in Section 6.

For those airports where capacity constraints were detected, the noise climate is determined as an additional scenario to the baseline (see section 7.2.4).

The effects mentioned in section 4.4 are taken into account for the relevant airports and are applied to all scenarios considered.

The Baseline Trend for each of the scenarios considered is established by comparing the 3 corresponding Noise Climate Databases, both at individual airport, airport group and Community level. The results will be compared with the Directive objective of "no growth in nº of people affected".

The resulting baseline Noise Climate Databases for the Probable scenario will be used as the reference situation for the studies described in the following sections. The results of this assessment adds a third dimension (i.e. number of people affected) to the Airport Matrix described in section 6.3

All calculations performed hereafter are based on the available data for each of the airports considered. Depending on both quality and quantity of these data, the model used will be able to represent more or less accurately the actual situation at the airport. It is recognised that differences may exist with the results of detailed studies on individual airport level. These possible differences, however, are considered to be acceptable within the scope of the current study, in which the main objective is to assess trends at an aggregate level.

In the following sections frequent use will be made of the Airport Classification Matrix as described in section 6.3. For easy reference this matrix is included here again.

Airport Classification Matrix	A	B	C
1	CDG LHR FRA AMS	MAD	
2		FCO BRU LGW MXP ORY	BCN CPH MUC
3	TFS LPA	MAN LIS LUX HAJ	VIE BHX CGN EMA DUS EDI HAM GLA STR LTN TXL STN AGP ABZ ALC ATH PMI DUB HEL CTA LYS LIN MRS NAP MLH VCE NCE ARN TLS GOT
4			BHD BMA LCY THF

7.1 Baseline Year (2002)

As mentioned earlier in section 2.1, for the purpose of this study the 'Baseline Year' is defined as the status when the ORD was introduced, i.e. 2002. Since information for 2002 on important items (e..g population) are not available or not considered as representative, it was decided to extend the concept of Baseline Year to those years closest to 2002 for which representative data are available. Hereafter Baseline Year 2002 has to be interpreted in these terms.

The number of movements and the fleet mix used for the determination of the noise contours for the Baseline Year are directly taken from the PRISME database provided by Eurocontrol (see section 4.3.4.1). From this database all military operations (if any) were removed so as to cover only civil operations. The resulting number of movements for each airport is given in Annex II-1.

The distribution of the movements among the runways and tracks was that provided by the airports. Where this information was not available, a best estimate was made based on other available data, as described in section 3.3.2.

For the population distribution around the airports, the most recent census data was used (see section 3.3.4). This information was plotted on the most recent maps available for the airports. It should be noted that for the Italian airports of Catania (CTA) and Milan-Linate (LIN), no representative maps were available at the time of the study. For these airports the noise contours were determined, but they had to be excluded from the analysis of number of people affected.

Based on the available data, the noise contours for both L_{den} and L_{night} were determined for the Baseline Year 2002. These noise contours are presented in Annex II-2 and Annex II-3 respectively.

The number of people exposed to aircraft noise around the airports was determined in 2 manners (see also section 6.2)

- Noise interval
  - 55-60, 60-65, 65-70, ≥70 dB(A) for L_{den}
  - 45-50, 50-55, 55-60, ≥60 dB(A) for L_{night}
- Annoyance
  - Little Annoyed (LA), Annoyed (A) and Highly Annoyed (HA), according to the Miedema curves based on L_{den} [16]
  - No relationships were available between annoyance and L_{night}

These data can be found for each airport in Annex II-4. It is noted that more detailed information (i.e. population affected on individual town level for each airport) can be found on the CD-ROM provided together with this report (see section 7.4).

The results of the calculations will be analysed in section 7.3.

7.2 Baseline scenarios for 2007 and 2015

In order to be able to assess future developments, various scenarios have been defined (see section 4.1.3):

- “Probable” – with a constant growth rate until 2015
- “Conservative” – with lower growth rates, depending on the type of airport
- “Differentiated” – with probable growth rates, depending on type of airport, taking into account regional differences

Noise contours and number of people affected by aircraft noise are determined for each of these scenarios and each of the airports considered.

When executing the SONDEO model for the abovementioned scenarios, the assumptions, described in sections 3 to 6, will be taken into consideration.

7.2.1 Probable scenario (2007P/2015P)

In this scenario the number of movements at each airport increases annually with 3.6%. The resulting total number of movements is found in Annex II-1.

Noise exposure data for this scenario can be found in Annex II-5. No noise contours are given here in printed form. However, all data are available on the CD-ROM provided with this report (See section 7.4).

7.2.2 Conservative scenario (2007C/2015C)

The conservative scenario prescribes different growth rates for different airport types. The following table gives the growth rate used for each of the airports considered in this study.

Airport type	Annual growth	Applied to airport group*
Mayor hub	2%	A1 B1
Intra- Communitarian	2.5 %	B2 C2
Local	1%	A3 B3 C3 C4

* see Airport Classification Matrix

The resulting number of movements at each of the airports is presented in Annex II-1.

Noise exposure data for this scenario can be found in Annex II-6. No noise contours are given here in printed form. However, all data are available on the CD-ROM provided with this report (See section 7.4).

7.2.3 Differentiated scenario (2007D/2015D)

In addition to the more general scenarios described above, it has been considered convenient to assess also a scenario which takes into account differences in development of traffic among the various EU regions, e.g. due to the enlargement of the EU and due to differences in economical development. This so-called “Differentiated” Scenario is based on the regional development foreseen by Eurocontrol [11] and takes into account differences in growth between the various flight types (domestic, long-haul, short-haul) served by the airports, as shown in the table in section 4.1.3.3. Applying these data, the following growth rates are established for the individual airports.

Airport	Annual growth (%)		Airport	Annual growth (%)		Airport	Annual growth (%)	
	2007	2015		2007	2015		2007	2015
ABZ	3.98	3.90	EMA	3.98	3.90	MAN	3.98	3.90
AGP	4.04	4.13	FCO	4.19	4.53	MLH	3.49	3.58
ALC	4.04	4.13	FRA	3.60	3.86	MRS	3.49	3.58
AMS	3.46	3.48	GLA	3.98	3.90	MUC	3.60	3.85
ARN	2.78	3.01	GOT	2.78	3.01	MXP	4.19	4.53
ATH	4.92	5.59	HAJ	3.60	3.85	NAP	4.19	4.53
BCN	4.04	4.13	HAM	3.60	3.85	NCE	3.49	3.58
BHD	3.00	2.98	HEL	4.33	4.71	ORY	3.49	3.58
BHX	3.98	3.90	LCY	3.00	2.98	PMI	4.04	4.13
BMA	1.35	1.54	LGW	3.98	3.90	STN	3.98	3.90
BRU	3.78	3.90	LHR	3.93	3.86	STR	3.60	3.85
CDG	3.47	3.56	LIN	4.19	4.53	TFS	4.04	4.13
CGN	3.60	3.85	LIS	4.48	4.69	THF	2.44	2.54
CPH	3.51	3.80	LPA	4.04	4.13	TLS	3.49	3.58
CTA	4.19	4.53	LTN	3.98	3.90	TXL	3.60	3.85
DUB	5.72	5.84	LUX	3.78	3.90	VCE	4.19	4.53
DUS	3.60	3.85	LYS	3.49	3.58	VIE	3.75	4.11
EDI	3.98	3.90	MAD	4.01	4.10			

The resulting number of movements at each of the airports is presented in Annex II-1.

Noise exposure data for this scenario can be found in Annex II-7. No noise contours are given here in printed form. However, all data are available on the CD-ROM provided with this report (See section 7.4).

7.2.4 The effect of capacity constraints

Airport capacity may be limited due to several factors (ATM, number of runways, environmental considerations, etc.). These limitations can be translated directly into a maximum number of movements an airport can absorb.

As already described in section 4.2.1, the following airports were found to be affected by capacity problems:

Airport	Max. capacity*	
	2007	2015
AMS (Amsterdam-Schiphol)	528000	528000
DUS (Dusseldorf)	210240	210240
FCO (Rome-Fiumicino)	490560	490560
FRA (Frankfurt-Main)	554800	554800
LHR (London-Heathrow)	683280	683280
MUC (Munchen)	478880	478880
STN (London-Stansted)	221920	221920

When these limits are overlayed on the traffic data provided in Annex II-1, the following constraints are found:

Airport	Scenario					
	2007P	2015P	2007C	2015C	2007D	2015D
AMS	ok	constraint	ok	ok	ok	constraint
DUS	constraint	constraint	ok	constraint	constraint	constraint
FCO	ok	ok	ok	ok	ok	constraint
FRA	ok	constraint	ok	constraint	ok	constraint
LHR	ok	constraint	ok	ok	ok	constraint
MUC	ok	constraint	ok	constraint	ok	constraint
STN	ok	constraint	ok	ok	ok	constraint

The model was executed for the constraint airport-scenario combinations, with the maximum number of movements as indicated above.

The following table gives the reduction in noise exposure (L_{den}) as a result of the capacity constraints at the airports.

Scenario	Airport	Reduction in number of people due to capacity constraints						
		LA	A	HA	55-60	60-65	65-70	>=70
2007P/2007D	DUS	1605	958	434	1373	1024	343	0
2015P	AMS	7689	4544	1997	8226	4720	374	0
	DUS	11982	7165	3224	14027	5101	1042	330
	FRA	16459	10189	4914	13319	11747	1226	0
	LHR	17227	10888	5422	13946	8637	2664	1808
	MUC	1946	1098	433	3074	597	0	0
	STN	2103	1258	565	2613	675	324	0
	Total	49717	30598	14558	46979	26757	5256	2138
2015C	DUS	244	140	59	434	0	0	0
	FRA	3345	2104	1047	1473	3456	212	0
	MUC	124	70	29	116	116	0	0
	Total	3713	2314	1135	2023	3572	212	0
2015D	AMS	21135	12590	5619	24011	9685	2012	790
	DUS	13146	7871	3552	15304	5540	1259	330
	FRA	19083	11764	5631	15651	12601	2530	0
	LHR	24955	15796	7890	20229	11284	4724	2803
	MUC	2016	1146	461	3124	636	0	0
	STN	2880	1703	746	4049	675	324	0
	FCO	25547	15182	6750	31990	8820	2660	560
	Total	108762	66052	30649	114358	49241	13509	4483

7.3 Baseline Trend

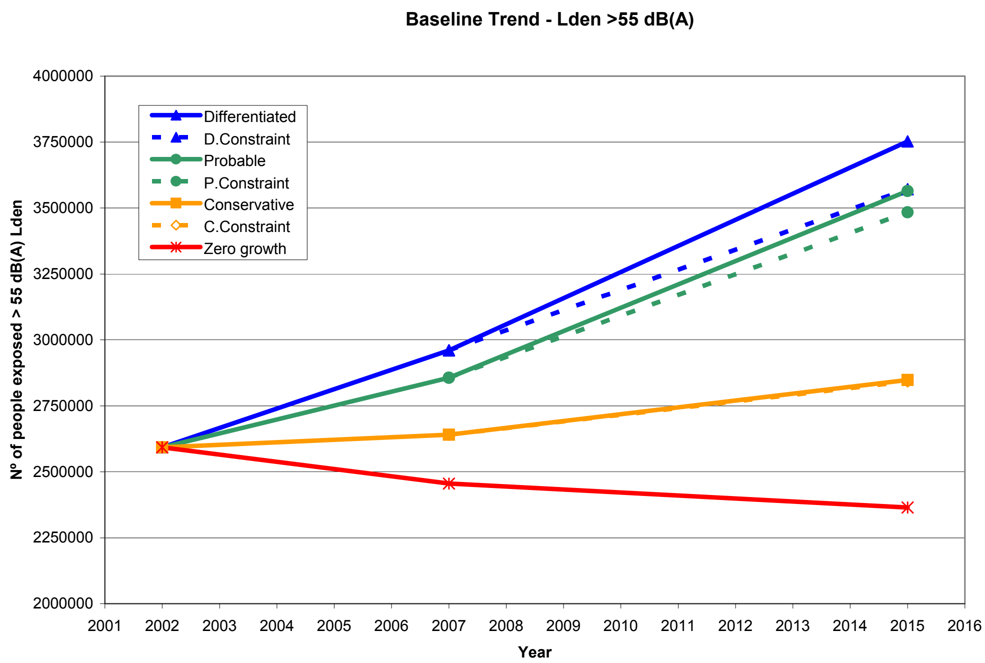
For the different scenarios considered above, the Baseline Trend can now be determined. In the following various ways of presentation will be used so as to highlight the different aspects related to the development of the noise exposure.

7.3.1 Baseline Trend at Community level

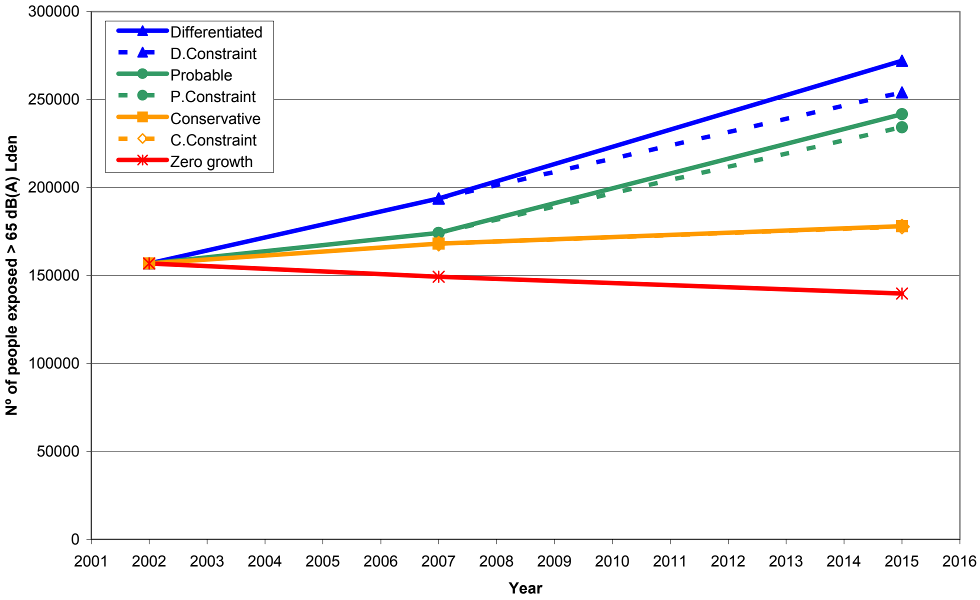
The following graphs show the Community Baseline Trends for the scenarios considered, expressed in the total number of people above a certain threshold:

- L_{den} ≥55 and ≥65 dB(A)
- L_{night} ≥45 and ≥55 dB(A)

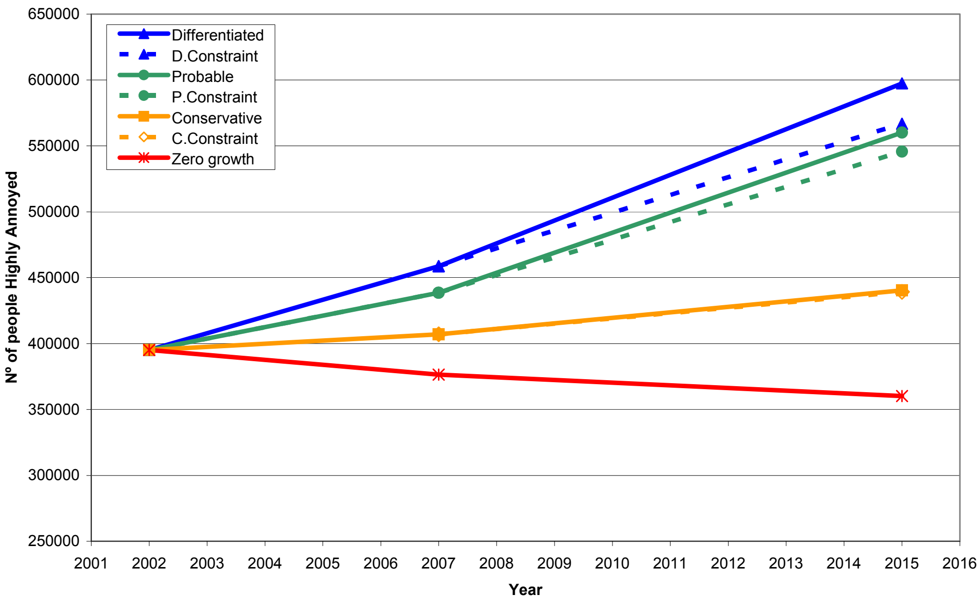
in addition to the number of people Highly Annoyed (HA).



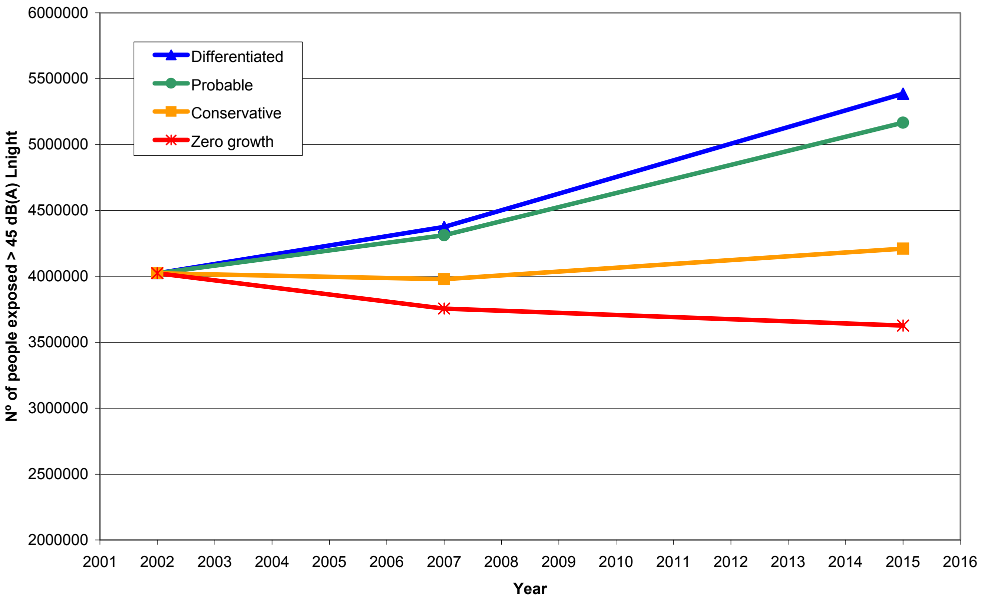
Baseline Trend - Lden >65 dB(A)



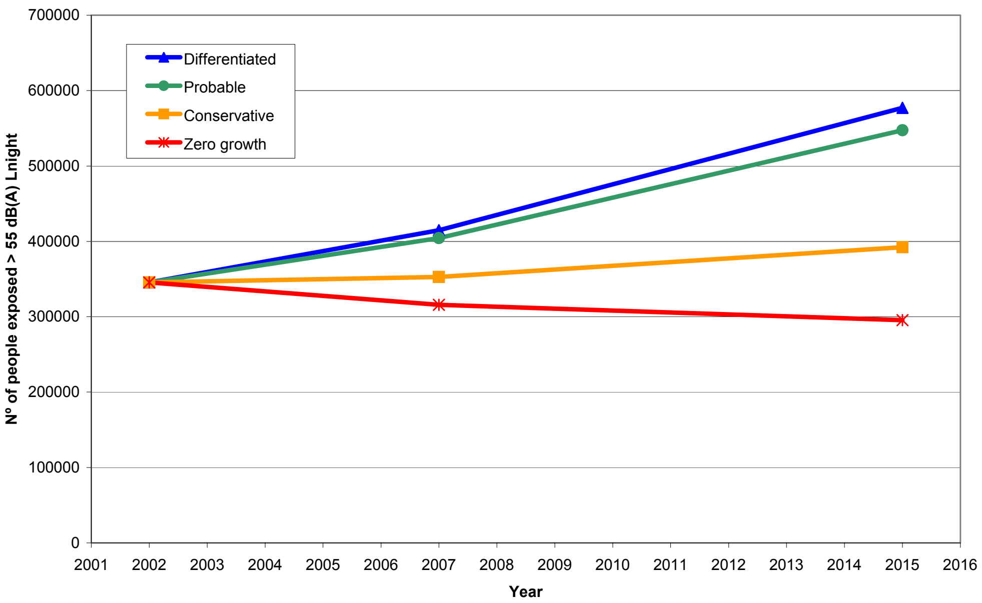
Baseline Trend - HA



Baseline Trend - Lnight >45 dB(A)



Baseline Trend - Lnight >55 dB(A)



With the number of people exposed to aircraft noise in the Baseline Year as a reference the following table can be established.

		increase in number of people exposed to aicraft noise					
		Lden>55 dB(A)		Lden>65 dB(A)		Highly Annoyed	
Scenario	Period	2007	2015	2007	2015	2007	2015
Probable	2002-2015	10%	37%	11%	54%	11%	42%
	annual	2%	3%	2%	4%	2%	3%
Conservative	2002-2015	2%	10%	7%	14%	3%	11%
	annual	0%	1%	1%	1%	1%	1%
Differentiated	2002-2015	14%	45%	24%	74%	16%	51%
	annual	3%	3%	5%	6%	3%	4%

From the above data it can be seen that a similar trend is found among the different parameters considered. In general an increase in the number of people exposed to aircraft noise is found for all scenarios. This increase is clearly more pronounced after the year 2007. The parameter HA is found to be a good indicator for the trends observed. Since this is also the indicator which should be used in the framework of the present study (according to the terms of reference), HA willl therefore be used in the following as the main parameter for noise exposure.

In order to explain this 2-phase behaviour, a “zero-growth” scenario was established, in which the number of movements was maintained at the 2002 level, whereas the fleet mix for 2007 and 2015 was established in the same manner as for the other scenarios (i.e. based on the aircraft evolution matrix, described in section 4.3.3.4). Hence, with this scenario the isolated effect of fleet modernisation can be established. This scenario is also indicated in the above graphs. It can clearly be seen that from 2002 to 2007 the replacement of older aircraft by newer, quieter types has a more pronounced effect than from 2007 onwards. This clearly reflects the observations made in section 4.1 on accelerated fleet renewal due to the availability of cheap, relatively new aircraft.

The noise benefits obtained by this fleet renewal, however, are not sufficient to offset the negative effects of the increase in number of movements, not even in the most conservative scenario.

The effect of constraints on airport capacity are certainly not negligible for the Probable and Differentiated scenarios, where for 2015 the number of people Highly Annoyed reduces with 3 and 5% respectively. No significant effect, however, is found for the conservative scenario.

The main conclusion to be drawn from the above information is that at Community level the total number of people exposed to aircraft noise will increase in the period up to 2015. The number of people highly annoyed (HA) will increase at a rate of 1 to 4% per year, depending on the scenario considered. This means that in 2015 the number of people seriously affected will have increased between 10 and 50% with respect to the current situation.

Based on the above, the Probable scenario is considered a good indicator to reflect with sufficient accuracy the trends observed. Therefore, and in order to reduce the extension of the analysis performed in the following sections, only the Probable scenario will be used. It is noted that data are available for other scenarios and noise descriptors which may be made available for consultation on request.

7.3.2 Baseline Trend at airport level

Due to differences between the airports in terms of population distribution, degree of implementation of noise mitigation actions etc, the situation at airport level might differ quite substantially from the trend observed at Community level. Therefore in this section the Baseline Trend will be established for each individual airport.

In the following the annual change in number of people Highly Annoyed is presented for each airport and for the periods 2002-2007 and 2002-2015, in the Airport Classification Matrix format, and based on the Probable scenario. Airports at which the annual change is negative (i.e. reduction in noise exposure) are indicated in green. Airports with a 'slight' annual increase (<1%) are indicated in ambar, whereas the rest is represented in red.

2002-2007	A		B		C	
1	AMS	-1,6	MAD	1,4		
	FRA	5,0				
	CDG	3,9				
	LHR	3,8				
	Total	3,7	Total	1,4		
2			BRU	-0,4	MUC	2,7
			ORY	1,1	CPH	3,0
			LGW	4,8	BCN	-0,3
			MXP	0,6		
			FCO	0,9		
			Total	0,7	Total	1,4
3	TFS	4,3	LIS	1,4	PMI	1,0
	LPA	3,0	HAJ	-0,8	ALC	1,0
			MAN	2,3	AGP	2,4
			LUX	1,6	CGN	0,6
					TXL	3,7
					STR	2,0
					VIE	1,9
					DUB	-13,0
					LYS	0,4
					NCE	6,9
					MRS	-2,6
					TLS	-0,3
					MLH	2,7
					STN	-5,2
					EDI	-1,2
					GLA	3,8
					BHX	-1,2
					EMA	-3,6
					LTN	-1,8
					ATH	4,6
					ABZ	1,8
					ARN	2,6
					GOT	-1,4
					HAM	3,3
					VCE	7,9
					NAP	-0,2
					HEL	5,1
					DUS	1,5
	Total	3,4	Total	1,3	Total	1,9
4					THF	3,5
					BHD	10,1
					LCY	7,9
					BMA	4,9
					Total	4,1

2002-2015	A		B		C	
1	AMS	2,2	MAD	3,2		
	FRA	4,4				
	CDG	4,9				
	LHR	3,2				
	TOT	3,5	TOT	3,2		
2			BRU	1,3	MUC	7,1
			ORY	1,6	CPH	4,3
			LGW	7,9	BCN	1,3
			MXP	1,1		
			FCO	1,4		
			TOT	1,6	TOT	3,0
3	TFS	5,7	LIS	2,0	PMI	1,6
	LPA	5,1	HAJ	-0,6	ALC	2,5
	TOT	5,3	MAN	2,9	AGP	4,3
			LUX	3,2	CGN	2,9
			TOT	1,9	TXL	4,3
					STR	4,0
					VIE	4,6
					DUB	-3,9
					LYS	7,9
					NCE	11,0
					MRS	0,6
					TLS	2,2
					MLH	4,7
					STN	1,0
					EDI	2,4
					GLA	4,8
					BHX	1,2
					EMA	-0,5
					LTN	5,2
					ATH	5,2
					ABZ	4,6
					ARN	9,7
					GOT	2,2
					HAM	3,6
					VCE	6,6
					NAP	1,1
					HEL	5,4
					DUS	2,9
	TOT	5,3			TOT	3,4
4					THF	4,5
					BHD	11,4
					LCY	7,6
					BMA	26,7
					TOT	9,1

Baseline Trend - Probable scenario - HA

It can be seen that for the period upto 2007 the noise climate at various airports (~25%) will improve with respect to the current situation, most probably due to the effect of fleet renewal previously observed. At Amsterdam-Schiphol (AMS) the reduction of people affected is (at least partly) due to the introduction of a new runway, fully operational in 2005. In 2015, however, almost all airports (~95%) will experience a deterioration of the noise climate. Although for some airports the annual change expressed in % might result sometimes 'spectacular', it should be noted that at some airports the absolute number of people affected is very small. Due to the minimum cell size required for the population module of SONDEO (see section 6.2) a single cell may already represent a relatively big percentage of the population.

The following table gives an overview of the distribution of the total number of people affected among the various airport groups (100% = total HA at Community level).

2002 2007 2015	A	B	C
1	28% 29% 28%	2% 2% 2%	
2		13% 12% 11%	3% 3% 3%
3	0.2 % 0.2 % 0.3 %	10% 10% 9%	41% 41% 42%
4			3% 3% 5%

Distribution of people Highly Annoyed (Probable scenario)

It can be seen that this distribution is almost constant over the years. In terms of airport groups, A1 and C3 are clearly the ones which most contribute to the total number of people affected in the Community. The airports within these groups are responsible for the noise exposure of 70% of the total.

However, analysing the same data at a somewhat less agregate level, it becomes clear that, averaged over the airports within each group, the contribution of each airport to the total is quite different from the above, as can be seen in the following matrix.

2002 2007 2015	A	B	C
1	7%	2%	
2		2%	1%
3	0,1%	2%	1%
4			1%

Average contribution per airport
to total number of people Highly Annoyed
(Probable scenario)

Clearly each major hub airport (group A1) has, on average, a much higher impact than any of the airports in the other groups. Each “B” airport appear to contribute about twice as much to the total as the “C” airports.

Another parameter that can be established at airport level is the number of people Highly Annoyed per 1000 movements, as shown in the following matrix.

	A	B	C
1	AMS 15 FRA 32 CDG 29 LHR 152 Avg. 57	MAD 22 Avg. 22	
2		BRU 52 ORY 110 LGW 6 MXP 16 FCO 15 Avg. 40	MUC 2 CPH 18 BCN 16 Avg. 12
3	TFS 6 LPA 5 Avg. 5	LIS 142 HAJ 67 MAN 54 LUX 53 Avg. 79	PMI 27 ALC 16 AGP 9 CGN 45 TXL 269 STR 31 VIE 4 DUB 12 LYS 2 NCE 15 MRS 15 TLS 20 MLH 4 STN 8 EDI 23 GLA 30 BHX 93 EMA 48 LTN 26 ATH 211 ABZ 14 ARN 0 GOT 0 HAM 132 VCE 0 NAP 107 HEL 10 DUS 37 Avg. 43
4			THF 268 BHD 17 LCY 6 BMA 93 Avg. 96

Nº of people HA per 1000 movements

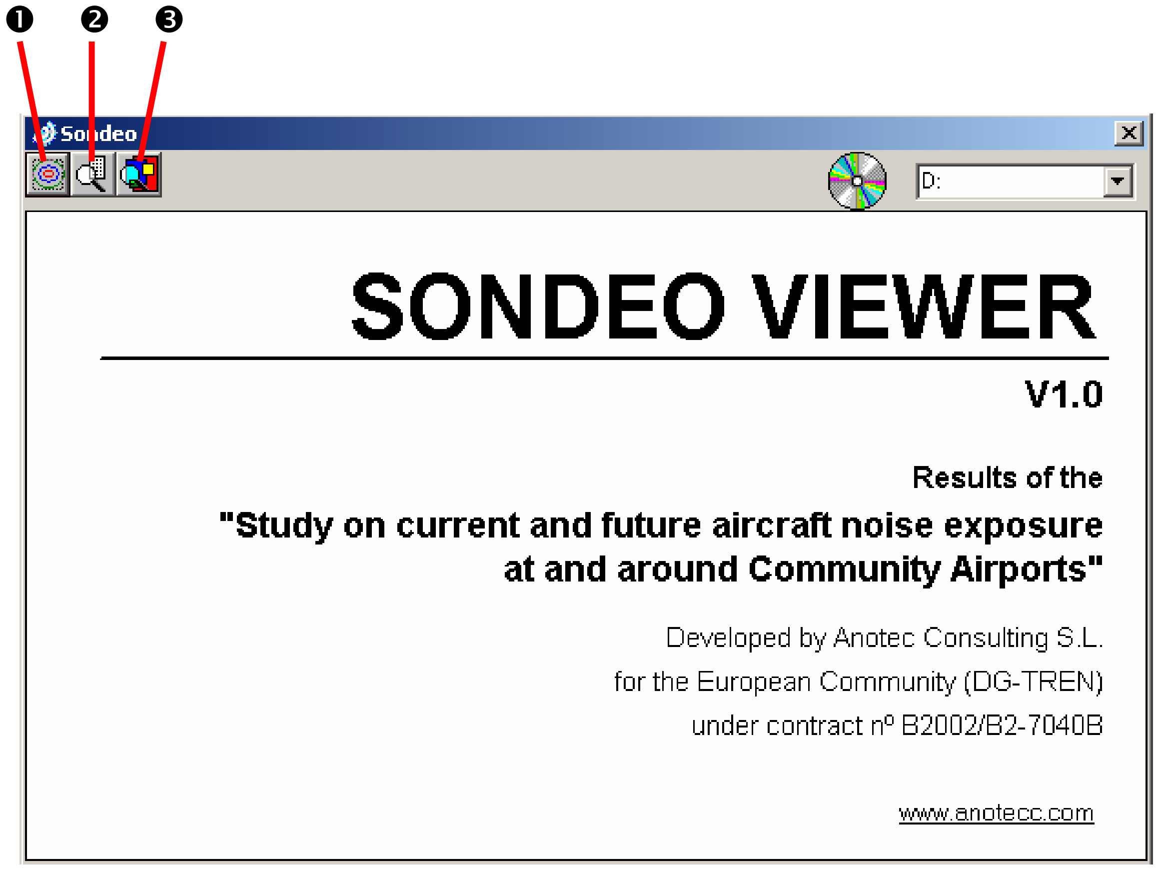
This parameter is given here for information purposes only, and will not be used hereafter.

7.4 CD-ROM

Due to the huge amount of data produced for the 3 baseline scenarios, it was decided to make this information available in electronic format rather than on paper. Access to the data is provided by means of a basic presentation tool supplied, together with the baseline noise climate databases, on a CD-ROM. This CD is included as a part of this final report.

The software is self-explanatory and therefore no manual or on-line help is provided. The program should be installed by executing the SETUP.EXE file on the CD. It should be installed on the hard-disk of a PC running under Windows 98 (2nd edition) or higher. The recommended screen size is 1024x768, or higher. The databases and noise contour maps will directly be read from CD, and will not be installed on the hard-disk, thus saving space.

The software has the following 3 major functions:
❶ Show noise contour maps
❷ Perform analysis on individual airport level (down to noise exposure at town level)
❸ Perform data analysis on airport group level



All data presented may be saved to file for further analysis or printing. The text files generated can directly be read by e.g. Microsoft Excel (";" separated)

It should be noted that the data provided is property of the European Commission and may only be used in the framework of the present study. For any other use, written permission shall be required from the European Commission (DG-TREN).

7.5 Comparison with MAGENTA

In this section a comparison is made between the results, obtained through the modelling developed for CAEP (MAGENTA) and the model used for the present study (SONDEO).

Up to now the MAGENTA modelling system offers the only database and software that can model trends on a worldwide base. In comparison, SONDEO is a model that permits similar studies as those developed for MAGENTA, but is has only be used for a study at regional level. SONDEO permits a more detailed study, due to the use of fewer assumptions than used by MAGENTA at worldwide level, and a more realistic analysis on airport level, as needed for the current study.

Although differences exist between both models with respect to e.g. objectives and data used, it was anticipated that the results of the present study (all EU airports) should show similar trends as the results from MAGENTA for the ECAC airports analysed for CAEP/5 (and recently adjusted in preparation for CAEP/6).

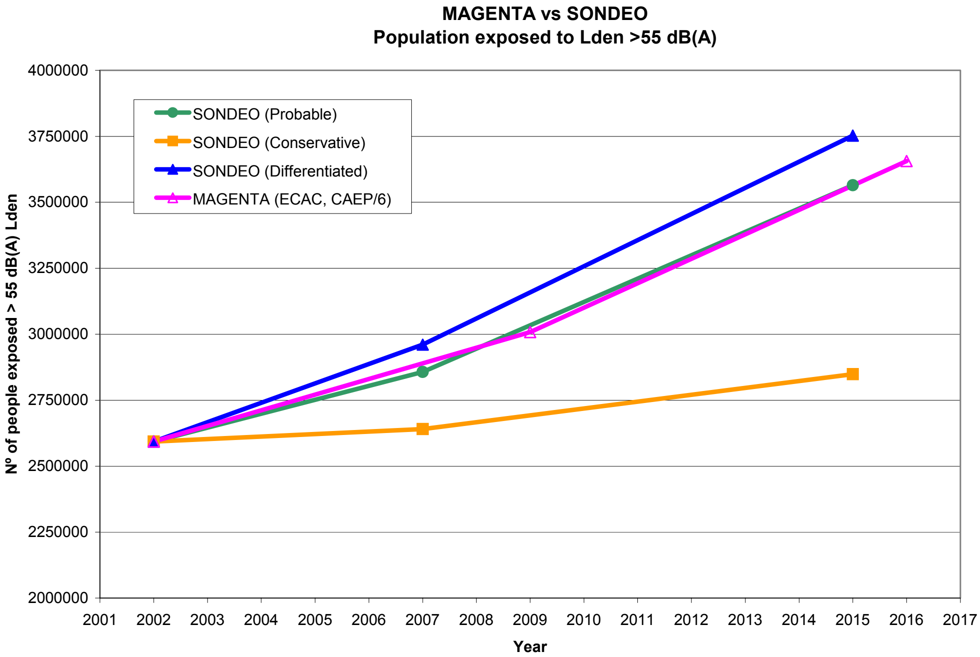
Some elements that need to be taken into account about MAGENTA are:
- MAGENTA is a global model established for a global analysis
- Database of MAGENTA mainly collected between 1995 and 1998, with significant differences with the actual situation
- MAGENTA data for fleet mix and traffic levels are based on global assumptions and not on individual data from airports or regions
- The results for population affected by noise are at ECAC level, not at EU level

The following table contains the main differences and assumptions between both models.

Considerations	**MAGENTA**	**SONDEO**
Level of analysis	Worlwide	Regional or national airports
Aircraft types	Surrogate aircraft fleet (ACAS Database)	Actual fleet by airport (Eurocontrol PRISME)
Noise model	INM	ECAC Doc.29 with INM database
Noise index	DNL	L_{den}, L_{night}
Noise exposure	DNL 55, 60,65	L_{den} 55-55-60-65-70 L_{night} 45-50-55-60-65 LA, A, HA (Miedema)
Base year	1998	2002
Number of airports	1700	53
Airport capacity constraints	None	Possible
ATM capacity constraints	None	Possible
Traffic data	IOAG (scheduled flights only)	Eurocontrol PRISME (actual flights, all types) IOAG (optional)
Traffic growth factors	Route growth forecast	Individual airports or regional forecast
Population database	1996-1998	2001-2002
Population change	No allowance	Possible change
Aircraft operating procedures	INM default	INM default Changes possible
Routes distribution	Homogeneous distribution	Use preferential routes established by airports, including restrictions in time or runways

The MAGENTA data used for the comparison is that, produced as an update to the CAEP/5 baseline, in preparation for CAEP/6 [20]. In order to be able to compare these data with SONDEO results, the MAGENTA data was scaled to SONDEO. To this end the annual growth in population exposed above DNL 55 was determined from the ECAC data given in Figure 5 of [20] and expressed in % of the number in 2002. This same factor was then applied to the number of people exposed to L_{den} >55 dB(A), as determined with SONDEO. In this manner the baseline year was set equal for both models. It is recognised that due to this scaling technique, no comparison can be made on absolute levels, but at the same time it enables a comparison of trends.

The following graph shows the results of this comparison exercise.



It is observed that the MAGENTA results coincide remarkably well with the SONDEO data for the Probable scenario. This result is another proof of the validity of the SONDEO model (in addition to section 6.5) and also indicates that the Probable scenario may be used for the further analysis performed in the remaining part of the present study.

7.6 Conclusions

The results of Task 3 (Determination of the Baseline Trend) can be summarised as follows:

- In all scenarios considered, the number of people seriously affected by aircraft noise will increase in the horizon 2007-2015 at Community level
- In 2007 at ~25% of the airports the noise climate will have improved with respect to 2002, mainly due to fleet modernisation.
- In 2015, however, at ~95% of the airports the noise climate will have deteriorated with respect to 2002, mainly due to the noise related to the increased traffic volume
- Capacity constraints will result in a measurable (but limited) reduction in population affected by aircraft noise.
- The Baseline Trend for the Probable scenario shows very good agreement with most recent results from MAGENTA.
- Further actions will be required in order to achieve the objective of the Directive “to limit or reduce the number of people significantly affected by the harmful effects of noise”

8. Assessment of further actions required (Task 4)

It was anticipated that, due to the traffic growth and in spite of the introduction of various mitigation actions, the ‘Baseline Trend’ as determined in Task 3 shows that the number of people affected by aircraft noise will grow at an important part of the airports studied.

Further actions will thus be required so as to be able to reach the Directive objective “to limit or reduce the number of people significantly affected by the harmful effects of noise“.

In the following, Further Action scenarios will be developed and calculated with the SONDEO model so as to be able to assess their effectiveness in limiting noise exposure in the future.

The assessments carried out in this Task will help the EC to identify at an early stage the possible need for revision of the ORD, in compliance with its Article 14.

The concept of the Balanced Approach to noise management establishes a framework within which noise mitigation actions should be taken. The objective is to address the noise problem using objective criteria in the most cost-effective manner.

8.1 Determination of further actions

In this section a new concept is being developed (Noise Mitigation Matrix), with which actions taken under the Balanced Approach are combined with the various elements contributing to noise exposure. This concept will enable the assessment of future actions and their effect on the number of people affected.

8.1.1 Elements of the Balanced Approach

Any future action will have to be considered in the framework of the Balanced Approach; therefore ICAO is elaborating guidelines on its implementation [21]. In this section these guidelines are followed to give a brief overview of the four principal elements available.

8.1.1.1 Reduction of noise at source

Noise control at source, induced by adoption and implementation of noise certification standards, is an important element in the management of aircraft noise. Included in this context is not only the introduction of new, quieter aircraft types, but also the improvement of existing types. This element, however, is not within control of the individual airports.

8.1.1.2 Land use planning and management

Land use planning is used to increase the compatibility of the land use with the airport activity. This can be accomplished by changing the noise sensitivity of the areas around the airport, for instance by replacing noise sensitive use (houses) by less sensitive use (industry).

Various instruments are available within this element:
- Planning instruments (e.g. noise zoning)
- Mitigating instruments (e.g. noise insulation, reallocation, noise barriers)
- Financial instruments (economic incentives, noise charges)

Land use planning is considered a very important instrument to prevent that benefits, obtained with complementary measures, are offset by an increase in noise sensitive areas closer to the airport due to the reduced noise level (encroachment).

8.1.1.3 Noise abatement operational procedures

The possibilities for the introduction of noise abatement operational procedures are mainly conditioned by safety issues. These procedures should not be introduced unless it has been confirmed that a noise problem exists.

Among these procedures the most important are:

- use of noise preferential runways
- use of noise preferential routes (SIDs and STARs)
- use of low noise flight procedures (variations in flap, thrust, …..; e.g. CDA (Continuous Descent Approach)

These procedures are usually 'tailor-made' for an airport and may be used to reduce noise exposure in certain areas, depending on the population distribution around the airport. Care should be taken that procedures designed to reduce noise exposure in certain areas, do not generate more noise in other areas, unless these are noise-insensitive.

In a wider context, the relationship with emissions should be addressed.

8.1.1.4 Operating restrictions

Under the Balanced Approach, an operating restriction is defined as "any noise-related action that limits or reduces an aircraft's access to an airport".

Operating restrictions should only be used after considering the benefits of other measures under the Balanced Approach. If they are introduced, they should be of a partial nature wherever possible. Economical issues should also be addressed, e.g. by a gradual introduction.

Two main categories of restrictions can be distinguished:

- Noise related restrictions of traffic
    - Limit number of movements or the total noise energy produced
    - Curfews, limiting operations during a certain period of time
    - Noise quota
- Restrictions of use
    - Limit use of specific aircraft, based on their noise and/or flight performance. The indicator(s) to be used for the noise performance shall be the certification levels or derivatives thereof (sum, average, margin)
    - Limit ground operations (engine run-up, APU)

8.1.2 Elements of aircraft noise exposure reduction

Aircraft noise exposure may be reduced by acting on one or more of the following elements. It is noted that all these elements are input parameters to the SONDEO model.

8.1.2.1 Aircraft/engine type used

New noise reduction technology is constantly being developed. Noise generation at source has considerably been reduced over the last decades. Large R&D projects have been set up so as to enable further noise reductions (e.g. Silence®).

In addition to this ‘natural’ improvement of aircraft noise performance, various reasons may exist to operate/acquire quieter aircraft types, such as high taxes for noisy aircraft, etc.

The use of a quieter aircraft will obviously have a beneficial effect on noise exposure.

8.1.2.2 Number of movements

Noise exposure is directly related to the number of flight operations. More flights will extend the noise contours further away from the airport, thus affecting a bigger area and usually a higher number of people.

Limiting the number of operations at Community level might theoretically be an effective measure, but due to the corresponding legal aspects and economical implications, it is not considered a viable action.

8.1.2.3 Time of operation

Noise sensitivity of people changes with time of day; at night people are more noise sensitive than at day. This response is included in the L_{den} metric, with different weighting factors according to the time of day of the operation (see section 6.1). Limiting operations during the most noise-sensitive period will reduce the number of people affected.

8.1.2.4 Routing

‘Intelligent’ distribution of the operations among the various runways of an airport might be a measure to reduce noise exposure. With an adequate distribution of flights among well-designed SIDs and STARs densely populated areas may be avoided. Boundary conditions will be safety and economics (extra time/fuel required), in addition to emissions.

8.1.2.5 Profile

The vertical profile of an aircraft operation may be optimised, depending on where to reduce noise (close to or far from) the airport and during which phase (approach, take-off). These profiles will thus be airport and even runway dependent. This latter aspect reduces the acceptance among pilots due to the high work-load, and thus safety risks, involved. However, new avionics will become available which may be used to automate many of the tasks involved. An example is the so-called “NAP-button” in the Fokker-100, designed to fly a specific noise abatement procedure by just pushing this button.

The benefits of noise abatement flight procedures are studied in e.g. the Sourdine project [22].

8.1.2.6 Reduce sensitivity

At the reception side of the noise problem various actions may be taken to reduce the noise sensitivity. The number of people sensitive to noise may be reduced or the level to which they are exposed. This may be accomplished by reallocation and sound insulation respectively.

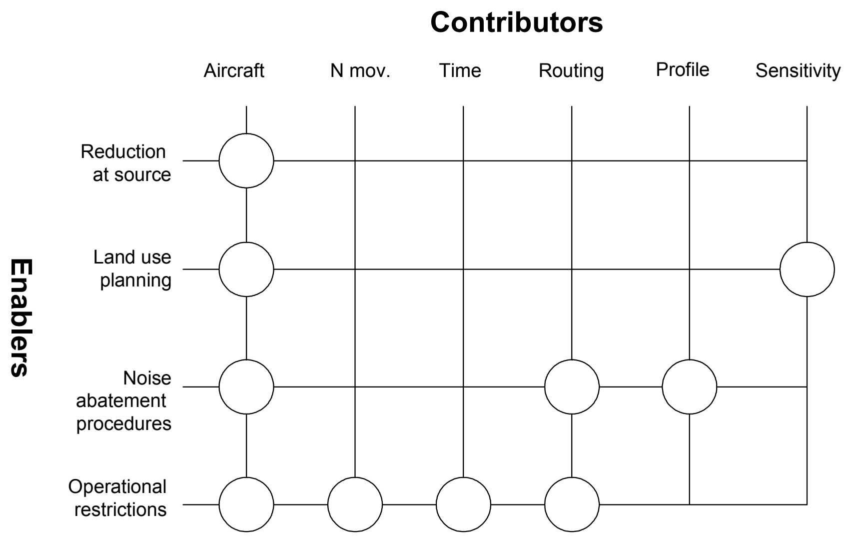
8.1.3 Noise Mitigation Matrix

The actions taken under the Balanced Approach are tools to enable noise reduction and are called here “Enablers”.

The elements contributing to the noise exposure and on which to act to obtain a noise reduction are called “Contributors”.

Not all Enablers will have the same effect. They will act on one or more Contributors. On the other hand, a single Contributor may be act upon through various Enablers.

The relationship between Enablers and Contributors may be presented in the following format, called the Noise Mitigation Matrix. At the nodes indicated an interaction occurs between Enabler and Contributor.



8.1.4 Simulation of further actions

From the Noise Mitigation Matrix it can be deduced that it will not be necessary to simulate each of the elements of the Balanced Approach (Enablers) separately. By directly simulating the Contributor, all corresponding Enablers are covered in a single scenario. In the following the possibilities are explored to simulate each Contributor by an appropriate selection of scenario indicators for the SONDEO model.

8.1.4.1 Contributor 1: Aircraft/engine type

The ‘natural’ evolution of noise reduction technology is already partly included in the aircraft evolution matrix used for all future scenarios. Any other effect within this Contributor will have to be simulated.

Two scenarios are simulated for years 2007 and 2015:
- Phase-out of marginally compliant aircraft (Ch.3-5dB) with 3 variants on its application:
  - Community wide
  - Only at those airports likely to introduce the ORD (groups A1, B1, B2 and C2, covering about 25% of all airports studied)
  - At all airports of groups A1, B1, B2, C2, B3 and the most noise sensitive airports of C3, corresponding to about 60% of all airports)
- All Chapter 4 fleet. This may be considered the maximum theoretically obtainable.

Simulation is done by substituting non-compliant aircraft with their most likely compliant aircraft as shown in the following table.

Current aircraft	Substitute aircraft	
	Ch.3-5	Ch.4
B707	B757/PW	B757/PW
B727	A320	A320
B737-200	B737-400	B737-400
B737-300	maintained	B737-400
B747-100	A340	A340
B747-200	B747-400	B747-400
B747-300	maintained	B747-400
B767-200	maintained	B767-300
A300-B4	maintained	A300-600
AN-12	B747-400	B747-400
DC10	A340	A340
DC8-50/60	B757/PW	B757/PW
DC-9	A319	A319
IL-62	B757/PW	B757/PW
IL-96	maintained	B747-400
L-1011	B747-400	B747-400
MD-80	maintained	A319
TU-154M	A320	A320
Yak-42	A320	A320

8.1.4.2 Contributor 2: Number of movements

The number of movements is the main contributor to the increase in people affected by aircraft noise. Acting on this contributor is an effective measure to take advantage of actions on other contributors and could ultimately reduce the number of people affected (see zero growth scenario in section 7). Some indication on its effect can be deduced from the constraints scenario in the Baseline Trend study (section 7.2.4).

Due to its large economical impact, it is not a preferred option.

Based on the abovementioned this Contributor will not further be assessed.

8.1.4.3 Contributor 3: Time of operation

In order to simulate actions affecting the time of day of operations the following scenarios were developed:

- A Community wide ban on night flights. This is considered the maximum theoretically achievable
- A ban on all night flights, except at major hub airports (group A1), where intercontinental flights are important
- A ban on all night flights, only applied at C3 type airports

These scenarios are simulated by shifting the operations from the night period to the evening period, thus avoiding the +10 dB penalty for night flights. It is recognised that this is a theoretical exercise, in which no constraints are assumed to exist due to the higher amount of operations during the evening. The objective of this simulation is to obtain an indication of the order of magnitude this Contributor has to the overall equation.

8.1.4.4 Contributor 4: Routing

Optimised routing may have an important noise benefit. Since the optimisation of both noise preferential runways and SIDs/STARs are airport dependent, no general simulation can be performed. It is considered outside the scope of the current study to perform this optimisation exercise for all airports involved.

In order to give an indication of the possible benefits obtainable by acting upon this Contributor, a single case study is performed for Naples airport (NAP). This airport is choosen since it is not yet applying any noise preferential routing. The simulation involves a re-distribution of the operations among the existing runway headings and routes so as to show the potential benefits which might be obtained by the application of this measure. No safety, meteorological or other considerations have been taken into account here.

8.1.4.5 Contributor 5: Profile

Flight procedures (profiles) may be optimised for specific conditions. The appropriate combination of aircraft configuration (flaps, gears), thrust setting and speed may influence the noise exposure considerably. However, no single optimised procedure can be designed serving all needs. Depending on the aircraft type and weight and the distribution of noise sensitive areas around the airport the optimum procedure will vary. Safety issues will play an important role in the development of flight procedures. It is considered outside the scope of the present study to design optimised flight procedures, so no simulations will be made here. One is referred to the documentation provided by the Sourdine project [22] for an indication on the benefits to be obtained from this Contributor.

8.1.4.6 Contributor 6: Sensitivity

The noise sensitivity of an area may be reduced by:
- a reduction of the number of people exposed to a certain noise level
- a reduction of the noise levels an area exposed to

It should be noted that Assumption 7 (no change in population) already implies a certain action on this Contributor, since it limits the number of people within a certain area (non-addition simulation). This effect is an integrated part of the Baseline Trend and will not be further discussed here.

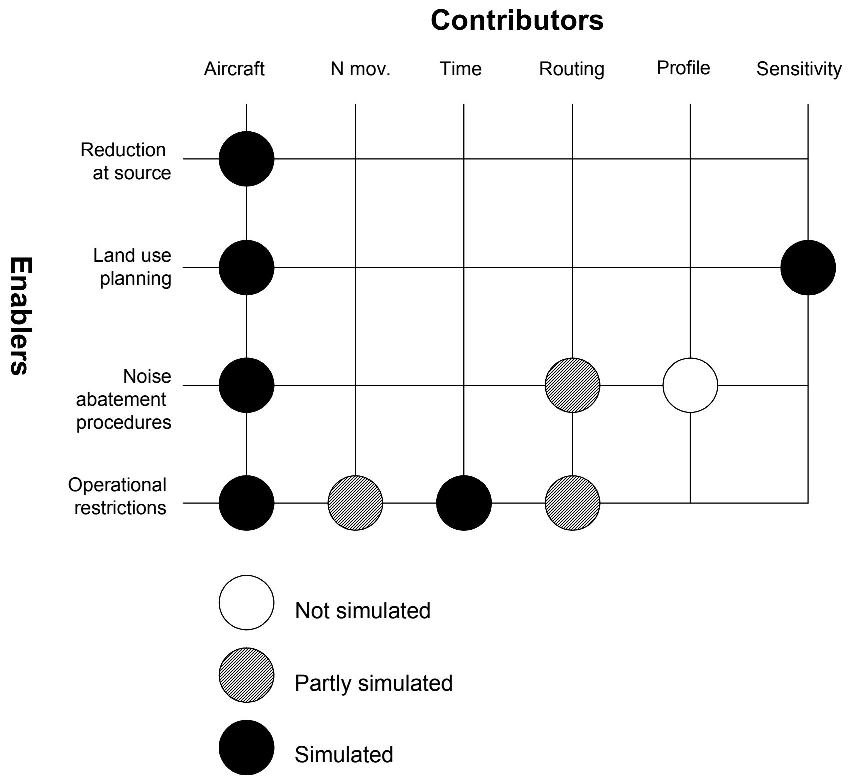
Two scenarios are defined:
- A reduction of 25% of the number of people exposed to L_{den} 65 or higher in the Baseline Trend (Probable scenario). This simulates e.g. a reallocation.
- For all people exposed to Lden 60 or higher, set their noise level equal to 60. This can be considered a simulation of sound insulation, where close to the airport a higher degree of insulation will be applied than further out. It is recognised that this simulation is a very rough approximation, since it does not take into account any indoor noise levels. It is included here to give an indication of the order of magnitude this action may have on the sensitivity Contributor.

8.1.4.7 Overview of further actions scenarios

The following tabe gives an overview of the various Further Actions scenarios considered in this study. It should be noted that these actions are applied Community wide, except where indicated otherwise. The baseline for these scenarios is the Probable scenario, for which the results were given in section 7.

Contributor	Scenario
1. Aircraft	Ch.3-5 (Community wide)
	Ch.3-5 (ORD airports; 25% of total)
	Ch.3-5 (60% of airports)
	All Ch.4
2. Movements	See baseline
3. Time	Full ban on night flights (Community wide)
	Full ban, except A1 airports
	Ban only at C3 airports
4. Routing	Example for Naples airport
5. Profile	Not simulated here
6. Sensitivity	Reallocation of 25% above 65 L_{den}
	Insulation down to 60 L_{den}

These simulations cover a wide range of actions to be taken in the Balanced Approach framework, as can be seen from the Noise Mitigation Matrix:

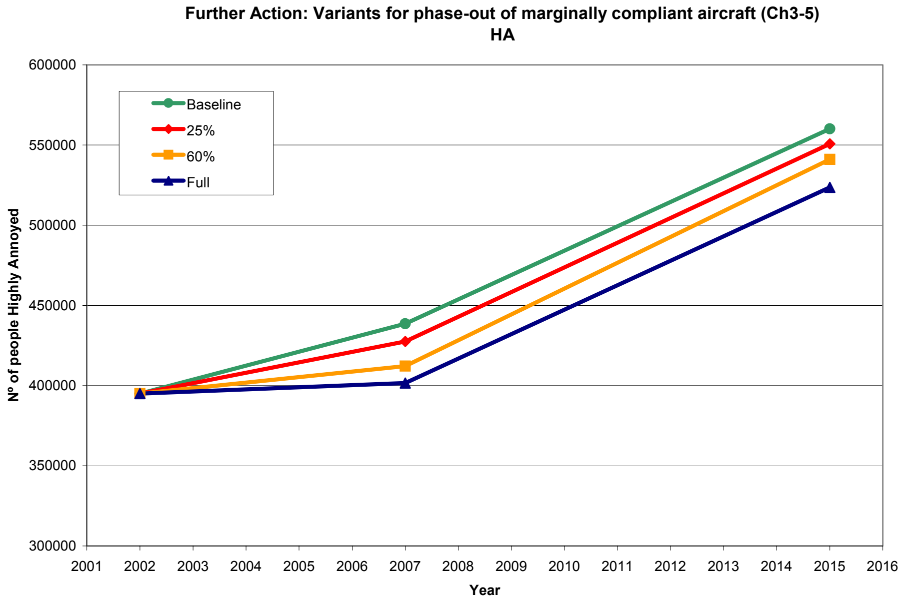


8.2 Trends with further actions

8.2.1 Contributor 1: Aircraft/engine type

8.2.1.1 Phase-out of marginally compliant aircraft (Ch.3-5) - (3 variants)

The results of the simulations with the 3 variants for the phase-out of marginally compliant aircraft and their substitution by compliant types, are given in Annex II-8. The Further Action Trend for these scenarios is given in the following graph.

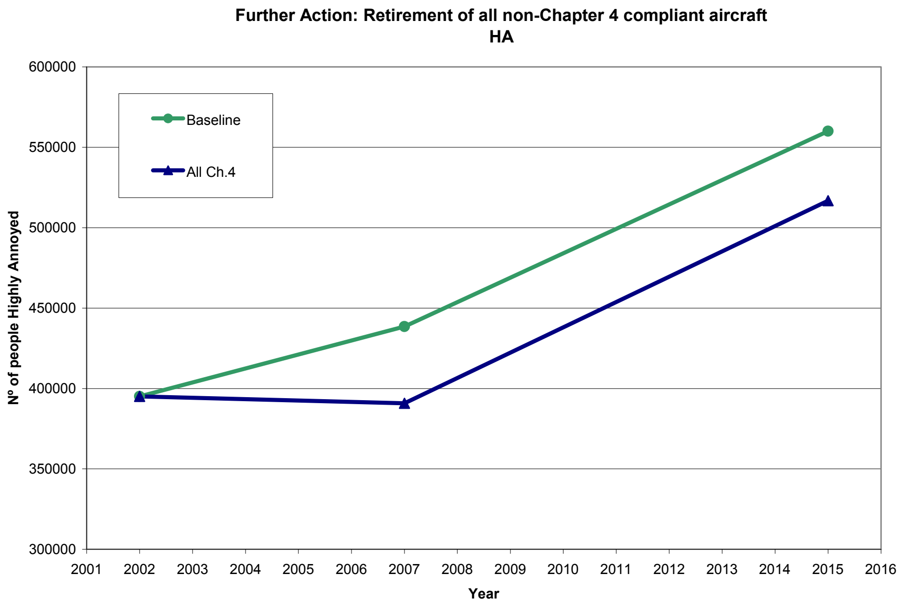


For the ‘Community wide’ variant, the trend is very similar to that of the Chapter 4 scenario from the previous section. This is due to the fact that the only difference between the 2 scenarios is the substitution of XX by YY, having a limited net effect on the overall picture.

When limiting the phase-out of these marginally compliant aircraft to those airports where the ORD is likely to be introduced, the benefits obtained are very limited. When extending the phase-out to 60% of the airports, the benefit is more pronounced, although still limited.

8.2.1.2 All Chapter 4 fleet

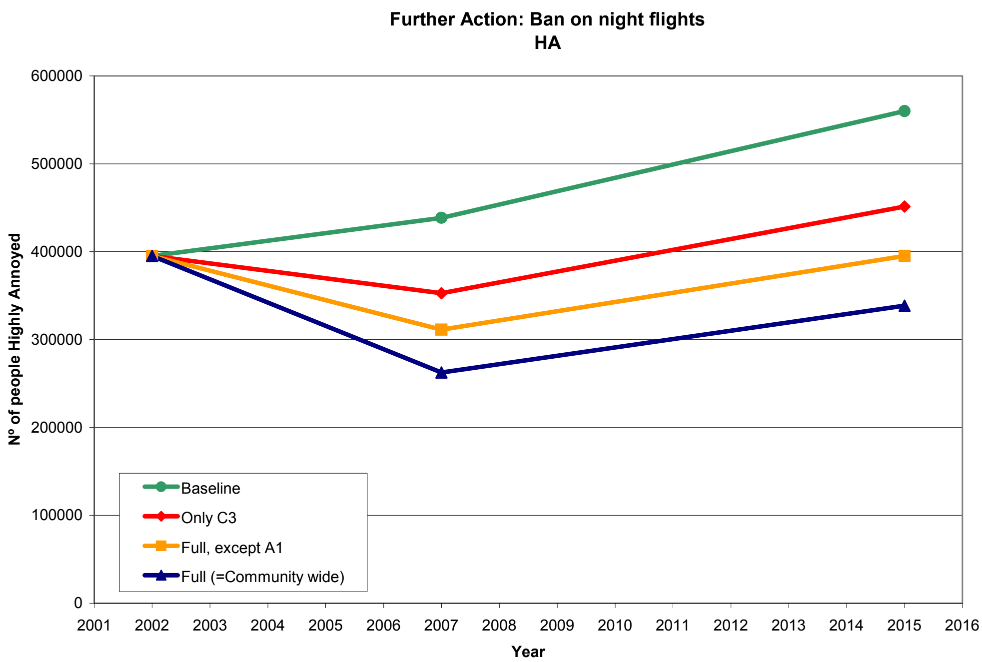
The results of the substitution of all non-Chapter 4 aircraft by compliant variants are given in Annex II-8. The resulting Further Action Trend is given in the following graph.



It can be seen that in this scenario an important short term benefit is obtained. On the longer term, however, this benefit is completely offset by the effect of the increased number of movements.

8.2.2 Contributor 3: Time of operation

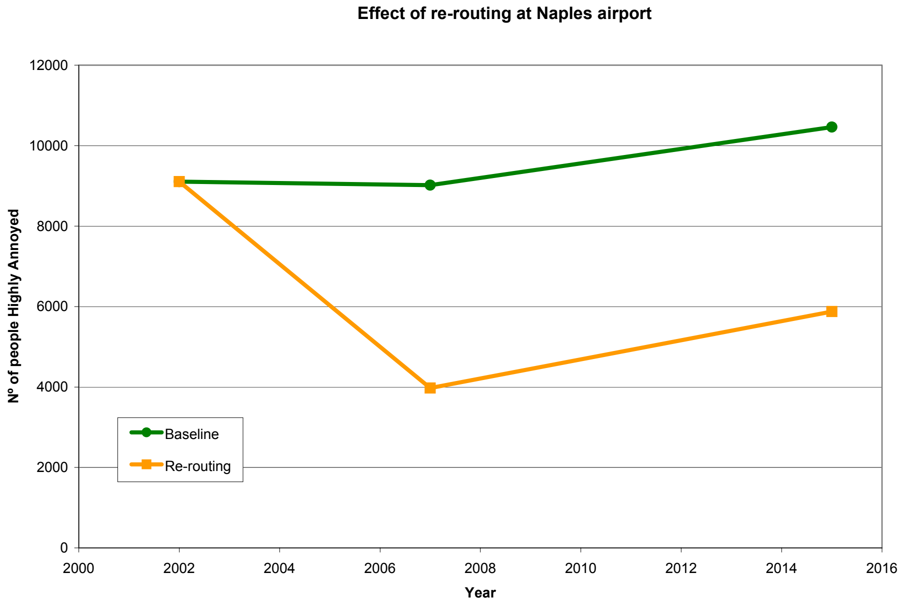
The results of the simulations with the 3 variants for a ban on night flights are given in Annex II-8. The Further Action Trend for these scenarios is given in the following graph.



This simulation clearly shows the importance the +10 dB weighting factor has in the noise exposure calculations. The number of people seriously affected may significantly be reduced by applying restrictions on night operations. There seems to be sufficient margin to apply only partial curfews.

8.2.3 Contributor 4: Routing

As described in section 8.1.2.4, an illustration of the potential benefits of optimised routing is only given for a single case. The following graph gives the results for both the baseline and the optimised situation.

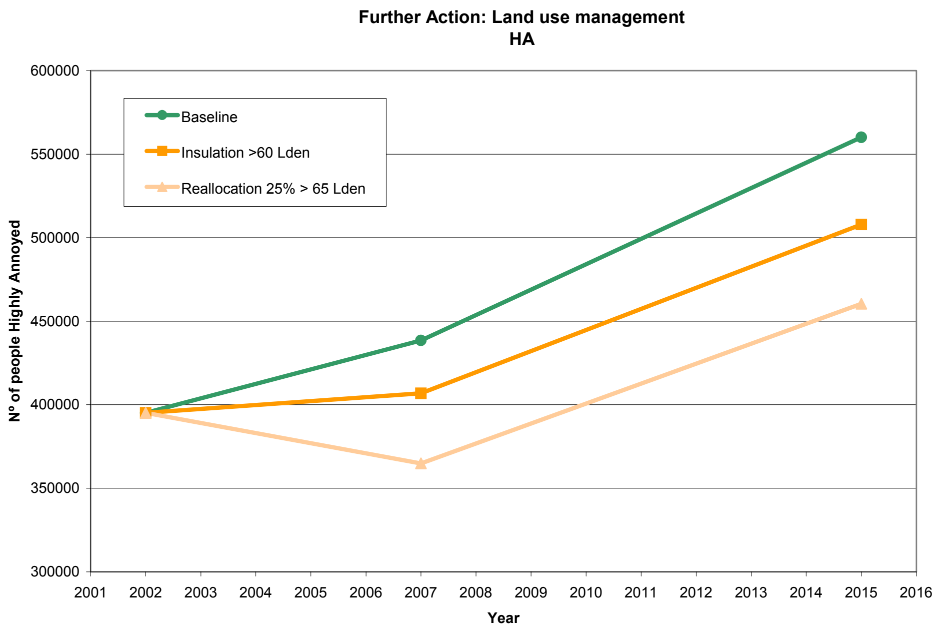


It can be seen that a proper distribution of the traffic among the available runways and SIDs/STARs may have a considerable influence in the noise exposure around an airport. It is recognised that this benefit may be limited due to other considerations to be taken into account (e.g. safety, meteorological conditions, aircraft performance).

It is remarked that the results obtained for this airport may not be extrapolated directly to other airports since local conditions will vary widely and subsequently the effect may be far less pronounced.

8.2.4 Contributor 6: Sensitivity

The results of the simulations of 2 variants for land use management are given in Annex II-8 and in the graph below.

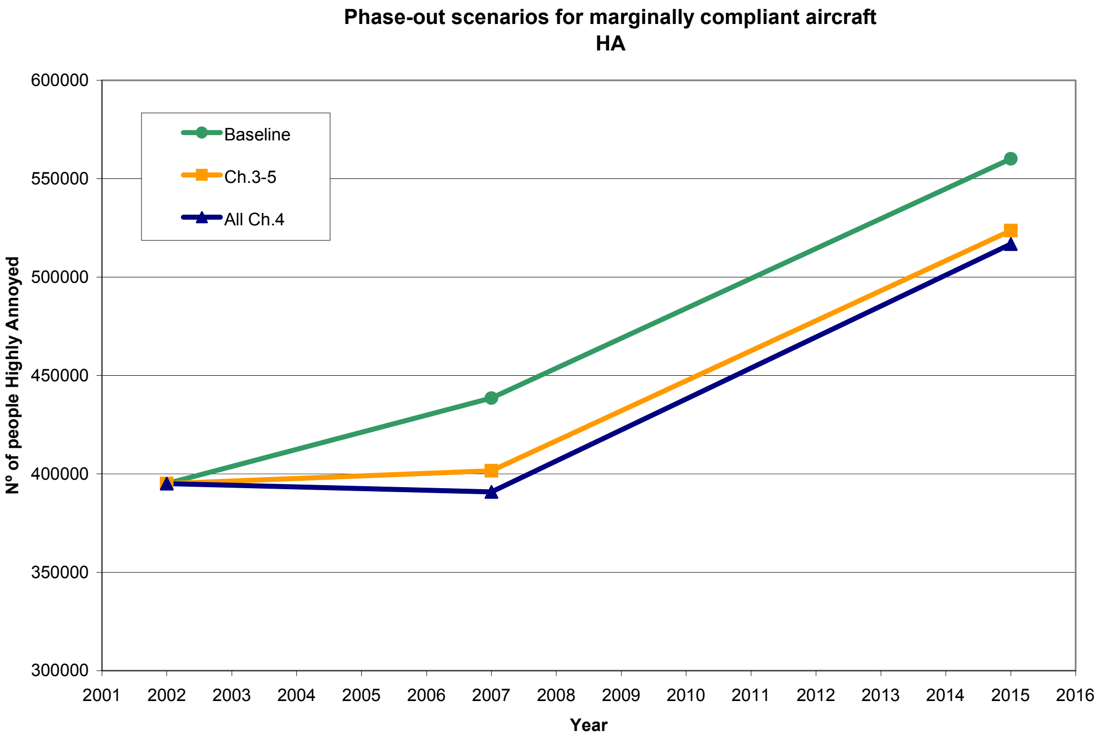


A significant reduction in noise exposure may be obtained by these measures. The costs involved, however, are high and a detailed cost/benefit analysis will be required to assess the implementation of these actions.

8.3 Marginally compliant aircraft

Scenarios for the phase-out of marginally compliant aircraft have already been treated in the former section. It was shown that when this action is applied Community wide (and completed in 2007), it will still show a slight increase in the noise exposure until that year. In the longer term, any benefits obtained are off-set by the effect of the increase in traffic volume, due to which the noise climate will deteriorate at an increased rate.

A more stringent definition of 'marginally compliant', even down to the theoretical maximum of Chapter 4 levels (i.e. Ch.3-10), does not provide significant improvements, at least at Community level (see following graph). The effect of this Further Action at airport level is assessed in section 9.



8.4 Conclusions on Further Actions on Community level

Based on the results of the calculations for various Further Action scenarios, the following conclusions may be drawn:

- The scenarios contemplated cover most of the possible Further Actions and in some cases analyse the theoretical limit that can be reach with the use of this actions.

- The actions considered are included in the balance approach and in the ORD.

- All actions considered have a beneficial effect on the number of people Highly Annoyed by aircraft noise in comparison with the baseline scenario

- This beneficial effect maintains or improves slightly the Community noise climate on the short term. On the longer term (2015) the benefits of all actions will have been almost or even fully offset by the increase of noise exposure due to traffic growth

- Although the noise climate will improve even on the long term, these actions, or the full application thereof, are considered only theoretical. In practice their implementation will not be viable due to e.g. economical constraints or actual legal limitations.

- The implementation of a Community-wide Phase-out of marginally compliant aircraft can freeze the increase in the number of people affected for 2007, whereas a partial introduction of this measure will result in a deterioration of the noise climate. The degree of effectiveness will depend of the percentage and types of airport where the ORD is implemented.

- The limitation or ban of night flights shows a high degree of effectiveness in limiting or reducing the population affected

- No single (practical) action will be able to guarantee a stable noise climate in the future.

- Any action taken should be accompanied by complementary measures so as to create sufficient margin to accommodate the increased noise exposure due to traffic growth.

- Various possibilities exist to accomplish the introduction of a set of complementary measures:
    - Serial introduction. First a single action is introduced. Subsequently, when its effect is becoming offset by the influence of traffic growth, a second measure is introduced so as to create margin again.
    - Parallel introduction. Various actions are taken simultaneously so as to create a larger margin from the beginning or to allow for a gradual implementation.

- Some actions require a long lead time to be effective (e.g. land use planning), so they should be implemented as soon as possible, even though their effect will not directly be noticeable.

9. Case studies (Task 5)

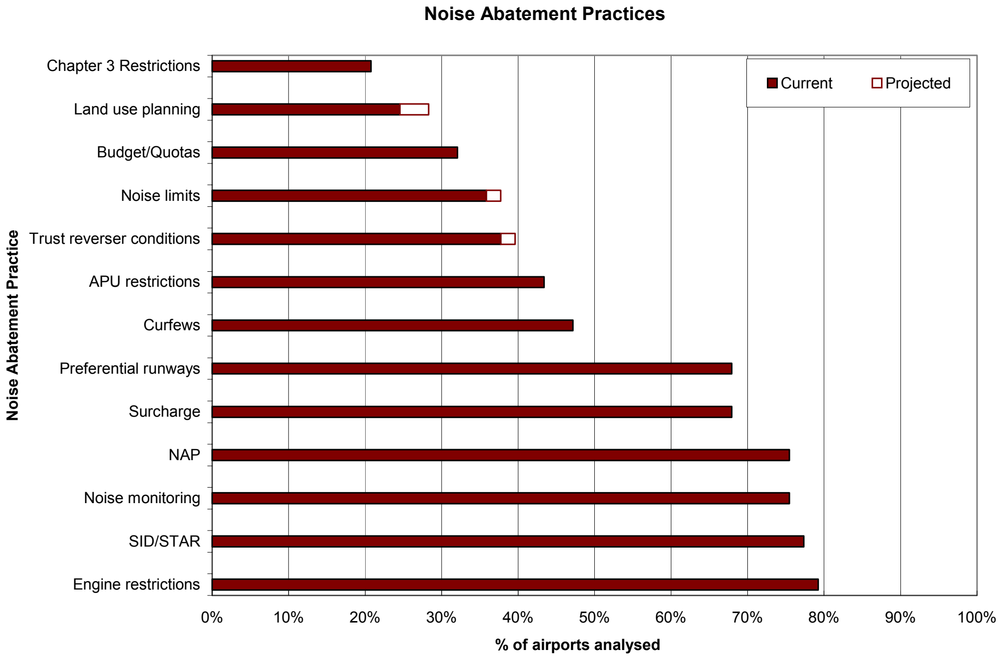
In order to illustrate the effects of the implementation of the ORD on airport level, case studies are performed. Originally it was planned to perform these case studies on some airport pairs. However, due to the large amount of information generated for all airports, it was considered of interest to extend this analysis to all airports. To this end the Airport Classification Matrix concept will be applied. Whenever possible the assessments will be performed at an aggregate level (airport group).

9.1 Degree of implementation of noise mitigation measures

To this end all current and projected noise mitigation actions at the airports have been determined, based on the results of the questionnaire and the information provided on the Boeing web-site [5]. An overview is given in the following table.

		NAP	SID/STAR	Pref.runway	Engine restr.	Surcharge	Noise limits	Noise mon.	APU restr.	Curfews	Ch.3 restr.	Budget/Quotas	Trust reverse
A1	AMS	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y
	CDG	Y	Y	Y	Y	Y		Y		Y	Y	Y	
	FRA	Y	Y	Y	Y	Y		Y					Y
	LHR	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
A3	LPA		Y										
	TFS	Y	Y	Y									
B1	MAD	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y
B2	BRU		Y	Y	Y	Y		Y			Y	Y	
	FCO	Y		Y		Y		Y		Y			
	LGW	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	MXP	Y	Y	Y	Y	Y		Y	Y	Y			
	ORY	Y	Y	Y	Y	Y		Y		Y		Y	Y
B3	HAJ	Y	Y		Y	Y		Y		Y			
	LIS	Y	Y		Y		Y	Y	Y	Y			
	LUX	Y	Y		Y	Y		Y		Y			
	MAN	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y
C2	BCN	Y	Y	Y	Y			Y	Y				Y
	CPH	Y		Y	Y		Y	Y	Y	Y		Y	
	MUC	Y	Y	Y	Y	Y		Y				Y	Y
C3	ABZ	Y	Y	Y	Y	Y				Y			
	AGP	Y	Y	Y	Y				Y				Y
	ALC		Y	Y									
	ARN			Y								Y	
	ATH	Y		Y	Y			Y	Y				
	BHX		Y	Y	Y	Y	Y	Y	Y		Y	Y	Y
	CGN	Y	Y	Y	Y	Y	Y	Y		Y			Y
	CTA		Y										
	DUB	Y		Y	Y			Y					
	DUS	Y	Y	Y	Y	Y		Y		Y			
	EDI		Y								Y		
	EMA	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y
	GLA	Y	Y		Y	Y	Y	Y				Y	Y
	GOT	Y		Y	Y	Y		Y	Y	Y			
	HAM		Y	Y	Y	Y	Y	Y	Y	Y			Y
	HEL		Y	Y	Y	Y		Y					Y
	LIN	Y		Y	Y	Y		Y	Y	Y			
	LTN	Y	Y		Y	Y	Y	Y					Y
	LYS	Y		Y	Y	Y		Y				Y	
	MLH												
	MRS	Y	Y	Y	Y	Y		Y	Y				
	NAP	Y				Y				Y			
	NCE	Y	Y	Y	Y	Y		Y	Y				Y
	PMI	Y	Y	Y	Y			Y	Y	Y			
	STN	Y	Y		Y	Y	Y	Y		Y		Y	
	STR	Y	Y		Y	Y		Y		Y			
	TLS	Y	Y		Y	Y							
	TXL		Y		Y	Y	Y	Y	Y				Y
	VCE			Y		Y	Y		Y				
	VIE	Y	Y	Y				Y	Y	Y			
C4	BHD	Y	Y	Y	Y		Y			Y		Y	
	BMA	Y			Y	Y	Y	Y	Y	Y			
	LCY	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	THF		Y		Y	Y		Y					Y

This leads to the following graph, presenting the degree of implementation of the different noise mitigation practices considered.



Some of these noise mitigation measures are mainly designed for reduction of noise exposure close to the airport (e.g. restrictions on APU, engine run-up or use of thrust reversers), often even for very limited areas (town level). Their potential to contribute to the solution of the noise problem, detected in the present study, is negligible. Therefore these measures are considered as being non-critical and will therefore be omitted from the following analysis.

The degree of implementation of noise mitigation measures may be quantified by assigning a value of 1 to each of the actions actually implemented at the airports. The following airport matrix gives the result of this exercise, where the implementation degree has been averaged over the airports within each group. It can clearly be seen that the major hubs have a high degree of implementation, whereas the short-haul airports (C-type) remain at a lower level.

	A	B	C
1	8	8	
2		7	5
3	2	6	4
4			5

Although differences might occur between individual airports within a group, in general the average degree appears to be a good indicator for the level of implementation on airport group level. This is logical, since in general airports within the same group face the same problems and will likely take comparable measures.

9.2 Further Actions

Depending on the current degree of implementation, more or less margin will be available to obtain benefits from any further actions. Several mitigation measures may already be fully exploited at some airports, whilst on other airports, where these actions are currently non-existent, the potential benefits may be significant.

In section 8 the potential benefits of several Further Actions were assessed at Community level. Due to the above, it is necessary to explore the possibilities of the various measures also at a lower aggregate (i.e. airport group) level. In the following the results of this analysis are given, based on the information provided in Annex II-8.

The airport classification matrix format is used to present the reduction in number of people Highly Annoyed among the airports in each group and the average reduction per airport expressed as the share in the total reduction of people affected (i.e. the Community total).

9.2.1 Contributor 1: Aircraft/engine type

Two phase-out variants were simulated in section 8. The results at airport group level are presented here.

9.2.1.1 Phase-out of marginally compliant aircraft (Ch.3-5)

For this analysis the Community-wide phase-out scenario has been used (thus covering all airport groups).

Further Action: Phase-out of marginally compliant aircraft (Ch.3-5dB)								
Change in number of people Highly Annoyed	**2007**	**A**	**B**	**C**	**2015**	**A**	**B**	**C**
	1	-3390	-2921		**1**	-2501	-3195	
	2		-3709	-1050	**2**		-3064	-573
	3	-139	-11199	-26218	**3**	-117	-8889	-25539
	4			0	**4**			0
Contribution to total reduction at Community level	**2007**	**A**	**B**	**C**	**2015**	**A**	**B**	**C**
	1	1.7%	6.0%		**1**	1.4%	7.3%	
	2		1.5%	0.7%	**2**		1.4%	0.4%
	3	0.1%	5.8%	1.9%	**3**	0.1%	5.1%	2.1%
	4			0.0%	**4**			0.0%

A significant effect of this measure can be found at various airport groups. This is mainly due to some flag carriers with an important fleet of older aircraft.

9.2.1.2 All Chapter 4 fleet

Further Action: All Chapter 4 fleet								
Change in number of people Highly Annoyed	2007	A	B	C	2015	A	B	C
	1	-4562	-5116		1	-3271	-5045	
	2		-9759	-3423	2		-7437	-2225
	3	-190	-11566	-24803	3	-160	-9272	-23271
	4			0	4			0
Contribution to total reduction at Community level	2007	A	B	C	2015	A	B	C
	1	1.9%	8.6%		1	1.6%	10.0%	
	2		3.3%	1.9%	2		2.9%	1.5%
	3	0.2%	4.9%	1.5%	3	0.2%	4.6%	1.6%
	4			0.0%	4			0.0%

Compared with the phase-out of marginally compliant aircraft (Ch.3-5) a slight shift can be observed in the share of the C3 group towards the B2 group. This is mainly due to the retirement of older aircraft types operating at Paris (Orly) and Rome airports.

9.2.2 Contributor 2: Movements

Limiting the number of movements might result an efficient measure, whenever introduced with care and complying with all legal requirements. In the current context the potential benefits to be obtained with this measure will be considered independent of airport type.

9.2.3 Contributor 3: Time of operation

The results of the simulation of a ban on night flights are presented here.

Further Action: Ban on night flights								
Change in number of people Highly Annoyed	2007	A	B	C	2015	A	B	C
	1	-48809	-5774		1	-56651	-7174	
	2		-16044	-5861	2		-18681	-7509
	3	-554	-16336	-85716	3	-652	-18915	-108775
	4			-8640	4			-10704
Contribution to total reduction at Community level	2007	A	B	C	2015	A	B	C
	1	6.5%	3.1%		1	6.2%	3.1%	
	2		1.7%	1.0%	2		1.6%	1.1%
	3	0.1%	2.2%	1.6%	3	0.1%	2.1%	1.7%
	4			1.2%	4			1.2%

The great importance of night operations at major hub airports (group A1) is clearly reflected in these data.

9.2.4 Contributor 4: Routing

In section 8 a single test case was explored so as to indicate potential benefits of designing noise preferential routings. It is not possible to extrapolate the results obtained to other airports, so no attempt is made here to quantify the potential benefits of this measure at airport group level. Based on the measures, acting on this Contributor, already implemented at the various airports a qualitative estimate may be made on the potential benefits of this Contributor.

9.2.5 Contributor 5: Profile

As discussed before, no attempt is made here to determine quantitavely the benefits of this Contributor, due to the complexity involved. However, an indication may be given based on the results of the Sourdine project [22], in which several noise abatement flight procedures have been developed and assessed on their noise performance.

Optimised take-off procedures may result in slight improvements in noise exposure, whereas the Continuous Descent Approach (CDA) appears to have a high potential for noise exposure reduction especially at those airports with noise problems at approach.

9.2.6 Contributor 6: Sensitivity

The results of the simulation of 2 land use management scenarios are presented here for each of the airport groups.

Further Action: Reallocation of 25% of population above 65 Lden								
Change in number of people Highly Annoyed	2007	A	B	C	2015	A	B	C
	1	-32669	-1326		1	-36427	-1931	
	2		-11210	-1082	2		-13743	-1423
	3	-70	-9922	-27306	3	-125	-10575	-38631
	4			-1766	4			-4187
Contribution to total reduction at Community level	2007	A	B	C	2015	A	B	C
	1	9.6%	1.6%		1	8.5%	1.8%	
	2		2.6%	0.4%	2		2.6%	0.4%
	3	0.0%	2.9%	1.1%	3	0.1%	2.5%	1.3%
	4			0.5%	4			1.0%

Further Action: Insulation down to 60 L_{den}								
Change in number of people Highly Annoyed	**2007**	**A**	**B**	**C**	**2015**	**A**	**B**	**C**
	1	-16379	-469		**1**	-21273	-700	
	2		-6129	-955	**2**		-7771	-1260
	3	-68	-5743	-12439	**3**	-109	-7164	-19266
	4			-1237	**4**			-2071
Contribution to total reduction at Community level	**2007**	**A**	**B**	**C**	**2015**	**A**	**B**	**C**
	1	9.4%	1.1%		**1**	8.9%	1.2%	
	2		2.8%	0.7%	**2**		2.6%	0.7%
	3	0.1%	3.3%	1.0%	**3**	0.1%	3.0%	1.2%
	4			0.7%	**4**			0.9%

From both tables it can be deduced that land use management may be highly effective at large airports, where a large number of people is exposed to high noise levels due to the large noise contour area. The high costs involved will probably limit the benefits to be obtained to lower levels than those indicated here.

9.3 Conclusions on Further Actions at airport level

The simulations of the various Further Actions and their analysis, as performed in section 9.2, indicate that the effect of a certain noise mitigation measure will depend on the airport type. A measure may be very effective at certain airports, whereas on others its effect is insignificant. No single ‘best’ measure exists to cover all cases.

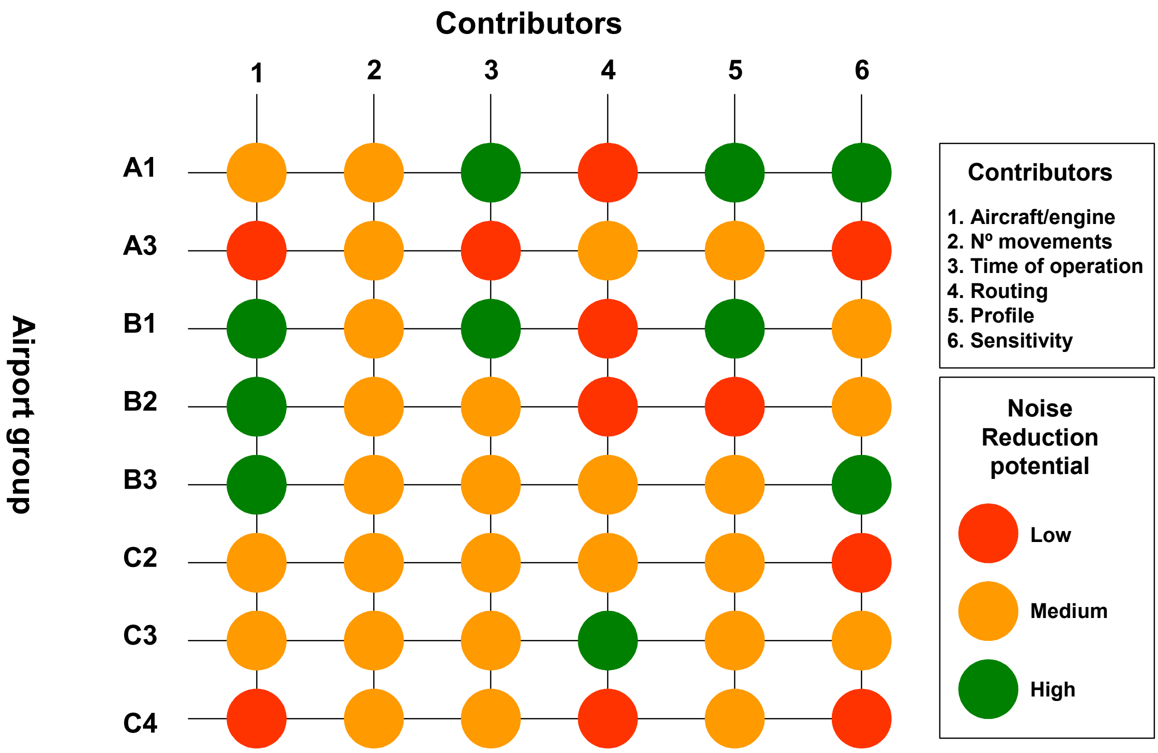
In the following section a tool will be given to assist the airports and the Commission in the selection of the proper actions for a given situation.

9.4 Best Practices

In order to be able to give guidance on the selection of Further Actions with the highest potential of noise exposure reduction for a given situation, the concept of the Noise Mitigation Matrix is combined with that of the Airport Classification Matrix.

This combined matrix has 3 dimensions:

- Airport group
- Noise mitigation Contributors (1 to 6)
- Potential for further noise exposure reduction (Low, Medium, High)



It is the aim of this matrix to assist the airports and the Commission in determining the Contributor(s) with the highest potential of noise exposure reduction for a given situation. Once these Contributors have been detected, the most appropriate Enabler(s) should be selected from the range of tools made available through the Balanced Approach concept.

It should be taken into account that the implementation of a single Enabler may act upon several Contributors at the same time (see section 8.1.3). On the other hand, various Enablers may be available to act upon a single Contributor.

10. Summary and Conclusions

1. In March 2002 the European Parliament and Council approved on the Directive 2002/30/EC on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports. The main objective of the Directive is to respond to the need for a common framework of rules and procedures for the introduction of operating restrictions, as part of a balanced approach on noise management in order to achieve its objective to "to limit or reduce the number of people significantly affected by the harmful effects of noise" in comparison with the 2002 situation.

2. In order to be able to estimate whether or not the Directive will be able to meet its objectives the "Study on Current and Future Aircraft Noise Exposure at and around Community Airports", carried out an assessment of the effects on the noise climate of the actions, induced by the introduction of the Directive.

3. First a baseline study has been performed to obtain a reference against which actions may be assessed. Starting at the 'Baseline Year' 2002, the study calculates the number of people affected by noise from aircraft and how it will change over time, the so-called 'Baseline Trend', for the scenario where the Directive 2002/30/EC is not applied. Future noise climates have been determined for the years 2007 and 2015, for several growth scenarios

4. The methodology applied is based on the use of a single, harmonised software model (SONDEO), capable of predicting with sufficient accuracy the noise contours around airports and the number of people affected. Using the same model for all airports and all scenarios guarantees data consistency. The SONDEO model is fully compatible with ECAC Doc.29, calculates L_{den} and L_{night} noise contours and has been updated to include the most recent recommendations made by the EC (and thus guarantees compatibility with the Environmental Noise Directive). The noise and performance databases used are those provided by INM, since these are one of the few globally accepted datasets publicly available.

5. Model validation has been made by the comparison with the MAGENTA results and detailed data available from several European airports.

6. All 53 Community airports with more than 50.000 movements of civil subsonic jet aircraft (as by the Directive definition) have been selected and the data required for the analysis have been obtained through a questionnaire and independent and reliable aviation sources.

7. Given the possibilities of the SONDEO model to calculate the effect of different growth scenarios, 3 baseline scenarios were considered for this study. These scenarios take into account different hypotheses to establish the growth factors and they are defined as: "Probable" Scenario, "Conservative" Scenario and "Differentiated" Scenario. With these scenarios the whole range from low to high air industry forecasts is covered.

8. The Eurocontrol PRISME database has been used as the primary source for traffic data. This database contains all necessary flight information of all movements at the airports (aircraft type, time of day, destination, etc.)

9. To be able to perform the study, several assumptions had to be made. These assumptions were clearly marked and they were approved by the Steering Committee at the mid-term meeting.

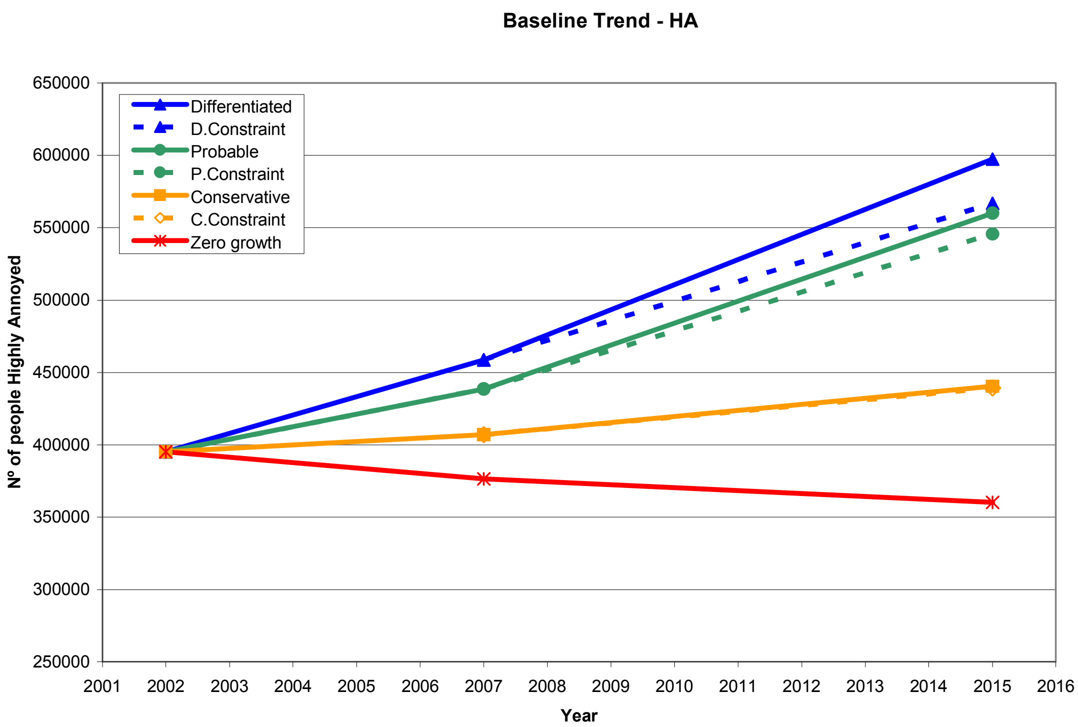
Analysis of the baseline trend for the different growth scenarios

One of the main conclusions to be drawn is that at Community level and when no further actions are taken, the total number of people exposed to aircraft noise will increase in the period up to 2015.

The number of people highly annoyed (HA) will increase at a rate of 1 to 4% per year, depending on the scenario considered. This means that in 2015 the number of people seriously affected will have increased between 10 and 50% with respect to the current situation.

The following table and graph show in detail this tendency:

		increase in number of people exposed to aicraft noise					
		Lden>55 dB(A)		Lden>65 dB(A)		Highly Annoyed	
Scenario	Period	2007	2015	2007	2015	2007	2015
Probable	2002-2015	10%	37%	11%	54%	11%	42%
	annual	2%	3%	2%	4%	2%	3%
Conservative	2002-2015	2%	10%	7%	14%	3%	11%
	annual	0%	1%	1%	1%	1%	1%
Differentiated	2002-2015	14%	45%	24%	74%	16%	51%
	annual	3%	3%	5%	6%	3%	4%



For the established of the baseline trend, noise benefits due to 'natural' fleet renewal where taken into account. The effect of this fleet renewal is shown by the 'zero-growth' scenario in the above graph. It can be concluded that theis benefit is not sufficient to offset the negative effects of the increase in number of movements, not even in the most conservative scenario.

The effect of constraints on the noise climate has been determined as a special case of the baseline. Its effect will be noticeable after 2007.

The results of the analysis of the Baseline Trend can be summarised at follows:

- In all scenarios considered, the number of people seriously affected by aircraft noise will increase in the horizon 2007-2015 at Community level
- In 2007 at ~25% of the airports the noise climate will have improved with respect to 2002, mainly due to fleet modernisation.
- In 2015, however, at ~95% of the airports the noise climate will have deteriorated with respect to 2002, mainly due to the noise related to the increased traffic volume
- Capacity constraints will result in a measurable (but limited) reduction in population affected by aircraft noise

Assessment of further actions required

Based on the results of the baseline study described above, it is considered that further actions will thus be required so as to be able to reach the Directive objective "to limit or reduce the number of people significantly affected by the harmful effects of noise".

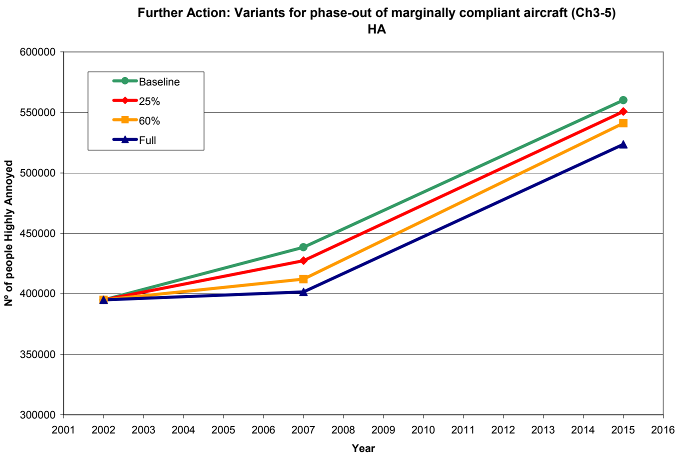
According to the Directive, the introduction of further actions shall take into account the balanced approach concept. Within this concept an appropriate combination of tools ('enablers') are available so as to improve the noise climate around airports. These enablers are:

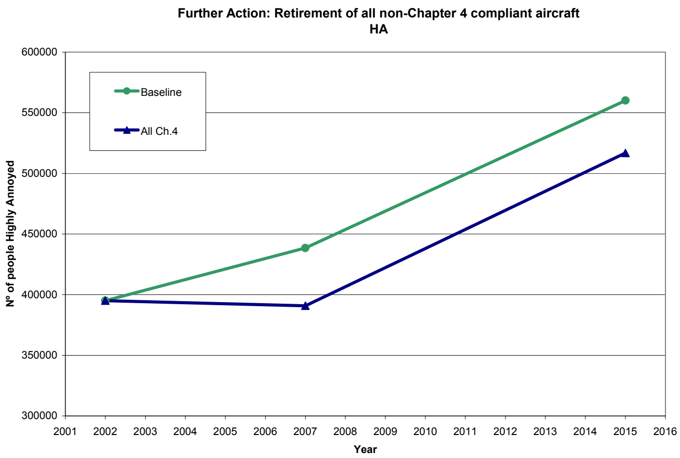
- Reduction of noise at source
- Land use planning and management
- Noise abatement operational procedures
- Operating restrictions

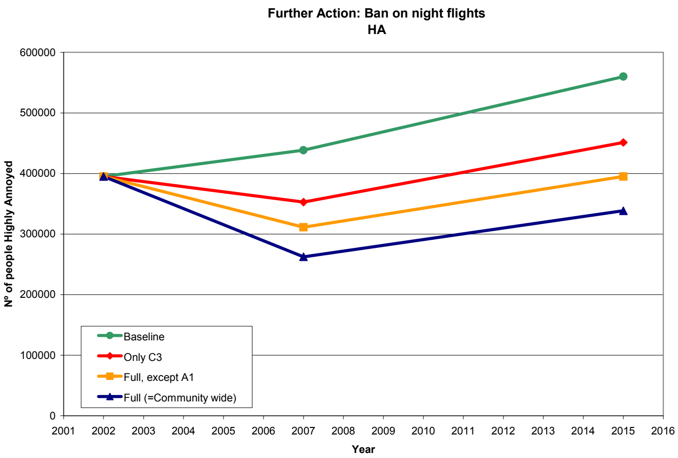
The elements which contribute to the reduction of noise exposure ('contributors') are given in the following table. When a further action is taken in the framework of the balanced approach, a suitable set of enablers is chosen to act on one or various contributors. The table gives an overview of the various scenarios established so as to simulate the interaction between enablers and contributors,

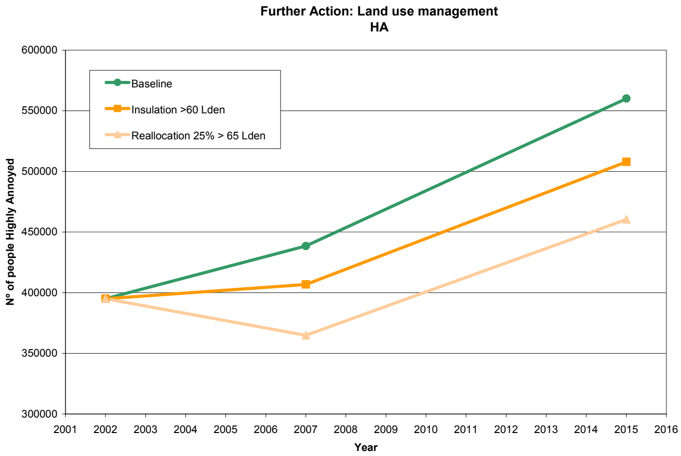
Contributor	**Scenario**
1. Aircraft	All Ch.4
	Ch.3-5 (Community wide)
	Ch.3-5 (ORD airports; 25% of total)
	Ch.3-5 (60% of airports)
2. Movements	Included in baseline (constraints)
3. Time	Full ban on night flights (Community wide)
	Full ban, except A1 airports
	Ban only at C3 airports
4. Routing	Example for Naples airport
5. Profile	Not simulated here
6. Sensitivity	Reallocation of 25% above 65 L_{den}
	Insulation down to 60 L_{den}

The results of the simulations performed is given in the following graphs.









Based on the results of the simulations of further actions scenarios, the following conclusions may be drawn:

- All actions considered have a beneficial effect on the number of people Highly Annoyed by aircraft noise in comparison with the baseline scenario

- This beneficial effect maintains or improves slightly the Community noise climate on the short term (2007). On the longer term (2015) the benefits of all actions will have been partly or even fully offset by the increase of noise exposure due to traffic growth

- The further actions for which the noise climate will improve even on the long term are considered only of theoretical application (e.g. a total ban on night flights throughout the EU). In practice their implementation would need careful consideration of economical constraints or actual legal limitations.

- The implementation of a Community-wide Phase-out of marginally compliant aircraft (those with less than 5 dB margin with respect to Chapter 3) can almost freeze the increase in the number of people affected for 2007, whereas a partial introduction of this measure will result in a deterioration of the noise climate. The degree of effectiveness will depend of the percentage and types of airport where the Directive will be implemented.

- The limitation or ban of night flights shows a high degree of effectiveness in limiting or reducing the population affected

- No single (practical) action will be able to guarantee a stable noise climate in the future.

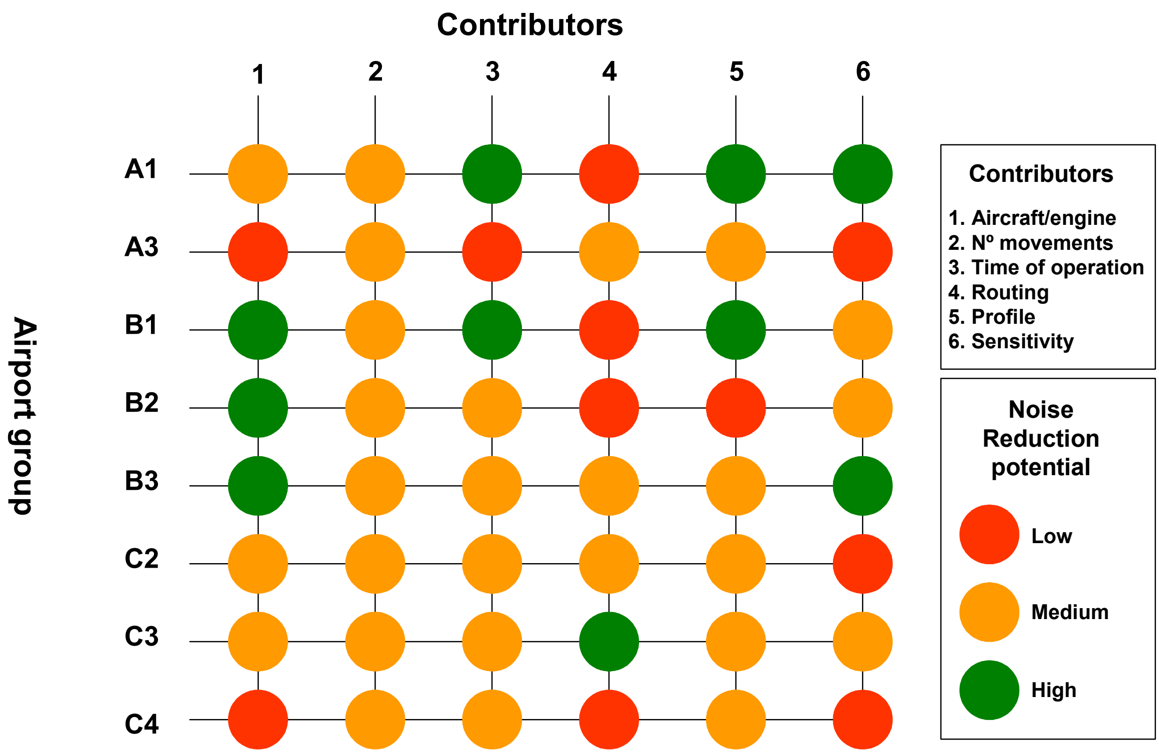
- Any action taken should be accompanied by complementary measures so as to create sufficient margin to accommodate the increased noise exposure due to traffic growth.

- Whatever actions taken, land use management will have to be introduced so as to avoid encroachment, where the benefits of lower noise levels are offset by the ‘invasion’ of population into the areas where the noise climate was improved.

- The following observations are made with respect to the introduction of complementary measures:
  - Serial introduction. First a single action is introduced. Subsequently, when its effect is becoming offset by the influence of traffic growth, a second measure is introduced so as to create margin again.
  - Parallel introduction. Various actions are taken simultaneously so as to create a larger margin from the beginning or to allow for a gradual implementation.
  - Some actions require a long lead time to be effective (e.g. land use planning), so they should be implemented as soon as possible, even though their effect will not directly be noticeable.

Best Practices

In order to be assist the airports and the Commission in determining the Contributor(s) with the highest potential of noise exposure reduction for a given situation, the so-called Airport / Noise Mitigation Matrix concept is introduced.



This matrix gives an indication of the potential of the various actions which may be taken . The main Contributor(s) may be selected from the matrix. Once these Contributors have been detected, the most appropriate Enabler(s) should be selected from the range of tools made available through the Balanced Approach concept.

It should be taken into account that the implementation of a single Enabler may act upon several Contributors at the same time. On the other hand, various Enablers may be available to act upon a single Contributor.

11. References

1. Directive 2002/30/EC of 26 March 2002, on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports
2. Directive 2002/49/EC of 25 June 2002, on evaluation and management of environmental noise
3. Commission recommendation 2003/613/ECof 6 August 2003, concerning the guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data
4. ICAO Airport Traffic 2000-2001
5. Boeing web-site on airport noise regulations http://www.boeing.com/commercial/noise/flash.html
6. Interim report of the "Study on Current and Future Aircraft Noise Exposure at and around Community airports" – PAN012-1-0 of 26 May 2003 by Anotec Consulting
7. Boeing Market Outlook 2002/2003
8. Report of the Forecasting and Economic Support Group (FESG) to CAEP/5
9. Airbus Global Market Forecast 2001-2020
10. Eurocontrol (STATFOR): Forecast of Annual Number of IFR Flights (2003-2010). Volume 1
11. Eurocontrol (STATFOR): Forecast of Annual Number of IFR Flights (2003-2010). Volume 2
12. Eurocontrol 1998 European Airports Database
13. Aeroports Magacine 2001/2002/2003
14. ITA World Air Transport Guide 1999-2003
15. Turbine Airliner Fleet Survey- AIRCLAIMS- 2000-2003
16. "Annoyance from transportation noise: Relationships with exposure metrics DNL and DENL and their confidence intervals". Henk Miedema & Catharina Oudshoorn - Environmental Health Perspectives Volume 109, nº 4, April 2001
17. ECAC.CEAC Doc.29 "Report on Standard Method of Computing Noise Contours around Civil Airports", 1997
18. "Geluidscontouren rond de luchthaven Brussel Nationaal Jaar 2002". KU-Leuven for BIAC (in Dutch)
19. "Noise Exposure Contours for Stansted Airport 2002" CAA-ERCD Report 0303
20. "Update to CAEP/5 MAGENTA baseline" – CAEP-SG20031-WP/19
21. Draft of "Guidance on the Balanced Approach to Noise Management" – August 10, 2002 – ICAO
22. "Establishment of Noise Abatement Solutions" Sourdine report nº D3 of 30 May 2000
23. JeppView – Electronic Airway Manual Service – Jeppesen May-2003