



EUROPEAN COMMUNITY
COMPETITIVE AND SUSTAINABLE
GROWTH PROGRAMME



SOURDINE II

D4-1-1b

Noise Results Summary

Project acronym: SOURDINE II
Project full title: "Study of Optimisation procedURes for
Decreasing the Impact of NoisE II"
Project number: GRD2-2000-30105
Contract number: G4RD-CT-2000-00394
Start date: 12 November 2001
Duration: 45 months

Sourdine II Consortium:

NLR	<i>Stichting Nationaal Lucht- en Ruimtevaartlaboratorium</i>	NL
AENA	<i>Aeropuertos Españoles y Navegación Aérea</i>	ES P
AIRBUS F	<i>AIRBUS FRANCE SAS</i>	F
EUROCONTROL	<i>European Organisation for the safety of Air Navigation</i>	INT
ISDEFE	<i>Ingeniería de Sistemas para la Defensa de España S.A.</i>	ES P
INECO	<i>Ingeniería y Economía del Transporte</i>	ES P
SICTA	<i>Sistemi Innovativi per il Controllo del Traffico Aereo</i>	IT



Document Change Log

Release	Author	Affected Sections / Comments	Document Nature	Date
0.1	INECO	All, Creation	Confidential	13/09/05
0.2	INECO, Aena	General review and contributions, Emissions section deleted.	Confidential	22/09/05
0.3	INECO, Aena	All	Confidential	22/11/05
1.0	INECO, Aena	All	Confidential	17/05/06
1.1	INECO, Aena	Chapter 1 and 7, comments EC	Confidential	12/06/06
2.0	INECO, Aena	EC approved version	Public	12/06/06

Document Distribution

Partner	Distribution list
AENA	Pablo Sánchez-Escalonilla Alfredo Gómez de Segura, Rosalía Pascual-Leal
Airbus France	Michel van Boven
Eurocontrol Experimental Centre	Peter Hullah Laurent Cavadini, Massimo Conte
Ineco	Peter Lubrani
Isdefe	Marcos Esteban Carlos Juste
NLR	Ruud den Boer Collin Beers, Bart Roeloffs
SICTA	Patrizia Criscuolo Mariacarmela Supino

Review and Approval of the Document

Organisation	Responsible for	Reference of comment	Date
-	-	-	-
Organisation	Responsible for	Name of person approving the document	Date
Project Manager		Ruud den Boer	17/05/06
Work Package Leader		Pablo Sánchez Escalonilla	17/05/06
EC Official		Morten Jensen	08/06/06

Document Information	
Document title	Noise Results Summary
Version	V2.0
Date	12-06-06
Classification	Public
Work Package	WP4
Document identification	SII_WP4_D4-1-1b_Noise Results Summary_v2.doc

Contributing Partners	Authors
Aena	Alfredo Gómez de Segura

Contact Information
INECO
MEng(Hons). Peter Lubrani
INECO, Space and European programs Division
Avda. del Partenon,4-4º (Edif.Egeo)
28042- Campo de las Naciones- Madrid
SPAIN
Tel: +34 914 52 1299/1290
Fax: +34 914 52 13 06

1. Summary

This document summarizes the different results deriving from the noise assessment carried out within the Sourdine II activities of a series of new noise abatement arrival and departure procedures for Madrid-Barajas, Naples-Capodichino, Amsterdam-Schiphol and Paris-Charles de Gaulle airport and provides general conclusions on the noise impact on the airport's surrounding areas for the new Sourdine II noise abatement procedures.

Also a study has been conducted calculating the variation in population impacted by noise based on the different procedures used, both for Noise abatement Departure Procedures (NADPs) and Noise Abatement Arrival Procedures (NAAPs). However, in this respect the study only tackles the Madrid-Barajas scenario, for which the, theoretical, necessary population density information was available.

Basically, four NAAPs for arrivals and two NADPs were analysed and compared with a conventional 3000ft arrival procedure defined within the baseline scenario, plus specifically for the Schiphol and Madrid-Barajas scenario with current approach procedures.

The Sourdine II procedures are based on data provided by Airbus and were simulated in each airport situation in 2015.

A brief description of the baseline arrival procedure considered:

- Procedure I: **Baseline FMS approach procedure:** This procedure has a standard vertical flight path, with a level segment at 3000ft, during this last part of the flight path deceleration is performed, making this procedure quite competitive and better than current standard approach procedures.

A brief description of the four arrival procedures considered:

- Procedure II: **Basic CDA with 2 degrees initial Flight-Path Angle (FPA) with a 3 degree ILS path and a variable speed profile.** This procedure follows a fixed 2-degree path angle from 7000ft up to ILS intercept at 3000ft. The aircraft decelerates at idle thrust in clean configuration during this part of the flight, deploying the cleanest possible landing configuration.
- Procedure III: **CDA with 2° initial FPA and increased final glide slope (4°).** The difference between procedure II and procedure III is the steeper flight path angle on the ILS (3°proc. II vs. 4° proc III).
- Procedure IV: **CDA with constant speed, variable FPA segment at landing configuration.** The procedure is largely flown, from 7000ft to ILS intercept, with idle thrust and in landing configuration.
- Procedure V: **CDA with constant speed, variable FPA segment at intermediate configuration.** The procedure is similar to procedure n° IV, with the difference that the variable FP is the result of an idle thrust descent from 7000ft to ILS intercept on an intermediate landing configuration.

Analysis was performed using a version of the US FAA's Integrated Noise Model, specially developed by the FAA to cover the needs of the Sourdine II project, with special data supplied both by Airbus and, with funding from NASA, Boeing. These data did not, however, cover the entire fleet at the selected airports and various substitutions had to be made to enable representative noise analysis.

The results show that:

1. The Sourdine II arrival procedure which features an increased final glide path angle (procedure III) provides the greatest benefit.
2. The distribution of the fleet mix will influence the shape of the noise contours considerably (i.e. unbalanced use of runways).
3. Noise assessment conclusions are the same (i.e slight differences depending on fleet-mix flow) for all scenarios.
4. Major noise benefits are mainly determined by higher altitudes for approaches while for departures on the thrust settings.

The two departure procedures studied have different aims, one to reduce noise close to the airport ("close-in") and one further away ("distant"). The results of the noise analysis show that the "close-in" procedure is beneficial only within the 3.5NM immediately after the end of the runway, whereas the "distant" procedure provides benefit from 2.5NM after the runway end.

Table of Contents

1.	SUMMARY	5
2.	INTRODUCTION	11
2.1.	PURPOSE	11
2.2.	BACKGROUND	11
2.3.	GLOSSARY	11
2.4.	REFERENCES	12
3.	ASSUMPTIONS AND HYPOTHESIS	13
4.	SCENARIOS AND TRAFFIC	15
4.1.	GEOGRAPHICAL SCOPE.....	15
4.2.	AIRPORT TRAFFIC.....	17
4.3.	TIME SCOPE	18
5.	METRICS AND METHODOLOGY	20
5.1.	METRICS	20
5.2.	METHODOLOGY TO ASSESS AIRPORT NOISE	20
5.3.	METHODOLOGY TO ASSESS POPULATION AFFECTED BY NOISE.....	21
6.	NOISE ASSESSMENT RESULTS	22
6.1.	SOURDINE II APPROACH PROCEDURES NOISE RESULTS	22
6.1.1.	<i>Lden</i>	22
6.1.2.	<i>Comparison with standard procedures(Madrid-Barajas)</i>	25
6.1.3.	<i>Lnight</i>	26
6.1.4.	<i>Lnight analysis</i>	28
6.2.	APPROACH PROCEDURES ANALYSIS	28
6.2.1.	<i>Arrivals</i>	28
6.3.	SOURDINE II DEPARTURE PROCEDURES NOISE RESULTS	29
6.3.1.	<i>Lden</i>	29
6.3.2.	<i>Lnight</i>	31
6.4.	DEPARTURE CONCLUSIONS	33
6.5.	NOISE AFFECTED POPULATION CALCULATION MADRID-BARAJAS AIRPORT	33
6.5.1.	<i>Reduction in affected people (55db)</i>	34
6.5.2.	<i>Reduction in affected people (65db)</i>	35
7.	CONCLUSIONS	36
APPENDIX 1 AIRCRAFT SUBSTITUTION FOR THE NOISE MODELLING STUDY.....		37
A1.1	INTRODUCTION	37
A1.2	OBJECTIVE	37
A1.3	REFERENCES	37
A1.4	ANALYSIS.....	38
A1.4.1	<i>INPUT needed for the analysis</i>	38
A1.4.2	<i>PARAMETERS</i>	40
A1.4.3	<i>STEP1 Aircraft belonging to fleet mix</i>	41
A1.4.4	<i>STEP2 Rearrangement of data</i>	42
A1.4.5	<i>STEP3 Review of past methodologies [1], [2]</i>	42
A1.4.6	<i>STEP 4 Evaluation</i>	44
A1.5	PROPOSAL.....	44
A1.6	CONCLUSION.....	46
APPENDIX 2 TABLES FOR THE TRAFFIC SUBSTITUTION PROCESS		49
A2.1	AIRCRAFT PARAMETERS FOR THE FLEET-MIX.	49



A2.2	CLASSIFICATION OF AIRCRAFT (SOURDINE)	51
A2.3	AMSTERDAM SCHIPHOL SIMULATION.....	53
A2.4	RE-ARRANGEMENT AND APPLICATION OF NOISE & MTOW CAT. TO SOURDINE II FLEET	55

List of Figures

Figure 3-1 Sourdine II procedures vertical profiles.....	14
Figure 4-1 Sourdine II airport Scenarios Madrid-Barajas & Paris-CDG.....	17
Figure 4-2 Sourdine II airport Scenarios Schiphol & Naples	17
Figure 5-1 i.e affected population on Departures (areas, towns, etc.).....	21
Figure 5-2 i.e affected population on Arrivals (areas, towns, etc.).....	21
Figure 6-1 Footprint area of Sourdine II NAAPs Naples-Capodichino airport.....	23
Figure 6-2 Footprint area of Sourdine II NAAPs Amsterdam Schiphol airport.....	23
Figure 6-3 Footprint area of Sourdine II NAAPs CDG Airport	24
Figure 6-4 Footprint area of Sourdine II NAAPs Madrid Barajas airport.....	24
Figure 6-5 Arrivals Lden relative contour area bar charts (Standard Approach) Madrid Barajas airport.....	25
Figure 6-6 Arrivals Lnight relative contour area bar charts (Standard Approach) Madrid Barajas airport.....	25
Figure 6-7 Relative contour area of Sourdine II NAAPs Naples-Capodichino airport	26
Figure 6-8 Relative contour area of Sourdine II NAAPs Amsterdam Schiphol airport	26
Figure 6-9 Relative contour area of Sourdine II NAAPs CDG Airport.....	27
Figure 6-10 Relative contour area of Sourdine II NAAPs Madrid Barajas airport	27
Figure 6-11 Footprint area of Sourdine II NADPs CDG Airport	29
Figure 6-12 Footprint area of Sourdine II NADPs Madrid-Barajas airport	30
Figure 6-13 Footprint area of Sourdine II NADPs Naples-Capodichino airport.....	30
Figure 6-14 Footprint area of Sourdine II NADPs Amsterdam Schiphol airport.....	31
Figure 6-15 Relative contour area of Sourdine II NADPs Madrid-Barajas airport.....	31
Figure 6-16 Relative contour area of Sourdine II NADPs CDG airport.....	32
Figure 6-17 Relative contour area of Sourdine II NADPs Schiphol airport	32
Figure 6-18 Relative contour area of Sourdine II NADPs Naples-Capodichino airport	33

List of Tables

Table 4-1 Airport classification.....	15
Table 4-2 INM7.0 aircraft substitution	18
Table 4-3 Airport regular traffic.....	19
Table 6-1 Reduction of affected population (>55dB):.....	34
Table 6-2 Reduction of affected population (>65dB).....	35
Table 10-1 Classification of aircraft into capacity categories and noise conversion factors for A340.....	51



Table 10-2 Classification of aircraft into capacity categories and noise conversion factors for A340.....	52
Table 10-3 Aircraft (category) conversion factors for departures	53
Table 10-4 Aircraft (category) conversion factors for approaches.....	54

2. Introduction

2.1. Purpose

The goal of this document is, on one hand, to summarize the different results deriving from the noise assessment of the Sourdine II procedures carried out for Madrid-Barajas, Naples-Capodichino, Amsterdam-Schiphol and Paris-Charles de Gaulle airports. On the other hand, to describe the assumptions and methodology followed in determining the calculation of the population affected by noise (Madrid-Barajas only) and the fleet-mix substitution for INM7.0.

This document is exclusively focused on the final results obtained from the assessments, so only comparative bar-charts are shown (SII procedures vs. Baseline), further details being available in the specific deliverables (D4-1-nb). Further information on the methodology for the Noise assessment and the INM 7.0 package feature are available D5-2 to which we address the interested reader.

This deliverable summarises the results of Sourdine II's noise and emission assessment for all the four chosen European Airports.

2.2. Background

SOURDINE II is a Research, Technology development and Demonstration (RTD) project aimed at providing solutions to the following issues:

- Airport approach and departure procedures that are aimed at reducing the environmental (noise and emissions) impact around airports require a co-ordinated solution by all involved parties. A European and international standardisation and harmonisation of such procedures is required in order for them to become operationally acceptable and only then can such new procedures be easily introduced on a larger scale and at a level of safety acceptable to the community.
- Provide an accepted implementation plan by all involved stakeholders to be able to migrate from the current situation to advanced environmentally friendly approach and departure procedures. This avoids the need to develop specific local solutions to a European problem.
- Produce air traffic controller and pilot tools to guarantee a high level of safety for the new advanced procedures

2.3. Glossary

Term	Description
CBA	Cost Benefit Analysis
CDA	Continuous Descent Approach
NAAP	Noise Abatement Approach Procedure
NADP	Noise Abatement Departure Procedure
INM	Integrated Noise Modelling
FAS	Final Approach Speed
FIR	Flight Information Region
FL	Flight Level
FTS	Fast time simulations
INM	Integrated Noise Model
KTS	Knots

Term	Description
Lden	Day-Evening-Night community noise Level
Lnight	Night level with a penalty of 10 dB(A).
NM	Nautical Mile
RNAV	Area Navigation
RTD	Research, Technology development and Demonstration
RTS	Real time simulations
RWY	Runway
SES	Single Event Simulations
SID	Standard Instrument Departure
SOURDINE	Study of optimisation procedures for decreasing the impact of noise

2.4. References

STOCK	“Community Noise” by B. Berglund, T. Lindvall D.H. Schwela , Stockholm University and Karolinska Institute for WHO (World Health Organisation), 1995
EEA	European Environmental Agency Glossary (http://glossary.eea.eu.int)
[SII_D2_1]	SOURDINE II “D2.1 Validation Methodology Report”, April 2004
[SII_D2_1_Appt]	SOURDINE II “D2.1 Validation Methodology Report, Appendixes”, April 2004
[D5-2]	Noise & Emission modelling methodology
[D4-1-2b]	Noise and Emission Results Schiphol
[D4-1-3b]	Noise and Emission Results Barajas
[D4-1-4b]	Noise and Emission Results Charles de Gaulle
[D4-1-5b]	Noise and Emission Results Capodichino

3. Assumptions and Hypothesis

As the main scope of the Sourdine II project is to assess design and promote new noise abatement procedures to decrease the impact of noise on the population surrounding the airport (specifically in SII project Madrid-Barajas, Paris Charles de Gaulle, Amsterdam Schiphol and Naples Capodichino) all the components of the system not directly related with the analysed procedures should be modelled in such a way that the noise results are clear and are not biased. Thus, the possible noise benefits capacity will be strictly due to the implementation of the new procedures designed within the Sourdine II project.

The main assumptions and hypothesis taken on during the noise assessment include the following:

I. Airport modelling

The airport system has been modelled in such a way that no element apart from the procedures could influence the envisioned benefits of the noise procedures.

II. Wind and weather modelling

The simulation has been carried out with nominal weather condition. No wind has been taken into account.

III. Aircraft equipment

All aircraft are supposed to be RNAV equipped. Simulations has been carried out under Vector and P-RNAV environment.

In 2015 Madrid-Barajas, Schiphol, Charles de Gaulle and Naples expect to operate within a full RNAV environment. Vectoring based approaches within the baseline scenario would be more close to current practise, but in order to maintain consistency among the simulations all simulations will be carried out under P-RNAV conditions. This will result in less lateral track deviation as well.

IV. Parallel runways, same CDA in both arrival RWYs

The CDA approaches selected by Sourdine II have been adapted to each airport environment. The design of the procedures cannot be segregated from the control technique that they intend to use. In this aspect SII means a huge conceptual change, since the operational concept eliminates the possibility to issue control instructions – speed control and vectoring- after the point of initiation of the CDA manoeuvre.

Currently, simultaneous approaches to parallel runways should maintain at least 1000ft of vertical separation before entry to the NTZ (Non-Transgression Zone). During the simulations, the same CDAs was inserted in both parallel runways, even though this might mean that the vertical separation is not maintained at the entrance of the NTZ. This is applied to all FTS scenarios with at least two arrival parallel runways: Madrid, Amsterdam, and Paris.

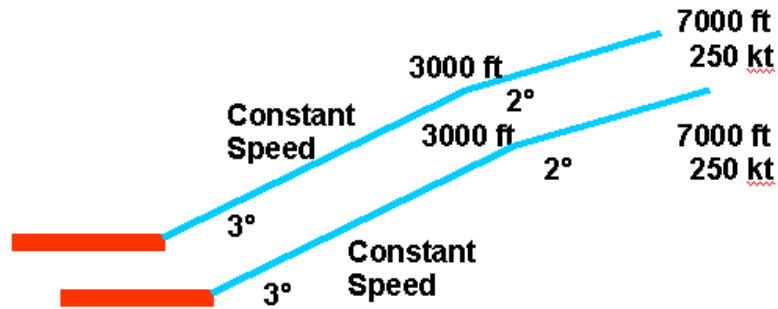


Figure 2-1: CDA Approaches for parallel runways

V. Aircraft substitution based on eight aircrafts contained in updated INM7 database (new NPD curves D5-2)

The timetable used in the final noise assessment contained real traffic data.

The traffic was increased based on 2015 forecast and aircraft model on airlines' future purchasing policy.

Aircrafts which were not included into the eleven aircraft of the INM7 database which includes 6 Airbus and 4 Boeings were substituted accordingly, while Turboprops were not taken into account by the assessment (see Appendix 1 for further details)

VI. Vertical profile

All the aircraft inside each of the previously described groups flew the same vertical profile for each single procedure.

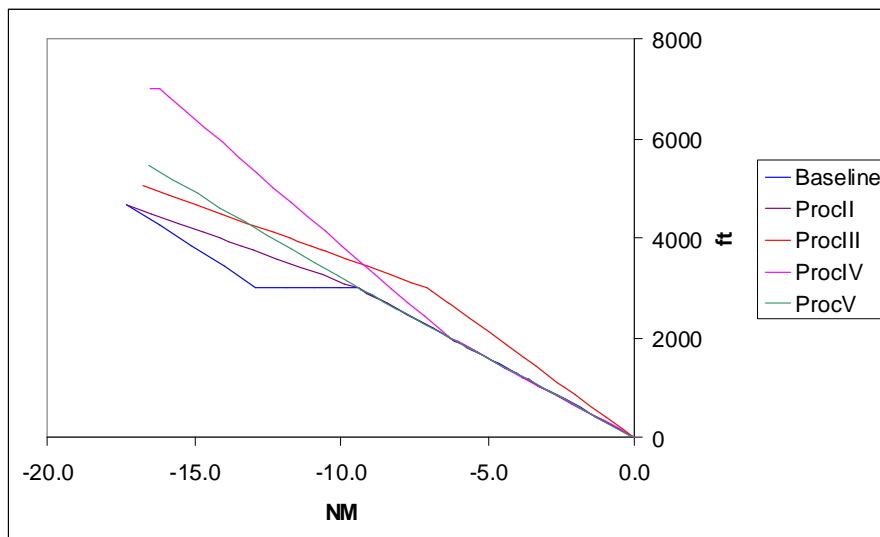


Figure 3-1 Sourdine II procedures vertical profiles

4. Scenarios and traffic

4.1. Geographical Scope

In the Sourdine II Project, one of the most important points was application of the set of NAAPs and NADPs to four different airports.

These four airports selected are: Madrid-Barajas, Naples-Capodichino, Amsterdam-Schiphol and Paris-Charles de Gaulle airports. The different environment and dimensions of the selected airports demonstrate the validity of the new NAPs for different airport types and validate the SII concept for the ECAC area. In the simulation scenarios not only the airport has been taken into account but also the TMA structure expected in 2015. Basically, a series of scenarios consisting in noise abatement procedures for arrivals and departures have been analysed and compared with a standard approach and a conventional 3000ft arrival procedure defined within the baseline scenario (the ICAO A procedure for departures). Each of the Sourdine II procedures was provided inside INM7.0 and applied to the traffic and the local SID and STAR TMA routes expected for the year 2015.

	Small airports	Medium airports	Large airports
Layout	Only one concrete	Usually, only one concrete	Usually, more than one concrete runway
Traffic	90% VFR - 10% IFR	80% IFR - 20% VFR	In principle, only IFR
	No capacity problems	Distribution not even along day	Operated with declared capacity
	Usually domestic flights Cat A, B and C aircraft	Domestic and international flights Cat A, B and C aircraft. D possible	Domestic and international flights Any category of aircraft
	Accessible to IFR flights	Accessible to VFR flights	
Procedures /Airspace	Generally IFR approach procedures based on NPA	Usually, ILS available only on one QFU	Normally, NPA and PA available on several QFU's
	Basic airspace	NPA procedures on other QFU	Usually CAT-III procedures implemented on several QFU's
	Class D CTR	Usually, a CTR and a TMA	Runway schemes to balance environmental impact
	Usually quite high minima		Complex airspace structure
			A TMA with one or more CTRs Associated airports
Air traffic control	Very limited ATC services	Limited ATC services	Full radar service available
	No ATC aiding tools	Generally radar services available	Controller tools available

Table 4-1 Airport classification

The specific airports described in Sourdine II classified into three categories: large (Paris-Charles de Gaulle), medium/large (Amsterdam Schiphol and Madrid Barajas) and small (Naples Capodichino). The following table contains information about each of the airports analysed in Sourdine II Project in the year 2015.

Airport	Runways	2015 Operations	Procedures
<p>Madrid-Barajas</p>	<p>2 set of parallel runways: 33L & 33R FOR ARRIVAL 36L & 36R FOR DEPARTURES</p>	<p>885 Arrivals Traffic load slightly unbalanced 10% Turboprops</p>	<p>RNAV Speed Control, Holding, No Vectoring</p>
<p>Paris-Charles de Gaulle</p>	<p>4 parallel independent runways: External for ARR (26L & 27R) Internal for DEP (26R & 27L)</p>	<p>1108 Arrivals 589 North (27R) / 519 South (26L) 3% Turboprops</p>	<p>RNAV</p>
<p>Amsterdam-Schiphol</p>	<p>4 runways: Inbound for ARR (18R & 18C) Outbound for DEP (18L & 24)</p>	<p>910 Arrivals 10% Turboprops</p>	<p>RNAV</p>
<p>Naples-Capodichino</p>	<p>1 runway (24-06): 100% of ARR RWY24 74% of DEP RWY24 / 26% RWY06</p>	<p>304 TOTAL 152 Arrivals 22% Turboprops</p>	<p>Conventional</p>

Table 3-2: Sourdine II Airports configuration

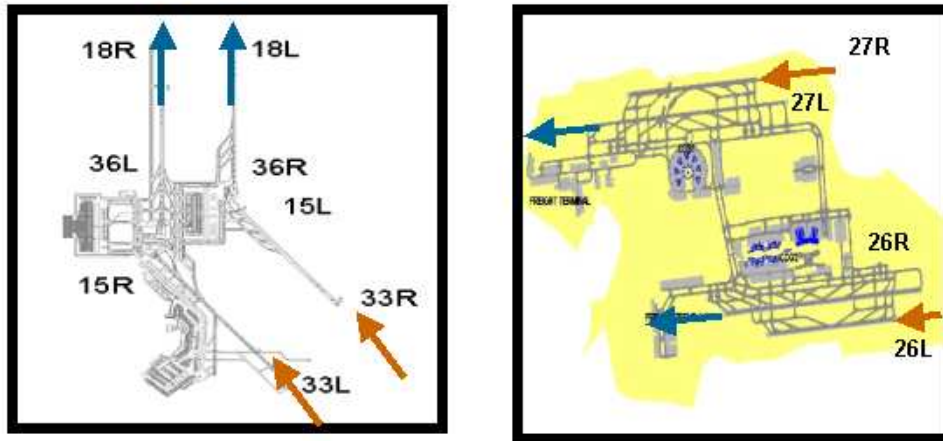


Figure 4-1 Sourdine II airport scenarios Madrid-Barajas & Paris-CDG

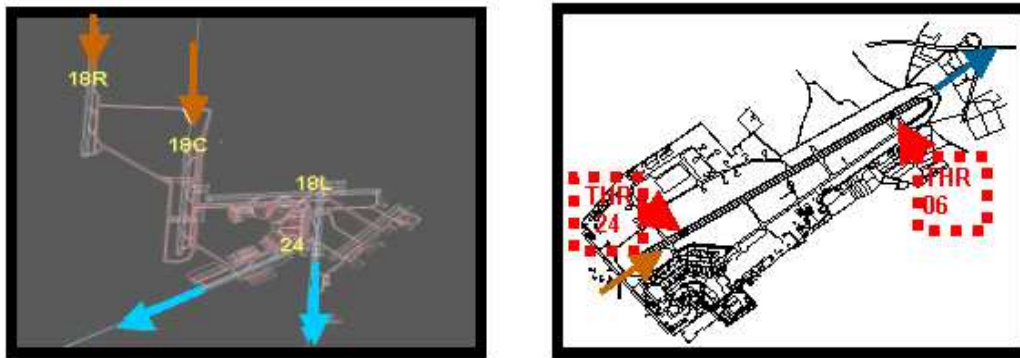


Figure 4-2 Sourdine II airport Scenarios Schiphol & Naples

4.2. Airport Traffic

Real traffic was used and adapted to the aircraft models present in Sourdine II's INM7.0 software. In table n the available aircraft and the substitutions made; turboprops were not included in the noise assessment, (for further details on the substitution process refer to Appendix 1).

MTOW Class [1000kg]	Aircraft	MTOW [1000kg]	SL Max EPNdb	Noise Assessment Substitution	
				substitution	optional
15 ≤ MTOW < 40	CRJ-100/200	21.5	86	none	
	EMB145	22-24	84.6	none	
	ATR42	16	80.7	none	

MTOW Class [1000kg]	Aircraft	MTOW [1000kg]	SL Max EPNdb	Noise Assessment Substitution	
				substitution	optional
	Dornier 328	16	83.8	none	
	Embraer RJ145	22	84.2 – 84.6	none	
40 ≤ MTOW < 60	FOKKER70/100	45.18	91.7	B737-300	A319-111
60 ≤ MTOW < 100	B737-300	62.8	90.4	B737-300	
	A319-111	64-75.5	92	A319-111	
	B737-400	62.9-68.1	93.2	B737-300	
	B737-700	60-70	94.7	B737-800	
	MD-88	72.5	97.2	A321-232	
60 ≤ MTOW < 100	MD-87	63.5	97.1	A321-232	
	MD 81(S80)	63.5	97.3	A321-232	
	MD82	67	96.3	A321-232	
	A320-211	73.5-77	94.4	A320-211	
	A320-214	73.5-77	94.4	A320-214	
	A320-232	73.5-77	94.4	A320-232	
	B737-800	78-79	93.1	B737-800	
	B737-900	78-79	94.3	B737-800	
	A321-211	83-93.5	94.3	A321-211	
	A321-232	83-93.5	95.6	A321-232	
100 ≤ MTOW < 160	B757-200	98.8-115.6	94.2-94.4	B757-200	
	B757-300	123.6	94.5	B757-200	
160 ≤ MTOW < 230	B767-300	184.8-186.8	97	A330-301	B777-200
230 ≤ MTOW < 300	A330-301	230-233	97.2	A330-301	
	A340-313	271-275	95.8	A340-313	
	MD11	275	96.1- 96.5	B777-200	
	B777-200	253-305.97	96.1	B777-200	
300 ≤ MTOW < 400	747-400	363-396.6	103.8	A340-313	
	A340-600	368-380	98	A340-313	

Table 4-2 INM7.0 aircraft substitution

4.3. Time Scope

2015 will be used as the timeframe for all the scenarios, including the baseline scenario.

Flown traffic database provided a set of six months of the most recent traffic data available (year 2001 or 2002) in order to select a representative day of traffic. From these traffic data,

a representative day was chosen, together with current airspace rules, to calibrate the simulation model to ensure that simulation results are sensible and that the model represents reality.

In order to obtain a realistic traffic sample, a set of criteria has been established to exclude days from the analysed period that will distort the traffic sample due to the following causes: Industrial actions, staff shortages, technical problems, runway accident or work on runways, security threats, humanitarian/military actions, temporary reductions in some approach capacity, bad weather, etc.

The methodology for acquiring the representative 2001 day depends on the airport traffic pattern and on the kind of traffic involved in each TMA. Table 4-3 shows some of the points to consider when selecting the reference day.

Airport Regular Traffic	Assess the relevant TMA / APP sector type of traffic.
	Select the most regular months.
	Eliminate extraordinary days.
	Evaluate the daily average hourly distribution.
	Select the most similar day, the best-correlated day.

Table 4-3 Airport regular traffic

This representative day (year 2001 or 2002) was then used as a basis to extrapolate a final baseline and SII concept traffic sample for the simulations (year 2015)

Changes in fleet mix and aircraft motorization foreseen for 2015 have been taken into account to obtain the final traffic samples. High predictions STATFOR forecasts from EUROCONTROL have been used to generate 2015 traffic samples. For each airport, the traffic (operations/day) was increased progressively in order to obtain enough data to perform a realistic noise assessment.

5. Metrics and Methodology

The outputs of the noise assessment are the indicators and metrics established in the SII Validation Methodology.

5.1. Metrics

The main metrics and indicators calculated in the SII project for the capacity assessment are:

Lden [European Environmental Agency, INM6.0 manual]

Community noise equivalent Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole day with a penalty of 10 dB(A) for night time noise (22.00-7.00) and an additional penalty of 5 dB(A) for evening noise (i.e. 19.00-23.00).

Lnight [EEA, D2-1],

Lnight: is the A-weighted long term average sound level, as defined by ISO 1996-2(1987), determined over all the night periods in a year. The definition of Lnight is the long-term LAeq over 8 hours outside at the most exposed facade. As Lnight is a relatively new definition and because the studies rarely cover such a long period, the research data are expressed in anything but Lnight..

LAMAX

Maximum A-weighted sound pressure level, it is often desired to measure the maximum level (LAMax) of individual noise events as those cases like noise coming from trains and aircraft (maximum noise level [STOCK]. LAMax values can be found inside the respective airport studies (D4-1-2b to 5b).

Range (db) of indicators

Noise levels will be given from 55 dB for Lden, 50 dB for Lnight, and incremented by 5dB. The highest noise level threshold to be accounted for in the results is determined by airport (and metric) specificities, and is determined by the surface of the corresponding contour - there is no point in presenting contour area variations (in percent) for very small areas – but in any case, the highest threshold levels do not exceed 75 dB for Lden, and 70 dB for Lnight.

5.2. Methodology to assess Airport Noise

In the following points, it is briefly explained the methodology agreed by the consortium to assess the noise impact of the new procedures designed within the Sourdine II project to each FTS site (for further details, refer to D4-1-2b,3b,4b,5b).

- Establish fleet mix applying the agreed aircraft substitution (see table Table 4-2).
- Superimpose the Sourdine II procedures vertical profile to the 2015 airport SID and STAR scenario.
- Use of INM7.0 to calculate the noise contours for the three metrics .
- Comparison of Sourdine II contours with Baseline and airport specific current approach procedures (Schiphol, Madrid).
- Further study has been made in Madrid Airport to calculate the impact of the Sourdine II procedures on the population affected by noise [see D4-1-3b].
- Analysis of the contours and summary of results.

5.3. Methodology to assess Population Affected by Noise

Thanks to the information available at Madrid Barajas Airport on population distribution in the surrounding areas a preliminary study on the number of population affected by noise and the subsequent benefits of the SII was conducted (See Table 6-1 & Table 6-2)

The variation in population impacted by these procedures was studied for Madrid –Barajas using the following assumptions:

- We have assumed an Homogeneous distribution of population in each populated area.
- Statistical data obtained from official sources: census 2001.
- Overlap Noise contours over the map of the surrounding populated areas
- Determine the part of each populated area inside the different noise contours.
- Calculate population inside 50dB, 55dB, 60dB, 65dB, 70dB, 75dB, 80dB, 85dB and 90 dB.

Following the current Methodology applied in Madrid-Barajas airport we have also considered Barajas' (expansion), including:

1. Isolation Acoustic Plan:

- LAeq > 65dB day
- LAeq > 55dB night
- More than 50.000 received funding from the Plan

2. Adaptation to European Union legislation Plan

- Lden and Lnight:
- Lden > 55dB day
- Lnight > 50dB night



Figure 5-1 i.e affected population on Departures (areas, towns, etc..)

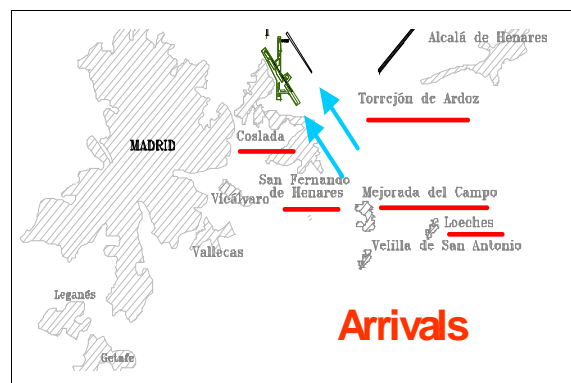


Figure 5-2 i.e affected population on Arrivals (areas, towns, etc..)

6. Noise Assessment Results

A brief summary of results obtained during the noise assessment will be presented in this section. The emphasis of the noise assessment was to analyse the effects of the Sourdine II arrival procedures compared to the baseline and the current standard procedures (see the Madrid and Schiphol assessment for further details).

The issues that will be described are:

- Lden results
- Lnight results
- Noise affected population (Madrid Barajas case only)
- General conclusions

These metrics and assessments have been obtained for Sourdine II procedures and compared against those obtained from the current standard and baseline procedures described before. Not all the sites analysed the current standard procedure with the set of arrival procedures designed within Sourdine II activities and, consequently, more results for certain procedures are available.

The graphs included in the following section intent to give a high level overview of the results obtained in the four airports involved in Sourdine II Project. A detailed simulation report has been produced for Madrid-Barajas, Amsterdam-Schiphol, Naples-Capodichino and Paris-Charles de Gaulle where the whole set of results for each airport is contained.

6.1. Sourdine II Approach Procedures Noise Results

6.1.1. Lden

The following comparative bar charts summarise the results of the Lden indicator as calculated per procedure and scenario. In Schiphol and Madrid-Barajas a further comparison was made with the current standard arrival procedure, see Figure 6-2 for Schiphol case while section 6.1.2 for Madrid's case.

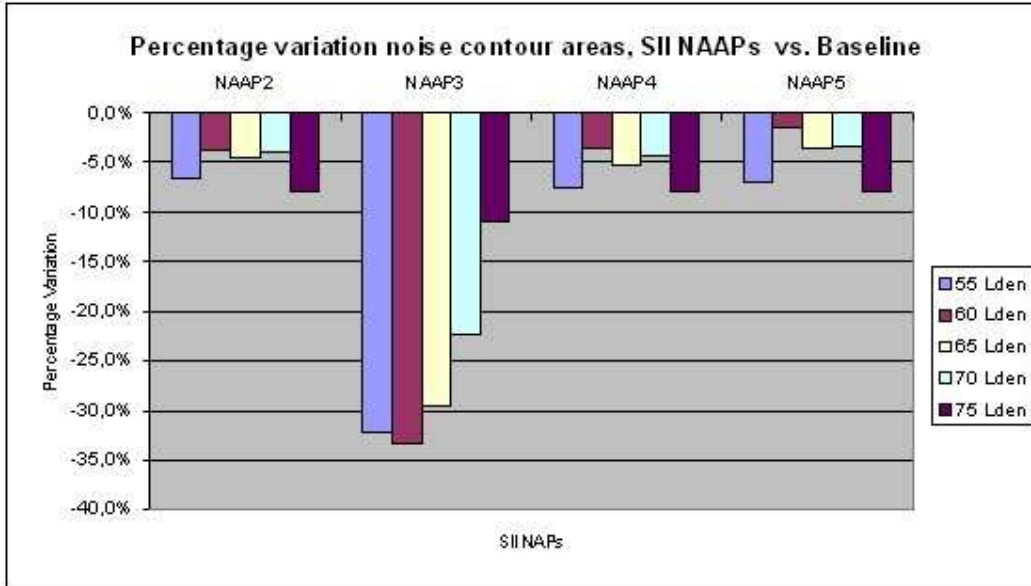


Figure 6-1 Footprint area of Sourdine II NAAPs Naples-Capodichino airport

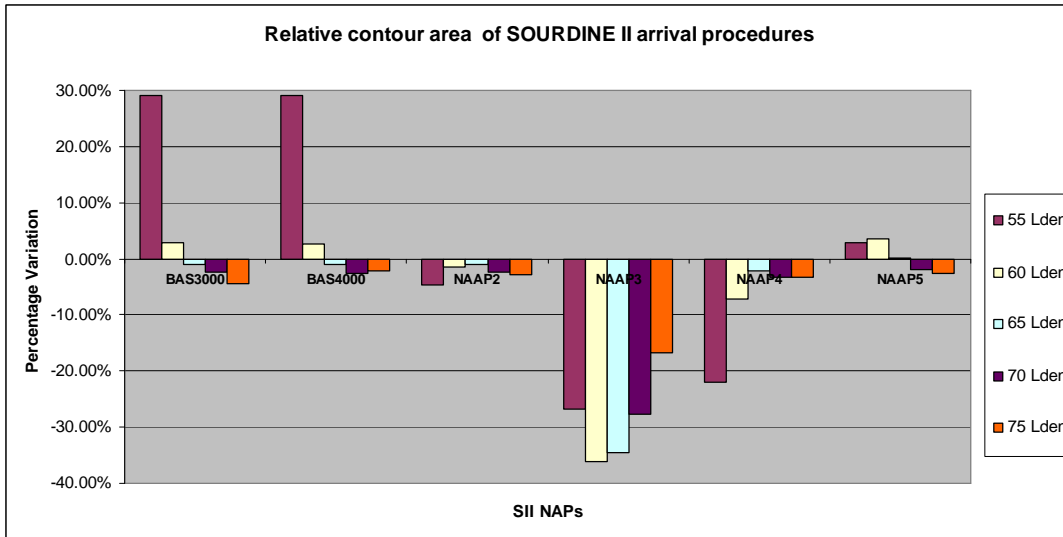


Figure 6-2 Footprint area of Sourdine II NAAPs Amsterdam Schiphol airport

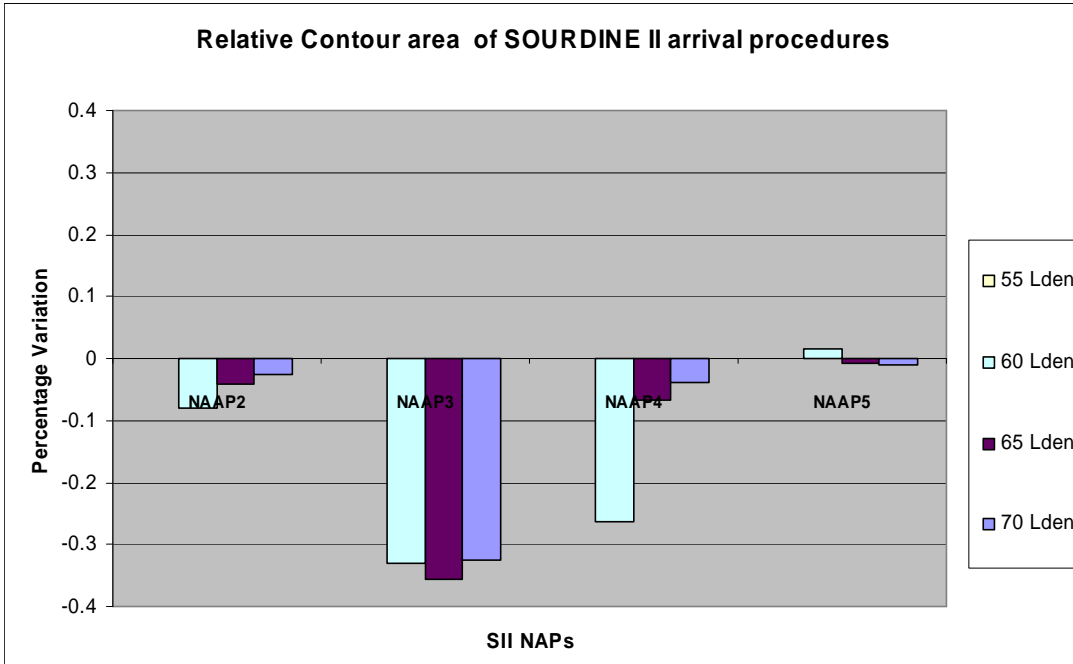


Figure 6-3 Footprint area of Sourdine II NAAPs CDG Airport

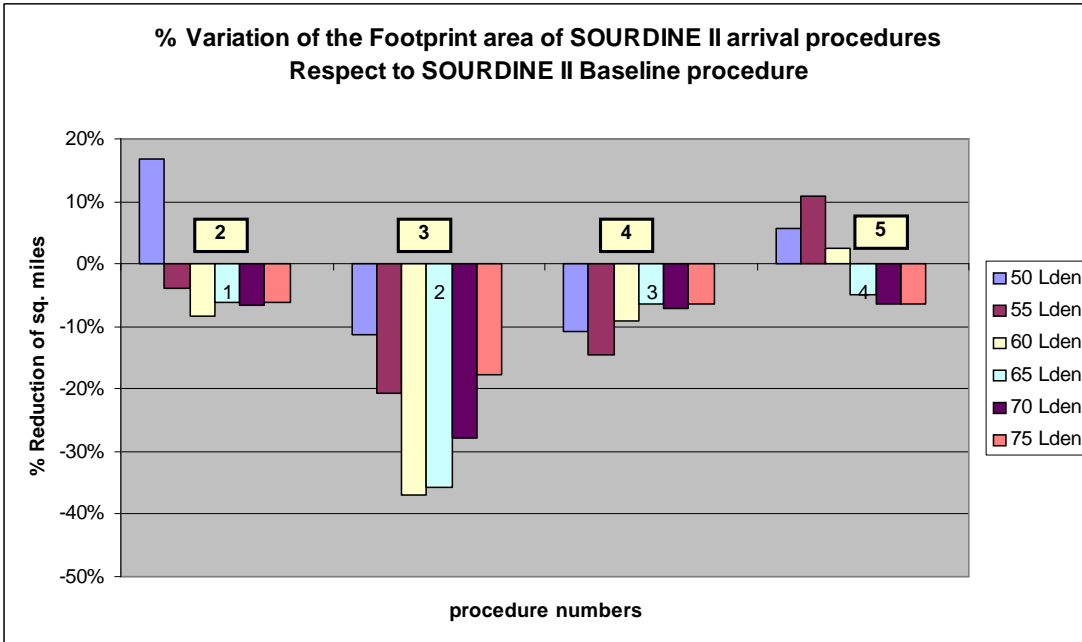


Figure 6-4 Footprint area of Sourdine II NAAPs Madrid Barajas airport

The first conclusion that can be obtained and common to all the airports is that procedure III is the most noise beneficial on all the range (db) followed by procedure nº IV, II and V.

6.1.2. Comparison with standard procedures(Madrid-Barajas)

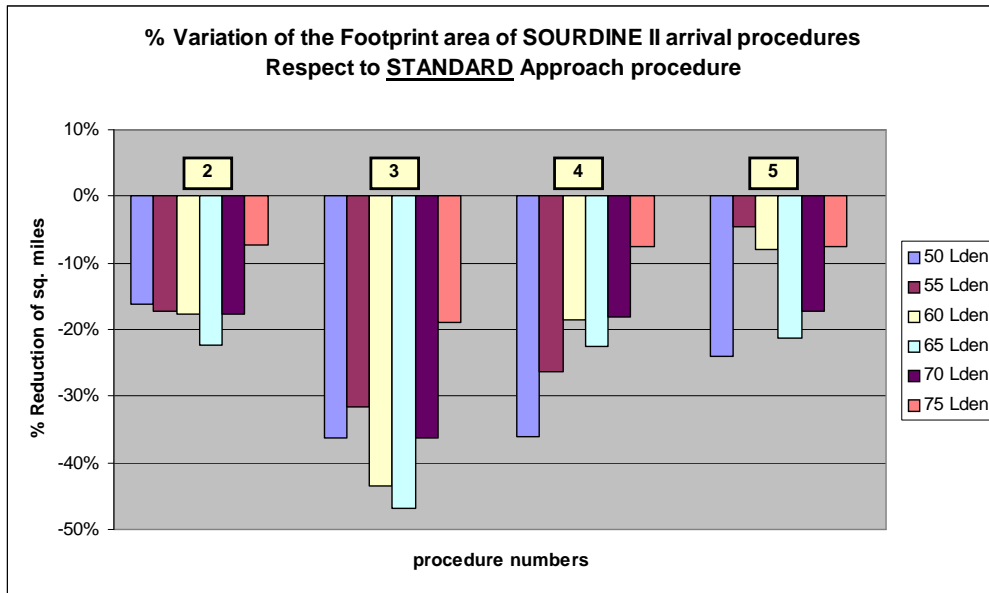


Figure 6-5 Arrivals Lden relative contour area bar charts (Standard Approach) Madrid Barajas airport

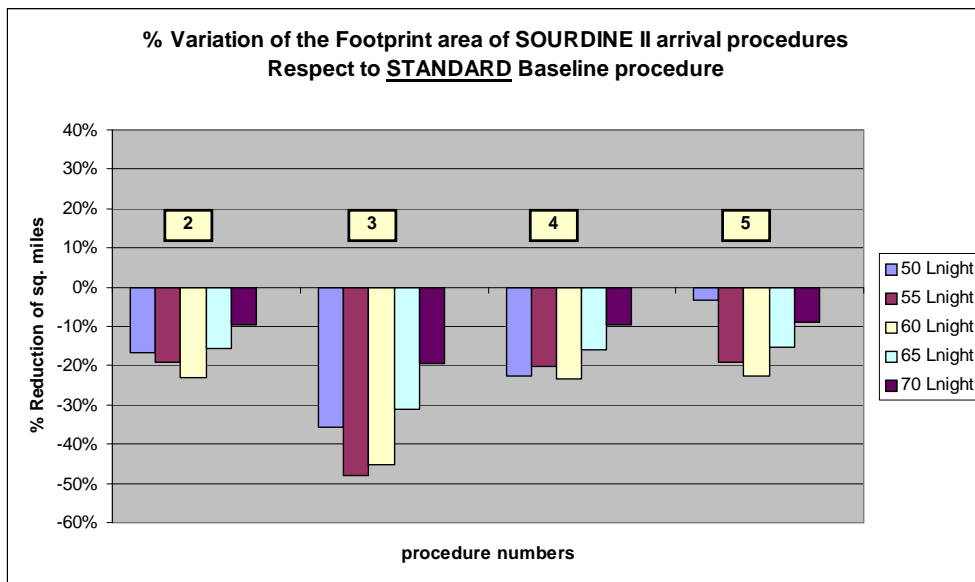


Figure 6-6 Arrivals Lnight relative contour area bar charts (Standard Approach) Madrid Barajas airport

6.1.3. Night

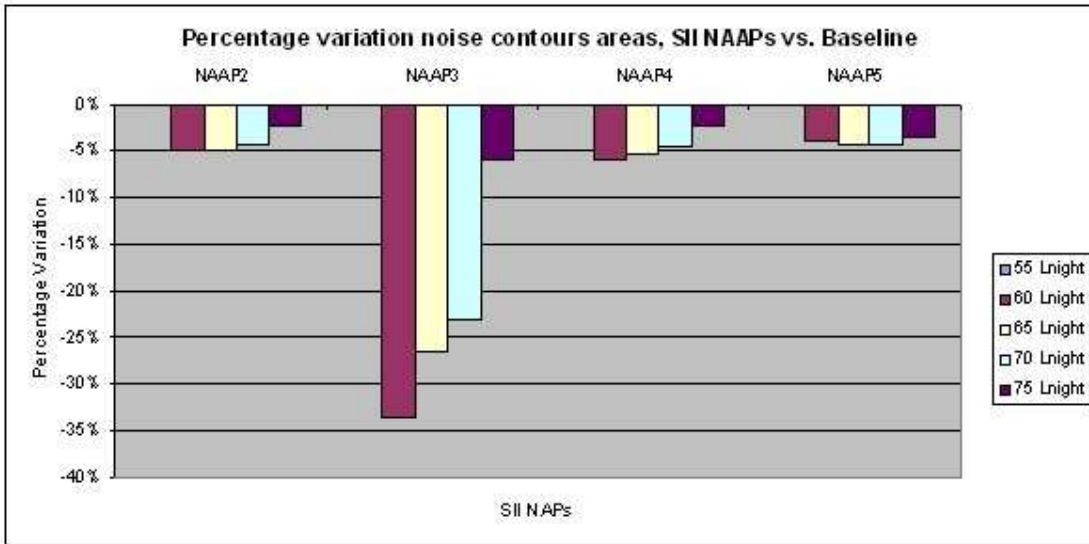


Figure 6-7 Relative contour area of Sourdine II NAAPs Naples-Capodichino airport

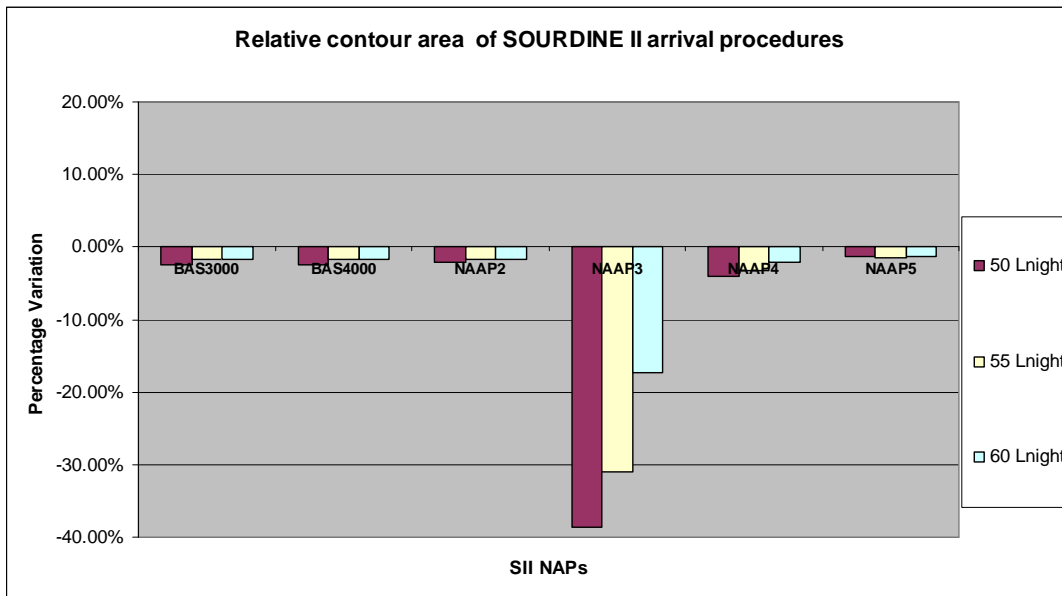


Figure 6-8 Relative contour area of Sourdine II NAAPs Amsterdam Schiphol airport

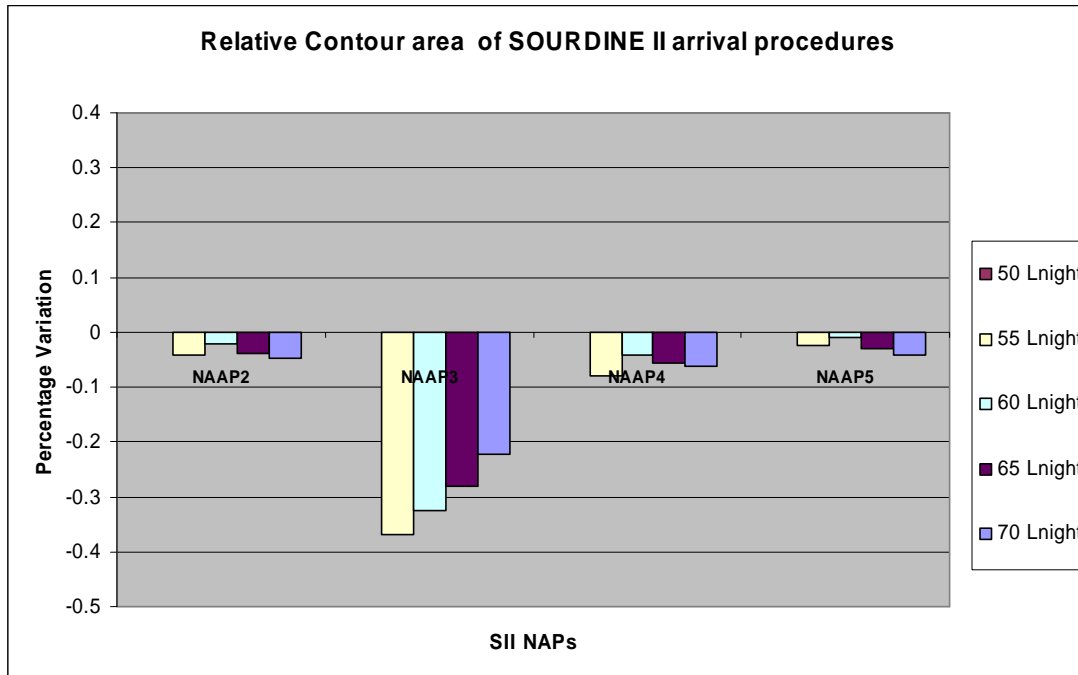


Figure 6-9 Relative contour area of Sourdine II NAAPs CDG Airport

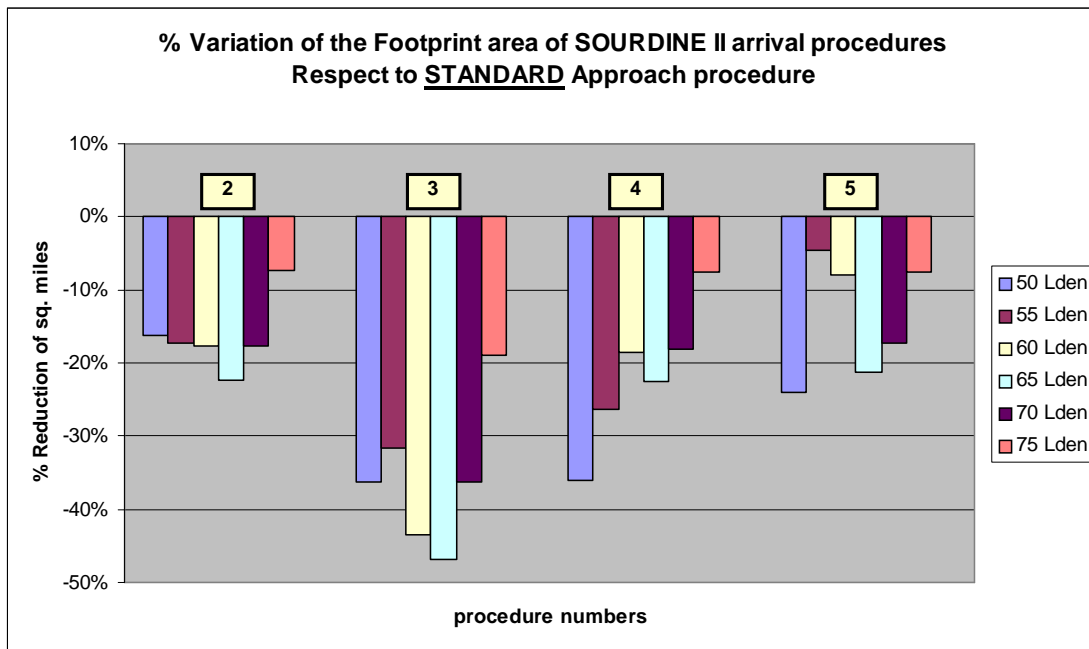


Figure 6-10 Relative contour area of Sourdine II NAAPs Madrid Barajas airport

The same happens for the Lnight indicator as in the Lden, the most noise beneficial procedure is the Sourdine II's procedure nº III followed by IV, II and V

6.1.4. Lnight analysis

The Lnight contours for procedures II, IV and V (figures 4, 8 and 10) show very little difference as they are all in the area where the aircraft follow the same 3° vertical flight path. Slight variations are visible, especially in the 50dB contour due to differences in thrust and configuration, as well as the cumulative duration effect which changes with aircraft speed. In procedure IV one can just appreciate the end of the height difference where the increased initial glide segment ends at the interception of the ILS glide slope at around 6.5NM. Procedure III, and is the case for the Lden index, shows a marked reduction in contour size. Again this is almost all due to the height difference between the two procedures.

6.2. Approach Procedures Analysis

The analysis of the contours obtained from the four noise assessments has shown that the behaviour of the Sourdine II procedures is similar to equal for all the airports. Small differences can be appreciated for fleet-mix difference and/or the unbalanced use of the runways.

In general the same noise results were obtained for all the procedures thus the analysis below is valid for all the scenarios.

6.2.1. Arrivals

Procedure II

Only the outer contour (55 dB) is slightly smaller, the other contours are virtually coinciding. This result is consistent with the altitude profiles: in Procedure II the altitude is higher at distances above ~ 9 NM, at smaller distances the profiles are the same. At approach the noise level is mainly determined by the altitude; the thrust settings are also different at final approach (e.g. ~3000 vs. ~4400 pounds for the A319), but this difference is not captured by the NPD tables.

Procedure III

Procedure III contours are significantly smaller than the baseline. This is a result of the final descent slope for Procedure III, 4°, whereas the baseline's is 3° and again, most of this difference is caused by the difference in height of the two profiles ($\sin 4^\circ / \sin 3^\circ$) which gives a reduction of around 2.5 dB. This difference in noise energy is increased by the differences in thrust settings.

Procedure IV

As with procedure ii, only the 55dB contour is affected by this procedure (with, again, a thinning of the 55dB and 60dB contours between 5.5 and 3.5 NM). The sharp initial approach angle increases the height of the aircraft before approx. 6.5NM and reduces the noise correspondingly.

Procedure V

The 55dB contour for procedure V is approx. 2NM shorter and fatter than that of the baseline, the contours melt into one, making no difference between the RWYs, whereas the 60dB contour is longer and thinner, showing the unbalanced traffic distribution effect encountered in all the previous procedures. The altitude profiles are the same after 10NM from the runway threshold which explains the shortening of the 55dB contour. So the rest of

the changes probably result from the different aircraft thrusts and configurations necessary for maintaining speed over the continuous 3° descent in procedure V.

In summary, the contours are mainly determined by the altitude profiles; the higher the aircraft, the lower the noise. The contour of the lowest noise level considered (55 dB) stretches out to a distance of ~ 12 NM, and it is the corresponding part of the profiles (i.e. < 12 NM) which determines the contours.

6.3. Sourdine II Departure Procedures Noise Results

The following bar-charts show the comparative results for the Sourdine II NADPs.

6.3.1. Lden

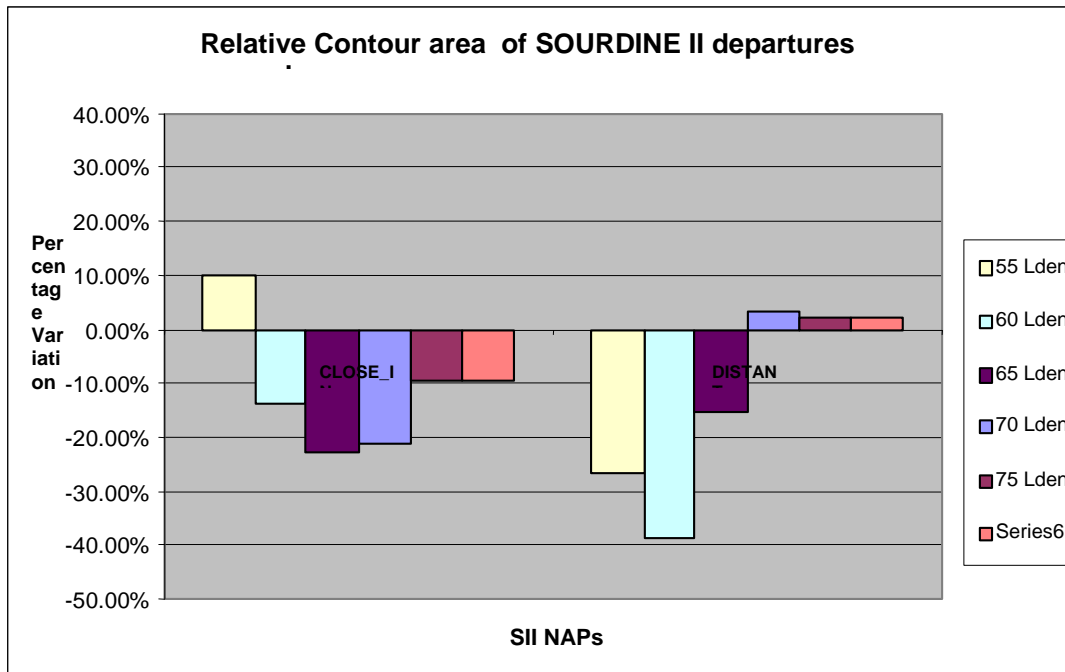


Figure 6-11 Footprint area of Sourdine II NADPs CDG Airport

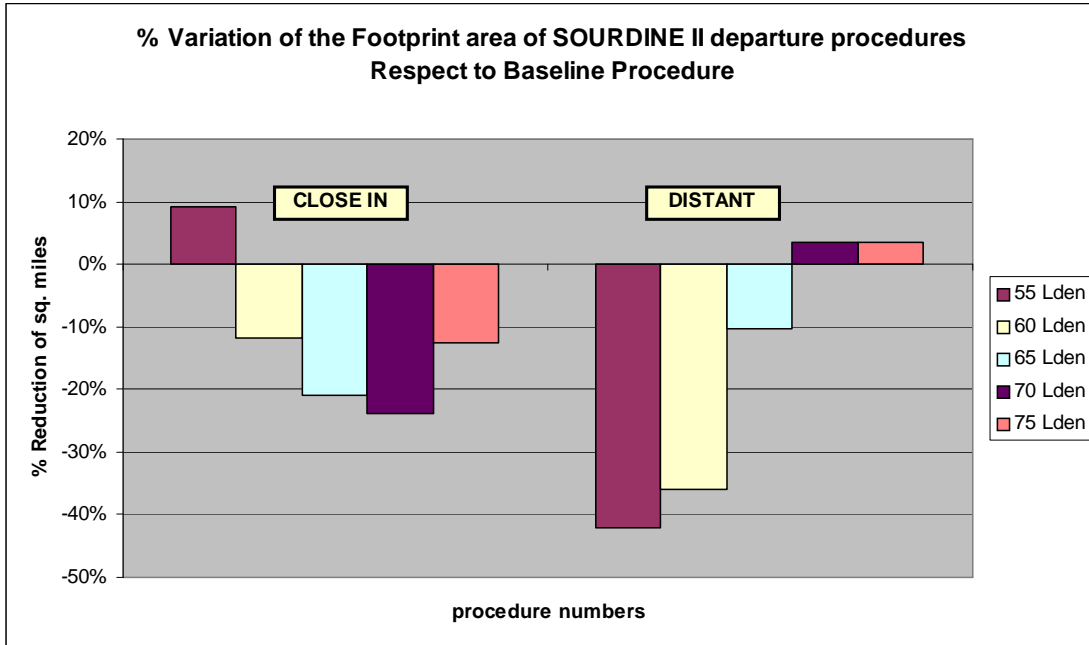


Figure 6-12 Footprint area of Sourdine II NADPs Madrid-Barajas airport

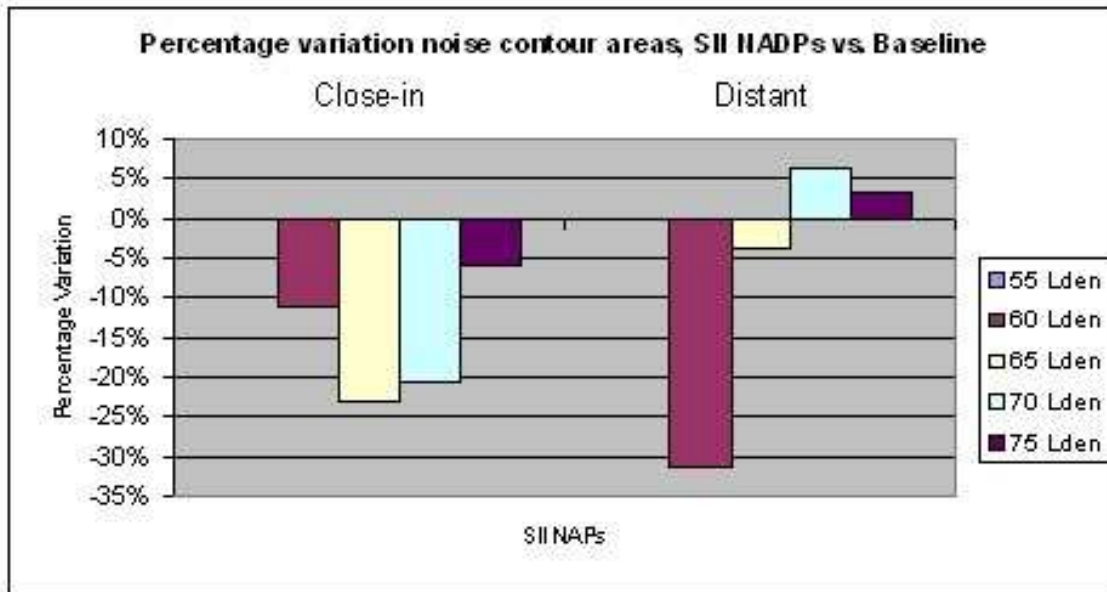


Figure 6-13 Footprint area of Sourdine II NADPs Naples-Capodichino airport

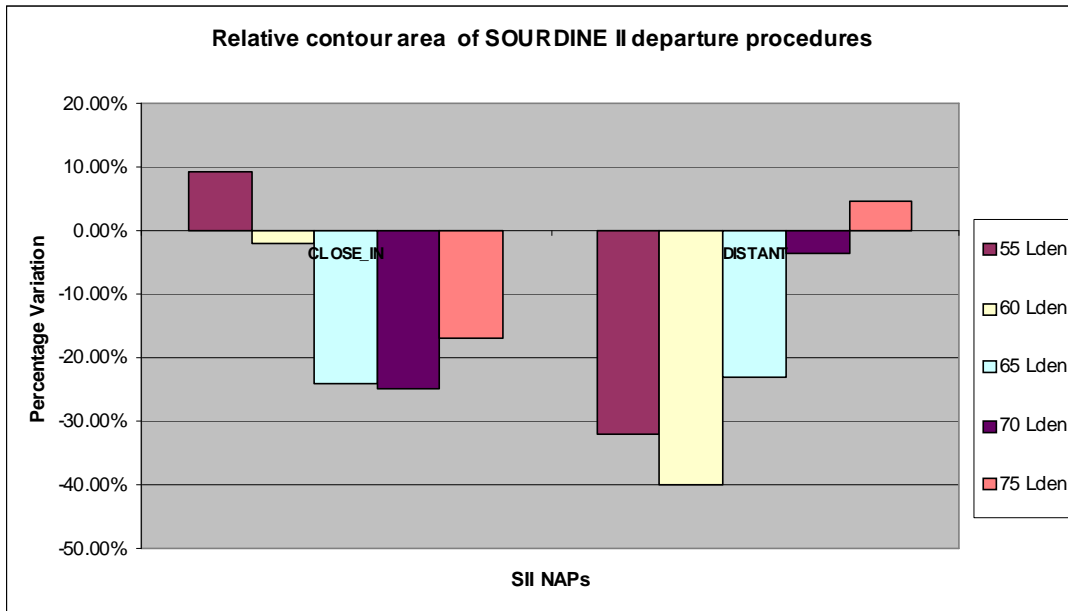


Figure 6-14 Footprint area of Sourdine II NADPs Amsterdam Schiphol airport

6.3.2. Night

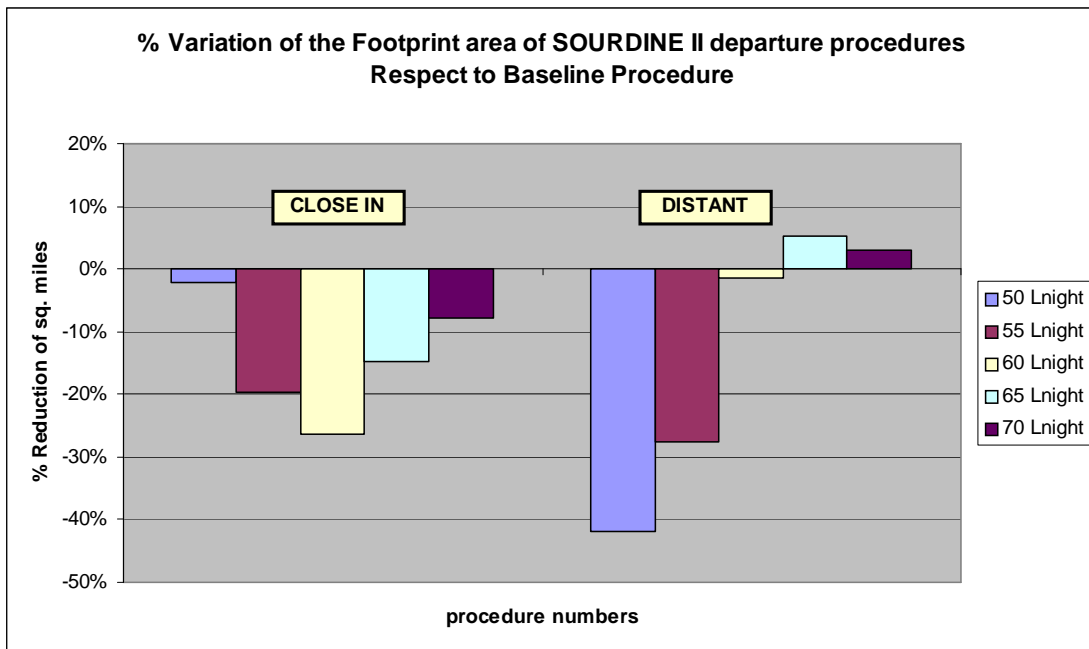


Figure 6-15 Relative contour area of Sourdine II NADPs Madrid-Barajas airport

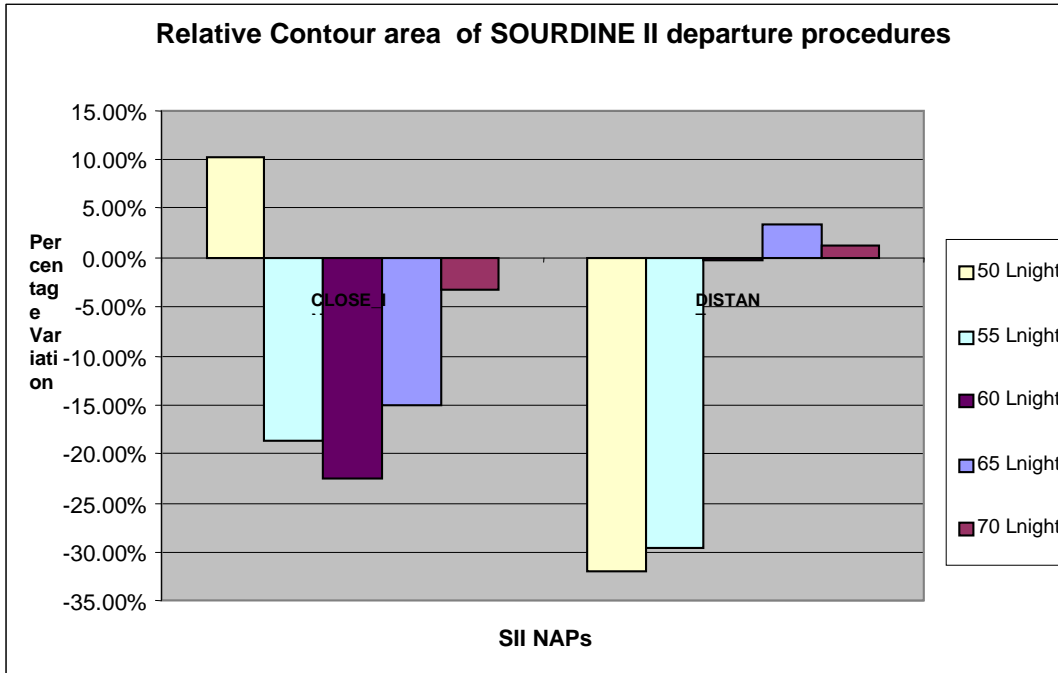


Figure 6-16 Relative contour area of Sourdine II NADPs CDG airport

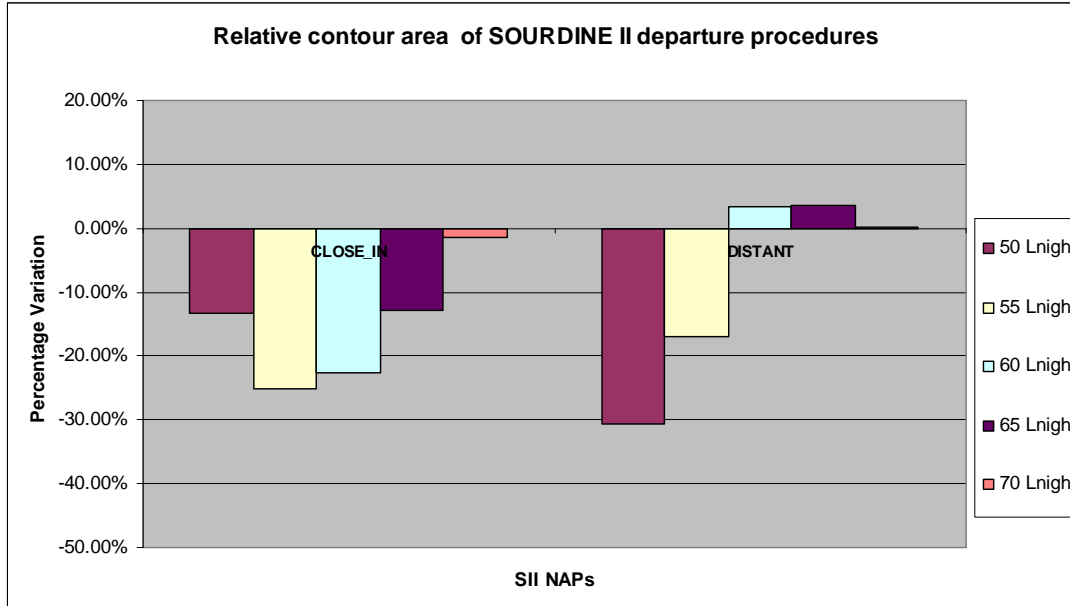


Figure 6-17 Relative contour area of Sourdine II NADPs Schiphol airport

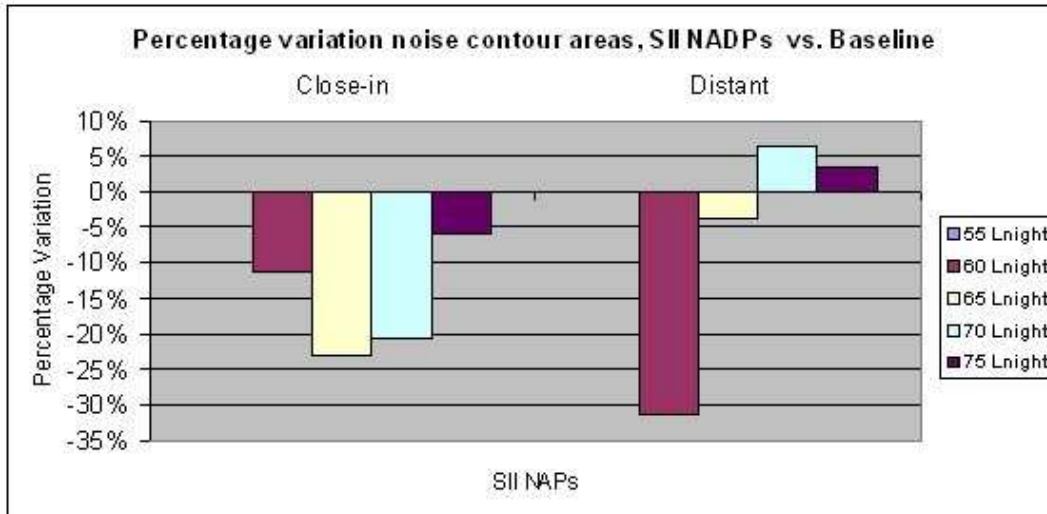


Figure 6-18 Relative contour area of Sourdine II NADPs Naples-Capodichino airport

6.4. Departure Conclusions

As for the Approach procedures the results of the noise analysis is common for all the four scenarios with slight difference on fleet-mix and unbalanced use of the runways.

Procedure 2

The two largest contours (55dB and 60dB) of the close-in procedure are longer and thinner than those of the baseline, whereas the other, smaller contours are smaller all round. This is the desired result of the close-in procedure though, as can be seen, the reduction in noise occurs within 5NM of the runway. The differences close in are due to the reduced thrust values of the Sourdine II procedure, whereas the increased lengths of the larger contours for this procedure is due to the lower altitude attained by the aircraft at these points when thrust is restored.

Procedure 3

The Distant procedure is significantly quieter (fig. 29) in the larger part of the area of interest, despite the lower altitude. In this case the lower thrust at distances from 3 to 15 NM determines the difference. Only at larger distances (> 15 NM) the lower altitude is decisive, as can be seen at the right hand side of figure 13. Also at positions very close to the runway the Distant procedure is somewhat noisier.

For the departures the noise level seems to be determined mainly by the thrust settings, instead of by the altitudes, as is the case at arrival.

6.5. Noise affected population calculation Madrid-Barajas Airport

At Madrid Barajas Airport, a preliminary study of population affected by noise in the surrounding areas has been conducted in order to analyse the influence of the proposed Sourdine II procedures, in these areas. This study does not try to obtain realistic figures about the number of population affected by airport operations. It should be understood

always from a comparative point of view between a baseline scenario and several Sourdine II scenarios that share the same hypothesis and assumptions. Obtaining a refined approximation of the number of population affected by the future activity of Madrid-Barajas airport is not the goal of this study and all the figures showed in this document shall not be used for any purpose different from this theoretical approach. With this objective it has been used the statistical data of distribution of population from the census 2001.

Noise contours previously obtained have been overlap over the map of the surrounding populated areas, obtaining in this way numerical results.

General assumptions

For departures, baseline has been compared with departures Close-in and departures Distant procedures, each for Lden and Lnight metrics.

From tables of general results, for both metrics, it can be deduced that the reduction of noise-affected population is bigger in departures Distant procedure, for all noise levels.

On the other hand, for arrivals the same metrics, Lden and Lnight, have been used. In this case there are two baselines, Standard Baseline and Baseline Procedure I. Taking whichever of these baselines like reference, noise contours of Procedure III are significant smaller, and in consequence the benefit for the population is higher. The reduction percentage of affected population is significant in all the procedures for the noise contours >65dB and especially for Procedure III, whit a reduction higher than 80% for both baselines.

6.5.1. Reduction in affected people (55db)

> 55 Db	TORREJÓN	COSLADA	SAN FERNANDO DE HENARES	MEJORADA DEL CAMPO	LOECHES	TOTAL
STANDARD BASELINE	9901	19817	3945	13903	233	47799
BASELINE PROC I	8547	18824	2854	13914	64	44203
PROCEDURE II	8184	16926	2649	13602	0	41361
PROCEDURE III	8191	16117	2458	11346	0	38112
PROCEDURE IV	8250	17286	2754	13727	0	42017
PROCEDURE V	8287	17362	2554	13822	689	42714

Table 6-1 Reduction of affected population (>55dB):

Conclusions

- With Respect to Procedure I: 6%/14%/5%/4%.
- With Respect to the Standard Baseline: 13%/20%/12%/11%.

6.5.2. Reduction in affected people (65db)

> 65 Db	TORREJÓN	COSLADA	SAN FERNANDO DE HENARES	MEJORADA DEL CAMPO	LOECHES	TOTAL
STANDARD BASELINE	2737	9550	740	0	0	13027
BASELINE PROC I	2272	8105	330	0	0	10707
PROCEDURE II	2110	6649	244	0	0	9003
PROCEDURE III	1441	457	0	0	0	1898
PROCEDURE IV	2232	6696	185	0	0	9113
PROCEDURE V	1999	6942	157	0	0	9098

Table 6-2 Reduction of affected population (>65dB)

Conclusions

- With Respect to Procedure I: 16%/82%/15%/15%.
- With Respect to the Standard Baseline: 31%/85%/30%/30%.

7. Conclusions

In conclusion, the sizes of the contours are generally a function of the altitude profiles, which is the most reflected mitigation by INM.

- Baseline Procedure I is very challenging from the noise impact point of view.
- All SII procedures reduce further the Noise Contour Areas compared to the Baseline scenario.
- Procedure III shows the biggest reduction of Noise contour area around Airports.
 - PROC III > PROC IV > PROC V » PROC II
- This reduction is especially significant during the night period.

For Madrid Barajas, where a study on population affected by noise was conducted, all procedures implied a significant reduction in the affected population, especially over 65 dB.

- PROC III > PROC II > PROC IV » PROC V

Departure procedures deliver noise benefits to well defined locations, following their definition of Close-in or Distant, in conclusion their choice is totally dependant on the density of population and its location around the airport. (Proc. 2 for Naples while Proc.3 for Madrid-Barajas airport).

These conclusions are valid for all the airports (for further details refer to appropriate deliverable D4-1-xb).

Appendix 1 Aircraft Substitution for the Noise Modelling study

A1.1 Introduction

Bearing in mind that INM's reliability depends on the database, a problem was brought to the forth once the project understood that no mixing of aircraft was possible outside those for which the data was reliable.

The data available to SII is only valid for certain aircraft belonging to the Airbus and Boeing family..

The question raised is thus the need to substitute aircraft the best way possible to either make sure that the capacity levels are maintained or the noise produced is comparable.

This task was already considered by the Sourdine (4th Framework) project which will be later detailed.

A1.2 Objective

The aim of the document is to try to answer the question on how and with which Airbus an being family aircraft we may substitute the future and current fleet mixes.

A1.3 References

- [1] Sourdine D3-001 document "Establishment of Noise Abatement Solutions", chapter 6.1 to 6.3.
- [2] Sourdine Annex G D3v83 Table G4 and G5
- [3] Madrid traffic fleet mix forecast for Madrid Barajas (email received on the) from Aena.
- [4] Naples-Capodichino Fleet mix forecast (email received on the) SICTA.
- [5] FAA AC 36-1H, Noise Levels for U.S certificated and foreign A/C, 11/15/01
- [6] Technical WebPages on Civil Airliners (www.airliners.net/)
- [7] "World Airliners Part 1 & 2" by Flight International (26Oct.—1 Nov. & 2-8 Nov 2004 issues)

A1.4 Analysis

A1.4.1 INPUT needed for the analysis

Below the inputs available at the time and the source of the data, used for substitutions:

1. Fleet mix for Madrid Barajas Airport both current and the foreseen (2015) [3]

The main companies operating at the airport and the corresponding percentage of operations have been determined from the data of the representative day. Results are summarised below:

Company	Percentage (%)
Iberia	50
Spanair	14
Air Europa	10
TOTAL	74

	Actual			2005			2015		
	Número	Modelo	Motor	Número	Modelo	Motor	Número	Modelo	Motor
AIR EUROPA	9	B737/300-400	CFM56	22	B737-800	CFM56	22	B737-800	CFM56
	11	B737/800	CFM56						
	6	B757/200	RB211	3	B767-300	CF6	3	B767-300	CF6
	3	B767/200	CF6						
SPANAIR	3	MD-87	JT8D	10	MD-80	JT8D	29	A320	V2500
	23	MD-83	JT8D	19	A320	V2500			
	11	MD-82	JT8D						
	3	A320-200	V2533				5	A319	V2500
	3	A321-200	V2527	5	A319	V2500	9	A321	V2500
	3	B767/300	PW4060	9	A321	V2500			
	4	B717	BR715						
	24	MD87	JT8D	24	MD87	JT8D	24	MD87	JT8D
	13	MD88	JT80	13	MD88	JT80	13	MD88	JT80
	8	B747	JT9D	18	A340-313	CFM56	18	A340-313	CFM56
	18	B757	RB211	3	A340-600	CFM56	3	A340-600	CFM56
	3	A300	JT9D	4	A319	CFM56	4	A319	CFM56

	Actual			2005			2015		
IBERIA	4	A319	CFM56	22	A320-211	CFM56	22	A320-211	CFM56
	54	A320	CFM56	33	A320-214	CFM56	33	A320-214	CFM56
	4	A321	CFM56	2	A321	CFM56	2	A321	CFM56
	16	A340	CFM56	16	B757	RB211	16	B757	RB211
	2	DC-8	JT3D						
	19	FOKKER-50	PW125	24	CRJ-200	CF34	24	CRJ-200	CF34
	5	ATR-72	PW124						
	24	CRJ-200	CF34						

New noise regulations have been taken into account as the replacement of Chapter 2 aircraft. Chapter three aircraft have time till the 1/01/05 to certify to the new noise limits.

2. Foreseen fleet-mix for Naples Capodichino airport

Currently, operating aircraft by Naples airport are indicated below.

Current scenario			
Aircraft type	Engine type	Aircraft number	Percentage
A319	CFM56	8	4%
A320	CFM 56	26	14%
ATR42	PW127F	16	9%
ATR700	PW127F	6	3%
B734/7/8	CFM56	6	3%
CRJ2/700	CF34	22	12%
D328	PW119C	18	10%
FOKKER 100	RR TAYMK -620-15	10	5%
MD80	PWJT8D	36	20%
MD82	PWJT8D	36	20%
		184	

Assuming the following list of possible aircraft substitutions:

Aircraft	Substitutions aircraft
A319	A319
A320	A320
ATR42	ATR72, CRJ200,EMB145,D328
ATR700	ATR700
B734/7/8	B737/8
CRJ2/700	CRJ200
D328	D328
FOKKER 100	ATR72, CRJ200,EMB145,D328
MD80	80%(A319, A320, B737/8)
MD82	20%(ATR72, CRJ200,EMB145,D328)

And on the basis of current available data, of airline requirements and local airport needs, the following aircraft fleet has been hypothesised for Naples Capodichino airport:

Fleet mix al 2015 (email Naples 24/06/04)		
A319	12%	CFM56
A320-211	23%	CFM56
ATR72	10%	PW127F
B734/737/738	20%	CFM56
CRJ100/200	15%	CF34
EMB145	9%	AE3007A
D328	12%	PW119C

At a first glance we may find turboprops which will not be simulated: ATR72 and D328, these a/c cannot be simulated, resulting in a 22% derived traffic lowering.

3. Aircraft Values:

- a. Values for Sideline¹ Noise certification level for civil airliners (EPNdb)[5], [6] . Where weight and aircraft engine type was available (Airbus) the nominal value was taken, in other cases the maximum value was used.
- b. Values for Range, MTOW and passengers were also collected from different sources. [6], [7]

A1.4.2 PARAMETERS

Classification was based on the following aircraft characteristics:

SL EPNdb: Max Sideline (SL) Effective Perceived Noise Level (EPNdb) range measured at a standard distance of 450 m. during FAA type certification with takeoff trust cut back applied unless otherwise noted, and corrected to sea level, 77 ° F and 70% relative humidity conditions. The EPNdb range takes into account engine models, flap settings and the aircraft maximum and minimum takeoff weights. Were the engine type and series was known the

¹ Max Sideline (SL) Effective Perceived Noise Level (EPNdb) range measured at a standard distance of 450 m. during FAA type certification with takeoff trust cut back applied unless otherwise noted, and corrected to sea level, 77 ° F and 70% relative humidity conditions. The EPNdb range takes into account engine models, flap settings and the aircraft maximum and minimum takeoff weights.

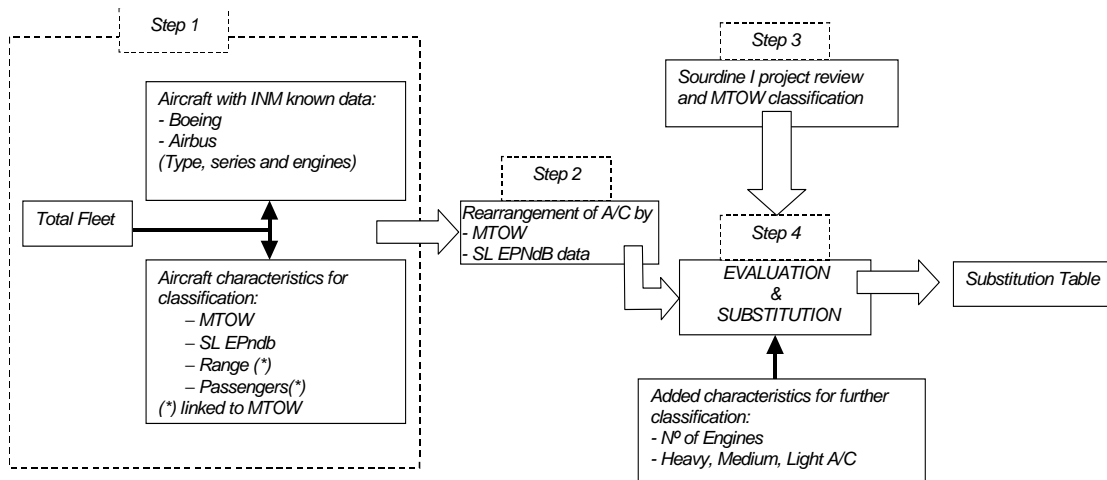
correspondent SL EPndb values were used, otherwise for those cases where type, engine and MTOW was not known a range of values was used. To later include the maximum value (or worst case).

MTOW: Maximum Take-Off Weight, precise values for MTOW were used where possible although knowing only the right values for Airbus a/c and a few Boeing, for the other aircrafts a range of values was assumed..

PASSENGERS: Passenger number was chosen based on 2-class accommodation and type or series of aircraft. In certain cases Range was coupled to determine the number of passengers and class disposition.

RANGE: dependant on aircraft type and series comes as a result after choosing the number of passengers or vice versa.

The following drawing explain the steps taken for the classification:



A1.4.3 STEP1 Aircraft belonging to fleet mix

Since the main objective is to substitute aircrafts we do not know, for others for which we have data, the first step was to see for which aircraft data was available:

Available Aircraft	Not Available and present in Fleet Mix
A319-111	B737-400
A320-211	B737-700
A320-214	B757-300
A320-232	B767-300
A321-211	MD-88
A321-232	MD-87
A330-301	CRJ100
A340-313	CRJ-200
B737-300	EMB145

Available Aircraft	Not Available and present in Fleet Mix
B737-800	Fokker100
B757-200	747-400
B777-200	MD 81(S80)
	CRJ-700

A1.4.4 STEP2 Rearrangement of data

To this first table the other parameters where added: SL MaxEPNdb, MTOW, Range and Passengers, from the lowest values to the highest (see Annex I).

To rearrange the data background colours for different groups and classes were used, some of the groups are only there to make classification easier. During the analysis of the data the four parameters where cut down to two those being the MTOW: range depends on number of passengers and the number of passengers in general to MTOW; and the Noise certification levels (in general) strongly dependent on the MTOW value.

A1.4.5 STEP3 Review of past methodologies [1], [2].

Previously done work and classification was studied to see if it was also applicable to the Sourdine II INM study.

In the Sourdine project the same problem occurred where data was available for only two Airbus aircraft: A320 and A340.

The main difference since then is that the _INM software now admits configuration changes and subsequently possesses the NPD curves related to these changes.

Below we may find the hypothesis used and the approach to the problem, besides the reader must bare in mind that the study was conducted specifically for the Schiphol Airport case.

Fleet mix used

The airport implementation studies to be carried out within the SOURDINE project are limited by the fact that optimised noise abatement procedures are only available to the project partners for specific aircraft types, i.e. Airbus aircraft. Therefore, in order to still be able to perform an airport implementation study of the proposed procedures, a surrogate aircraft fleet is constructed in which other aircraft types are replaced as far as practical by available and representative (Airbus) aircraft types. Due to these assumptions, any results obtained with this approach therefore can only provide a comparison of the implications between the original and alternative situation and should not be looked at in an absolute sense. For the airport implementation studies, two different aspects will be investigated, both of which require a specific representative aircraft fleet.

Implementation aspects of a certain procedure with respect to airport capacity:

The focus of such a study is on the effect of a given procedure on the airport capacity, i.e. the number of aircraft movements from and to the airport, given the operational behaviour of the different aircraft. A study into the capacity effects of a proposed operational measure should reflect the aircraft mix for the reference situation, i.e. the current situation. If possible, the best option here would be to apply the *actual* fleet mix and daily traffic load for an airport,

with the procedures for the different aircraft types (turboprop and jet a/c) adjusted to the proposed measure, where possible. In case this is not possible, the daily traffic load, including variations over the day and aircraft differences in operational behaviour, should remain comparable to that of the original fleet mix, when replacing relevant aircraft types by comparable Airbus aircraft.

Implementation aspects of a certain procedure with respect to overall airport noise:

The focus is on the amount of noise exposure as a result of the aircraft movements on an overall basis. The fleet mix used in the study should reflect current noise impact around the airport, i.e. the overall noise contour as a result of the fleet used should be *comparable* to the current contour. Practically this might be achieved by replacing specific aircraft by *x* Airbus aircraft in such a way that the footprint area and shape are more or less equal. The value of *x* is dependent on the specific aircraft, noise contour value, and flight mode (eg. departure and approach) and should be determined with the national noise model available at the airports under consideration.

Determination of aircraft type conversion factors

For both types, noise footprints of all procedures will be calculated. For the purpose of this study, the Airbus data are added to the Schiphol database, which was used to determine the aircraft conversion factors for the different airport implementation studies in the current project.

In the procedure implementation within the airport noise contour calculation model currently used for Amsterdam Airport Schiphol, aircraft are categorised with specific performance and noise data representative for the specific category. Categorisation is based on maximum take-off weight and noise characteristics.

Since no Airbus data is used at the moment as a representative category in the current Schiphol database, conversions from Airbus data to the current representatives have to be made for the relevant representative aircraft, in order to be in compliance with the current Ke-zone. The following method has been used:

For each representative aircraft a conversion factor is calculated based on comparison of shape and area of footprints. For departures, the footprint of the highest distance class available is used, i.e. that for the heaviest take-off weight. For approaches, the full flap configuration is used for a 2000-ft. descent. The take-off factor and approach factor for each corresponding category, will be used to multiply the number of movements. Because of this the number of aircraft movements changes drastically but the aim is to keep the total noise exposure more or less constant.

In short, for the determination of the conversion factors the following method has been applied:

1. For take-off the area enclosed by the 65 dB(A) noise contour has been calculated, for approach the noise level of 75 dB(A) (for reasons of having a closed contour)
2. The noise level of the relevant Airbus type matching the same area as the representative aircraft has been determined.
3. The difference in dB(A) has been converted into a conversion factor
4. Conversion Factor = $10^{((65 - \text{dB})/10)}$
 e.g. a delta dB(A) of 3 gives a conversion factor of 2.

This leads to the results summarised in Appendix II and III. The aircraft categorisation as provided in these tables is according to the official classification used at Schiphol Amsterdam

Airport. In addition, the conversion factors that were determined have been added to the table. Tables G-1 and G-2 in Appendix III provide more information on the calculation of the factors.

After calculation of the baseline scenario with surrogate Airbus fleet (2 aircraft), the contours are compared with the original scenario, obtained using the original traffic mix. Subsequently the alternative scenario is calculated and compared with the baseline scenario, to illustrate the differences resulting from the implemented noise abatement procedures.

A1.4.6 STEP 4 Evaluation

We cannot apply the Sourdine's method since although practical, INM hadn't at that time the option for change in configuration with relative NPD curves. As such the change in configuration cannot be modelled or compared with the Airbus or boeing family aircraft.

With older versions of INM it would be possible to see the difference in SEL area as produced by a known airbus aircraft and the others, but it would only estimate the difference between a constant configuration of the old aircraft versus a changing configuration.

Of course it would be possible for smaller aircraft to see how the substitution could affect the noise area (since a big difference can be estimated), but that would only include those noise levels for which at a certain height and speed we have compared the values. This does not include the time and resources which would be needed and not foreseen by the project.

Over more the calculated conversion factors from the Sourdine project are only available for a certain amount of aircraft, some current aircraft were not even flying at that time, while others are not present in the fleet mix sent by either Aena or SICTA.

The Sourdine analysis has been used where possible as a guideline, i.e. MTOW classification (Appendix IV), but we do not think it is applicable to the current SII situation.

BASIC Hypothesis and comments

A/C from Boeing as the 747, have no straight forward substitution (as can be seen in tables from Appendix I), others can be substituted on the noise basis but not by using the MTOW or Passengers (B757, B767,..).

Only those aircraft which were sent by Aena and SICTA were taken into account by this analysis.

Small regional jet aircraft cannot be substituted completely without twitching with passenger numbers and a/c weights. Noise wise they create less noise than the A319, but this is the would be the only close enough aircraft available for substitution.

A1.5 PROPOSAL

In general, the purpose of substitution techniques (as far as noise modelling is concerned) is to represent an actual fleet-mix by a limited number of aircraft types (i.e. those available in the database of the noise model), in such a way that the calculated noise contours are equivalent to the actual noise load produced at the airport.

This is not an easy process, given that noise footprints are a mix of noise source characteristics and aircraft performance (i.e. through the resulting flight profiles, which define the source-to-receiver geometry, and the aircraft state along the trajectory). In particular, applying a one-by-one substitution method (i.e. one movement of an unlisted aircraft is

replaced by one movement of an "equivalent", listed aircraft) cannot completely capture these two effects. Some more sophisticated methods, based on the concept of "equivalencies" (i.e. one movement of an unlisted aircraft is replaced by 2.16... movements of an equivalent listed aircraft) give better results, but are more complex to implement.

The objective of the noise study is to simulate and weigh the improvement in noise surrounding the airports based on using the new procedures, thus we must :

1. Use only an Airbus and Boeing (known) fleet-mix for the Baseline Noise study
2. Use only an Airbus and Boeing fleet-mix for the Future scenario (2015)
3. Avoid the mixing with aircraft for which we have no data, no NPD curves and no values for configuration changes.
4. Maintain the same traffic number, thus maintain the airports capacity (n° of flights).
5. Try to maintain where possible the number of heavies substituting them for other heavies (although the noise values are an may turn to be different).

Thus we may compare the difference and evaluate the procedures' benefits, not the eventual changes in fleet or aircraft.

The INM study should then be approached by using the following aircraft substitution classes, which are a balance between MTOW (Sourdine class values were taken into consideration) and Max SL EPNdb values.

MTOW Class [1000kg]	Aircraft	MTOW [1000kg]	SL Max EPNdb	Noise Assessment Substitution	
				substitution	optional
15 ≤ MTOW < 40	CRJ-100/200	21.5	86	none	
	EMB145	22-24	84.6	none	
	ATR42	16	80.7	none	
	Dornier 328	16	83.8	none	
	Embraer RJ145	22	84.2 – 84.6	none	
40 ≤ MTOW < 60	FOKKER70 FOKKER100	45.18	91.7	B737-300	A319-111
60 ≤ MTOW < 100	B737-300	62.8	90.4	B737-300	
	A319-111	64-75.5	92	A319-111	
	B737-400	62.9-68.1	93.2	B737-300	
	B737-700	60-70	94.7	B737-800	
	MD-88	72.5	97.2	A321-232	
60 ≤ MTOW < 100	MD-87	63.5	97.1	A321-232	
	MD 81(S80)	63.5	97.3	A321-232	
	MD82	67	96.3	A321-232	

MTOW Class [1000kg]	Aircraft	MTOW [1000kg]	SL Max EPNdb	Noise Assessment Substitution	
				substitution	optional
	A320-211	73.5-77	94.4	A320-211	
	A320-214	73.5-77	94.4	A320-214	
	A320-232	73.5-77	94.4	A320-232	
	B737-800	78-79	93.1	B737-800	
	B737-900	78-79	94.3	B737-800	
	A321-211	83-93.5	94.3	A321-211	
	A321-232	83-93.5	95.6	A321-232	
100 ≤ MTOW < 160	B757-200	98.8-115.6	94.2-94.4	B757-200	
	B757-300	123.6	94.5	B757-200	
160 ≤ MTOW < 230	B767-300	184.8-186.8	97	A330-301	B777-200
230 ≤ MTOW < 300	A330-301	230-233	97.2	A330-301	
	A340-313	271-275	95.8	A340-313	
	MD11	275	96.1- 96.5	B777-200	
	B777-200	253-305.97	96.1	B777-200	
300 ≤ MTOW < 400	747-400	363-396.6	103.8	A340-313	
	A340-600	368-380	98	A340-313	

The MTOW class used is as defined in the Sourdine project [see Appendix II]. Blue and red colour for aircrafts designate aircraft for which we have the INM profiles data.

The table above shows the suggested aircraft substitutions as seen comparing the combination of the two parameters as far as possible (MTOW and SLMaxEPNdb).

In the extremities of the table we may find those aircrafts for which there are no possible straightforward substitutions, both on weight basis and certified noise since differences are quite great. Further study, which is not in the scope of the Sourdine II project, such as establishment and “use” of conversion factors (as done in the Sourdine project) could probably solve this substitution more precisely although the best way remains having the INM7 data format available for all aircraft.

Four engine aircraft have been substituted with the nearest available four engine aircraft (B747-400 with A340-313, above).

Substitution options have been put on a second column.

A1.6 Conclusion

Now, in the context of Sourdine II, the proposed one-by-one substitution method (incl. discarding some aircraft types from the airport noise studies) can be considered as a reasonable choice, given that the purpose is to compare the noise effect of different

procedures, applied to a given - unchanged - fleet mix, and that using a more sophisticated method would be anyway too much time consuming. As a result of that choice, the calculated noise contours may not reflect the actual noise load, but this has to be considered as a limitation of the project.

The objective of the noise study is to show if benefits will be gained by using New Advanced NAPs, designed by the SII consortium. In order to obtain these results we need to perform an INM study comparing a baseline and a the future scenario procedure with an operational Fleetmix.

Since the only data provided is the Airbus data for eight aircraft and the Boeing Data for four aircraft, the possibility for substitution of unknown aircraft with known aircraft was envisaged and then performed. The substitution took into account parameters as: MTOW, SLMaxEPNdb, Passengers and Range, giving a higher importance to SLMaxEPNdb coupled with MTOW (when possible).

A table containing the substitutive aircraft valid for the fleet-mix of both Barajas Madrid airport and Naples Capodichino was completed (see table Sec.5). The above table will also be used in Schiphol Airport for the relative INM study.

The table must be seen as a proposal since certain substitutions (the extremities of the table) cannot be substituted directly without a more in depth analysis.

Two open questions still remain, how do we behave with the small aircrafts and the heaviest?

For the heaviest the decision was taken to substitute them for known heavy aircraft, while for the smaller aircraft the decision was taken to not consider them, bearing in mind the scope of the SII project and the time schedule.

As such the question above is still open to future answers which we hope will come from future projects.

Appendix 2 Tables for the traffic substitution process

A2.1 Aircraft Parameters for the fleet-mix.

Type	SL Max EPNdb		Type	MTOW (tons)		Type	Passengers		Type	Range X 1000 (km)	
CRJ100	82-86		CRJ100	21.5		CRJ100	50		CRJ100	1.8	
CRJ-200	82-86		CRJ-200	21.5		CRJ-200	50	C1	CRJ-200	1.8	
EMB145	84.2 - 84.6		EMB145	22-24	C1	EMB145	50		EMB145	2.7-3.7	
Fokker100	91.7	C1	Fokker100	45.18		Fokker100	107		Fokker100	3.1	C1
A319-111	92		B737-300	62.8		MD-87	114	C2	MD 81(S80)	2.9	
B737-400	88.2 - 93.2		A319-111	64-75.5		A319-111	124		MD82	3.8	
B737-300	90.4		B737-400	62.9-68.1		B737-300	141		B737-300	3-4.8	
A320-211	92.8 - 94.4		B737-700	60-70		MD-88	144		MD-87	4.4	
A320-214	92.8 - 94.4		MD-88	72.5	C2	B737-400	146	C3	MD-88	4.6	
A320-232	92.8 - 94.4		MD-87	63.5		B737-700	146		B737-400	4-4.6	C2
A321-211	94.3	C2	MD 81(S80)	63.5		A320-211	150		A319-111	4.7	
B737-800	93.1		MD82	67		A320-214	150		A320-211	5.35	
B757-300	94.5		A320-211	73.5-77		A320-232	150		B737-800	5.44	
B737-700	94.7		A320-214	73.5-77	C3	MD 81(S80)	155	C4	A320-214	5.55	
B757-200	95.1		A320-232	73.5-77		MD82	155		A320-232	5.55	C3
MD	94.5 - 97.3		B737-800	78-79		B737-800	160		A321-211	5.55	



Type	SL Max EPNdb		Type	MTOW (tons)		Type	Passengers		Type	Range X 1000 (km)	
81(S80)											
A340-313	95.3 -95.8	C3	A321-211	83-93.5		A321-211	185		A321-232	5.55	
A321-232	95.6		A321-232	83-93.5	C4	A321-232	185	C5	B737-700	6 (126)	
MD82	95.9 -96.3		B757-200	98.8-115.6		B757-200	201		B757-300	6.41	C3-4
B767-300	94-97		B757-300	123.6	C5	B767-300	218	C6	B757-200	5.5-7.4	
B777-200	96.1		B767-300	184.8 - 186.8	C6	B757-300	243	C7	A330-301	10.4	
MD-87	97.1	C4	A330-301	230-233	C7	A330-301	295	C8	B767-300	11.4	C5
A330-301	97.2		777-200	253-305.97		A340-313	295		777-200	10.7-14.3	
MD-88	97.2		A340-313	271-275	C8	777-200	305		747-400	11.4-13.4	
A340-600	98		A340-600	368-380		A340-600	380		A340-600	13.9 - 14.8	
747-400	99.5 - 103.8	C5	747-400	363-396.6	C9	747-400	416	C9	A340-313	16-16.4	C6

A2.2 Classification of aircraft (SourDine)

Classification of aircraft into capacity categories and noise conversion factors for A320

$\Delta EPNdB^* = (\Sigma H3 \text{ certification level}) - (\Sigma H3 \text{ limit values}), (H3 = \text{Chapter } 3).$

Capacity Category	MTOW [1000kg]	Noise classification			
		1 $\Delta EPNdB > 0$ not H3	2 $0 \geq \Delta EPNdB > -9$	3 $-9 \geq \Delta EPNdB > -18$	4 $\Delta EPNdB \leq -18$
Representative a/c (in bold) relative to A320	1 $6 \leq MTOW < 15$			Saab SF-340 EMB-110/120 Dornier 228/328 Bae Jetstream 31 Shorts 330 DEP 0.03 APP 0.2	
	2 $15 \leq MTOW < 40$	F-28 N/A	F-27 N/A	F-70 FK50 ATR-72 Dash 8-300/400 BAe-ATP BAe146-100 DEP 0.5 APP 0.5	ATR-42 Canadair RJ100 Saab 2000 DEP 0.4 APP 0.3
	3 $40 \leq MTOW < 60$	B737-200 Tupolev 134 Bac-1-11 DC-9 N/A	DC9 Hushkit Yakovlev 42 DEP 21.5 APP 4.1	B737-300 B737-500 BAe AVRO RJ100 F-100 DEP 1.4 APP 1.6	BAe-146-300 BAe-146-200 L-188 DEP 1.6 APP 0.8
	4 $60 \leq MTOW < 100$	B727-200 Antonov 12 N/A	B737-400 OC² A-319 MD-83 B727-200 RE ³ Lockheed Hercules DEP 1.8 APP 2.0	B737-400 HBC⁴ MD-82 MD-88 A-320-100/200 MD-81 MD-87 A-321-200 B737-600/700/800 DEP 1.4 APP 1.6	

Table 7-1 Classification of aircraft into capacity categories and noise conversion factors for A340

² Other carriers
³ Re-engined
⁴ Home based carriers

Capacity Category	MTOW [1000kg]	Noise classification				
		1 $\Delta\text{EPNdB} > 0$ & not H3	2 $0 \geq \Delta\text{EPNdB} > -9$	3 $-9 \geq \Delta\text{EPNdB} > -18$	4 $\Delta\text{EPNdB} \leq -18$	
Representative a/c (in bold) relative to A340	5	100 ≤ MTOW < 160	B707 DC-8 N/A	TUPOLEV 154 A-300F B767-200 DEP 1.3 APP 2.2	B757-200 A310-200/300 Short Belfast DEP 0.8 APP 1.7	
	6	160 ≤ MTOW < 230	Illushin 76 N/A	B767-200 ER Lockheed Tristar 200 DEP 1.7 APP 4.6	B767-300 ER A-300B4 A330-300 A300-600 DEP 0.7 APP 2.5	
	7	230 ≤ MTOW < 300	N/A	DC10-30 DC-10-40 Lockheed Tristar 500 DEP 7.7 APP 5.7	MD-11 DEP 3.3 APP 3.1	B777-200 A-340-200/300 0 DEP 1.4 APP 2.2
	8	300 ≤ MTOW < 400	B747-100	B747-300 B747-200 B747-SP DEP 20.3 APP 5.7	B747-400 DEP 9.0 APP 5.9	

Table 7-2 Classification of aircraft into capacity categories and noise conversion factors for A340

A2.3 Amsterdam Schiphol simulation

DEPARTURE	Representative aircraft in class dB(A)	A320-214/P dB(A)*	Noise footprint area	Conversion Factor
Category_Class				
013	65.0	79.9	4.15	0.03
023	65.0	68.2	18.22	0.5
024	65.0	69.5	12.35	0.4
032	65.0	51.7	217.37	21.5
033	65.0	63.4	42.64	1.4
034	65.0	63.0	45.43	1.6
042	65.0	62.4	49.22	1.8
043	65.0	63.4	42.64	1.4
Category_Class	Representative A/C dB(A)	A340-311 dB(A)*	Area	Conversion Factor
052	65.0	63.8	61.97	1.3
053	65.0	65.9	44.24	0.8
062	65.0	62.6	71.26	1.7
063	65.0	66.3	44.95	0.7
072	65.0	56.2	154.43	7.7
073	65.0	59.8	99.89	3.3
074	65.0	63.6	63.24	1.4
082	65.0	51.9	249.46	20.3
083	65.0	55.4	168.08	9.0

** Noise level of A320/A340 with the same area size at representative aircraft noise level*

Table 7-3 Aircraft (category) conversion factors for departures

APPROACH	Representative aircraft in class dB(A)	A320-214/P dB(A)*	Noise footprint area	Conversion Factor
Category Class				
013	75.0	82.9	2.42	0.2
023	75.0	78.4	3.88	0.5
024	75.0	80.8	3.11	0.3
032	75.0	68.9	9.43	4.1
033	75.0	73.1	6.10	1.6
034	75.0	75.7	4.79	0.8
042	75.0	71.9	6.89	2.0

APPROACH				
043	75.0	73.1	6.10	1.6
052	75.0	71.6	6.95	2.2
053	75.0	72.6	5.68	1.7
062	75.0	68.4	11.01	4.6
063	75.0	71.0	7.68	2.5
072	75.0	67.5	12.28	5.7
073	75.0	70.1	8.85	3.1
074	75.0	71.6	6.98	2.2
082	75.0	67.4	12.42	5.7
083	75.0	67.3	12.95	5.9
* Noise level of A320/A340 with the same area size at representative aircraft noise level				

Table 7-4 Aircraft (category) conversion factors for approaches

A2.4 Re-arrangement and Application of Noise & MTOW cat. to Sourdine II fleet

MTOW (tons)			Noise Category	SL Max EPNdb
15 ≤ MTOW < 40	CRJ100	21.5	CRJ100	82-86
	CRJ-200	21.5	CRJ-200	82-86
	EMB145	22-24	EMB145	84.2 -84.6
	CRJ-700	33	CRJ-700	89.5
40 ≤ MTOW < 60	Fokker 70/100	45.18	B737-300	90.4
			Fokker 70/100	91.7
60 ≤ MTOW < 100			A319-111	92
			B737-400	93.2
			A320-211	92.8 - 94.4
			B737-300	62.8
			A320-214	92.8 - 94.4
			A319-111	64-75.5
			A320-232	92.8 - 94.4
			B737-400	62.9-68.1
			A321-211	94.3
			B737-700	60-70
			B737-800	93.1
			MD-88	72.5
			B757-300	94.5
			MD-87	63.5
B737-700	94.7			
100 ≤ MTOW < 160			B757-200	94.2-94.4
			MD 81(S80)	94.5 - 97.3
			MD82	67
			A340-313	95.3 -95.8
			A320-211	73.5-77
			A321-232	95.6
			A320-214	73.5-77
			B777-200	96.1
			A320-232	73.5-77
			B737-800	78-79
160 ≤ MTOW < 230	B767-300	184.8 - 186.8	MD82	95.9 -96.3
			MD11	96.1 – 96.5
100 ≤ MTOW < 160	B757-200	98.8-115.6	B767-300	94 - 97
			B757-300	123.6
			MD-87	97.1
160 ≤ MTOW < 230	B767-300	184.8 - 186.8	A330-301	97.2
			MD-88	97.2
			A340-600	98
			747-400	99.5 - 103.8



$230 \leq MTOW < 300$	A330-301 A340-313	230-233 271-275
$230 \leq MTOW < 300$	MD11 B777-200	275 253 – 305.97
$300 \leq MTOW < 400$	747-400 A340-600	363-396.6 368-380