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COMPETITIVE AND SUSTAINABLE GROWTH PROGRAMME

SOURDINE II

D4-1-2b

Noise Results Amsterdam Schiphol

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NLR	*Stichting Nationaal Lucht- en Ruimtevaartlaboratorium*	*NL*
AENA	*Entidad Pública Empresarial Aeropuertos Españoles y Navegación Aérea*	*ESP*
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Partner	Distribution list
AENA	Pablo Sánchez Escalonilla Alfredo Gomez de Segura
Eurocontrol Experimental Centre	Peter Hullah Laurent Cavadini
NLR	Ruud den Boer Collin Beers Harry Brouwer Bart Roeloffs
SICTA	Patrizia Criscuolo Mariacarmela Supino

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Contributing Partners	Authors
-	-

Contact Information
National Aerospace Laboratory, NLR
Attn. Mr. R.G. den Boer
Anthony Fokkerweg 2
1059 CM Amsterdam
The Netherlands
Tel.: +31-20-5113194
Fax: +31-20-5113210
e-mail: rgboer@nlr.nl

Summary

The Sourdine II project defined four advanced and innovative approach procedures, and two departure procedures to be analysed for their ability to reduce the noise burden on people around the airports at which they would be implemented.

This analysis was performed for four European airports – Paris Charles de Gaulle, Amsterdam Schiphol, Madrid Barajas and Napoli Capodichino. This document describes the Noise analysis performed for Amsterdam Schiphol.

The Integrated Noise Model INM has been used to produce noise contours at Amsterdam Airport Schiphol for different arrival procedures applied to a single arrival scenario (i.e. fleet mix / runway / track combination), and different departure procedures, also applied to the same departure scenario. In total seven arrival procedures and three departure procedures were analyzed.

It can be concluded that the sizes of the contours at arrival are mainly determined by the altitude profiles, while at departure the thrust seems to be the dominant parameter.

Arrival Procedure V (Proc V) has noise contours similar to the baseline procedure (Proc I), all the other procedures generate smaller contours. The most significant reduction is obtained by Proc III. The ranking of the reductions (for both Lden and Lnight) is:

- Proc III > Proc IV > Proc II > Proc V

The additional two baseline procedures, based on the current practice at Schiphol, have a lower altitude at distances larger than 6 NM, which is reflected in larger contours for the lower noise levels.

The ‘Distant‘ departure procedure causes significantly smaller Lden noise contours (except at small distances), because of the strongly reduced thrust from 3 to 15 NM from the runway. The ‘Close-in’ departure procedure also yields some reduction in contour size, except at larger distances.

The main differences in Lden and Lnight contours are caused by differences in traffic volumes: at smaller volumes, the contour of a specific level shifts to smaller distances, and is thus determined by the profile (altitude or thrust) at smaller distances.

Table of Contents

1. Introduction

1.1. Purpose

Within Sourdine-II several assessment are conducted to gain feedback and results on the proposed procedures and tools. These assessments are:

- Expert judgement
- Single Event Simulations, SES
- Fast time simulations, FTS (capacity assessment as well as noise and emission calculations)
- Safety assessment
- Cost Benefit Analysis, CBA
- Real time simulations, RTS

This report describes the results of the noise assessment for Schiphol airport performed by NLR.

1.2. 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

1.3. Glossary

Term	Description
CBA	Cost Benefit Analysis
CDA	Continuous Descent Approach
FAS	Final Approach Speed
FIR	Flight Information Region
FL	Flight Level
FTS	Fast time simulations
INM	Integrated Noise Model
KTS	Knots
NLR	Nationaal Lucht- en Ruimtevaartlaboratorium National Aerospace Laboratory
NM	Nautical Mile
RNAV	Area Navigation
RTD	Research, Technology development and Demonstration
RTS	Real time simulations
SES	Single Event Simulations
SID	Standard Instrument Departure

Term	Description
SOURDINE	Study of optimisation procedures for decreasing the impact of noise

1.4. References

Short Reference	Author / Organisation, Title, Edition, Date and Reference
[D2-1]	D2-1: Validation Methodology Report, version 0.9
[D3-1-2]	Updated Definition of New Noise Abatement Procedures
[D6-6]	D6-6: Concept of operation for Schiphol airport simulations

2. Description of the analysis

2.1. Amsterdam Airport Schiphol

Operations at Amsterdam Airport Schiphol (AAS) started already in 1916. Today AAS is the 4th largest European airport both in terms of number of movements, with approximately 1200 movements per day, and in terms of number of passengers.

AAS is situated some 10km South-West of the city centre of Amsterdam at the extremity of its conurbation, with medium-sized towns to the South (Aalsmeer), West (Hoofddorp) and the city of Haarlem to the North-West of the airport.

Since 2003, AAS operates five main runways: 18R-36L, 18C-36C, 18L-36R, 24-06, and the 27-09. A smaller sixth runway, 04-22, is mainly used for general aviation. Most of the landings take place on the 18R and 06, and less frequent, on the 18C, 27, and 36R. Departures mostly use 36L and 24, and less frequent, the 36C and 18L.

2.2. Noise Modelling Method

The United States (US) Federal Aviation Administration (FAA's) Integrated Noise Model (INM) is a de facto standard for noise modelling worldwide. In its current version, version 6.1, it takes no account of aircraft configuration changes (flaps, slats and landing gear), which have a major impact on the noise produced by aircraft on approach. A new version of INM was therefore produced by the FAA especially for the Sourdine II project, with data supplied by Airbus and by Boeing with financing from the US National Aeronautics and Space Administration (NASA). Details of this new version are given in the Sourdine II document "D5.2 Noise and Emission Modelling Methodology".

Data used for modelling aircraft noise in this study come from Sourdine II procedure flight profiles specially supplied by Airbus and Boeing for height, speed, thrust and configuration information, and from the paths used for the capacity simulations for the ground track.

Simulations were run for landings and departures in southerly direction only – arrivals on 18R and 18C, departures on 24 and 18L. The routes used are shown in Section 3.4.

2.3. Procedures Modelled

Noise modelling was performed for 7 arrival procedures in total:

- Baseline procedure (Procedure I),
- Four Sourdine II procedures (Procedures II, III, IV and V) and
- Two additional baseline procedures, based on the current practice at Schiphol (see section 3.6).

Noise modelling was also performed for 3 departure procedures:

- Baseline,
- Close-in and
- Distant

The reader is referred to Sourdine II WP3 [D3-1-2] for a full description of these procedures. Graphical representations of the procedures are shown chapter 5, which contains an analysis of the results.

3. Input data and modelling assumptions

3.1. Original fleet mix

The table below provides the list of “real” aircraft, used for the ‘Arrivals’ simulations.

Aircraft Type	*Total Nb. of Movements (24H)*	*% during Day 07:00:00 - 18:59:00*	*% during Evening 19:00:00 - 22:59:00*	*% during Night 23:00:00 - 06:59:00*
738	99	56.57%	24.24%	19.19%
733	87	70.11%	24.14%	5.75%
F70	83	55.42%	34.94%	9.64%
100	80	70.00%	27.50%	2.50%
333	66	59.09%	34.85%	6.06%
320	61	73.77%	14.75%	11.48%
319	55	70.91%	20.00%	9.09%
744	51	80.39%	7.84%	11.76%
772	36	83.33%	2.78%	13.89%
AT4	36	58.33%	25.00%	16.67%
734	32	53.13%	37.50%	9.38%
752	32	56.25%	9.38%	34.38%
D32	31	77.42%	9.68%	12.90%
739	30	70.00%	20.00%	10.00%
EM4	26	84.62%	11.54%	3.85%
321	22	81.82%	13.64%	4.55%
343	21	71.43%	14.29%	14.29%
763	21	61.90%	9.52%	28.57%
MD1	13	53.85%	0.00%	46.15%
MD8	12	66.67%	0.00%	33.33%
73G	7	71.43%	0.00%	28.57%
74F	4	75.00%	0.00%	25.00%
74X	2	50.00%	0.00%	50.00%
74E	1	100.00%	0.00%	0.00%
74Y	1	0.00%	0.00%	100.00%

Table 1: Arrivals aircraft movements

The original data on the Departure aircraft movements is not available anymore and therefore all aircraft types were reduced to the categories given in the table below.

Aircraft Type	***Total Nb. of Movements (24H)***	***% during Day 07:00:00 - 18:59:00***	***% during Evening 19:00:00 - 22:59:00***	***% during Night 23:00:00 - 06:59:00***
SMR	721	62.00%	21.78%	16.23%
LR2	129	81.40%	5.43%	13.18%
LR4	40	65.00%	10.00%	25.00%
BSJ	20	45.00%	35.00%	20.00%
MD11	7	28.57%	14.29%	57.14%

Table 2: Departure aircraft movements

3.2. Performed substitutions

- The table below provides the substitution mapping for ‘Arrivals’.
- The original aircraft types are sorted by number of movements, in descending order
- This table indicates in particular the aircraft which have been discarded, like turbo-prop (the second column indicating “None” in that case)

Original aircraft type	***INM70-SII aircraft***
738	B737-800
733	B737-300
F70	A319-111
100	A319-111
333	A330-301
320	A320-211
319	A319-111
744	A340-313
772	B777-200
AT4	None
734	B737-800
752	B757-200
D32	None
739	B737-800
EM4	None
321	A321-211
343	A340-313
763	B757-200

MD1	B777-200
MD8	A320-211
73G	B737-800
74F	A340-313
74X	A340-313
74E	A340-313
74Y	A340-313

Table 3: Substitutions used for arrival aircraft

The table below provides the substitution mapping for 'Departures'. As the original data are not available anymore, the totals per category have been distributed (roughly following the same ratios as for arrivals) over the corresponding INM70-SII aircraft types.

Original Category	***Representative aircraft type***	***INM70-SII aircraft***
SMR	A320	A319-111
		A320-211
		A321-211
		B737-300
		B737-800
LR2	A330	A330-301
		B757-200
LR4	A340	A340-313
BSJ	F50	None
MD11	MD11	B777-200

Table 4: Substitutions used for departure aircraft

3.3. Resulting Fleet mix

The table below provides the final fleet mix per route and runway for all ‘arrivals’ simulations.

Runway	***Route/track***	***Aircraft type***	***Day***	***Evening***	***Night***
18C	**O1**		**285**	**86**	**26**
		737300	12.98%	15.12%	0.00%
		737800	23.16%	26.74%	34.62%
		777200	4.91%	1.16%	11.54%
		757RR	7.37%	2.33%	15.38%
		A319-111	16.84%	31.40%	15.38%
		A320-211	13.33%	6.98%	3.85%
		A321-211	0.70%	1.16%	0.00%
		A330-301	5.26%	9.30%	7.69%
		A340-313	15.44%	5.81%	11.54%
18R	**NW1**		**17**	**2**	**1**
		737300	5.88%	0.00%	0.00%
		777200	17.65%	0.00%	100.00%
		757RR	5.88%	0.00%	0.00%
		A319-111	41.18%	100.00%	0.00%
		A320-211	17.65%	0.00%	0.00%
		A321-211	5.88%	0.00%	0.00%
		A330-301	5.88%	0.00%	0.00%
18R	**NW2**		**54**	**15**	**0**
		737300	5.56%	26.67%	0.00%
		737800	5.56%	13.33%	0.00%
		777200	9.26%	0.00%	0.00%
		757RR	5.56%	0.00%	0.00%
		A319-111	38.89%	53.33%	0.00%
		A320-211	3.70%	0.00%	0.00%
		A321-211	9.26%	0.00%	0.00%
		A330-301	9.26%	6.67%	0.00%
		A340-313	12.96%	0.00%	0.00%
18R	**NW3**		**96**	**15**	**3**
		737300	8.33%	0.00%	0.00%
		737800	2.08%	0.00%	0.00%
		777200	19.79%	0.00%	66.67%

		757RR	2.08%	0.00%	0.00%
		A319-111	38.54%	46.67%	0.00%
		A320-211	4.17%	0.00%	0.00%
		A321-211	3.13%	13.33%	0.00%
		A330-301	11.46%	33.33%	0.00%
		A340-313	10.42%	6.67%	33.33%
18R	**ZW1**		**130**	**55**	**31**
		737300	11.54%	7.27%	6.45%
		737800	26.92%	30.91%	35.48%
		777200	0.77%	0.00%	0.00%
		757RR	7.69%	5.45%	22.58%
		A319-111	26.15%	32.73%	16.13%
		A320-211	8.46%	5.45%	16.13%
		A321-211	6.15%	0.00%	0.00%
		A330-301	6.92%	16.36%	0.00%
		A340-313	5.38%	1.82%	3.23%

Table 5: Arrivals fleet mix per route and runway

The table below provides the final fleet mix per route and runway for all 'departures' simulations.

Runway	***Route/track***	***Aircraft type***	***Day***	***Evening***	***Night***
18L	**N2**		**95**	**35**	**18**
		737300	11.58%	20.00%	11.11%
		737800	15.79%	11.43%	22.22%
		757RR	5.26%	0.00%	5.56%
		A319-111	29.47%	37.14%	33.33%
		A320-211	6.32%	8.57%	5.56%
		A321-211	15.79%	14.29%	5.56%
		A330-301	3.16%	0.00%	0.00%
		A340-313	12.63%	8.57%	16.67%
18L	**O2**		**180**	**61**	**64**
		737300	16.67%	22.95%	21.88%

		737800	28.33%	29.51%	28.13%
		777200	1.11%	0.00%	3.13%
		757RR	7.78%	4.92%	6.25%
		A319-111	21.11%	21.31%	20.31%
		A320-211	15.56%	9.84%	9.38%
		A321-211	2.78%	8.20%	4.69%
		A330-301	3.33%	3.28%	3.13%
		A340-313	3.33%	0.00%	3.13%
18L	**Z1**		**109**	**36**	**44**
		737300	17.43%	16.67%	15.91%
		737800	29.36%	41.67%	34.09%
		757RR	7.34%	2.78%	9.09%
		A319-111	21.10%	19.44%	18.18%
		A320-211	16.51%	16.67%	13.64%
		A321-211	4.59%	2.78%	2.27%
		A330-301	3.67%	0.00%	2.27%
		A340-313	0.00%	0.00%	4.55%
24	**N1**		**106**	**15**	**10**
		737300	11.32%	20.00%	10.00%
		737800	7.55%	6.67%	10.00%
		777200	0.00%	6.67%	10.00%
		757RR	23.58%	0.00%	10.00%
		A319-111	14.15%	40.00%	10.00%
		A320-211	7.55%	6.67%	10.00%
		A321-211	9.43%	13.33%	10.00%
		A330-301	20.75%	0.00%	10.00%
		A340-313	5.66%	6.67%	20.00%

24	ZW2		90	22	12
		737300	16.67%	18.18%	8.33%
		737800	24.44%	31.82%	33.33%
		777200	0.00%	0.00%	8.33%
		757RR	13.33%	4.55%	16.67%
		A319-111	20.00%	22.73%	8.33%
		A320-211	14.44%	13.64%	8.33%
		A321-211	2.22%	9.09%	0.00%
		A330-301	6.67%	0.00%	8.33%
		A340-313	2.22%	0.00%	8.33%

Table 6: Departures fleet mix per route and runway

3.4. Runways – Routes/tracks description

Figure 1 shows the runways and routes/tracks for all ‘arrival’ scenarios. The tracks shown are point tracks.

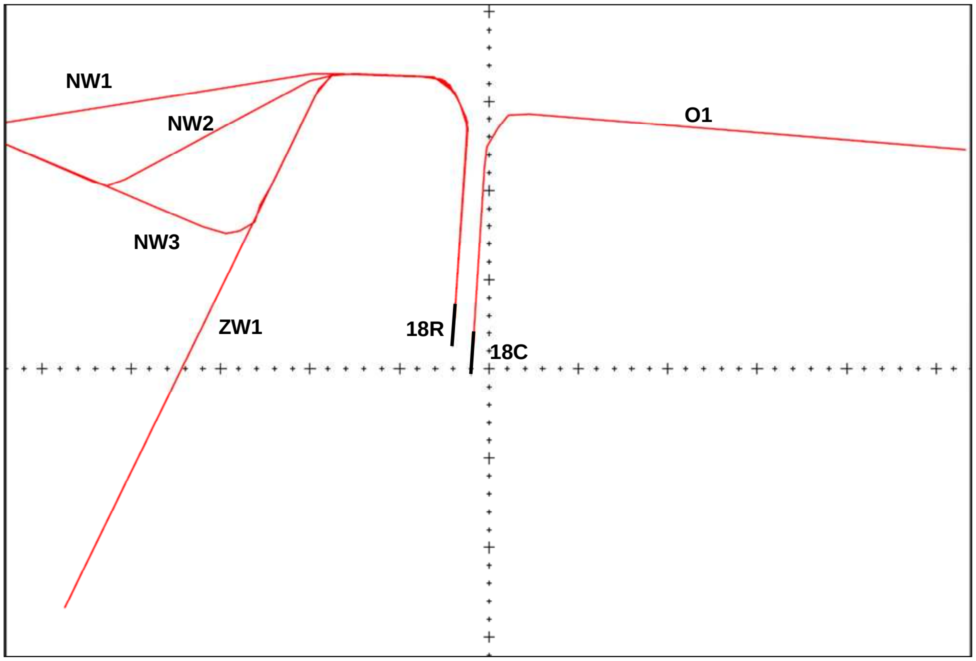


Figure 1: Arrivals runways/tracks.

The trajectories used inside INM have been retrieved from the Fast Time Simulation study. The trajectories represent the P- RNAV approach trajectories which have also been used during the Real Time simulations. The trajectories used are lateral fixed. So, aircraft involved will fly the same lateral trajectories, with no dispersion, tromboning or vectoring involved. Figure 2 shows the runways and routes/tracks for all ‘departures’ scenarios. The tracks shown are point tracks.

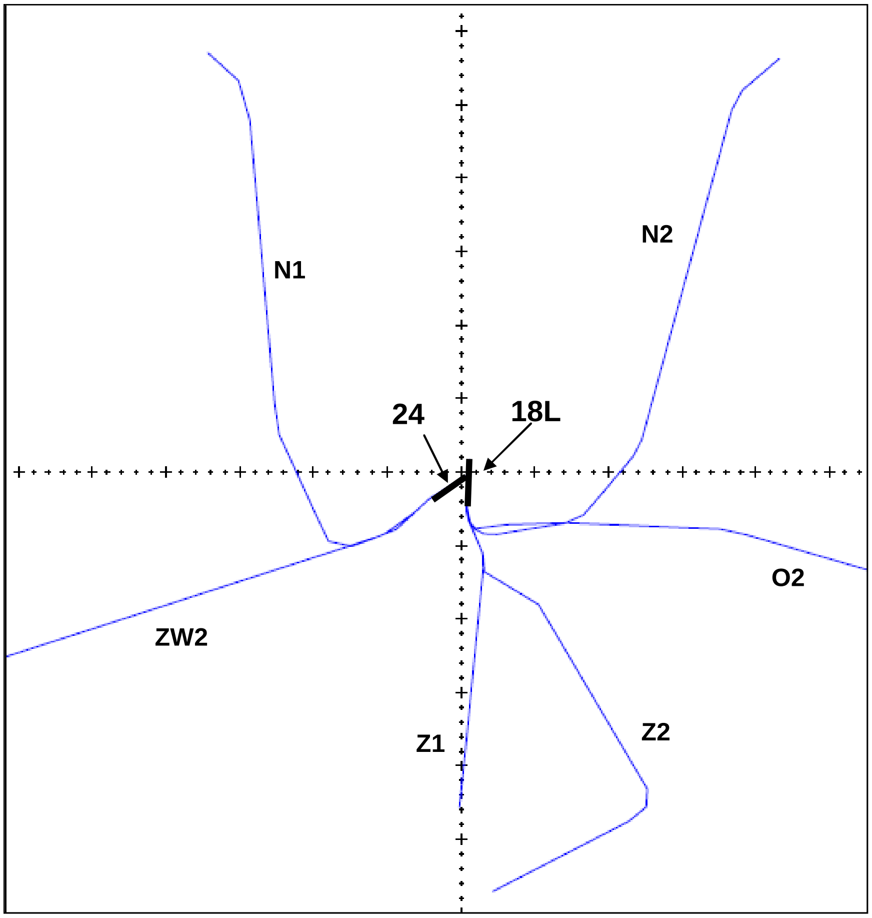


Figure 2: Departures runways/tracks.

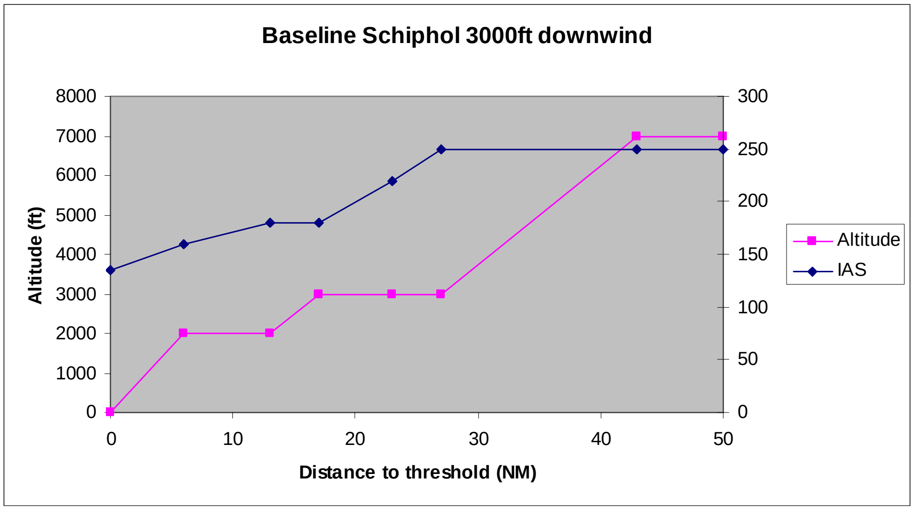
Departure procedures used inside INM are retrieved from the Fast Time Simulation study. The trajectories are published within the AIP the Netherlands as Standard Instrument Departures (SIDs).

3.5. Study/Case parameters description

- Airport elevation: 0 ft
- Atmospheric conditions:
    - Temperature: 59 F
    - Pressure: 29.92 in Hg
    - Headwind: 8 kt
- Terrain: No Terrain elevation data have been used

3.6. Other information

For Schiphol, two additional approach baseline procedures were used besides the reference procedure I. These procedures (3000ft and 4000ft Baseline) are based on the current practice at Schiphol. On downwind, the aircraft descend to transition level (dependent on the pressure, within SII a level at 4000ft has been selected), or to transition altitude (3000ft). The aircraft fly at these altitudes for approximately 10 NM, and descend then to 2000ft base leg. This part is about 7 NM and ends at the GS intercept. These profiles are shown in figure 3.



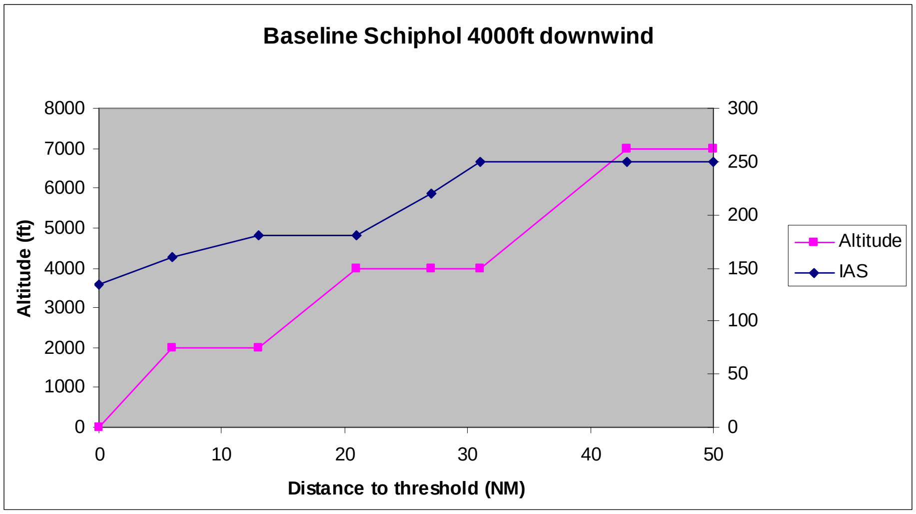


Figure 3: Additional approach baseline procedures for Schiphol

4. Noise results

Noise results are presented in a relative way: SII procedures have to be evaluated versus the Baseline Procedures (arrival procedure I and departure procedure 1). Results are provided only for Lden and Lnight.

Noise levels start at 55 dB for Lden, 50 dB for Lnight, and are incremented by 5dB. The highest noise level threshold to be accounted for in the results remains airport (and metric) specific, and should be determined by the surface of the corresponding contour: there is indeed no point to present contour area variations (in percent) for areas smaller than 1 km^2. In any case, highest threshold levels should not exceed 75 dB for Lden, and 70 dB for Lnight.

4.1. Noise Contours

The following diagrams show noise contours for SII procedures, overlayed on those resulting from Baseline.

Arrivals, Lden

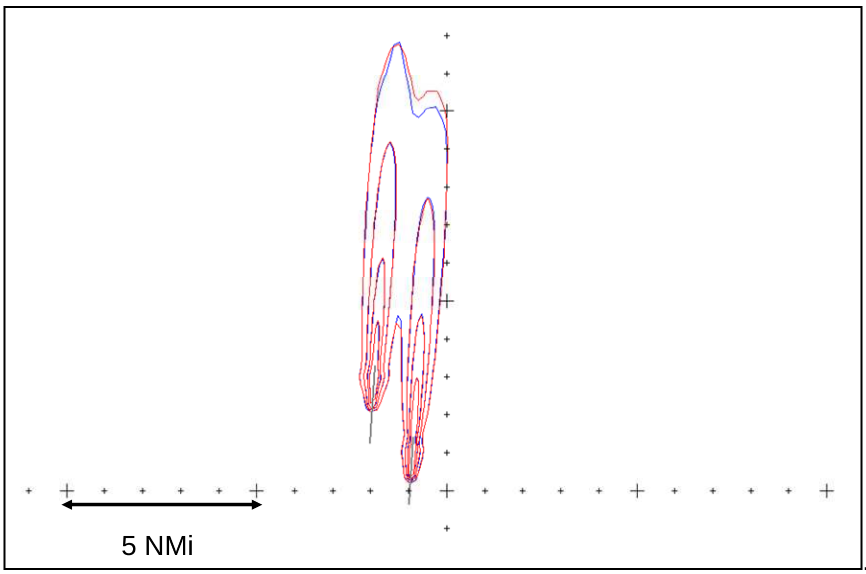


Figure 4: Arrivals Lden Baseline procedure (red) and Procedure II (blue) contours

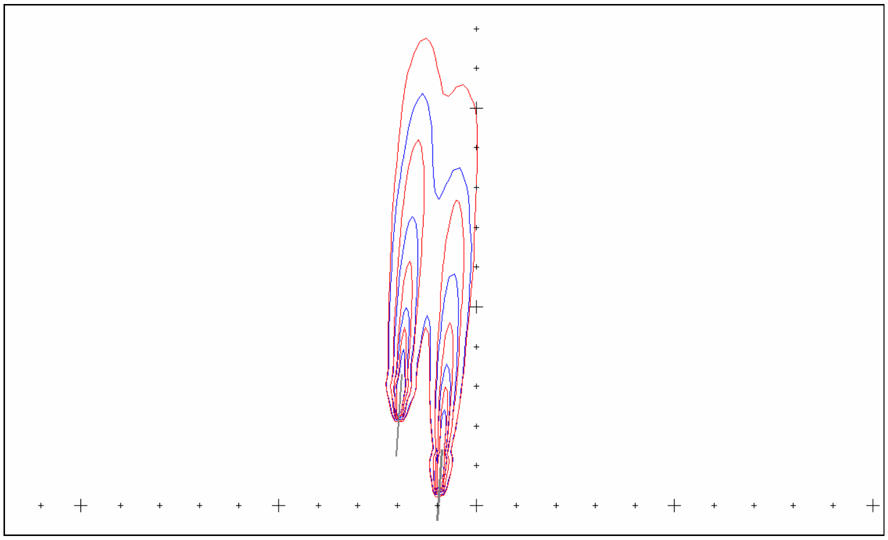


Figure 5: Arrivals Lden Baseline procedure (red) and Procedure III (blue) contours

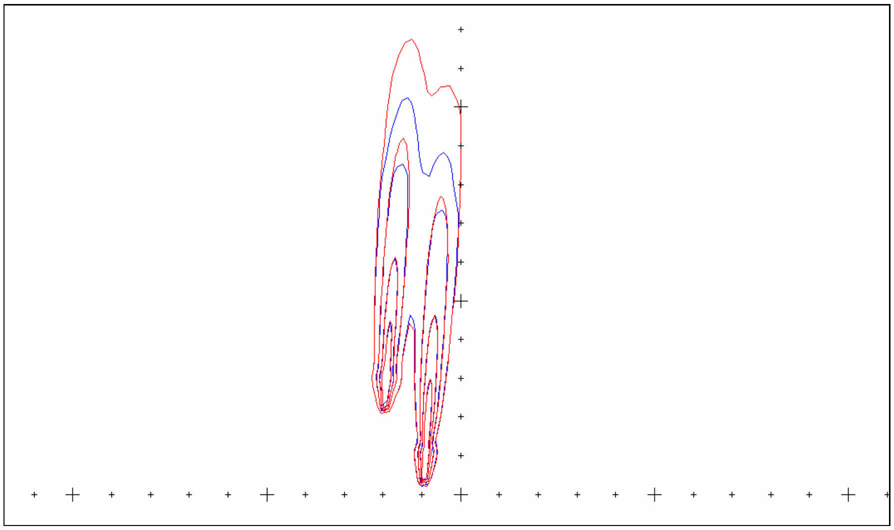


Figure 6: Arrivals Lden Baseline procedure (red) and Procedure IV (blue) contours

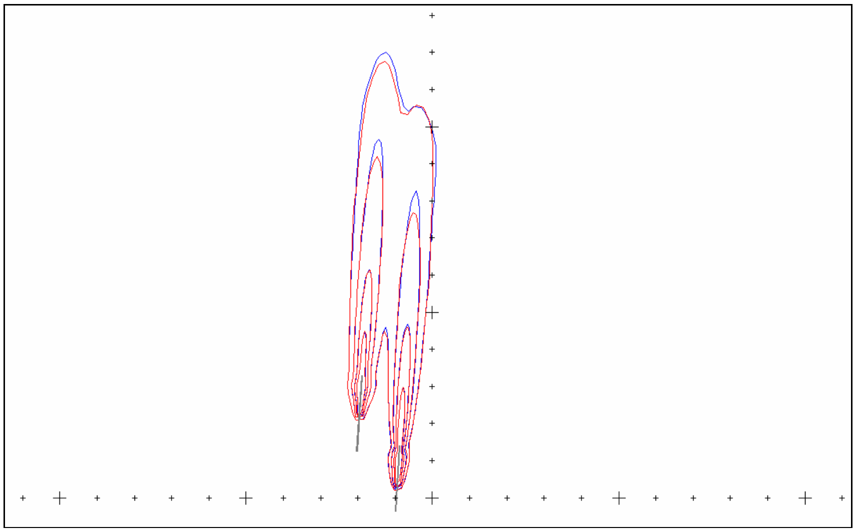


Figure 7: Arrivals Lden Baseline procedure (red) and Procedure V (blue) contours

Arrivals, Lnight

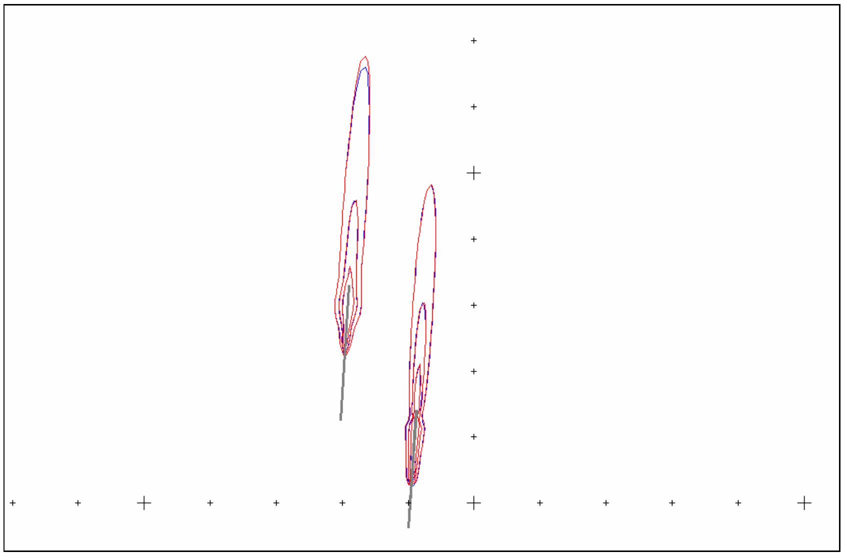


Figure 8: Arrivals Lnight Baseline procedure (red) and Procedure II (blue) contours

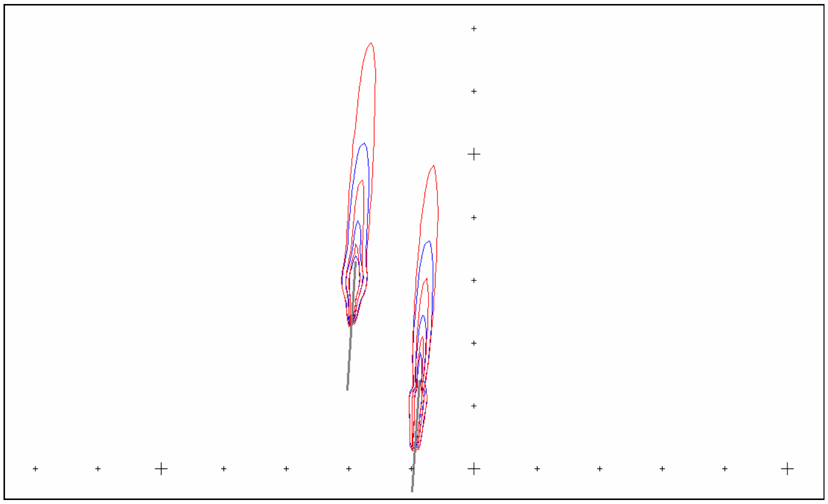


Figure 9: Arrivals Lnight Baseline procedure (red) and Procedure III (blue) contours

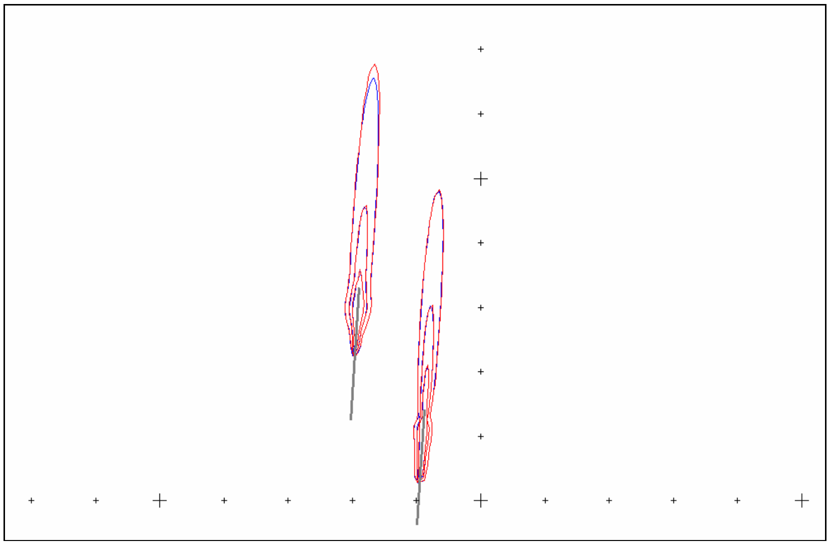


Figure 10: Arrivals Lnight Baseline procedure (red) and Procedure IV (blue) contours

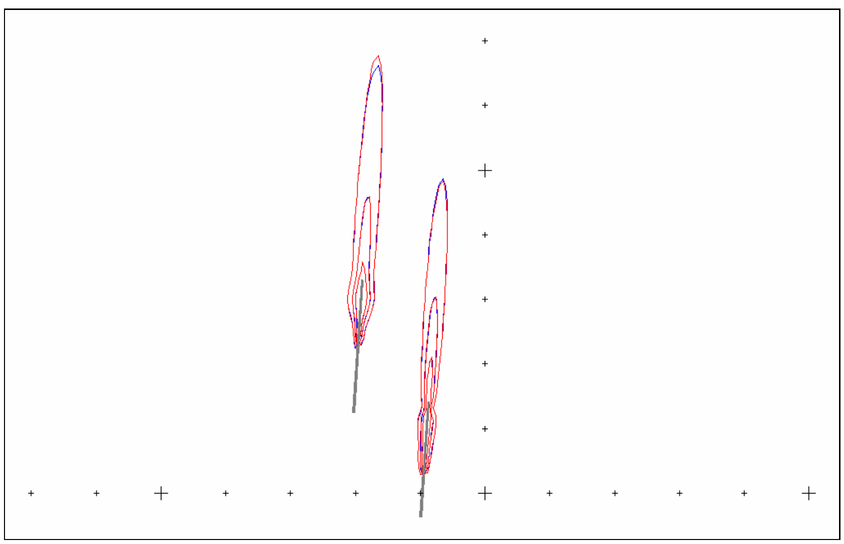


Figure 11: Arrivals Lnight Baseline procedure (red) and Procedure V (blue) contours

Departures, Lden

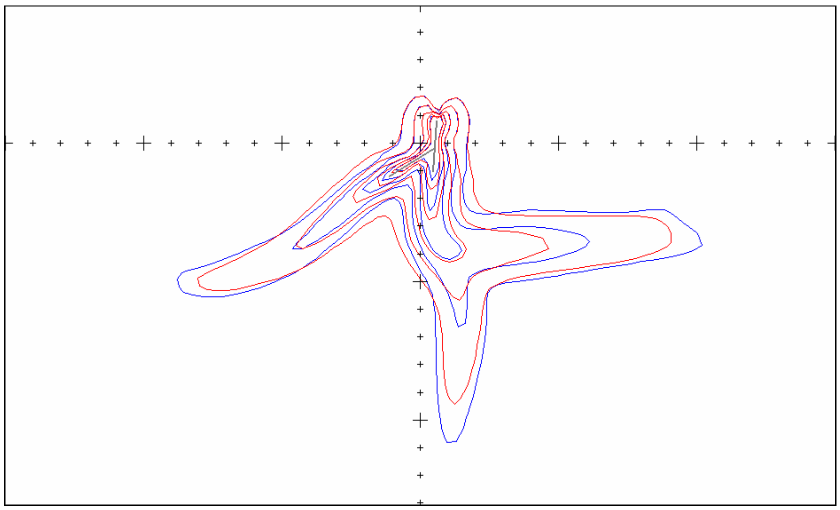


Figure 12: Departures Lden Baseline procedure (red) and Close-in (blue) contours

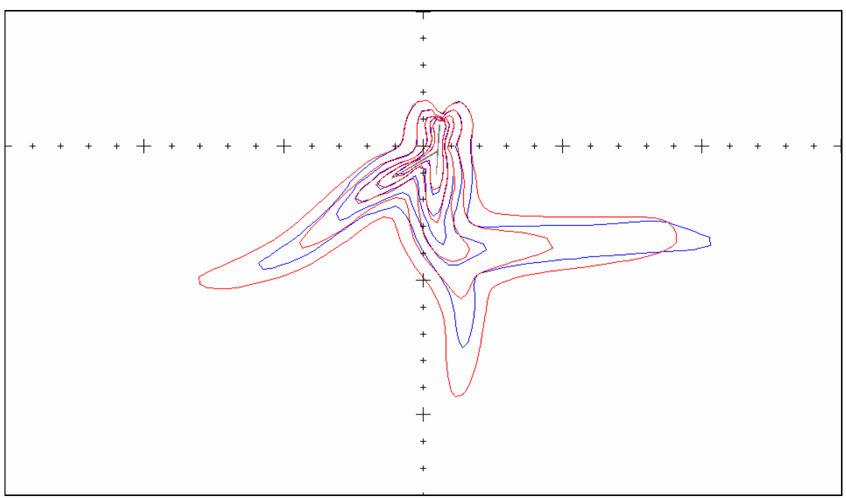


Figure 13: Departures Lden Baseline procedure (red) and Distant (blue) contours

Departures, Lnight

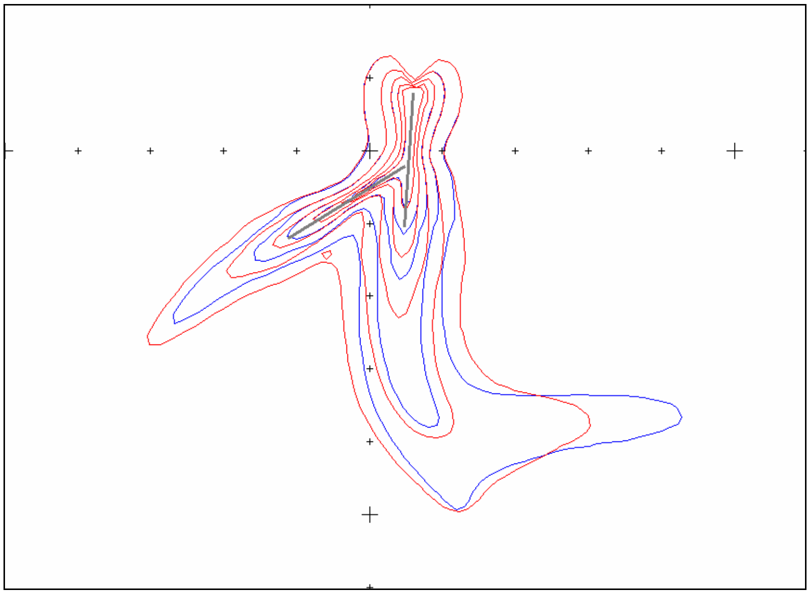


Figure 14: Departures Lnight Baseline procedure (red) and Close-in (blue) contours

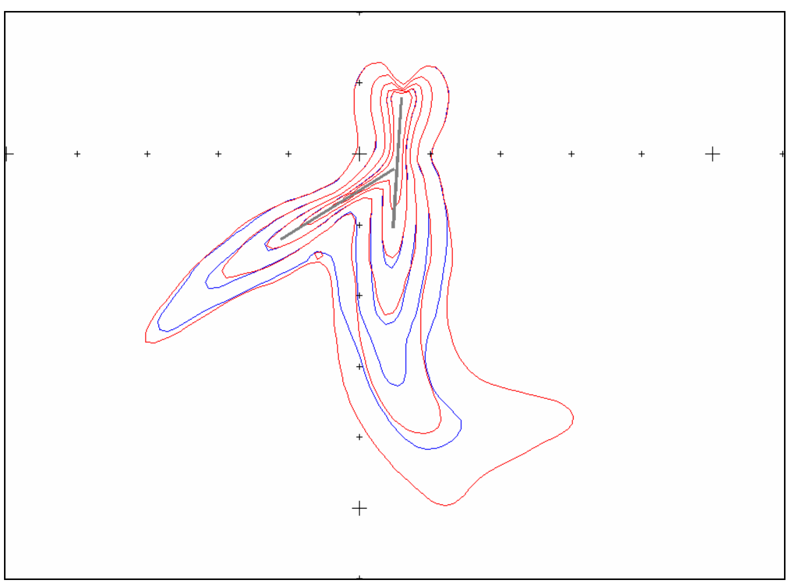


Figure 15: Departures Lnight Baseline procedure (red) and Distant (blue) contours

Arrivals, additional baseline 3000 ft, Lden

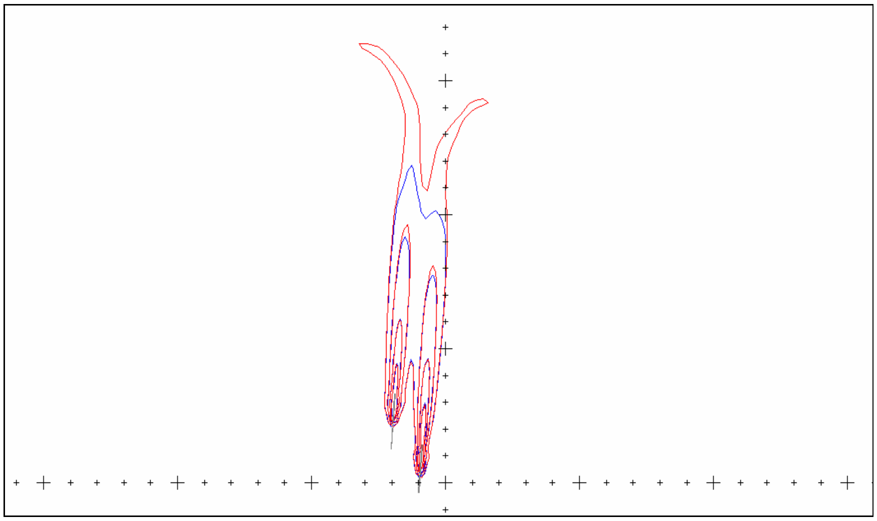


Figure 16: Arrivals Lden Baseline_3000ft procedure (red) and Procedure II (blue) contours

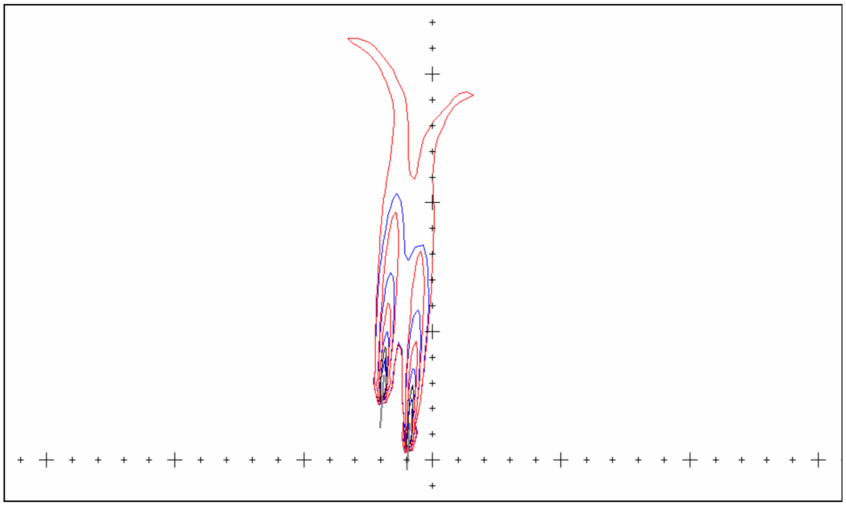


Figure 17: Arrivals Lden Baseline_3000ft procedure (red) and Procedure III (blue) contours

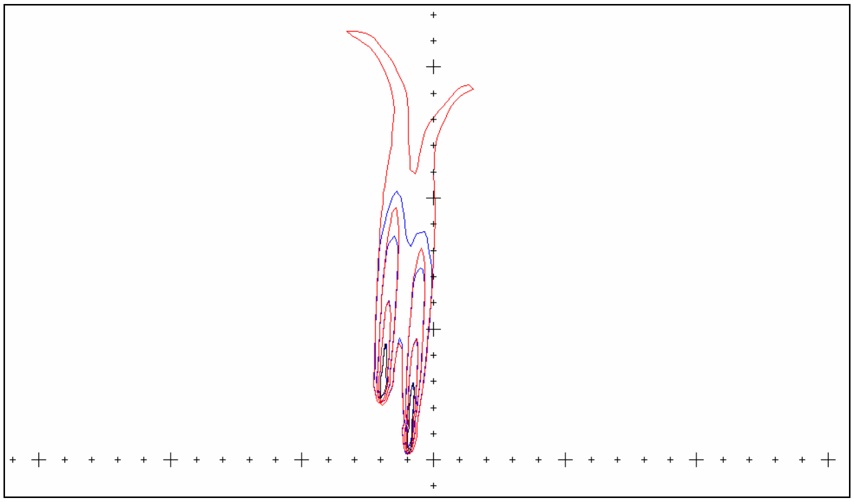


Figure 18: Arrivals Lden Baseline_3000ft procedure (red) and Procedure IV (blue) contours

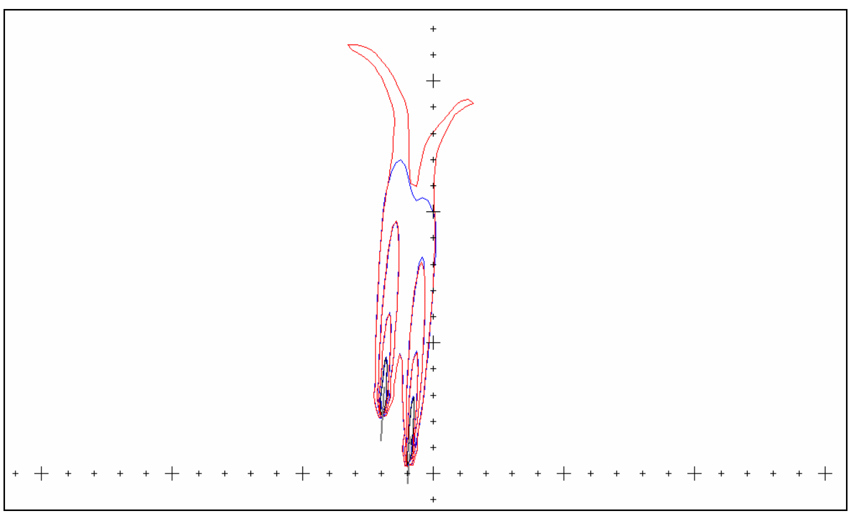


Figure 19: Arrivals Lden Baseline_3000ft procedure (red) and Procedure V (blue) contours

Arrivals, additional baseline 3000 ft, Lnight

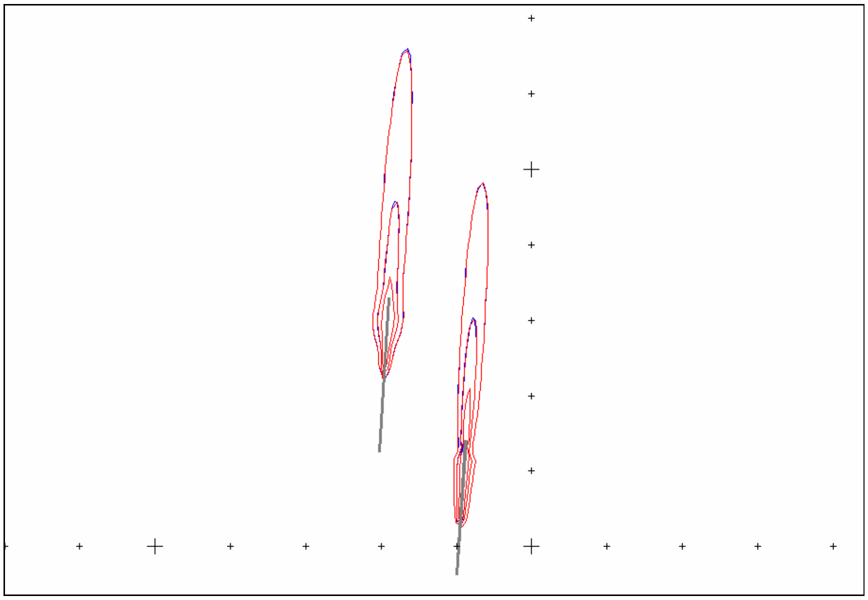


Figure 20: Arrivals Lnight Baseline_3000ft procedure (red) and Procedure II (blue) contours

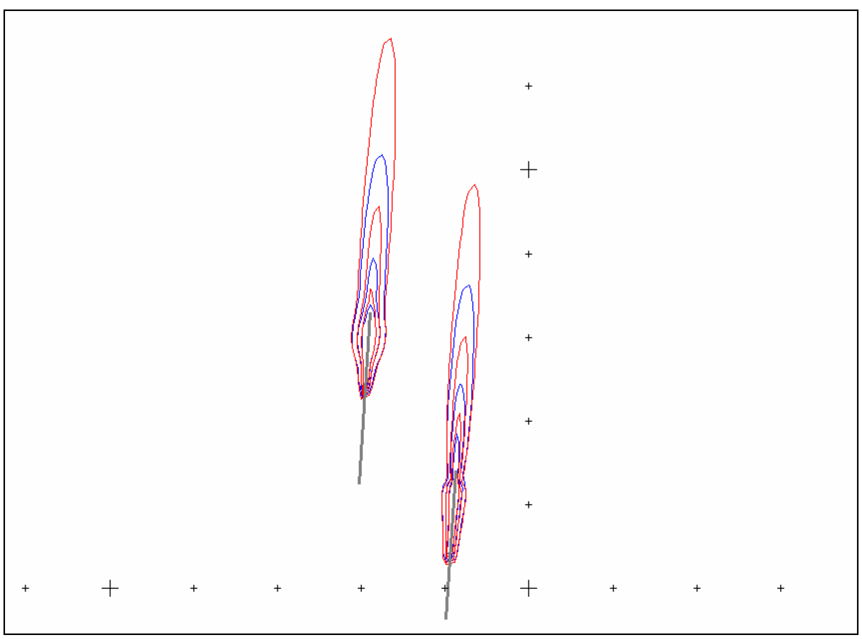


Figure 21: Arrivals Lnight Baseline_3000ft procedure (red) and Procedure III (blue) contours

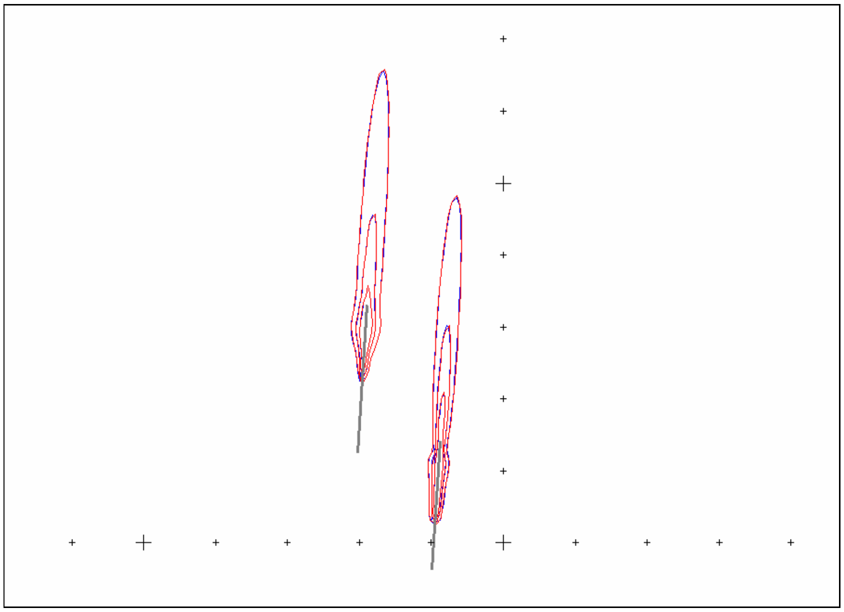


Figure 22: Arrivals Lnight Baseline_3000ft procedure (red) and Procedure IV (blue) contours

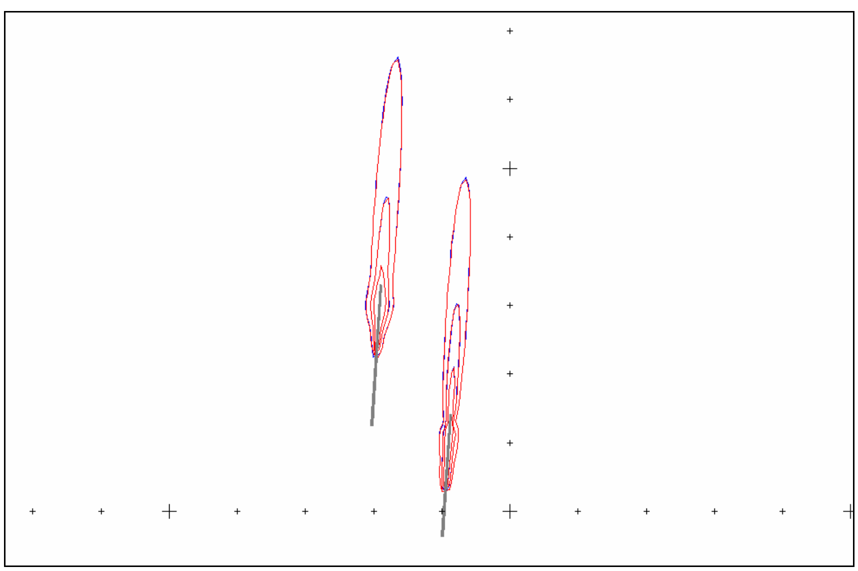


Figure 23: Arrivals Lnight Baseline_3000ft procedure (red) and Procedure V (blue) contours

Arrivals, additional baseline 4000 ft.

The contours for the Baseline 4000 ft arrivals are virtually identical to those of the Baseline 3000 ft arrivals in the region of interest. For this reason the Baseline 4000 ft arrivals contours are not shown here.

4.2. Contour area tables

- Contour areas expressed in Km^2, to two decimal places
- One table with absolute values, one table with variations (in percent) Vs Baseline

Arrivals, Lden

	Contour area (Km^2)				
Contour level	Baseline	Proc 2	Proc 3	Proc 4	Proc 5
> 55 Lden	60.12	57.38	44.01	46.81	61.69
> 60 Lden	22.97	22.60	14.68	21.24	23.66
> 65 Lden	7.11	7.06	4.66	6.96	7.14
> 70 Lden	2.41	2.35	1.74	2.33	2.36

	Contour area change (%)				
Contour level	Baseline	Proc 2	Proc 3	Proc 4	Proc 5
> 55 Lden	Reference	-5%	-27%	-22%	3%
> 60 Lden		-2%	-36%	-8%	3%
> 65 Lden		-1%	-35%	-2%	0%
> 70 Lden		-2%	-28%	-3%	-2%

Arrivals, Lnight

	Contour area (Km^2)				
Contour level	Baseline	Proc 2	Proc 3	Proc 4	Proc 5
> 50 Lden	8.48	8.29	5.20	8.14	8.37
> 55 Lden	2.63	2.58	1.81	2.54	2.59
> 60 Lden	0.93	0.92	0.77	0.91	0.92

	Contour area change (%)				
Contour level	Baseline	Proc 2	Proc 3	Proc 4	Proc 5
> 50 Lden	Reference	-2%	-39%	-4%	-1%
> 55 Lden		-2%	-31%	-3%	-2%
> 60 Lden		-2%	-17%	-2%	-1%

Departures, Lden

	Contour area (Km^2)		
Contour level	Baseline	Close-in	Distant
> 55 Lden	166.35	181.87	113.16
> 60 Lden	67.32	65.78	40.55
> 65 Lden	27.00	20.42	20.76
> 70 Lden	10.81	8.14	10.45
> 75 Lden	4.56	3.79	4.77

	Contour area change (%)		
Contour level	Baseline	Close-in	Distant
> 55 Lden	Reference	9%	-32%
> 60 Lden		-2%	-40%
> 65 Lden		-24%	-23%
> 70 Lden		-25%	-3%
> 75 Lden		-17%	5%

Departures, Lnight

	Contour area (Km^2)		
Contour level	Baseline	Close-in	Distant
> 50 Lden	42.58	36.88	29.51
> 55 Lden	18.15	13.58	15.08
> 60 Lden	7.13	5.52	7.37
> 65 Lden	3.06	2.67	3.17
> 70 Lden	1.26	1.24	1.26

	Contour area change (%)		
Contour level	Baseline	Close-in	Distant
> 50 Lden	Reference	-13%	-31%
> 55 Lden		-25%	-17%
> 60 Lden		-23%	3%
> 65 Lden		-13%	3%
> 70 Lden		-1%	0%

Arrivals, Baseline-3000ft, Lden

	Contour area (Km^2)				
Contour level	Bas-3000	Proc 2	Proc 3	Proc 4	Proc 5
> 55 Lden	77.58	57.38	44.01	46.81	61.69
> 60 Lden	23.56	22.60	14.68	21.24	23.66
> 65 Lden	7.04	7.06	4.66	6.96	7.14
> 70 Lden	2.35	2.35	1.74	2.33	2.36

	Contour area change (%)				
Contour level	Bas-3000	Proc 2	Proc 3	Proc 4	Proc 5
> 55 Lden	Reference	-26%	-43%	-40%	-20%
> 60 Lden		-4%	-38%	-10%	0%
> 65 Lden		0%	-34%	-1%	1%
> 70 Lden		0%	-26%	-1%	1%

Arrivals, Baseline-3000ft, Lnight

	Contour area (Km^2)				
Contour level	Bas-3000	Proc 2	Proc 3	Proc 4	Proc 5
> 50 Lden	8.27	8.29	5.20	8.14	8.37
> 55 Lden	2.58	2.58	1.81	2.54	2.59
> 60 Lden	0.92	0.92	0.77	0.91	0.92

	Contour area change (%)				
Contour level	Bas-3000	Proc 2	Proc 3	Proc 4	Proc 5
> 50 Lden	Reference	0%	-37%	-2%	1%
> 55 Lden		0%	-30%	-2%	0%
> 60 Lden		0%	-16%	-1%	0%

Arrivals, Baseline-4000ft, Lden

	Contour area (Km^2)				
Contour level	Bas-4000	Proc 2	Proc 3	Proc 4	Proc 5
> 55 Lden	77.38	57.38	44.01	46.81	61.69
> 60 Lden	23.48	22.60	14.68	21.24	23.66
> 65 Lden	7.04	7.06	4.66	6.96	7.14
> 70 Lden	2.35	2.35	1.74	2.33	2.36

	Contour area change (%)				
Contour level	Bas-4000	Proc 2	Proc 3	Proc 4	Proc 5
> 55 Lden	Reference	-26%	-43%	-40%	-20%
> 60 Lden		-4%	-38%	-10%	1%
> 65 Lden		0%	-34%	-1%	1%
> 70 Lden		0%	-26%	-1%	1%

Arrivals, Baseline-4000ft, Lnight

	Contour area (Km^2)				
Contour level	Bas-4000	Proc 2	Proc 3	Proc 4	Proc 5
> 50 Lden	8.27	8.29	5.20	8.14	8.37
> 55 Lden	2.58	2.58	1.81	2.54	2.59
> 60 Lden	0.92	0.92	0.77	0.91	0.92

	Contour area change (%)				
Contour level	Bas-4000	Proc 2	Proc 3	Proc 4	Proc 5
> 50 Lden	Reference	0%	-37%	-2%	1%
> 55 Lden		0%	-30%	-2%	0%
> 60 Lden		0%	-16%	-1%	0%

4.3. Bar-charts

Arrivals, Lden

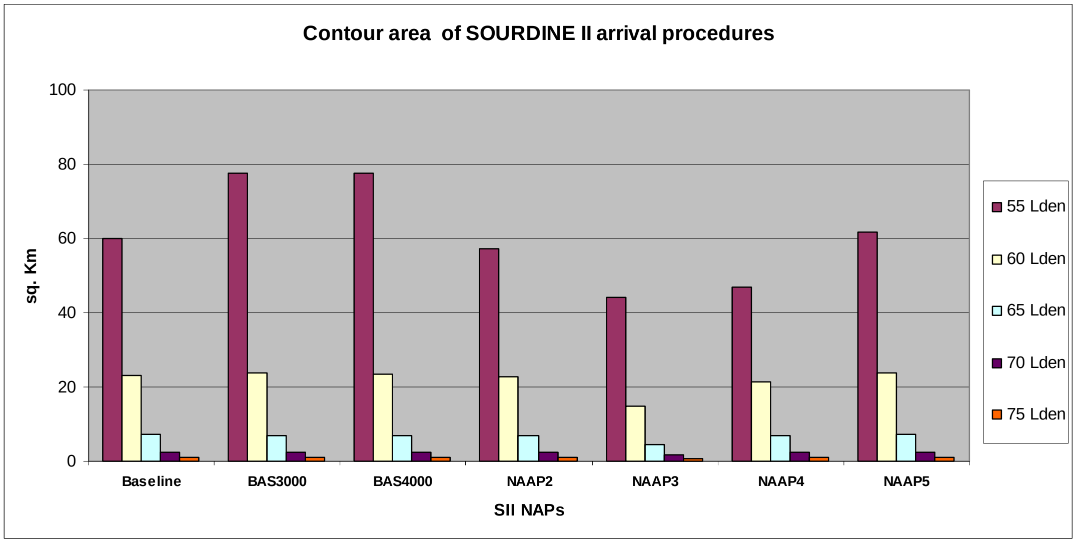


Figure 24: Arrivals Lden contour area bar charts

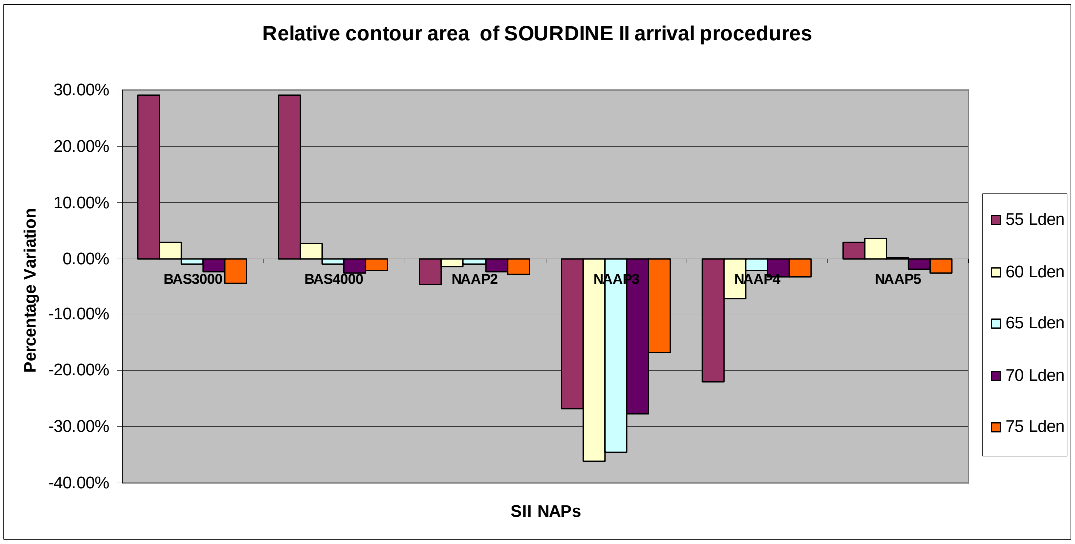


Figure 25: Arrivals Lden relative contour area bar charts

Arrivals, Lnight

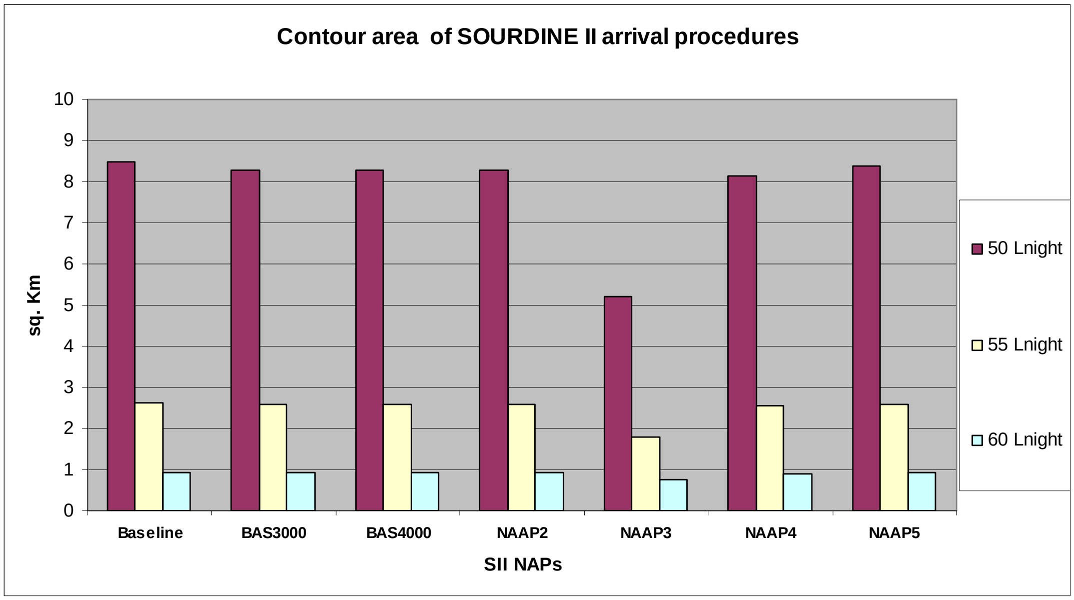


Figure 26: Arrivals Lnight contour area bar charts

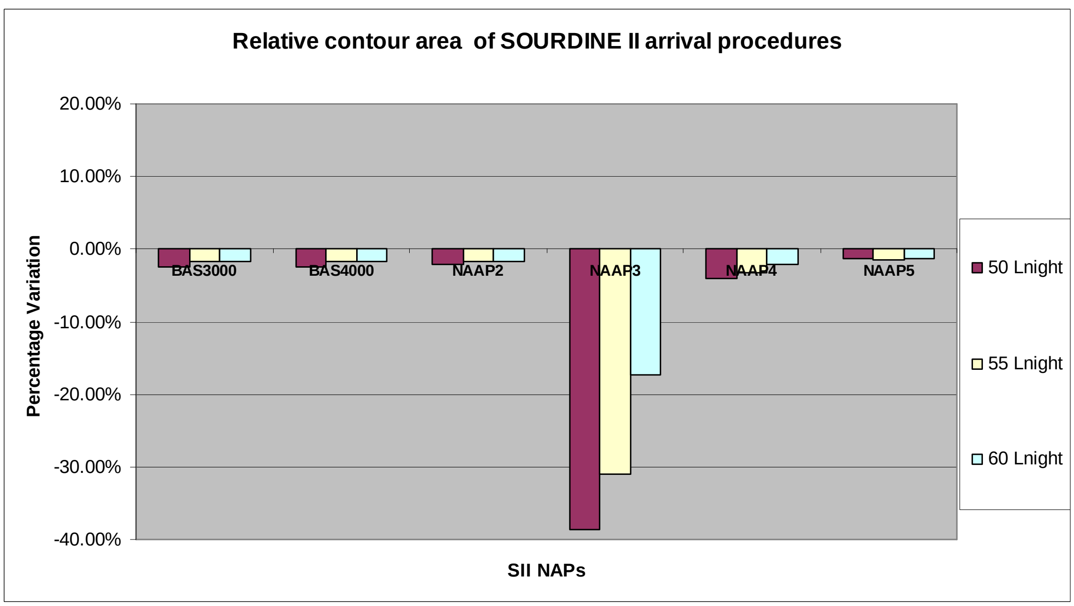


Figure 27: Arrivals Lnight relative contour area bar charts

Departures, Lden

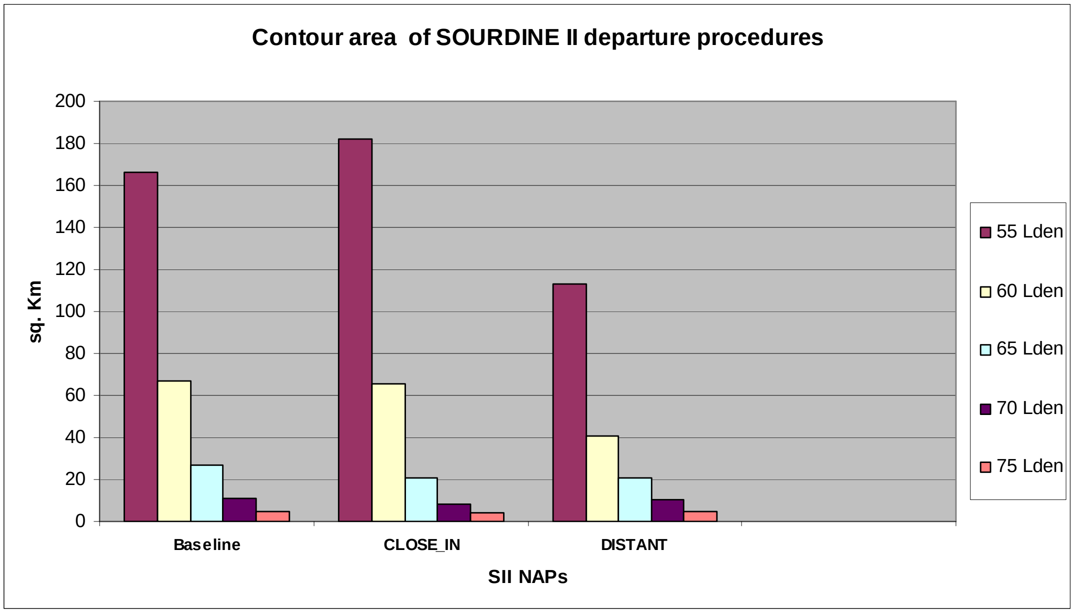


Figure 28: Departures Lden contour area bar charts

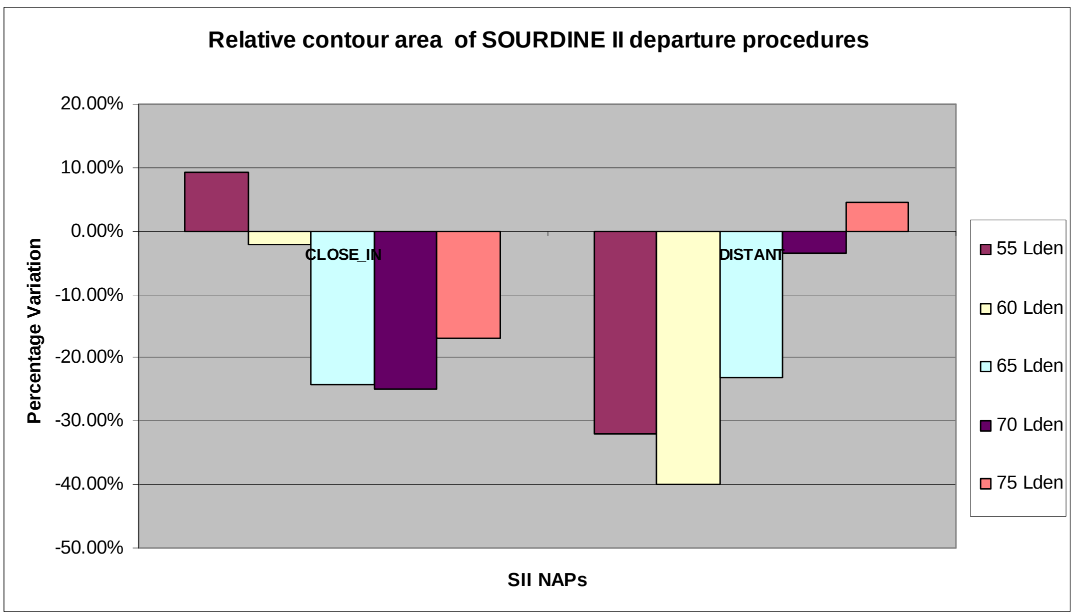


Figure 29: Departures Lden relative contour area bar charts

Departures, Lnight

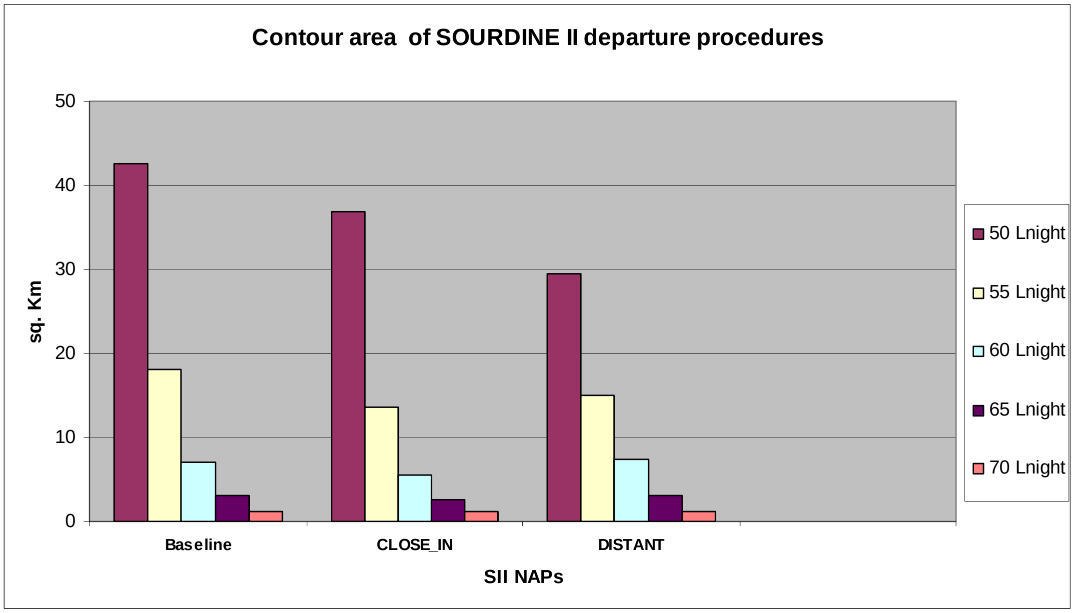


Figure 30: Departures Lnight contour area bar charts

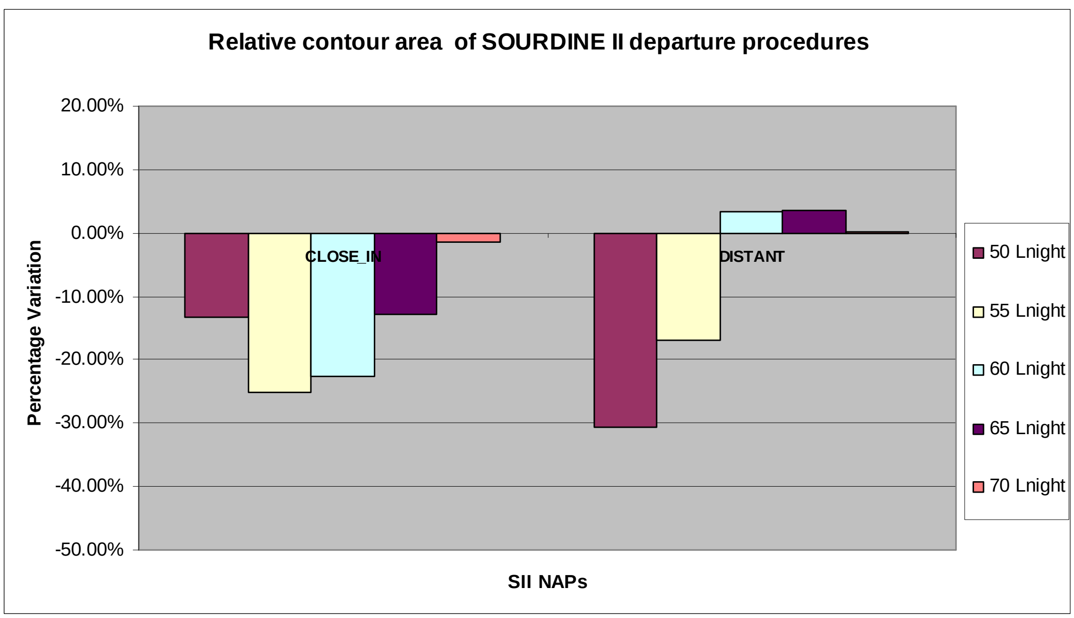


Figure 31: Departures Lnight relative contour area bar charts

5. Analysis of noise results

5.1. Lden, Arrivals

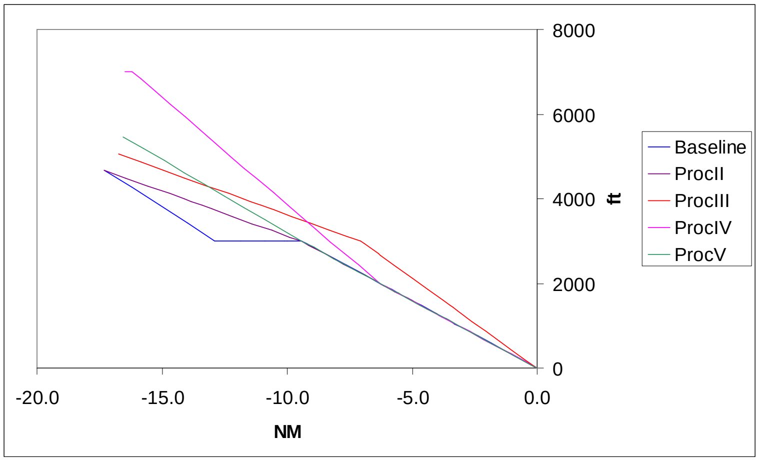


Figure 32: Approach altitude profiles

5.1.1. Procedure II

Only the outer contour of figure 4 (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.

5.1.2. Procedure III

All contours of figure 5 are significantly smaller for Procedure III. The final descent slope for Procedure III is 4°, vs. 3° for the Baseline. Right underneath the flight path, the distance effect alone will cause a difference in noise level of 2.5 dB (=20 x log (4/3)), which explains why the 55 dB contour of Procedure III is located more or less halfway the 55 dB and 60 dB Baseline contours, and similar for the other contours. In this case the larger differences in thrust settings (e.g. ~2000 vs. ~4400 pounds for the A319 at final approach) will add to the difference in noise levels.

5.1.3. Procedure IV

At distances larger than ~6.5 NM in figure 6 the altitude of the Procedure IV is higher than the Baseline, at smaller distances the profiles coincide. So only the outer contour (55 dB) is significantly smaller.

5.1.4. Procedure V

The altitude profiles in figure 7 are the same at distances smaller than 10 NM, which is reflected in the contours. Only a small difference can be seen in the 60 dB contours, probably caused by differences in the thrust profiles of some aircraft (e.g. A340).

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.

5.1.5. Additional baselines

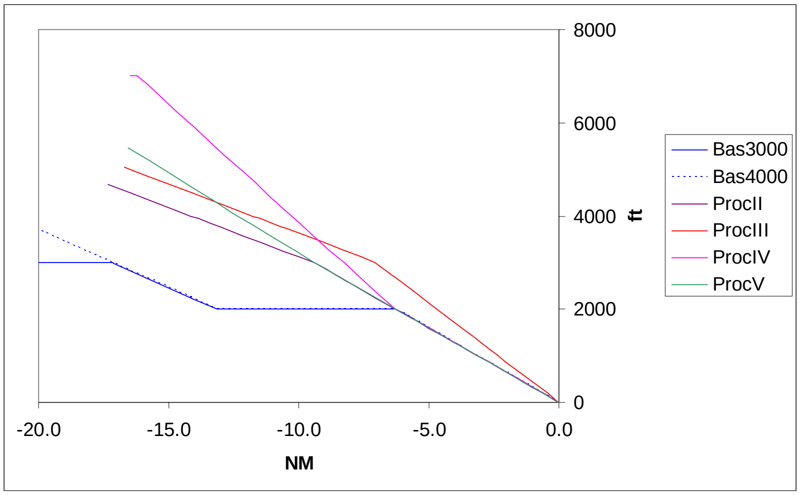


Figure 33: Approach altitude profiles, additional baselines

As the noise levels, as shown in figs. 16 - 19, are mainly determined by the altitude profiles at distances smaller than 15 NM, it is clear from figure 33 why the results for both additional baseline procedures are the same. As the profiles coincide with the SII baseline profile at distances below 6 NM, only the outer contours are larger.

The results for the Lnight values (figs. 20 – 23) are the same as before.

5.2. Lden, Departures

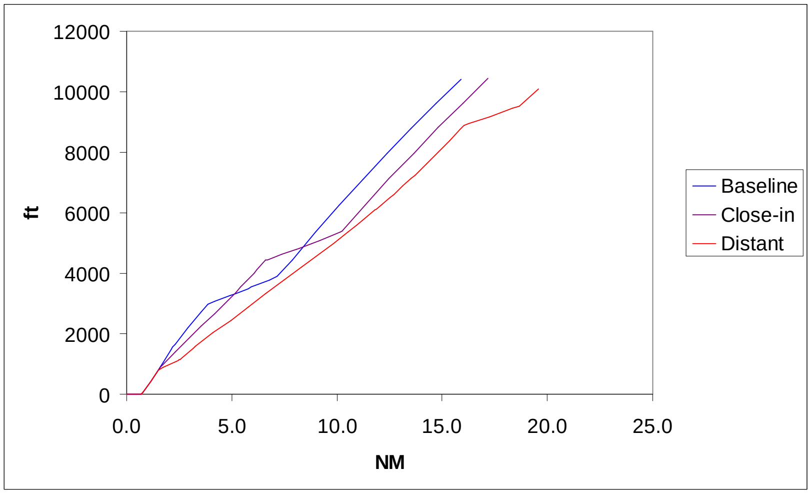


Figure 34: Departure altitude profiles

5.2.1. Close-in

At larger distances (~10 NM) the Close-in procedure is slightly noisier than the Baseline procedure (fig. 29), which can be explained by the lower altitude. However, the differences at smaller distances, where the Close-in procedure is slightly less noisy, can not be correlated with the altitudes. In figure 35 the thrust profiles are shown for the A319.

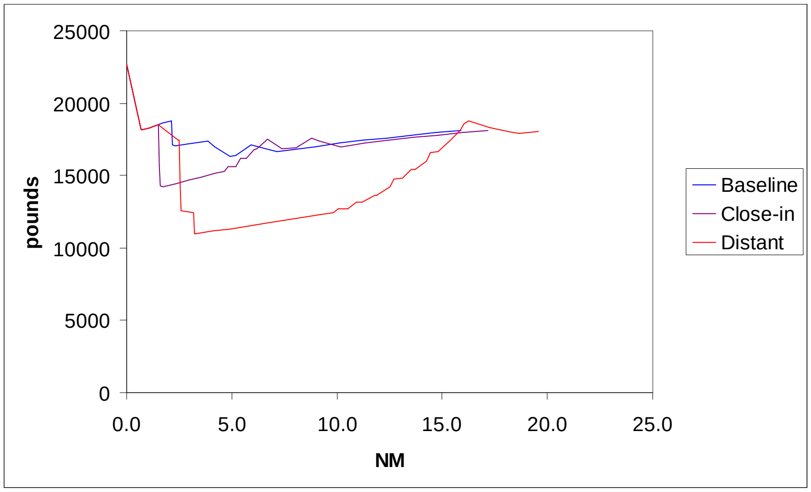


Figure 35: Departure thrust profiles for the A319

At distances smaller than 5 NM the difference between the profiles is mainly in the thrust, instead of in the altitude, causing the Baseline procedure to be noisier between 2 and 5 NM.

5.2.2. Distant

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.

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

5.3. Lnight, Arrivals

The Lnight contours (50 dB and higher, Figs. 8 – 11) are much smaller than the Lden contours, and are located within ~ 7 NM from the runways. In this area, the only profile that is different from the Baseline is that of Procedure III, which is consistent with the contour plots.

5.4. Lnight, Departures

The conclusions for the Lnight levels are basically the same as for the Lden.

6. Conclusions

The Integrated Noise Model INM has been used to produce noise contours at Amsterdam Airport Schiphol for different arrival procedures applied to a single arrival scenario (i.e. fleet mix / runway / track combination), and different departure procedures, also applied to the same departure scenario. In total seven arrival procedures and three departure procedures were analyzed.

The main conclusions are:

- The sizes of the contours at arrival are mainly determined by the altitude profiles, while at departure the thrust seems to be the dominant parameter.

Arrivals:

- Arrival Procedure V (Proc V) has noise contours similar to the baseline procedure (Proc I), all the other procedures generate smaller contours.
- The most significant reduction is obtained by Proc III. The ranking of the reductions is:
    - Proc III > Proc IV > Proc II > Proc V
- The same ranking is found for both Lden and Lnight.
- The additional two baseline procedures, based on the current practice at Schiphol, have a lower altitude at distances larger than 6 NM, which is reflected in larger contours for the lower noise levels.

Departures:

- The ‘Distant‘ procedure causes significantly smaller Lden noise contours (except at small distances), because of the strongly reduced thrust from 3 to 15 NM from the runway.
- The ‘Close-in’ procedure also yields some reduction in contour size, except at larger distances.
- The same ranking is found for Lnight contours, although the reductions are smaller.

The main differences in Lden and Lnight contours are caused by differences in traffic volumes: at smaller volumes, the contour of a specific level shifts to smaller distances, and is thus determined by the profile (altitude or thrust) at smaller distances.