

SOURDINE II

D7-2

Comparative Analysis of Results

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

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Document Change Log

Release	Author	Affected Sections / Comments	Document Nature	Date
0.1	ISDEFE	All, Creation	Confidential	29/12/04
0.2	ISDEFE	All (working document)	Confidential	23/06/05
0.3	ISDEFE	All (tables of results and analysis)	Confidential	29/07/05
0.4	ISDEFE	All (new comments and results)	Confidential	25/08/05
0.5	ISDEFE	All (revision of data and conclusions)	Confidential	05/09/05
0.6	ISDEFE	All (format revision & SICTA contribution)	Confidential	07/09/05
0.7	ISDEFE	All (general revision of ISDEFE & SICTA)	Confidential	08/09/05
0.8	ISDEFE	All (comments from NLR, Airbus France and INECO)	Confidential	3/10/05
0.9	ISDEFE	All (comments from AENA)	Confidential	10/10/05
0.10	ISDEFE	4.3, 4.4 and annex B (new comments from INECO)	Confidential	14/10/05
0.11	ISDEFE	Chapter 6 (comments from EC and ISDEFE)	Confidential	01/12/05
1.0	ISDEFE	EC approved version	Public	19/12/05

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Review and Approval of the Document

Organisation Responsible for Review	Reference of comment documents	Date
AENA		01/12/05
Organisation Responsible for Approval	Name of person approving the document	Date
Project Manager	Ruud den Boer	01/12/05
ISDEFE Responsable	Vicente Bordón	01/12/05
EC Official	Morten Jensen	19/12/05
Document Information		
Document title	D7-2 Comparative analysis of results	
Version	1.0	
Date	19/12/05	
Classification	Public	
Work package	WP7 (WP7-3)	
Document identification	SII_WP7-3_D7-2-Comparative analysis of results_ISD_P_v10	
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Summary

This document depicts the process of data analysis carried out in SOURDINE II project in order to reach some conclusions about new noise abatement procedures designed and improved in the project for approach and departure operations. The main objective of this document is giving high level and grouped results, specific conclusions and recommendations to allow decision makers have a primary approach about the goodness of proposed procedures.

Over the course of the SOURDINE II project, a number of new procedures was selected and several simulation exercises had been run in several airports by several partners of the consortium. Those simulations have provided specific information and data about the influence of new procedures in the areas of NOISE, SAFETY, CAPACITY, WORKLOAD - pilots and controllers -, ECONOMICS and ACCEPTANCE - of pilots and controllers. The whole set of data and results has been put together in this document and a Comparative analysis of results of them is given.

Project partners agreed in the first stages of the project a list of metrics and indicators that had to be measured so as to provide accurate information for each area. The list can be found in the deliverable D2-1. This list has been refined after the simulation runs, since new metrics have been added and others have been removed. Some indicators and metrics has been also broken down in more specific ones. The final list of metric and indicators measured can be found in annex A of the present document.

Since data come from different simulation exercises runs, from different groups of people involved and from different airports, some assumptions have been made in order to provide uniformity and coherency to the calculations. Among these assumptions, how to group indicators or giving different weights to metrics to calculate averages are the main ones.

All the results are expressed in percentages. The reason is that all the figures are referred to the reference procedure or reference procedure, so, each result has to be read as how much better or worse is the procedure for the correspondent indicator with respect to the reference. In some cases, a negative percentage will mean improvement – e.g., reduction of noise contour - and in others it will mean worsening – e.g., throughput of the airport. This fact has been also taken in account to calculate averages.

Tables of data in this document present the results for each indicator and for each airport. Not all the cells are filled in, since for the areas of SAFETY, WORKLOAD and ACCEPTANCE only numerical data from RTS in Amsterdam – Schiphol are available. Some other indicators are missing due to different reasons which can be found in the deliverable D7-1. For departure procedures, only noise results and pilots' acceptance - for one of the procedures - are available.

The Comparative analysis of results provides the following outputs:

- Comparison bar charts by area and airport.
- Comparison bar charts by procedure and airport.
- Conclusions.
- Recommendations.

From the comparison chart by area and airport, the main conclusions obtained are:

- NOISE: all of the procedures has more or less the same conclusions for all of the airports. Procedure III reduces dramatically noise, procedure IV reduces it moderately and procedures II and V reduces it slightly.
- SAFETY: procedure II and II-A do not have significant influence in the level of safety reached with the reference procedure whereas procedure V shows a slight increment of risks. There is no data for procedures III and IV.
- CAPACITY: a general loss of capacity of the airports is reported from simulations, ranked from a moderate one in Paris – CDG for procedures II, III and V to a great one with procedure IV in Amsterdam – Schiphol.

- **WORKLOAD:** both controllers and pilots experience a decrease of their workload with procedures II and II-A, but pilots have a significant increment with procedure V whereas controllers still have a reduction. There is no data available for procedures III and IV.
- **ACCEPTANCE:** pilots are willing to accept procedures II and II-A but they reject procedure V, always comparing with the reference procedure. Controllers do not show significant acceptance or rejection for procedures II and II-A but a strong rejection for procedure V. There is no data available for procedures III and IV.

From the comparison chart by procedure and airport, the main conclusions obtained are:

- **PROCEDURE II:** this procedure is better than the reference for NOISE, SAFETY, WORKLOAD and ACCEPTANCE - above all, of the pilots - but implies a significant amount of delays with respects the reference procedure and a slight loss of throughput of the airports.
- **PROCEDURE II-A:** results for II-A are the same as the procedure II with less reduction of NOISE.
- **PROCEDURE III:** out of the results available - NOISE and CAPACITY -, this procedure shows a large reduction of noise with a slight loss of throughput and a moderate increment of delays.
- **PROCEDURE IV:** out of the results available - NOISE and CAPACITY -, this procedure shows a significant reduction of NOISE, but an exaggerated increment of delays. Throughput has a significant loss, as well.
- **PROCEDURE V:** only NOISE and controllers' WORKLOAD improve with regards the reference procedure. Delays, pilots' WORKLOAD and controllers' ACCEPTANCE are severely penalized.

Table of contents

Summary	5
1. Introduction	10
1.1. Purpose	10
1.2. Background	10
1.3. Document structure	10
1.4. Glossary	11
1.5. Reference documents	12
2. Methodology	13
2.1. Objectives	13
2.2. Process	13
2.2.1. Procedures: selection and refinement process	14
2.2.2. Results analysis	15
2.3. Relationship with other Work Packages	21
3. Procedures: selection and refinement process	23
4. Results and procedure analysis	24
4.1. Overview of results available	24
4.2. Assumptions for the Comparative analysis of results	25
4.3. Procedure analysis (approach)	28
4.3.1. Procedure II	28
4.3.2. Procedure II-A	33
4.3.3. Procedure III	37
4.3.4. Procedure IV	39
4.3.5. Procedure V	41
4.4. Procedures analysis (departure)	46
4.4.1. Procedure 2: Close-in	46
4.4.2. Procedure 3: Distant	48
5. Comparison of procedures	50
5.1. Comparison charts	50
5.1.1. Analysis of NOISE (arrivals)	50
5.1.2. Analysis of NOISE (departures)	53
5.1.3. Analysis of SAFETY*	56
5.1.4. Analysis of CAPACITY	57
5.1.5. Analysis of WORKLOAD*	59
5.1.6. Analysis of ECONOMICS	60
5.1.7. Analysis of ACCEPTANCE (pilots & controllers)*	61
5.2. Procedure analysis (approach)	62
5.2.1. Procedure II	62
5.2.2. Procedure II-A	65
5.2.3. Procedure III	66
5.2.4. Procedure IV	67
5.2.5. Procedure V	68
5.3. Procedures analysis (departure)	70
5.3.1. Procedure 2 Close-in	70
5.3.2. Procedure 3 distant	72
6. Conclusions and recommendations	73
6.1. General conclusions	73
6.1.1. NOISE	74
6.1.2. SAFETY	74
6.1.3. CAPACITY	75
6.1.4. WORKLOAD AND ACCEPTANCE (PILOTS & CONTROLLERS)	75
6.1.5. ECONOMICS	75
6.1.6. INTERACTION BETWEEN CAPACITY AND NOISE	75
6.2. Recommendations	75

ANNEX A: Summary of SOURDINE II procedures.

ANNEX B: Summary of LWP methodology.

Figures

Figure 2-1. Comparative analysis of results process diagram.....	14
Figure 2-2. Procedures: refinement process.....	14
Figure 2-3. Methodology of the Comparative analysis of results.....	15
Figure 2-4. Relationships with other Work Packages.....	21
Figure 5-1. Analysis of NOISE (arrivals). Average results.....	50
Figure 5-2. Analysis of NOISE (arrivals) for L_{den} and L_{night}	51
Figure 5-3. Analysis of NOISE (departures). Average results.....	53
Figure 5-4. Analysis of NOISE (departures) for L_{den} and L_{night}	54
Figure 5-5. Analysis of SAFETY.....	56
Figure 5-6. Analysis of CAPACITY.....	57
Figure 5-7. Analysis of WORKLOAD.....	59
Figure 5-8. Analysis of ACCEPTANCE.....	61
Figure 5-9. Procedure II performance per airport.....	63
Figure 5-10. Procedure II A performance per airport.....	65
Figure 5-11. Procedure III performance per airport.....	66
Figure 5-12. Procedure IV performance per airport.....	67
Figure 5-13. Procedure V performance per airport.....	69
Figure 5-14. Procedure 2 performance per airport.....	71

Tables

Table 1-1. Glossary.....	12
Table 1-2. Related documents.....	12
Table 2-1. Final list of metrics and indicators.....	20
Table 2-2. List of Work Packages related.....	21
Table 2-3. Inputs for the Comparative analysis of results.....	22
Table 3-1. Procedures selected.....	23
Table 4-1. Results available.....	24
Table 4-2. Meaning of results.....	25
Table 4-3. NOISE results for Procedure II.....	28
Table 4-4. SAFETY results for Procedure II.....	29
Table 4-5. CAPACITY results for Procedure II.....	30
Table 4-6. WORKLOAD results for Procedure II.....	31
Table 4-7. ACCEPTANCE results for Procedure II.....	32
Table 4-8. SAFETY results for Procedure II A.....	33
Table 4-9. CAPACITY results for Procedure II A.....	34

Table 4-10. WORKLOAD results for Procedure II A.....	35
Table 4-11. ACCEPTANCE results for Procedure II A	36
Table 4-12. NOISE results for Procedure III	37
Table 4-13. CAPACITY results for Procedure III	38
Table 4-14. NOISE results for Procedure IV.....	39
Table 4-15. CAPACITY results for Procedure IV.....	40
Table 4-16. NOISE results for Procedure V.....	41
Table 4-17. SAFETY results for Procedure V	42
Table 4-18. CAPACITY results for Procedure V	43
Table 4-19. WORKLOAD results for Procedure V.....	44
Table 4-20. ACCEPTANCE results for Procedure V	45
Table 4-21. NOISE results for Procedure 2: CLOSE IN	46
Table 4-22. ACCEPTANCE results for Procedure 2.....	47
Table 4-23. NOISE results for Procedure 3: DISTANT.....	48
Table 6-1. Ranking of arrival procedures per area	73
Table 6-2. Ranking of departure procedures per area.....	74

1. Introduction

1.1. Purpose

The objective of this document is to summarize the Comparative analysis of results process performed in SII with respect to the new noise abatement procedures. This process has been structured in several steps aiming to:

- Summarize how the SII procedures were selected and refined along the project.
- Provide an overview of all the results obtained - all areas of interest, validation exercises and airports - for each procedure compared to the reference procedure.
- Evaluate and compare the procedures with respect to the results obtained.
- Address conclusions, provide recommendations and identify the most promising procedures.

At the end of the analysis it will be possible to identify and recommend the most beneficial procedures in function of the different areas of the analysis.

1.2. Background

The main objective of SII project is to decrease the impact of aircraft noise and emissions by defining new approach and departure procedures and modifying or optimising ATM operations and air traffic flow around airports.

First, SII defined a preliminary set of procedures. To prove that new procedures solve the ATM problem that they were designed for, several experiments have been conducted. Various validation exercises - experiments - have been proposed, using the most suitable validation techniques and assessment methods for each phase of the validation lifecycle. Homogeneity of experiments results was ensured through the elaboration of a validation plan and the set up of a suitable validation management structure. The validation plan was based on existing ATM validation frameworks - MAEVA - and emphasised exercises to build confidence in the airport approach and departure procedures developed within SII.

The overall assessment process, including fast-time simulations, real-time simulations, area assessment - NOISE, SAFETY, etc. - , expert panels etc, produced results that are analysed in the present Comparative analysis of results. This analysis compares, assesses and combine results in order to identify the most promising procedures and make the appropriate recommendations.

Finally, the most promising procedures have been identified, considering the different areas of the analysis.

1.3. Document structure

Chapter 1 explains the project background, document structure, glossary and reference documents.

Chapter 2 summarises the methodology used to perform the Comparative analysis of results: the objectives, inputs used, outputs produced and relationship with other task of the project.

Chapter 3 summarises the selection and refinement of procedures process along the project. This is the process that provided the six filtered procedures for the final assessment and Comparative analysis of results.

Chapter 4 gathers and summarises the most relevant results obtained for each procedure from all the validation exercises performed.

Chapter 5 contains comparison information between procedures regarding the validation results obtained. The procedure performances are put together and compared to assess and evaluate which ones are the most beneficial or suitable for implementation.

Chapter 6 addresses conclusions of the Comparative analysis of results and recommendations about the most promising procedures.

1.4. Glossary

Term	Description
Actor	An organisation or agency, formal or informal, or an individual involved in validation activity or any of its tasks.
ATC	Air traffic control.
ATCo	Air traffic controller.
ATM	Air traffic management.
CBA	Cost benefits analysis.
CDA	Constant descend approach.
dB	Decibels.
EATMS	European air traffic management system
Exercise runs	The set of individual time periods over which measurements are made in a validation exercise.
FMS	Flight management system.
FTS	Fast-time simulations.
GS	Glide slope.
HLO	High level objective.
HMI	Human-machine interface
INM	Integrated noise model.
L_{Amax}	Maximum instantaneous value of noise recorded.
L_{den}	Average sound level weighted – for (d)ay, (e)vening and (n)ight.
L_{night}	Average sound level for night time period – 22:00 to 7:00.
LLO	Low level objective.
LWP	Level weighted population.
Metric	A system parameter measured in a validation exercise to provide the data used to derive conclusions.
NAAP	Noise abatement approach procedure.
NADP	Noise abatement departure procedure.
NAP	Noise abatement procedure.
NARSIM	NLR air traffic control research simulator.
NM	Nautical miles.
RFS	Research flight simulator.
RNAV	Area navigation.
RTS	Real-time simulations.
SII	Sourdine II project.
SIMMOD	Airport and airspace simulator model (by FAA).

Term	Description
Stakeholders	Actors in the ATM System whose support, co-operation and service is important in ensuring that a proposed operational concept can be brought into service.
TMA	Terminal manoeuvring area.
Validation	The process through which a desired level of confidence in the ability of an operational concept to operate in a real-life environment may be demonstrated to the user, against the actual needs captured as a pre-defined level of functionality, operability and performance.
Validation exercise	The set of one or several tests performed to determine whether an ATM configuration meets the validation requirements specified for it, which may range from a formal meeting of experts to the performance of empirical trials in validation environments and platforms.
Validation scenario	Representation of an operational situation in which an ATM operational concept is validated within one or several validation exercises, to enable the measurement and characterisation of the operational concept's performance. Descriptions of validation scenarios should cover location, timeframe, events and ATM environment.
VMP	Validation master plan.
WP	Work package.

Table 1-1. Glossary

1.5. Reference documents

LIST OF REFERENCE DOCUMENTS	
Short Reference	Description
[TA]	SII Technical Annex.
[VGH]	Validation Guideline Handbook (MAEVA), 2001.
[OCP]	Operational concept document (by EUROCONTROL).
[D2-1]	SII deliverable: Validation methodology report.
[D3-1.1]	SII deliverable: Definition of new noise abatement procedures.
[D3-1.2]	SII deliverable: Detailed definition of new noise abatement procedures.
[D3-2]	SII deliverable: Definition of SII required ATCo and pilot tools.
[D4-1]	SII deliverable: FTS simulation (capacity calculations).
[D4-2]	SII deliverable: Safety assessment
[D4-3]	SII deliverable: CBA assessment
[D5-2]	SII deliverable: Noise and emission modelling methodology.
[D5-3]	SII deliverable: Detailed procedure description (A320 and A380 single event sims.)
[D6-1]	SII deliverable: RTS - Prototyping results ATC simulator
[D6-2]	SII deliverable: RTS - Prototyping results flight simulator
[D6-3]	SII deliverable: RTS - Real time simulations results
[D7-1]]	SII deliverable: Validation Process Control.
[EEC_CAEm]	Fuel burn and emissions document (by Eurocontrol).
[EATMS/MOSD]	Mission, objectives and strategy document (edition 1.3), Eurocontrol (1995)
[WP7 Plan]	SII WP7 Work-plan.
[OC_Schiphol]	Schiphol airport concept of operation document (by NLR)

Table 1-2. Related documents

2. Methodology

2.1. Objectives

The main objective of the Comparative analysis of results is to gather results from all the validation exercises and assessments performed during the project, combine them and assess the overall to determine the procedure performances and identify the most promising ones. It is very important to point out that Comparative analysis of results will give a primary overview of comparative results that will allow to decision makers to have a first picture about the performance of each of the procedures. More specific and detailed information of performances of each procedure in each area of the study can be found in the correspondent documents – deliverables D4-1 to D4-3, D5-2 and D6-3.

The experiments conducted during the lifetime of the project produced several set of results but independent amongst each other. WP7.3 will bring all the results together in order to evaluate the procedures overall.

The Comparative analysis of results will provide good visibility about the procedures performances compared to each other. Several tables, charts and figures will clearly show results in function of specific indicators, objectives and areas of interest. In this way, the selection of procedures will be much more simple and reliable.

It is worth mentioning that the selection of procedure should be made in function of specific interests or airport needs. In general terms, it will not be possible to state that one procedure is more beneficial than another in any circumstance. Most airports will have particular interests or constraints, therefore the selection of the procedure will have to be done in function of these particular needs - capacity constraints, time of the day, number of runways of the airport, distance from the nearest population, etc.

2.2. Process

It was decided to divide the Comparative analysis of results in four different tasks:

- Selection and refinement of procedures process: during the project the various procedures identified went through a refinement process as part of the validation plan. It must be remembered that the selection of procedures was done with respect to several criteria agreed amongst the consortium. This process ended with the selection of 4 final approach procedures and 2 departure procedures.
- Overview and analysis of results in all areas of interest for each procedure: this task intends to gather all the results obtained for each procedure. The results are all compared to the reference procedure. In order better visualise the results and comparisons with the reference procedure several colour codes were defined and displayed in a comparison table.
- Evaluation and comparison the procedures with respect to the results obtained: once the results overviewed and analysed this task intends to compare procedures together to evaluate in what aspects which procedures are the best. For this is necessary to define specific airport needs to define the selection criteria and lead the selection of procedures.
- Elaboration of conclusions and recommendations: this final task will provide conclusions about the Comparative analysis of results and recommend the most promising procedures.

The following figures, Figure 2-1, summarises how the previous task are related together and what are the inputs required in each of them:

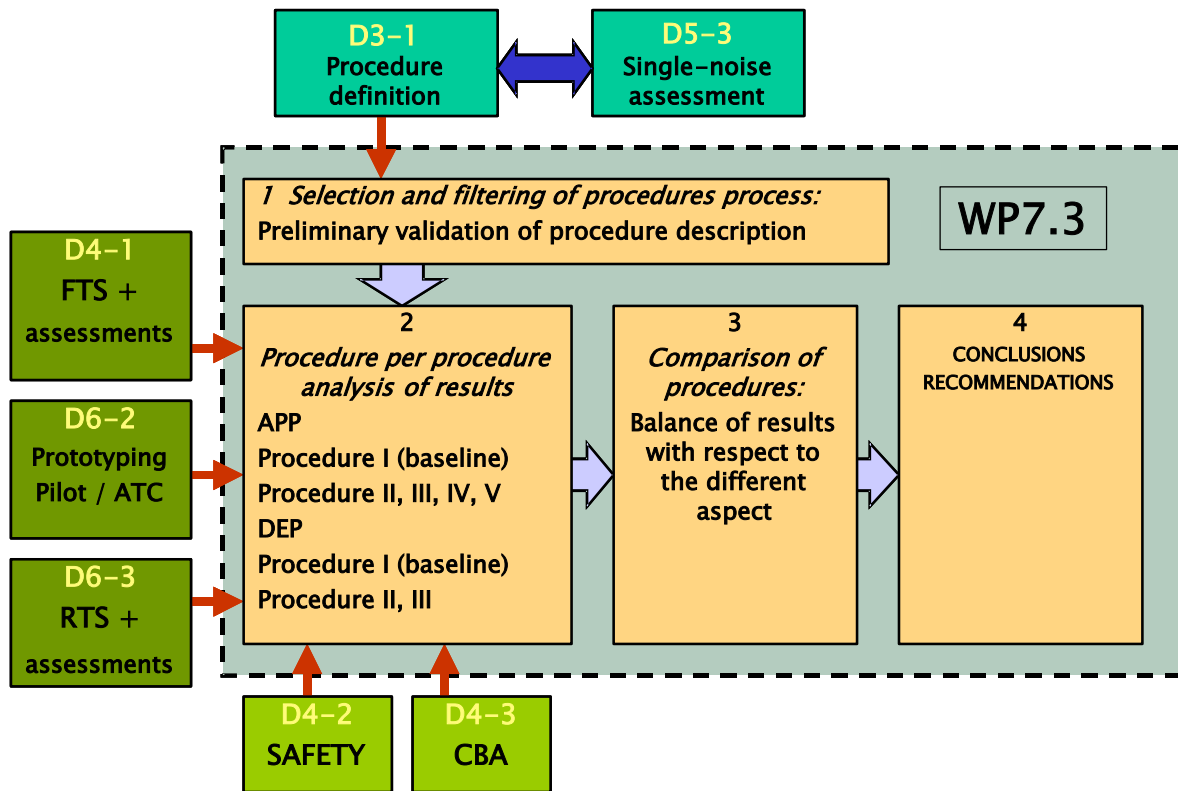


Figure 2-1. Comparative analysis of results process diagram

2.2.1. Procedures: selection and refinement process

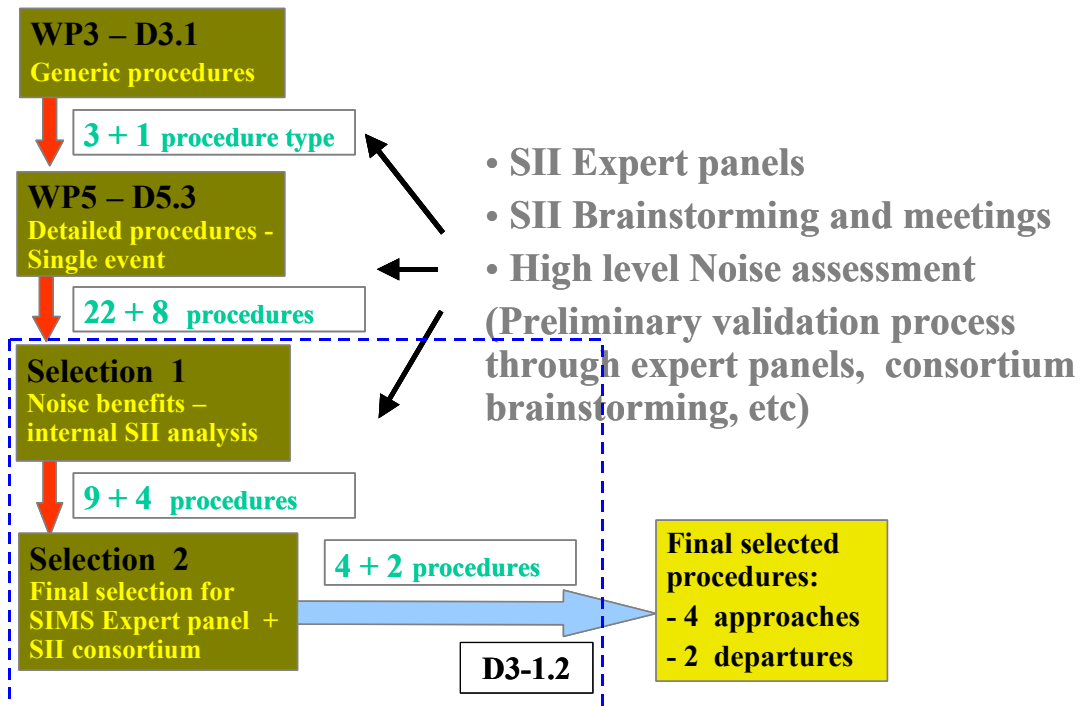


Figure 2-2. Procedures: refinement process

2.2.2. Results analysis

The results analysis is based on the list of metrics and indicators defined in the deliverable D2-1, Validation Methodology Report. Out of the results available after the simulations, the list of metrics and indicators was revised and some of them were removed, some others were broken down in more specific ones and some new indicators and metrics were added.

For each area of the project and according to the nature of each indicator and metric, some assumptions have been formulated in order to be able to group results and calculate accurate averages for comparison purposes. Final results of the Comparative analysis of results are given with the combination of airports, areas and procedures.

A general overview of the whole methodology is given in Figure 2-3:

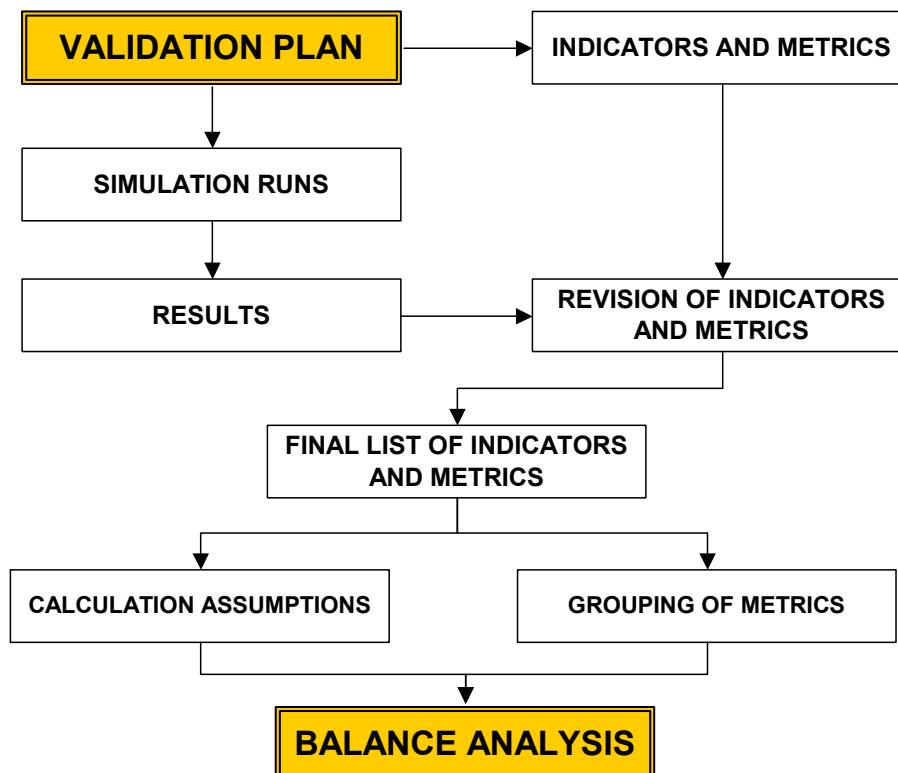


Figure 2-3. Methodology of the Comparative analysis of results

Metrics and indicators broken down

Out of the simulations, some indicators or metrics were found too generic or not very specific. For this reason, these indicators were broken down in more specific ones and proper averages were calculated afterwards, having in account this fact.

NOISE

- **M1:** Noise contour L_{den} area reduction comparing NAPs with existing procedures.
 - **M1₁:** 55 dB – 75 dB.

The average reduction of noise contour areas of 55, 60, 65, 70 and 75 dB has been calculated. The selection of these areas is based on the assumptions that area for 55 dB is the superior legal limit proposed in the EU and regions which are above the 75 dB will be either inside the airport or inside the runway.

- **M1₂**: 55 dB.
Reference for legal limit proposed in the EU. Noise contour for 55 dB is the biggest one of the areas above this limit, therefore a good reference to compare SOURDINE II procedures.
- **M2**: Noise contour L_{night} area reduction comparing NAPs with existing procedures.
 - **M2₁**: 50 dB – 70 dB.
The average reduction of noise contour areas of 50, 55, 60, 65 and 70 dB has been calculated. The selection of these areas is based on the assumptions that area for 50 dB is the superior legal limit proposed in the EU and regions which are above the 70 dB will be either inside the airport or inside the runway
 - **M2₂**: 50 dB.
Reference for legal limit proposed in the EU. Noise contour for 50 dB is the biggest one of the areas above this limit, therefore a good reference to compare SOURDINE II procedures.
- **M3**: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures.
 - **M3₁**: 55 dB – 75 dB.
The average reduction of noise contour areas of 55, 60, 65, 70 and 75 dB has been calculated. The selection of these areas is based on the assumptions that area for 55 dB is the inferior legal limit proposed in the EU for L_{den} and it is a good reference for the inferior limit of the interval and regions which are above the 75 dB will be either inside the airport or inside the runway.
 - **M3₂**: 55 dB.
Reference for legal limit for L_{den} proposed in the EU. Noise contour for 55 dB is the biggest one of the areas above this limit, therefore a good reference to compare SOURDINE II procedures.

EMISSIONS

No broken down indicators or metrics.

SAFETY

- **BM1**: Relative safety perception according to the tactical ATCo.
 - **BM1₁**: Arrival controllers.
 - **BM1₂**: Feeder / Departure controllers.
- **DI2**: Situation awareness of the tactical and planner controller and the pilot.
 - **DI21**: Pilots.
 - * **DI21₁**: Navigational awareness.
 - * **DI21₂**: Energy awareness.
 - **DI22**: Tactical and planner controllers.
 - * **DI22₂**: Arrival controllers.
 - * **DI22₃**: Feeder/departure controllers.
- **EI1**: Number of incident detection events that will require ATC intervention per ATC sector.

- **E11₂**: Loss of separation.

CAPACITY

No broken down indicators or metrics.

WORKLOAD

- **I6**: Tactical controller workload for each ATC approach/departure sector.
 - **I61**: Instantaneous self-assessment.
 - * **I61₁**: Arrival controllers.
 - * **I61₂**: Feeder / Departure controllers.
 - **I62**: Experienced level of workload.
 - * **I62₁**: Arrival controllers.
 - * **I62₂**: Feeder / Departure controllers.
- **I7**: Number of sequencing actions that occur in an approach/departure within ATC sector.
 - **I7₁**: Speed up/slow down actions.
 - **I7₂**: Vectoring actions.
 - **I7₃**: Holding actions.
- **I8**: Average number of co-ordinations between pilot/ATCo and ATCo/ATCo per each aircraft.
 - **I81**: Amount of R/T calls per hour.
 - * **I81₁**: Arrival controller – pilot.
 - * **I81₂**: Feeder / departure controller – pilot.
 - **I82**: Time spent on R/T.
 - * **I82₁**: Arrival controller – pilot.
 - * **I82₂**: Feeder / departure controller – pilot.
- **I9**: Pilot workload for each ATC approach/departure procedure.
 - **I9₁**: NASA-TLX rating.
 - **I9₂**: RSME rating.

ECONOMICS

No broken down indicators or metrics.

ACCEPTANCE / FEASIBILITY (PILOTS)

No broken down indicators or metrics.

ACCEPTANCE / FEASIBILITY (CONTROLLERS)

- **M1**: ATCo acceptance of NAPs and tool prototypes and identification of foreseen changed ATCo tasks.
 - **M11**: Experienced level of control over the traffic.
 - * **M11₁**: Arrival controllers.

- * **M11₂**: Feeder / Departure controllers.
- **M12**: Experienced level of being able to plan and organise the work.
- * **M12₁**: Arrival controllers.
- * **M12₂**: Feeder / Departure controllers.

New metrics and indicators

Taking advantage of the simulation scenarios, some other indicators were added to the primary list. The selection of these was made under the criteria of the quality of the information they could give for the analysis of the correspondent area.

NOISE

- Global noise/area reduction comparing NAPs with existing procedures. Assessment of how noisy a procedure is with respect the reference procedure.
 - **M1₃**: L_{den} .
 - **M2₃**: L_{night} .
 - **M3₃**: L_{Amax} .
- **I1**: Reduction of the population affected within L_{den} area comparing NAPs with existing procedures. Only for L_{night} and L_{Amax} were foreseen. L_{den} has been also calculated.

EMISSIONS

No new metric or indicator.

SAFETY

- **FI1**: % of time using speed brakes.

CAPACITY

No new metric or indicator.

WORKLOAD

No new metric or indicator.

ECONOMICS

- **DM2**: Distance flown in the TMA.

ACCEPTANCE / FEASIBILITY (PILOTS)

No new metric or indicator.

ACCEPTANCE / FEASIBILITY (CONTROLLERS)

No new metric or indicator.

This is the final list of metrics and indicators:

HLO1 NOISE	A	LLO1-M1 ₁	Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB – 75 dB).
		LLO1-M1 ₂	Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB).
		LLO1-M1 ₃	Global noise/area reduction L_{den} comparing NAPs with existing procedures.
		LLO1-M2 ₁	Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB – 70 dB).
		LLO1-M2 ₂	Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB).
		LLO1-M2 ₃	Global noise/area reduction L_{night} comparing NAPs with existing procedures.
		LLO1-M3 ₁	Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB – 70 dB).
		LLO1-M3 ₂	Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB).
		LLO1-M3 ₃	Global noise/area reduction L_{Amax} comparing NAPs with existing procedures.
		LLO1-I1	Reduction of the population affected within L_{den} area comparing NAPs with existing procedures.
		LLO1-I2	Reduction of the population affected within L_{night} area comparing NAPs with existing procedures.
		HLO3 SAFETY	B
LLO3-BM1 ₂	Relative safety perception according to the feeder / departure ATCo.		
C	LLO3-CM1		Relative safety perception according to the pilot.
D	LLO3-DI21 ₁		Navigational awareness of the pilots.
	LLO3-DI21 ₂		Energy awareness of the pilots
	LLO3-DI22 ₁		Situational awareness of the arrival controllers.
	LLO3-DI22 ₂		Situational awareness of the feeder/departure controllers.
E	LLO3-EI1		Number of incident detection events that will require ATC intervention per ATC sector.
	LLO3-EI1 ₂		Loss of separation.
	LLO3-EI2		Average time of incident event duration per ATC sector.
F	LLO3-FI1	% of time using speedbrakes.	
HLO4 ₁ CAPACITY	A	LLO4-I2	Airport throughput.
		LLO4-I3 ₁	Total delay for each aircraft (arrivals).
		LLO4-I3 ₂	Total delay for each aircraft (departures).
		LLO4-I4	Percentage of delayed aircrafts.

HL04 ₂ WORKLOAD	A	LLO4-I61 ₁	Instantaneous self-assessment ISA (arrival controllers).
		LLO4-I61 ₂	Instantaneous self-assessment ISA (feeder/departure controllers).
		LLO4-I62 ₁	Experienced level of workload (arrival controllers).
		LLO4-I62 ₂	Experienced level of workload (feeder/departure controllers).
		LLO4-I7 ₁	Number of speed up/slow down actions that occur in an approach/departure within ATC sector.
		LLO4-I7 ₂	Number of vectoring actions that occur in an approach/departure within ATC sector.
		LLO4-I7 ₃	Number of holding actions that occur in an approach/departure within ATC sector.
		LLO4-I81 ₁	Amount of R/T calls per hour (arrival controller - pilot).
		LLO4-I81 ₂	Amount of R/T calls per hour (feeder/departure controller – pilot).
		LLO4-I82 ₁	Time spent on R/T (arrival controller - pilot).
		LLO4-I82 ₂	Time spent on R/T (feeder/departure controller - pilot).
		LLO4-I9 ₁	Pilot workload for each ATC approach/departure procedure (NASA-TLX rating).
		LLO4-I9 ₂	Pilot workload for each ATC approach/departure procedure (RSME rating).
		HLO5 ECONOMICS	A
LLO5-DM2	Distance flown in the TMA.		
HLO6 ACCEPTANCE / FEASIBILITY (PILOTS)	A	LLO6-M1	Pilot acceptance of NAPs and tool prototypes and identification of foreseen changed pilot tasks.
HLO7 ACCEPTANCE / FEASIBILITY (CONTROLLERS)	A	LLO7-M11 ₁	Experienced level of control over the traffic (arrival controllers).
		LLO7-M11 ₂	Experienced level of control over the traffic (feeder/departure controllers).
		LLO7-M12 ₁	Experienced level of being able to plan and organise the work (arrival controllers).
		LLO7-M12 ₂	Experienced level of being able to plan and organise the work (feeder/departure controllers).

Table 2-1. Final list of metrics and indicators

2.3. Relationship with other Work Packages

The Comparative analysis of results, as a part of the project, is closely related with other work packages. It receives inputs from simulations and assessments and provides outputs for final conclusions.

WP	Description
WP2	Validation plan specification
WP3	Definition of the noise abatement procedures and ATCo and pilot tools.
WP4	FTS simulations + assessments
WP5	Noise and emission assessment
WP6	RTS Prototyping / simulations + assessments
WP7	Validation Process Control.

Table 2-2. List of Work Packages related

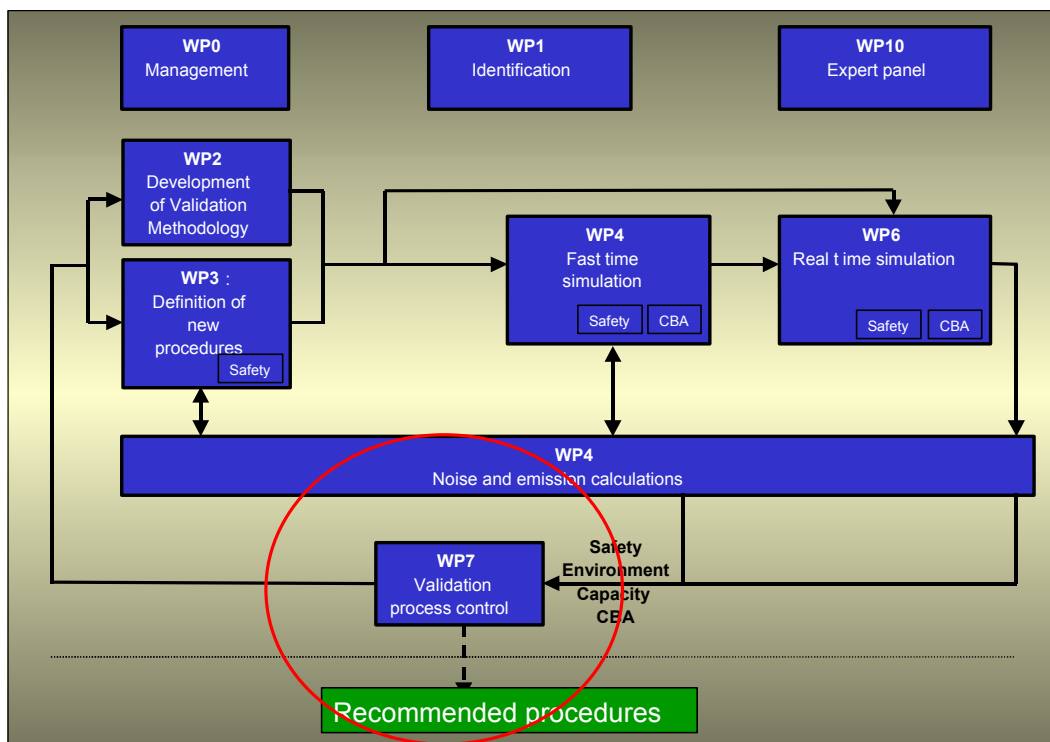


Figure 2-4. Relationships with other Work Packages

In order to perform the Comparative analysis of results the following inputs will be required:

Document	Description
D3-1.1	SII deliverable: Definition of the noise abatement procedures.
D3-1.2	SII deliverable: Update of definition of the noise abatement procedures.
D3-2	SII deliverable: Definition of SII required ATCo and pilot tools.
D5-2	SII deliverable: Description of noise and emission results
D5-3	SII deliverable: Detailed procedure description (A320 and A380 single event sims.)
D4-1	SII deliverable: FTS simulation (capacity calculations).
D4-2	SII deliverable: Safety assessment
D4-3	SII deliverable: CBA assessment
D6-1	SII deliverable: RTS – Prototyping results ATC simulator
D6-2	SII deliverable: RTS - Prototyping results of flight simulator
D6-3	SII deliverable: RTS – Real time simulations results

Table 2-3. Inputs for the Comparative analysis of results

The Comparative analysis of results will be used in documents:

- D9-1 in WP9 (final report).

3. Procedures: selection and refinement process

The procedures selection process has taken a long time for its realisation and its refinement. The procedures selection and refinement has been done in three succeeding phases, described in the following lines:

1. Specify and design NAPs and their variants as generic as possible, for a implementing them at several airports, without taking into account constraints of a specific airport. These procedures were designed combining altitude, speed and thrust parameters, on the basis of suggestions and ideas come out from the Brainstorming meeting and on the basis of current procedures/practices that have been demonstrated to be Noise abatement beneficial (see Chapter 4 of D3-1.1). As results of this parameters' combination, a set of 16 NADP variants (see par. 5.3.1 of D3-1.1) and of 150 NAAP variants (see par 5.3.2 of D3-1.2) per aircraft were designed. The number of NAAPs to analyse was reduced to 39 due to the big analysis effort required for the acoustical analysis of each procedure[D3-1.1].
2. Evaluate the effects of designed NAPs on acoustic point of view, through the single event calculations performed by Airbus.
3. Filter the most noise beneficial procedures on the basis on SES data [D5-3], establishing a set of selection methods and criteria (see par. 2 of D3-1.2) and taking into account recommendations coming from the Brainstorming session. At the end of the selection process four approaches and two departures procedures were selected for the next analyses, FTS and RTS, as listed in the next table.

SES Procedures selected				
Approaches	2 CDA standard GS)	10(A340)/7(A320) CDA increased GS	20 CDA variable path	21 CDA variable path
Departures	NADP1	NADP2		

Table 3-1. Procedures selected

The procedures selected above were aircraft dependant, so it was decided to extrapolate a description of those procedures as general as possible, that could be used for each aircraft type and that only need to be adapted to a specific airport where they will be tested. For more information on the procedures description see Chapter 4 of D3-1.2.

4. Results and procedure analysis

In this section, the results obtained are assessed independently for each procedure. Each procedure results is compared against the reference procedure.

4.1. Overview of results available

TMA areas and airports		AVAILABLE RESULTS									
		ARRIVAL PROCEDURES						DEP. PROCEDURES			
		RNAV	I	II	II A	III	IV	V	1	2	3
NOISE	Madrid	■	■	■	■	■	■	■	■	■	■
	Paris	■	■	■	■	■	■	■	■	■	■
	Naples	■	■	■	■	■	■	■	■	■	■
	Amsterdam	■	■	■	■	■	■	■	■	■	■
EMISSIONS	Madrid	■	■	■	■	■	■	■	■	■	■
	Paris	■	■	■	■	■	■	■	■	■	■
	Naples	■	■	■	■	■	■	■	■	■	■
	Amsterdam	■	■	■	■	■	■	■	■	■	■
SAFETY	Madrid	■	■	■	■	■	■	■	■	■	■
	Paris	■	■	■	■	■	■	■	■	■	■
	Naples	■	■	■	■	■	■	■	■	■	■
	Amsterdam	■	■	■	■	■	■	■	■	■	■
CAPACITY	Madrid	■	■	■	■	■	■	■	■	■	■
	Paris	■	■	■	■	■	■	■	■	■	■
	Naples	■	■	■	■	■	■	■	■	■	■
	Amsterdam	■	■	■	■	■	■	■	■	■	■
WORKLOAD	Madrid	■	■	■	■	■	■	■	■	■	■
	Paris	■	■	■	■	■	■	■	■	■	■
	Naples	■	■	■	■	■	■	■	■	■	■
	Amsterdam	■	■	■	■	■	■	■	■	■	■
ECONOMICS	Madrid	■	■	■	■	■	■	■	■	■	■
	Paris	■	■	■	■	■	■	■	■	■	■
	Naples	■	■	■	■	■	■	■	■	■	■
	Amsterdam	■	■	■	■	■	■	■	■	■	■
PILOT / CONTROLLERS ACCEPTANCE	Madrid	■	■	■	■	■	■	■	■	■	■
	Paris	■	■	■	■	■	■	■	■	■	■
	Naples	■	■	■	■	■	■	■	■	■	■
	Amsterdam	■	■	■	■	■	■	■	■	■	■

Table 4-1. Results available



4.2. Assumptions for the Comparative analysis of results

Since the main goal of the Comparative analysis of results is to give a primary and quick overview of the new procedures, all of the results shown will be expressed in a percentage with respect the reference procedure or reference procedure. It must be mentioned that the reference procedure is a RNAV procedure, already a noise friendly procedure. The reference RNAV procedure uses a fixed lateral route from IAF to the ILS. All aircraft will follow this route, unless instructed otherwise by the controllers. This procedure does not specify vertical and speed profiles. The controllers are also responsible for descending the aircraft and reducing speed.

In this sense, a result of 5% in a metric will have to be interpreted as the procedure has a value of 5% more than the reference procedure or the reference procedure. A positive percentage will be improvement in some indicators but it will be a worsening in others. This fact will be taken in account to calculate averages, since there could have positive figures in different metrics but with counter meanings. For instance, in terms of CAPACITY, a positive figure in delays will indicate more delays, and thus, negative performance of the procedure, but a positive figure in throughput will be an improvement. Therefore, in order to accomplish balanced results, the sign of the figures to calculate averages will be given according to next table:

AREA	% of variation vs reference procedure	
	Negative % (-)	Positive % (+)
NOISE	Improvement	Worsening
EMISSIONS	Improvement	Worsening
SAFETY	Worsening	Improvement
CAPACITY	Worsening	Improvement
WORKLOAD	Improvement	Worsening
ECONOMICS	Improvement	Worsening
ACCEPTANCE (P. & C.)	Worsening	Improvement

Table 4-2. Meaning of results

In the previous example, to calculate a single average figure for CAPACITY, delays will be taken with the opposite sign.

At this point, it is necessary to stress that all of the calculation assumptions are intended to give the biggest coherency to the final average for each area. Not too much significance has to be given to the final figure, since it is the magnitude of these averages what will allow to have a primary idea about the goodness of the procedures. In this way, a lost of a 5% of CAPACITY with procedure X does not mean very much but if procedure Y has a lost of 20% of CAPACITY, then procedure Y is much worse than X in terms of CAPACITY. This information will lead to decision makers to select at a glance the most promising procedures regarding the areas of their priority interests. More precise and useful information will be found afterwards in metrics and indicators related.

The calculation assumptions made per area are:

NOISE

- Since goal in noise is reduction, better results than the reference will have a minus sign and will indicate reduction of noise.
- To assess the noise area reduction with respect the reference procedure for L_{den} , L_{night} and L_{Amax} , the 55 dB to 75 dB areas - for L_{den} - , 50 dB to 70 dB areas - for L_{night} - , and 55 dB to 75 dB areas - for L_{Amax} - , were selected and the average of reduction in each one was calculated. Areas under

55 dB - for L_{den} - and under 50 dB - for L_{night} - were left out because of no legal significance and for the ones above 75 dB - for L_{den} - and above 70 dB - for L_{night} - will be either inside the airport or inside the runway, therefore, no significance for comparative purposes was found. The results are given in indicators LLO1-M1₁, LLO1-M2₁ and LLO1-M3₁.

- An additional indicator for noise area reduction was calculated with only the noise area reduction for a significant limit, which were taken in 55 dB for L_{den} , 50 for L_{night} and 55 for L_{Amax} . The results are expressed in indicators LLO1-M1₂, LLO1-M2₂ and LLO1-M3₂.
- To assess how noisy a procedure was, an index with a combination of dB and area affected was calculated and compared with the same index for the reference procedure. The calculation was based in the Leveled Weighted Population - LWP - noise index methodology but using areas affected by noise instead of population. A brief reference for this methodology is given in annex B. Results for L_{den} , L_{night} and L_{Amax} are given in indicators LLO1-M1₃, LLO1-M2₃ and LLO1-M3₃, respectively.
- In order to give sound results for noise, three averages were calculated with the results of the indicators and metrics related:
 - For L_{den} .
 - For L_{night} .
 - For L_{Amax} .

A final result for noise with the average of the three averages is given.

Some remarks about these assumptions can be formulated. For instance, noise in night hours is used to calculate L_{night} but also to calculate L_{den} , so it could be questionable to calculate a final average with results from L_{den} and L_{night} , since the both of them are related. But it has to be stressed again that the final result is not significant by itself but in comparison with the ones for the other procedures. Thus, the main fact is that assumptions and calculations are the same for all of the procedures.

EMISSIONS

No quantitative result has been provided for none of the new procedures. Refer to document D5-2 of the project for additional information.

SAFETY

- Safety assessment of procedures is given in the D4-2 deliverable. Some numerical values of some SAFETY indicators have been provided and are included in this document but only for comparative purposes – the procedure N is safer than procedure M. In any case, unacceptable risks have been found with none of the new procedures.
- Results from indicator LLO3-FI1 - % of time using speedbrakes – have been excluded of the average calculations for all procedures because of the indirect safety indicator that it is and the large figure obtained for procedure V which may distort the final average.
- In this area, there are indicators whose positive result has a negative meaning – e.g., “Number of incident detection events that will require ATC intervention per ATC sector” – and others whose positive result has a positive meaning – e.g., “Situation awareness of the tactical and planner controller and the pilot”. Since the improvement in SAFETY will be given with positive sign, to reach a final average sign will be changed in the indicators whose negative result indicates a positive meaning – or positive result with a negative meaning.

CAPACITY

- The delays for arrival and departure flights are given separately. The calculation takes the cumulative minutes delay of each procedure and compares with the same value of the reference procedure. The overall result given for indicator I3 comes from comparing the sum of delayed minutes of arrivals and departures of each procedure against the reference procedure.

- For I4 indicator, a combination of percentages of aircrafts and time of delay or weight average has been used to give a single figure.
- Since positive values for delay related indicators have a negative meaning, these indicators have been taken with the opposite sign to give a final result for CAPACITY.

WORKLOAD

- Results for LLO04-I7 comes from FTS and the rest of this group comes from RTS.
- Results of WORKLOAD are given separately for controllers and pilots, since a significant difference between them has been found.
- Pilots workload was investigated by letting the participants fill in two self-assessment scales, the NASA Task Load Index (TLX) and the Rating Scale for Mental Effort (RSME). The NASA-TLX is a measurement that is based on six different scales that contribute to workload: physical demand, mental demand, temporal demand, performance, frustration, and effort. A rating on each of these scales is multiplied by a weighing factor and results in a single rating for overall workload. The RSME scale however is a rating of mental effort only. For these reasons and according figure 3-26 of document D6-3, a correlation factor between both indicators has been calculated and this one has been applied to calculate the final average.
- For controllers, the final average has been calculated from the averages of the answers of each question or metric given by arrival controllers and feeder/departure controllers. Another logical option would have been to calculate the average of answers of arrival controllers, the same for feeder/departure controllers and calculating a final average with the two of them. This approach has been considered and since results were very similar, both options were found valid. The results shown comes from the first approach.

ECONOMICS

- Only numerical data for one of the foreseen metrics is available in this area. Since this is the total aircraft flight time spent per scenario, it may be consider as a first good approach and that is the reason why a data for ECONOMICS is given in the bar charts of section 5.

ACCEPTANCE (PILOTS)

No assumptions were needed.

ACCEPTANCE (CONTROLLERS)

- As depicted in WORKLOAD, calculations were made from the average of each metric, instead of taking the average of the answers of each group of controllers – arrival and feeder/departure.

4.3. Procedure analysis (approach)

4.3.1. Procedure II

NOISE

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO1 ENVIRONMENT (NOISE)	A	LLO1-M11	-5,8%	-4,6%	-5,3%	-2,5%	-4,5%
		LLO1-M12	-3,6%	-8,1%	-6,6%	-4,6%	-5,7%
		LLO1-M13	0,4%	-5,4%	-6,1%	-0,6%	-2,9%
		LLO1-I1	-2,6%				-2,6%
		AVERAGE L_{den}	-3,0%	-6,0%	-6,0%	-2,6%	-3,9%
		LLO1-M21	-6,4%	-4,0%	-4,7%	-1,7%	-4,2%
		LLO1-M22	-6,7%	-4,3%	-6,8%	-2,2%	-5,0%
		LLO1-M23	-6,7%	-3,8%	-5,4%	-1,8%	-4,4%
		LLO1-I2	-2,1%				-2,1%
		AVERAGE L_{night}	-5,5%	-4,0%	-5,6%	-1,9%	-3,9%
		LLO1-M31			0,8%		0,8%
		LLO1-M32			-5,5%		-5,5%
		LLO1-M33			0,9%		0,9%
		AVERAGE L_{Amax}			-1,3%		-1,3%
		NOISE			-4,2%	-5,0%	-5,8%

Table 4-3. NOISE results for Procedure II

LLO1-M1₁: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB - 75 dB).

LLO1-M1₂: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB).

LLO1-M1₃: Global noise/area reduction L_{den} comparing NAPs with existing procedures.

LLO1-M2₁: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB - 70 dB).

LLO1-M2₂: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB).

LLO1-M2₃: Global noise/area reduction L_{night} comparing NAPs with existing procedures.

LLO1-M3₁: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB - 75 dB).

LLO1-M3₂: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB).

LLO1-M3₃: Global noise/area reduction L_{Amax} comparing NAPs with existing procedures.

LLO1-I1: Reduction of the population affected within L_{den} area comparing NAPs with existing procedures.

LLO1-I2: Reduction of the population affected within L_{night} area comparing NAPs with existing procedures.

Since results for L_{Amax} has been only provided for Naples-Capodichino, and LLO1-I1 and LLO1-I2 have been only provided for Madrid-Barajas, averages have been calculated without these metrics.

SAFETY

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO3 SAFETY	B	LLO3-BM1					
		LLO3-BM1 ₁					1,0%
		LLO3-BM1 ₂					8,6%
		AVERAGE B					4,8%
	C	LLO3-CM1					1,6%
		AVERAGE C					1,6%
	D	LLO3-DI2					
		LLO3-DI2 ₁					
		LLO3-DI2 ₁₁					7,7%
		LLO3-DI2 ₁₂					0,0%
		AVERAGE D2 ₁					3,9%
		LLO3-DI2 ₂					
		LLO3-DI2 ₂₁					1,8%
		LLO3-DI2 ₂₂					0,9%
		AVERAGE D2 ₂					1,4%
		AVERAGE D2					2,6%
		AVERAGE D					2,6%
	E	LLO3-EI1					-40,9%
		LLO3-EI1 ₂					-8,5%
		LLO3-EI2					9,7%
		AVERAGE E					13,2%
	F	LLO3-FI1					0,0%
		AVERAGE F					0,0%
		SAFETY					5,6%

CONTROLLERS PERCEPTION (B & D22)	3,1%
PILOTS PERCEPTION (C6 & D21)	2,7%
OBJECTIVES MEASUREMENTS (E)	13,2%

Table 4-4. SAFETY results for Procedure II

- LLO3-BM1₁ Relative safety perception according to the arrival ATCo.
- LLO3-BM1₂ Relative safety perception according to the feeder / departure ATCo.
- LLO3-CM1 Relative safety perception according to the pilot.
- LLO3-DI2₁ Navigational awareness of the pilots.
- LLO3-DI2₁₂ Energy awareness of the pilots
- LLO3-DI2₂ Situational awareness of the arrival controllers.
- LLO3-DI2₂₂ Situational awareness of the feeder/departure controllers.
- LLO3-EI1 Number of incident detection events that will require ATC intervention per ATC sector.
- LLO3-EI1₂ Loss of separation.
- LLO3-EI2 Average time of incident event duration per ATC sector.
- LLO3-FI1 % of time using speedbrakes.

CAPACITY

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO04 CAPACITY	A	LLO04-I2	-6,7%	-1,3%	-3,6%	-4,8%	-4,1%
		TOTAL I2	-6,7%	-1,3%	-3,6%	-4,8%	-4,1%
		LLO04-I3 ₁	120,2%	10,6%	13,8%	25,5%	42,5%
		LLO04-I3 ₂	-22,4%		21,4%	5,5%	1,5%
		TOTAL I3	0,6%	10,6%	17,6%	11,3%	10,0%
		LLO04-I4	29,3%	6,2%		10,3%	15,3%
	TOTAL I4	29,3%	6,2%		10,3%	15,3%	
CAPACITY			-12,2%	-6,0%	-10,6%	-8,8%	-9,8%

	Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
Throughput (I2)	-6,7%	-1,3%	-3,6%	-4,8%	-4,1%
Delays (I3 & I4)	15,0%	8,4%	17,6%	10,8%	12,6%

Table 4-5. CAPACITY results for Procedure II

- LLO4-I2 Airport throughput.
- LLO4-I3₁ Total delay for each aircraft (arrivals).
- LLO4-I3₂ Total delay for each aircraft (departures).
- LLO4-I4 Percentage of delayed aircrafts.

WORKLOAD

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				Average
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	
HLO04 WORKLOAD	A	LLO04-I6					
		LLO04-I61					
		LLO04-I611	-	-	-	7,9%	
		LLO04-I612	-	-	-	5,6%	
		AVERAGE I61	-	-	-	6,8%	
		LLO04-I62					
		LLO04-I621	-	-	-	13,0%	
		LLO04-I622	-	-	-	11,7%	
		AVERAGE I62	-	-	-	12,4%	
		AVERAGE I6	-	-	-	9,6%	
		LLO04-I7					
		LLO04-I71	-	-	-	-34,0%	
		LLO04-I72	-	-	-		
		LLO04-I73	-	-	-	32,0%	
		AVERAGE I7	-	-	-	-1,0%	
		LLO04-I8					
		LLO04-I81					
		LLO04-I811	-	-	-	-20,3%	
		LLO04-I812	-	-	-	-16,2%	
		AVERAGE I81	-	-	-	-18,3%	
		LLO04-I82					
		LLO04-I821	-	-	-	-13,6%	
		LLO04-I822	-	-	-	-11,6%	
		AVERAGE I82	-	-	-	-12,6%	
		AVERAGE I8	-	-	-	-15,4%	
		LLO04-I9					
		LLO04-I91	-	-	-	-6,7%	
		LLO04-I92	-	-	-	23,3%	
AVERAGE I9	-	-	-	6,0%			
WORKLOAD			-	-	-	-0,2%	

CONTROLLERS (I6, I7 & I8)	-2,3%
PILOTS (I9)	6,0%

Table 4-6. WORKLOAD results for Procedure II

- LLO4-I61₁: Instantaneous self-assessment ISA (arrival controllers).
- LLO4-I61₂: Instantaneous self-assessment ISA (feeder/departure controllers).
- LLO4-I62₁: Experienced level of workload (arrival controllers).
- LLO4-I62₂: Experienced level of workload (feeder/departure controllers).
- LLO4-I7₁: Number of speed up/slow down actions that occur in an approach/departure within ATC sector.
- LLO4-I7₂: Number of vectoring actions that occur in an approach/departure within ATC sector.
- LLO4-I7₃: Number of holding actions that occur in an approach/departure within ATC sector.
- LLO4-I81₁: Amount of R/T calls per hour (arrival controller - pilot).
- LLO4-I81₂: Amount of R/T calls per hour (feeder/departure controller – pilot).
- LLO4-I82₁: Time spent on R/T (arrival controller - pilot).
- LLO4-I82₂: Time spent on R/T (feeder/departure controller - pilot).
- LLO4-I9₁: Pilot workload for each ATC approach/departure procedure (NASA-TLX rating).
- LLO4-I9₂: Pilot workload for each ATC approach/departure procedure (RSME rating).

ACCEPTANCE (PILOTS & CONTROLLERS)

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO6 ACCEPTANCE – FEASIBILITY (PILOTS)	A	LLO6-M1				13,0%	
	ACCEPTANCE – FEASIBILITY (PILOTS)					13,0%	
HLO7 ACCEPTANCE – FEASIBILITY (CONTROLLERS)	A	LLO7-M1					
		LLO7-M11					
		LLO7-M111				-5,5%	
		LLO7-M112				0,9%	
		AVERAGE M11				-2,3%	
		LLO7-M12					
		LLO7-M121				1,0%	
		LLO7-M122				5,5%	
ACCEPTANCE – FEASIBILITY (CONTROLLERS)					0,5%		

Table 4-7. ACCEPTANCE results for Procedure II

- LLO6-M1** Pilot acceptance of NAPs and tool prototypes and identification of foreseen changed pilot tasks.
- LLO7-M11₁** Experienced level of control over the traffic (arrival controllers).
- LLO7-M11₂** Experienced level of control over the traffic (feeder/departure controllers).
- LLO7-M12₁** Experienced level of being able to plan and organise the work (arrival controllers).
- LLO7-M12₂** Experienced level of being able to plan and organise the work (feeder/departure controllers).

4.3.2. Procedure II-A

NOISE

No quantitative result has been provided. Refer to document D5-2 of the project for additional information.

SAFETY

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO3 SAFETY	B	LLO3-BM1					
		LLO3-BM11				1,6%	
		LLO3-BM12				7,9%	
		AVERAGE B				4,8%	
	C	LLO3-CM1				1,6%	
		AVERAGE C				1,6%	
	D	LLO3-DI2					
		LLO3-DI21					
		LLO3-DI211				6,1%	
		LLO3-DI212				-5,1%	
		AVERAGE DI21				0,5%	
		LLO3-DI22					
		LLO3-DI221				-9,1%	
		LLO3-DI222				-7,2%	
		AVERAGE DI22				-8,2%	
		AVERAGE DI2				-8,6%	
	AVERAGE D				-8,6%		
	E	LLO3-EI1				-29,3%	
		LLO3-EI12				-23,9%	
		LLO3-EI2				20,2%	
		AVERAGE EI				11,0%	
	F	LLO3-FI1				-3,2%	
		AVERAGE F				-3,2%	
	SAFETY				2,2%		

CONTROLLERS PERCEPTION (B & D22)	-1,7%
PILOTS PERCEPTION (C6 & D21)	1,1%
OBJECTIVES MEASUREMENTS (E)	11,0%

Table 4-8. SAFETY results for Procedure II A

- LLO3-BM1₁ Relative safety perception according to the arrival ATCo.
- LLO3-BM1₂ Relative safety perception according to the feeder / departure ATCo.
- LLO3-CM1 Relative safety perception according to the pilot.
- LLO3-DI21₁ Navigational awareness of the pilots.
- LLO3-DI21₂ Energy awareness of the pilots
- LLO3-DI22₁ Situational awareness of the arrival controllers.
- LLO3-DI22₂ Situational awareness of the feeder/departure controllers.
- LLO3-EI1 Number of incident detection events that will require ATC intervention per ATC sector.
- LLO3-EI1₂ Loss of separation.
- LLO3-EI2 Average time of incident event duration per ATC sector.
- LLO3-FI1 % of time using speedbrakes.

CAPACITY

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO04 CAPACITY	A	LLO04-I2				-4,0%	
		TOTAL I2				-4,0%	
		LLO04-I3 ₁				10,2%	
		LLO04-I3 ₂				6,1%	
		TOTAL I3				7,2%	
		LLO04-I4				4,1%	
		TOTAL I4				4,1%	
		CAPACITY					-5,1%

	Amsterdam FTS - RTS
Throughput (I2)	-4,0%
Delays (I3 & I4)	5,7%

Table 4-9. CAPACITY results for Procedure II A

- LLO4-I2 Airport throughput.
- LLO4-I3₁ Total delay for each aircraft (arrivals).
- LLO4-I3₂ Total delay for each aircraft (departures).
- LLO4-I4 Percentage of delayed aircrafts.

WORKLOAD

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO04 WORKLOAD	A	LLO04-I6					
		LLO04-I61					
		LLO04-I611	-	-	-	14,3%	
		LLO04-I612	-	-	-	17,8%	
		AVERAGE I61	-	-	-	16,1%	
		LLO04-I62					
		LLO04-I621	-	-	-	21,7%	
		LLO04-I622	-	-	-	16,7%	
		AVERAGE I62	-	-	-	19,2%	
		AVERAGE I6	-	-	-	17,6%	
		LLO04-I7					
		LLO04-I71	-	-	-	-25,0%	
		LLO04-I72	-	-	-		
		LLO04-I73	-	-	-	19,0%	
		AVERAGE I7	-	-	-	-3,0%	
		LLO04-I8					
		LLO04-I81					
		LLO04-I811	-	-	-	-28,8%	
		LLO04-I812	-	-	-	-21,9%	
		AVERAGE I81	-	-	-	-25,4%	
		LLO04-I82					
		LLO04-I821	-	-	-	-26,2%	
		LLO04-I822	-	-	-	-15,7%	
		AVERAGE I82	-	-	-	-21,0%	
		AVERAGE I8	-	-	-	-23,2%	
		LLO04-I9					
		LLO04-I91	-	-	-	-8,1%	
		LLO04-I92	-	-	-	17,1%	
AVERAGE I9	-	-	-	2,5%			
WORKLOAD			-	-	-	-1,5%	

CONTROLLERS (I6, I7 & I8)	-2,8%
PILOTS (I9)	2,5%

Table 4-10. WORKLOAD results for Procedure II A

- LLO4-I61₁: Instantaneous self-assessment ISA (arrival controllers).
- LLO4-I61₂: Instantaneous self-assessment ISA (feeder/departure controllers).
- LLO4-I62₁: Experienced level of workload (arrival controllers).
- LLO4-I62₂: Experienced level of workload (feeder/departure controllers).
- LLO4-I7₁: Number of speed up/slow down actions that occur in an approach/departure within ATC sector.
- LLO4-I7₂: Number of vectoring actions that occur in an approach/departure within ATC sector.
- LLO4-I7₃: Number of holding actions that occur in an approach/departure within ATC sector.
- LLO4-I81₁: Amount of R/T calls per hour (arrival controller - pilot).
- LLO4-I81₂: Amount of R/T calls per hour (feeder/departure controller – pilot).
- LLO4-I82₁: Time spent on R/T (arrival controller - pilot).
- LLO4-I82₂: Time spent on R/T (feeder/departure controller - pilot).
- LLO4-I9₁: Pilot workload for each ATC approach/departure procedure (NASA-TLX rating).
- LLO4-I9₂: Pilot workload for each ATC approach/departure procedure (RSME rating).

ACCEPTANCE (PILOTS & CONTROLLERS)

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO6 ACCEPTANCE – FEASIBILITY (PILOTS)	A	LLO06-M1	-	-	-	13,0%	13,0%
		ACCEPTANCE – FEASIBILITY (PILOTS)	-	-	-	13,0%	13,0%
HLO7 ACCEPTANCE – FEASIBILITY (CONTROLLERS)	A	LLO07-M1	-	-	-	-	-
		LLO07-M11	-	-	-	-9,1%	-9,1%
		LLO07-M111	-	-	-	-	-
		LLO07-M112	-	-	-	-4,3%	-4,3%
		AVERAGE M11	-	-	-	-6,7%	-6,7%
		LLO07-M12	-	-	-	-	-
		LLO07-M121	-	-	-	-1,6%	-1,6%
		LLO07-M122	-	-	-	-3,0%	-3,0%
		AVERAGE M12	-	-	-	-2,3%	-2,3%
ACCEPTANCE – FEASIBILITY (CONTROLLERS)	-	-	-	-4,5%	-4,5%		

Table 4-11. ACCEPTANCE results for Procedure II A

- LLO6-M1** Pilot acceptance of NAPs and tool prototypes and identification of foreseen changed pilot tasks.
- LLO7-M11₁** Experienced level of control over the traffic (arrival controllers).
- LLO7-M11₂** Experienced level of control over the traffic (feeder/departure controllers).
- LLO7-M12₁** Experienced level of being able to plan and organise the work (arrival controllers).
- LLO7-M12₂** Experienced level of being able to plan and organise the work (feeder/departure controllers).

4.3.3. Procedure III

NOISE

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO1 ENVIRONMENT (NOISE)	A	LLO1-M11	-27,5%	-32,2%	-25,7%	-28,4%	-28,4%
		LLO1-M12	-20,5%	-33,0%	-32,3%	-26,8%	-28,1%
		LLO1-M13	-23,0%	-33,1%	-34,0%	-26,4%	-29,1%
		LLO1-I1	-11,2%				-11,2%
		AVERAGE L_{den}	-23,6%	-32,8%	-30,7%	-27,2%	-24,2%
		LLO1-M21	-28,1%	-26,7%	-22,9%	-19,6%	-24,3%
		LLO1-M22	-28,0%	-36,8%	-25,3%	-38,7%	-32,2%
		LLO1-M23	-29,8%	-31,0%	-24,8%	-27,4%	-28,3%
		LLO1-I2	-13,1%				-13,1%
		AVERAGE L_{night}	-24,8%	-31,5%	-24,3%	-28,5%	-24,5%
		LLO1-M31			-29,6%		-29,6%
		LLO1-M32			-15,7%		-15,7%
		LLO1-M33			-29,7%		-29,7%
		AVERAGE L_{Amax}			-25,0%		-25,0%
		NOISE			-24,2%	-32,1%	-27,5%

Table 4-12. NOISE results for Procedure III

LLO1-M1₁: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB - 75 dB).

LLO1-M1₂: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB).

LLO1-M1₃: Global noise/area reduction L_{den} comparing NAPs with existing procedures.

LLO1-M2₁: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB - 70 dB).

LLO1-M2₂: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB).

LLO1-M2₃: Global noise/area reduction L_{night} comparing NAPs with existing procedures.

LLO1-M3₁: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB - 75 dB).

LLO1-M3₂: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB).

LLO1-M3₃: Global noise/area reduction L_{Amax} comparing NAPs with existing procedures.

LLO1-I1: Reduction of the population affected within L_{den} area comparing NAPs with existing procedures.

LLO1-I2: Reduction of the population affected within L_{night} area comparing NAPs with existing procedures.

Since results for L_{Amax} has been only provided for Naples-Capodichino, and LLO1-I1 and LLO1-I2 have been only provided for Madrid-Barajas, averages have been calculated without these metrics.

SAFETY

No quantitative result has been provided. Refer to document D4-2 of the project for additional information.

CAPACITY

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				Average
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	
HLO04 CAPACITY	A	LLO04-I2	-5,9%	-1,3%			-3,6%
		TOTAL I2	-5,9%	-1,3%			-3,6%
		LLO04-I3 ₁	105,9%	12,4%			59,2%
		LLO04-I3 ₂	-29,4%				-29,4%
		TOTAL I3	-7,5%	12,4%			2,5%
		LLO04-I4	23,0%	4,9%			14,0%
		TOTAL I4	23,0%	4,9%			14,0%
CAPACITY			-7,1%	-6,2%			-6,7%

	Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
Throughput (I2)	-5,9%	-1,3%			-3,6%
Delays (I3 & I4)	7,8%	8,7%			8,2%

Table 4-13. CAPACITY results for Procedure III

- LLO4-I2 Airport throughput.
- LLO4-I3₁ Total delay for each aircraft (arrivals).
- LLO4-I3₂ Total delay for each aircraft (departures).
- LLO4-I4 Percentage of delayed aircrafts.

WORKLOAD

No quantitative result has been provided. Refer to document D6-3 of the project for additional information.

ACCEPTANCE (PILOTS & CONTROLLERS)

No quantitative result has been provided. Refer to document D6-3 of the project for additional information.

4.3.4. Procedure IV

NOISE

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO1 ENVIRONMENT (NOISE)	A	LLO1-M11	-8,3%	-10,4%	-5,7%	-7,6%	-8,0%
		LLO1-M12	-14,4%	-26,3%	-7,6%	-21,9%	-17,5%
		LLO1-M13	-10,0%	-13,6%	-6,7%	-14,1%	-11,1%
		LLO1-I1	-3,4%				-3,4%
		AVERAGE L_{den}	-10,9%	-16,8%	-6,7%	-14,5%	-10,0%
		LLO1-M21	-8,2%	-6,4%	-5,2%	-2,8%	-5,7%
		LLO1-M22	-13,7%	-8,0%	-7,8%	-4,0%	-8,4%
		LLO1-M23	-9,5%	-6,4%	-6,2%	-3,2%	-6,3%
		LLO1-I2	-2,3%				-2,3%
		AVERAGE L_{night}	-8,4%	-6,9%	-6,4%	-3,3%	-5,7%
		LLO1-M31			-20,2%		-20,2%
		LLO1-M32			-23,0%		-23,0%
		LLO1-M33			-19,5%		-19,5%
		AVERAGE L_{Amax}			-20,9%		-20,9%
NOISE			-9,7%	-11,9%	-6,5%	-8,9%	-7,8%

Table 4-14. NOISE results for Procedure IV

LLO1-M1₁: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB - 75 dB).

LLO1-M1₂: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB).

LLO1-M1₃: Global noise/area reduction L_{den} comparing NAPs with existing procedures.

LLO1-M2₁: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB - 70 dB).

LLO1-M2₂: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB).

LLO1-M2₃: Global noise/area reduction L_{night} comparing NAPs with existing procedures.

LLO1-M3₁: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB - 75 dB).

LLO1-M3₂: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB).

LLO1-M3₃: Global noise/area reduction L_{Amax} comparing NAPs with existing procedures.

LLO1-I1: Reduction of the population affected within L_{den} area comparing NAPs with existing procedures.

LLO1-I2: Reduction of the population affected within L_{night} area comparing NAPs with existing procedures.

Since results for L_{Amax} has been only provided for Naples-Capodichino, and LLO1-I1 and LLO1-I2 have been only provided for Madrid-Barajas, averages have been calculated without these metrics.

SAFETY

No quantitative result has been provided. Refer to document D4-3 of the project for additional information.

CAPACITY

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO04 CAPACITY	A	LLO04-I2	-6,7%		-10,7%	-7,1%	-8,2%
		TOTAL I2	-6,7%		-10,7%	-7,1%	-8,2%
		LLO04-I3 ₁	159,8%		70,9%	122,7%	117,8%
		LLO04-I3 ₂	-19,6%		34,4%	6,2%	7,0%
		TOTAL I3	9,4%		52,7%	39,5%	33,9%
		LLO04-I4	38,4%			53,8%	46,1%
		TOTAL I4	38,4%			53,8%	46,1%
		CAPACITY	-18,2%		-31,7%	-33,5%	-29,4%

	Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
Throughput (I2)	-6,7%		-10,7%	-7,1%	-8,2%
Delays (I3 & I4)	23,9%		52,7%	46,7%	40,0%

Table 4-15. CAPACITY results for Procedure IV

- LLO4-I2** Airport throughput.
- LLO4-I3₁** Total delay for each aircraft (arrivals).
- LLO4-I3₂** Total delay for each aircraft (departures).
- LLO4-I4** Percentage of delayed aircrafts.

WORKLOAD

No quantitative result has been provided. Refer to document D6-3 of the project for additional information.

ACCEPTANCE (PILOTS & CONTROLLERS)

No quantitative result has been provided. Refer to document D6-3 of the project for additional information.

4.3.5. Procedure V

NOISE

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO1 ENVIRONMENT (NOISE)	A	LLO1-M11	-0,5%	-0,7%	-4,6%	0,4%	-1,4%
		LLO1-M12	11,1%	1,6%	-7,0%	2,8%	2,1%
		LLO1-M13	3,6%	-0,1%	-5,3%	0,7%	-0,3%
		LLO1-I1	-0,7%				-0,7%
		AVERAGE L_{den}	4,7%	0,2%	-5,6%	1,3%	-0,1%
		LLO1-M21	-3,2%	-3,3%	-4,4%	-1,5%	-3,1%
		LLO1-M22	8,0%	-2,4%	-6,0%	-1,3%	-0,4%
		LLO1-M23	-1,7%	-2,6%	-4,8%	-1,4%	-2,6%
		LLO1-I2	-1,5%				-1,5%
		AVERAGE L_{night}	0,4%	-2,8%	-5,1%	-1,4%	-1,9%
		LLO1-M31			3,2%		3,2%
		LLO1-M32			-6,6%		-6,6%
		LLO1-M33			3,5%		3,5%
		AVERAGE L_{Amax}			0,0%		0,0%
		NOISE			2,6%	-1,3%	-5,3%

Table 4-16. NOISE results for Procedure V

LLO1-M1₁: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB - 75 dB).

LLO1-M1₂: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB).

LLO1-M1₃: Global noise/area reduction L_{den} comparing NAPs with existing procedures.

LLO1-M2₁: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB - 70 dB).

LLO1-M2₂: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB).

LLO1-M2₃: Global noise/area reduction L_{night} comparing NAPs with existing procedures.

LLO1-M3₁: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB - 75 dB).

LLO1-M3₂: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB).

LLO1-M3₃: Global noise/area reduction L_{Amax} comparing NAPs with existing procedures.

LLO1-I1: Reduction of the population affected within L_{den} area comparing NAPs with existing procedures.

LLO1-I2: Reduction of the population affected within L_{night} area comparing NAPs with existing procedures.

Since results for L_{Amax} has been only provided for Naples-Capodichino, and LLO1-I1 and LLO1-I2 have been only provided for Madrid-Barajas, averages have been calculated without these metrics.

SAFETY

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO3 SAFETY	B	LLO3-BM1					
		LLO3-BM1 ₁					-23,8%
		LLO3-BM1 ₂					11,1%
			AVERAGE B				-6,4%
	C	LLO3-CM1					-14,4%
		AVERAGE C					-14,4%
	D	LLO3-DI2					
		LLO3-DI2 ₁					
		LLO3-DI2 ₁₁					10,4%
		LLO3-DI2 ₁₂					2,7%
		AVERAGE D2 ₁					6,6%
		LLO3-DI2 ₂					
		LLO3-DI2 ₂₁					-33,3%
		LLO3-DI2 ₂₂					-1,4%
		AVERAGE D2 ₂					-17,4%
		AVERAGE D2					-25,3%
	AVERAGE D					-25,3%	
	E	LLO3-EI1					-10,2%
		LLO3-EI1 ₂					-1,8%
		LLO3-EI2					12,7%
			AVERAGE EI				-0,2%
	F	LLO3-FI1					>1000%
		AVERAGE F					-
		SAFETY				-11,6%	

CONTROLLERS PERCEPTION (B & D22)	-11,9%
PILOTS PERCEPTION (C6 & D21)	-3,9%
OBJECTIVES MEASUREMENTS (E)	-0,2%

Table 4-17. SAFETY results for Procedure V

- LLO3-BM1₁ Relative safety perception according to the arrival ATCo.
- LLO3-BM1₂ Relative safety perception according to the feeder / departure ATCo.
- LLO3-CM1 Relative safety perception according to the pilot.
- LLO3-DI2₁₁ Navigational awareness of the pilots.
- LLO3-DI2₁₂ Energy awareness of the pilots
- LLO3-DI2₂₁ Situational awareness of the arrival controllers.
- LLO3-DI2₂₂ Situational awareness of the feeder/departure controllers.
- LLO3-EI1 Number of incident detection events that will require ATC intervention per ATC sector.
- LLO3-EI1₂ Loss of separation.
- LLO3-EI2 Average time of incident event duration per ATC sector.
- LLO3-FI1 % of time using speedbrakes.

CAPACITY

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO04 CAPACITY	A	LLO04-I2	-5,9%	-2,6%	-3,6%	-7,1%	-4,8%
		TOTAL I2	-5,9%	-2,6%	-3,6%	-7,1%	-4,8%
		LLO04-I3 ₁	111,3%	13,7%	37,1%	45,2%	51,8%
		LLO04-I3 ₂	-29,0%		23,8%	5,6%	0,1%
		TOTAL I3	-6,4%	13,7%	30,5%	16,9%	13,7%
		LLO04-I4	32,0%	4,2%		18,2%	18,1%
	TOTAL I4	32,0%	4,2%		18,2%	18,1%	
CAPACITY			-10,5%	-6,8%	-17,0%	-14,1%	-12,2%

	Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
Throughput (I2)	-5,9%	-2,6%	-3,6%	-7,1%	-4,8%
Delays (I3 & I4)	12,8%	9,0%	30,5%	17,6%	15,9%

Table 4-18. CAPACITY results for Procedure V

- LLO4-I2 Airport throughput.
- LLO4-I3₁ Total delay for each aircraft (arrivals).
- LLO4-I3₂ Total delay for each aircraft (departures).
- LLO4-I4 Percentage of delayed aircrafts.

WORKLOAD

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				Average
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	
HLO04 WORKLOAD	A	LLO04-I6					
		LLO04-I61					
		LLO04-I611	-	-	-	21,4%	
		LLO04-I612	-	-	-	9,0%	
		AVERAGE I61	-	-	-	15,2%	
		LLO04-I62					
		LLO04-I621	-	-	-	10,1%	
		LLO04-I622	-	-	-	5,6%	
		AVERAGE I62	-	-	-	7,9%	
		AVERAGE I6	-	-	-	11,5%	
		LLO04-I7					
		LLO04-I71	-	-	-	-30,0%	
		LLO04-I72	-	-	-		
		LLO04-I73	-	-	-	33,0%	
		AVERAGE I7	-	-	-	1,5%	
		LLO04-I8					
		LLO04-I81					
		LLO04-I811	-	-	-	-33,8%	
		LLO04-I812	-	-	-	-20,1%	
		AVERAGE I81	-	-	-	-27,0%	
		LLO04-I82					
		LLO04-I821	-	-	-	-33,7%	
		LLO04-I822	-	-	-	-14,5%	
		AVERAGE I82	-	-	-	-24,1%	
		AVERAGE I8	-	-	-	-25,5%	
		LLO04-I9					
		LLO04-I91	-	-	-	11,9%	
		LLO04-I92	-	-	-	47,7%	
		AVERAGE I9	-	-	-	27,0%	
		WORKLOAD			-	-	-
CONTROLLERS (I6, I7 & I8)			-4,2%				
PILOTS (I9)			27,0%				

Table 4-19. WORKLOAD results for Procedure V

- LLO4-I61₁: Instantaneous self-assessment ISA (arrival controllers).
- LLO4-I61₂: Instantaneous self-assessment ISA (feeder/departure controllers).
- LLO4-I62₁: Experienced level of workload (arrival controllers).
- LLO4-I62₂: Experienced level of workload (feeder/departure controllers).
- LLO4-I7₁: Number of speed up/slow down actions that occur in an approach/departure within ATC sector.
- LLO4-I7₂: Number of vectoring actions that occur in an approach/departure within ATC sector.
- LLO4-I7₃: Number of holding actions that occur in an approach/departure within ATC sector.
- LLO4-I81₁: Amount of R/T calls per hour (arrival controller - pilot).
- LLO4-I81₂: Amount of R/T calls per hour (feeder/departure controller – pilot).
- LLO4-I82₁: Time spent on R/T (arrival controller - pilot).
- LLO4-I82₂: Time spent on R/T (feeder/departure controller - pilot).
- LLO4-I9₁: Pilot workload for each ATC approach/departure procedure (NASA-TLX rating).
- LLO4-I9₂: Pilot workload for each ATC approach/departure procedure (RSME rating).

ACCEPTANCE (PILOTS & CONTROLLERS)

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				Average
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	
HLO6 ACCEPTANCE – FEASIBILITY (PILOTS)	A	LLO06-M1	-	-	-	-4,4%	-4,4%
		ACCEPTANCE – FEASIBILITY (PILOTS)	-	-	-	-4,4%	-4,4%
HLO7 ACCEPTANCE – FEASIBILITY (CONTROLLERS)	A	LLO07-M1	-	-	-	-	-
		LLO07-M11	-	-	-	-36,4%	-36,4%
		LLO07-M111	-	-	-	-1,4%	-1,4%
		LLO07-M112	-	-	-	-	-
		AVERAGE M11	-	-	-	-18,9%	-18,9%
		LLO07-M12	-	-	-	-	-
		LLO07-M121	-	-	-	-30,2%	-30,2%
		LLO07-M122	-	-	-	3,0%	3,0%
AVERAGE M12	-	-	-	-13,6%	-13,6%		
		ACCEPTANCE – FEASIBILITY (CONTROLLERS)	-	-	-	-16,3%	-16,3%

Table 4-20. ACCEPTANCE results for Procedure V

LLO6-M1 Pilot acceptance of NAPs and tool prototypes and identification of foreseen changed pilot tasks.

LLO7-M11₁ Experienced level of control over the traffic (arrival controllers).

LLO7-M11₂ Experienced level of control over the traffic (feeder/departure controllers).

LLO7-M12₁ Experienced level of being able to plan and organize the work (arrival controllers).

LLO7-M12₂ Experienced level of being able to plan and organize the work (feeder/departure controllers).

4.4. Procedures analysis (departure)

4.4.1. Procedure 2: Close-in

NOISE

AREA	LOW LEVEL OBJECTIVES	INDICATORS & METRICS	AIRPORT / VALIDATION EXERCISE				Average
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	
LLO1 ENVIRONMENT (NOISE)	A	LLO1-M11	-12,0%	-11,5%	-12,2%	-11,8%	-11,9%
		LLO1-M12	9,2%	9,9%	-11,2%	9,3%	4,3%
		LLO1-M13	-18,0%	-8,8%	-12,7%	-7,3%	-11,7%
		LLO1-I1	122,2%				122,2%
		AVERAGE L_{den}	-6,9%	-3,5%	-12,0%	-3,3%	-6,4%
		LLO1-M21	-14,1%	-9,9%	-9,7%	-15,0%	-12,2%
		LLO1-M22	-2,1%	10,2%		-13,4%	-1,8%
		LLO1-M23	-12,0%	-7,9%	-10,4%	-16,6%	-11,7%
		LLO1-I2	0,0%				0,0%
		AVERAGE L_{night}	-9,4%	-2,5%	-10,1%	-15,0%	-8,6%
		LLO1-M31			-3,6%		-3,6%
		LLO1-M32			-1,3%		-1,3%
		LLO1-M33			-4,2%		-4,2%
		AVERAGE L_{Amax}			-3,0%		-3,0%
NOISE			-8,2%	-3,0%	-8,4%	-9,1%	-6,0%

Table 4-21. NOISE results for Procedure 2: CLOSE IN

LLO1-M1₁: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB - 75 dB).

LLO1-M1₂: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB).

LLO1-M1₃: Global noise/area reduction L_{den} comparing NAPs with existing procedures.

LLO1-M2₁: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB - 70 dB).

LLO1-M2₂: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB).

LLO1-M2₃: Global noise/area reduction L_{night} comparing NAPs with existing procedures.

LLO1-M3₁: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB - 75 dB).

LLO1-M3₂: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB).

LLO1-M3₃: Global noise/area reduction L_{Amax} comparing NAPs with existing procedures.

LLO1-I1: Reduction of the population affected within L_{den} area comparing NAPs with existing procedures.

LLO1-I2: Reduction of the population affected within L_{night} area comparing NAPs with existing procedures.

Since results for L_{Amax} has been only provided for Naples-Capodichino, and LLO1-I1 and LLO1-I2 have been only provided for Madrid-Barajas, averages have been calculated without these metrics.

SAFETY

No quantitative result has been provided. Refer to document D4-2 of the project for additional information.

CAPACITY

No quantitative result has been provided. Refer to document D4-1 of the project for additional information.

WORKLOAD

No quantitative result has been provided. Refer to document D6-3 of the project for additional information.

ACCEPTANCE (PILOTS & CONTROLLERS)

No quantitative result has been provided for controllers' acceptance. Refer to document D6-3 of the project for additional information.

HIGH LEVEL OBJECTIVES	LOW LEVEL OBJECTIVES	INDICATORS AND METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
HLO6 ACCEPTANCE – FEASIBILITY (PILOTS)	A	LLO06-M1	-	-	-	16,0%	16,0%
		ACCEPTANCE – FEASIBILITY (PILOTS)	-	-	-	16,0%	16,0%
HLO7 ACCEPTANCE – FEASIBILITY (CONTROLLERS)	A	LLO07-M1					
		LLO07-M11					
		LLO07-M111	-	-	-		
		LLO07-M112	-	-	-		
		AVERAGE M11	-	-	-		
		LLO07-M12					
		LLO07-M121	-	-	-		
		LLO07-M122	-	-	-		
		AVERAGE M12	-	-	-		
		ACCEPTANCE – FEASIBILITY (CONTROLLERS)	-	-	-		

Table 4-22. ACCEPTANCE results for Procedure 2

- LLO6-M1** Pilot acceptance of NAPs and tool prototypes and identification of foreseen changed pilot tasks.
- LLO7-M11₁** Experienced level of control over the traffic (arrival controllers).
- LLO7-M11₂** Experienced level of control over the traffic (feeder/departure controllers).
- LLO7-M12₁** Experienced level of being able to plan and organise the work (arrival controllers).
- LLO7-M12₂** Experienced level of being able to plan and organise the work (feeder/departure controllers).

4.4.2. Procedure 3: Distant

NOISE

AREA	LOW LEVEL OBJECTIVES	INDICATORS & METRICS	AIRPORT / VALIDATION EXERCISE				
			Madrid FTS	Paris FTS	Naples FTS	Amsterdam FTS - RTS	Average
LLO1 ENVIRONMENT (NOISE)	A	LLO1-M11	-16,3%	-15,0%	-5,1%	-18,8%	-13,8%
		LLO1-M12	-42,2%	-26,7%	-31,3%	-31,9%	-33,0%
		LLO1-M13	-18,0%	-21,4%	-9,1%	-24,7%	-18,3%
		LLO1-I1	-96,0%				-96,0%
		AVERAGE L_{den}	-43,1%	-21,0%	-15,2%	-25,1%	-21,7%
		LLO1-M21	-12,5%	-11,5%	3,1%	-8,1%	-7,2%
		LLO1-M22	-41,8%	-32,0%		-30,7%	-34,8%
		LLO1-M23	-15,4%	-17,4%	3,2%	-12,0%	-10,4%
		LLO1-I2	0,0%				0,0%
		AVERAGE L_{night}	-17,4%	-20,3%	3,2%	-16,9%	-17,5%
		LLO1-M31			-16,0%		-16,0%
		LLO1-M32			-10,7%		-10,7%
		LLO1-M33			-11,7%		-11,7%
		AVERAGE L_{Amax}			-12,8%		-12,8%
NOISE			-30,3%	-20,7%	-8,3%	-21,0%	-17,3%

Table 4-23. NOISE results for Procedure 3: DISTANT

LLO1-M1₁: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB - 75 dB).

LLO1-M1₂: Noise contour L_{den} area reduction comparing NAPs with existing procedures (55 dB).

LLO1-M1₃: Global noise/area reduction L_{den} comparing NAPs with existing procedures.

LLO1-M2₁: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB - 70 dB).

LLO1-M2₂: Noise contour L_{night} area reduction comparing NAPs with existing procedures (50 dB).

LLO1-M2₃: Global noise/area reduction L_{night} comparing NAPs with existing procedures.

LLO1-M3₁: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB - 75 dB).

LLO1-M3₂: Noise contour L_{Amax} area reduction comparing NAPs with existing procedures (only for night flights) (55 dB).

LLO1-M3₃: Global noise/area reduction L_{Amax} comparing NAPs with existing procedures.

LLO1-I1: Reduction of the population affected within L_{den} area comparing NAPs with existing procedures.

LLO1-I2: Reduction of the population affected within L_{night} area comparing NAPs with existing procedures.

Since results for L_{Amax} has been only provided for Naples-Capodichino, and LLO1-I1 and LLO1-I2 have been only provided for Madrid-Barajas, averages have been calculated without these metrics.

SAFETY

No quantitative result has been provided. Refer to document D4-2 of the project for additional information.

CAPACITY

No quantitative result has been provided. Refer to document D4-1 of the project for additional information.

WORKLOAD

No quantitative result has been provided. Refer to document D6-3 of the project for additional information.

ACCEPTANCE (PILOTS & CONTROLLERS)

No quantitative result has been provided. Refer to document D6-3 of the project for additional information.

5. Comparison of procedures

5.1. Comparison charts

5.1.1. Analysis of NOISE (arrivals)

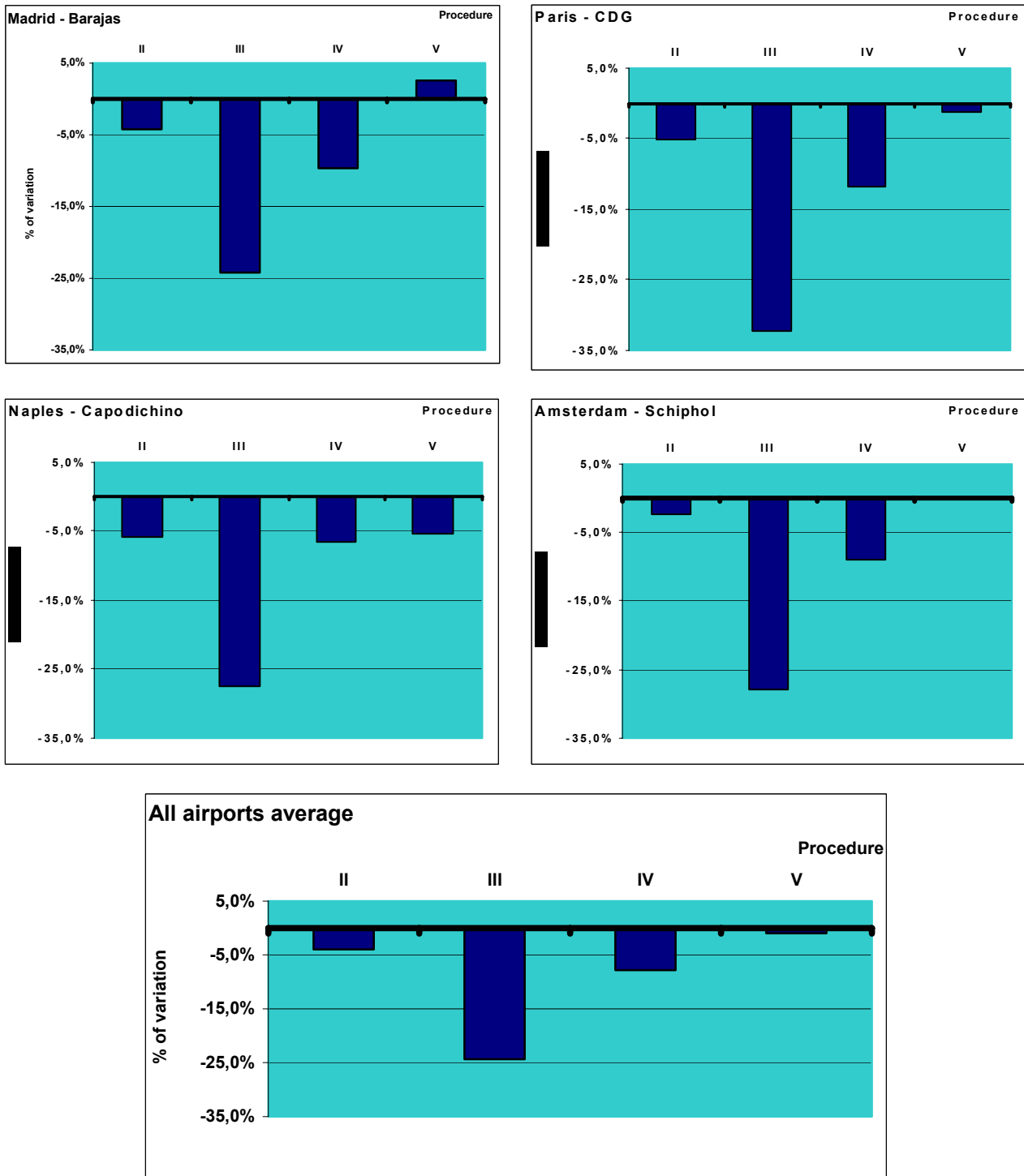


Figure 5-1. Analysis of NOISE (arrivals). Average results.

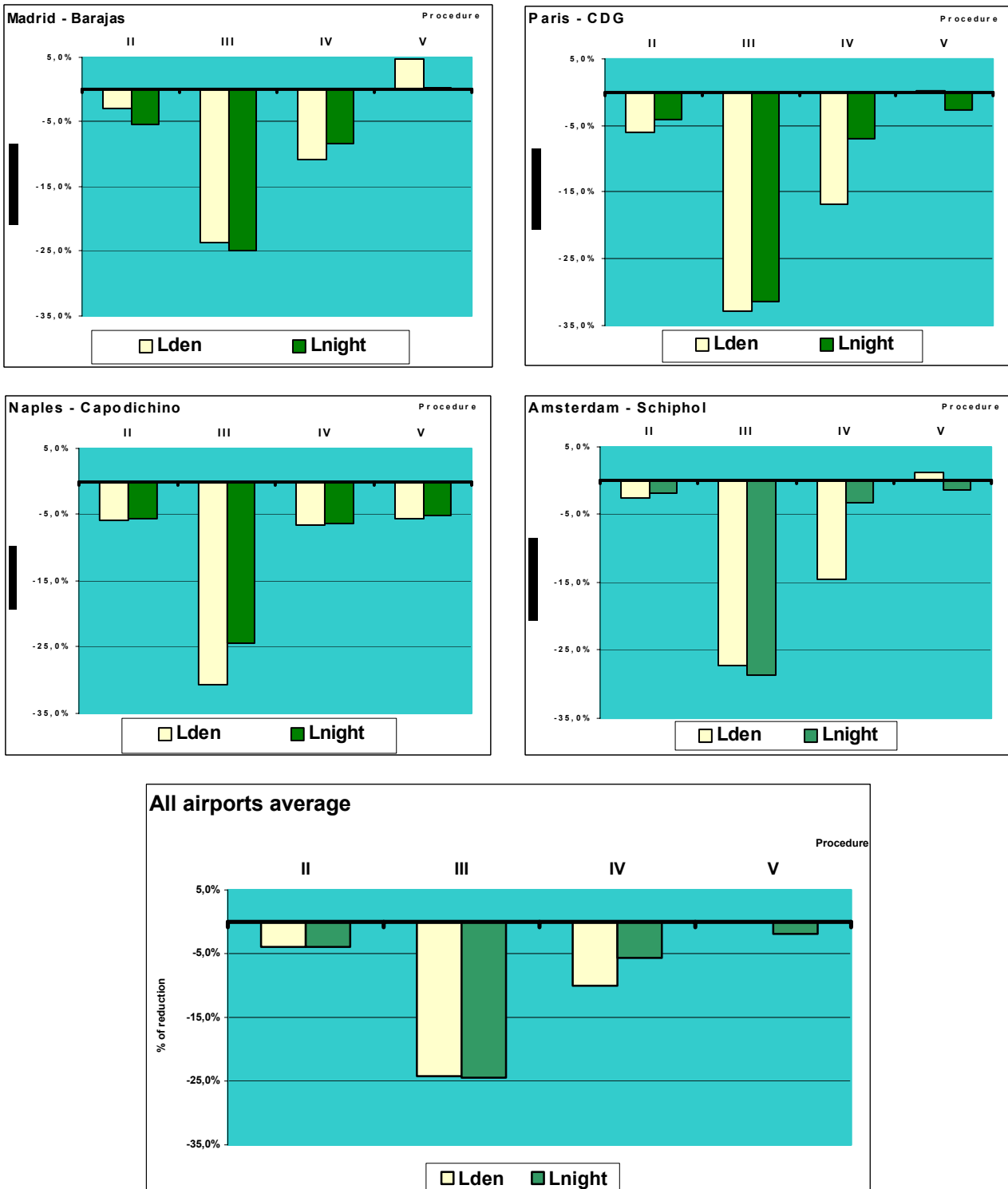


Figure 5-2. Analysis of NOISE (arrivals) for L_{den} and L_{night} .

Preliminary comments

- There are no significant differences between airports in NOISE abatement within the same procedure, but in procedure V, where only significant noise abatement is reached in Naples for the both of L_{den} and L_{night} .

- Arrival procedure III reduces dramatically noise. Provided that no capacity constraints arrives, this is the most promising procedure for noise abatement.
- Arrival procedure IV is a very good alternative to procedure III because the noise abatement is half of number III but influence in other areas must be considered.
- Arrival procedure II is the most balanced one in terms of noise abatement and capacity losing.
- There are no significant differences between results for L_{den} and L_{night} in each procedure, but with procedure IV for Paris-CDG and Amsterdam-Schiphol where a large different between L_{den} and L_{night} results has been found.

5.1.2. Analysis of NOISE (departures)

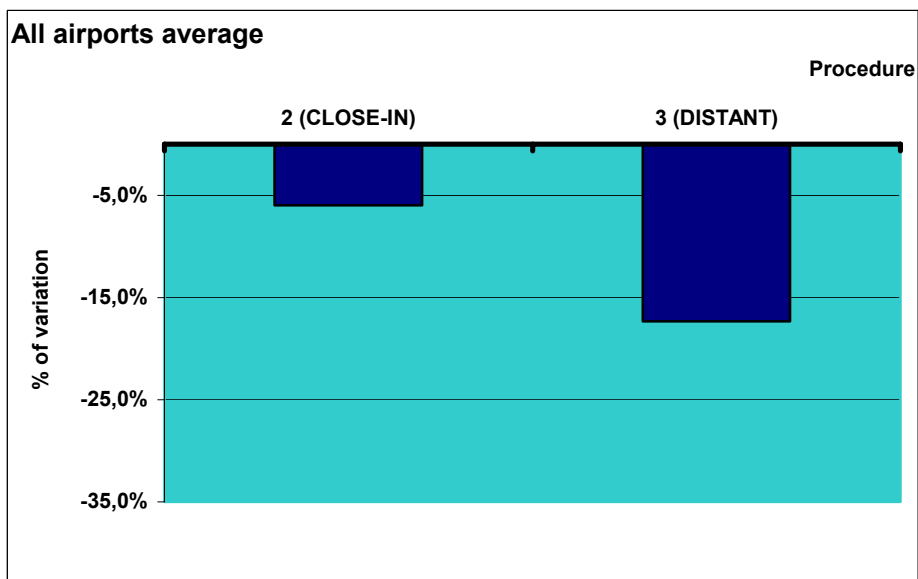
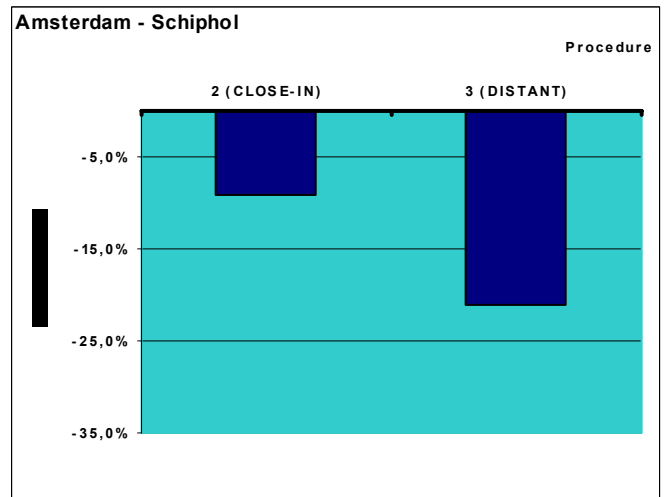
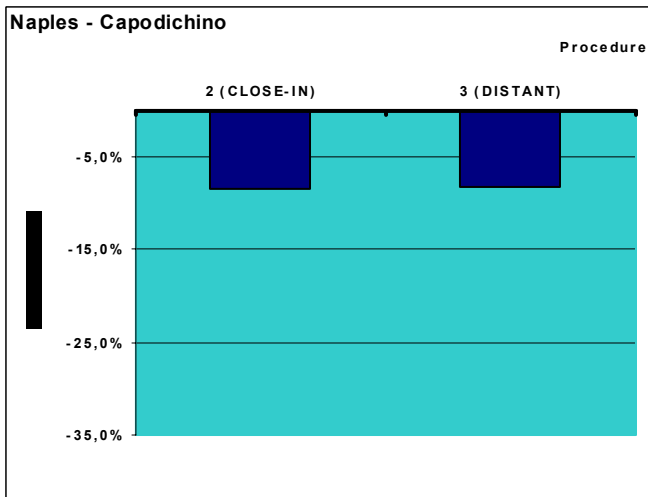
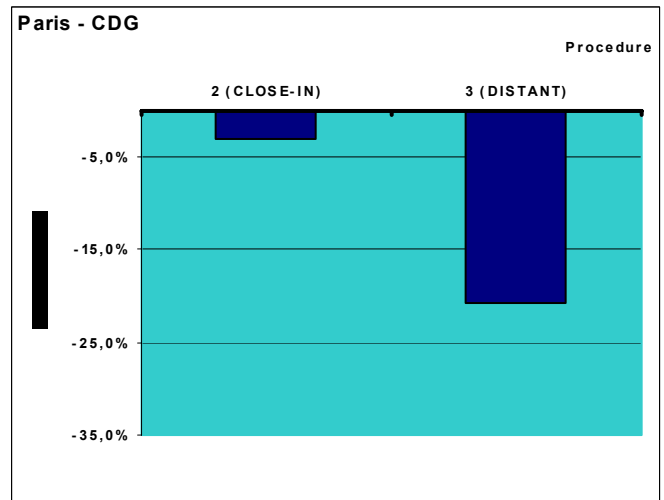
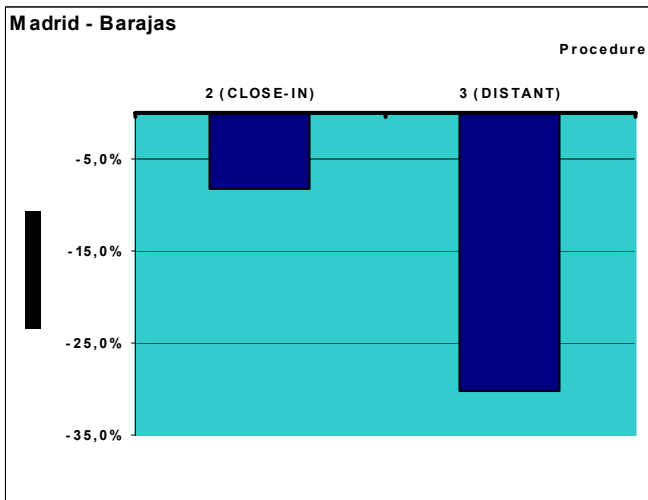


Figure 5-3. Analysis of NOISE (departures). Average results.

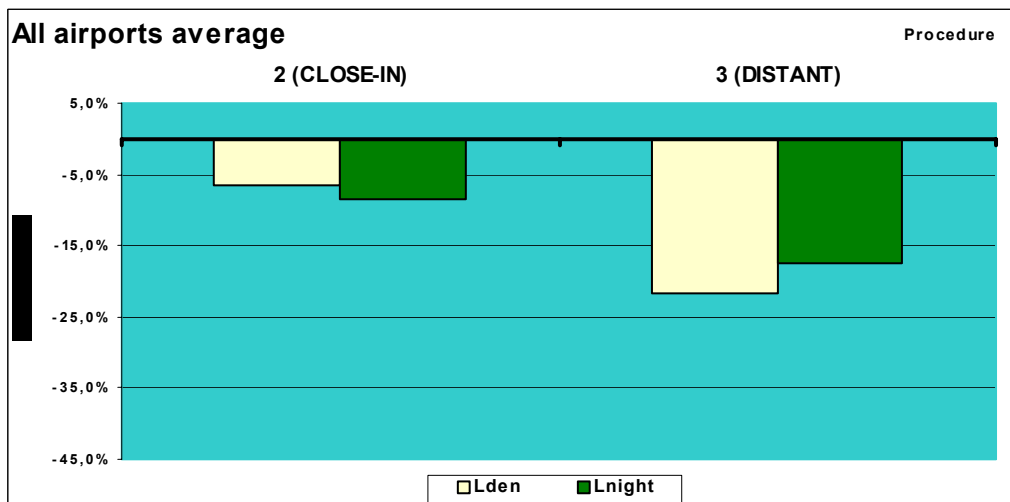
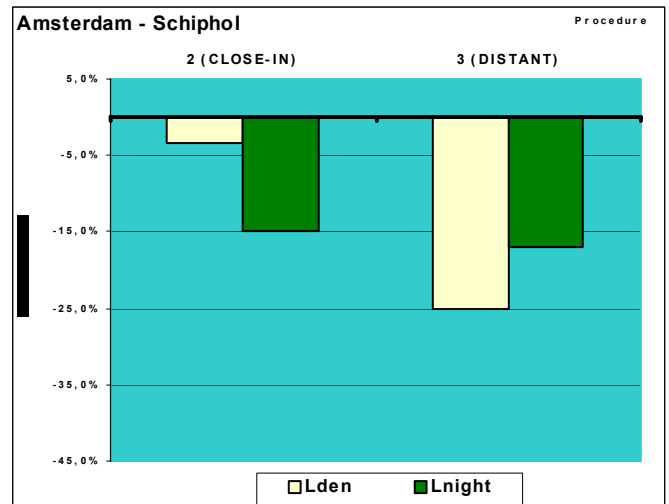
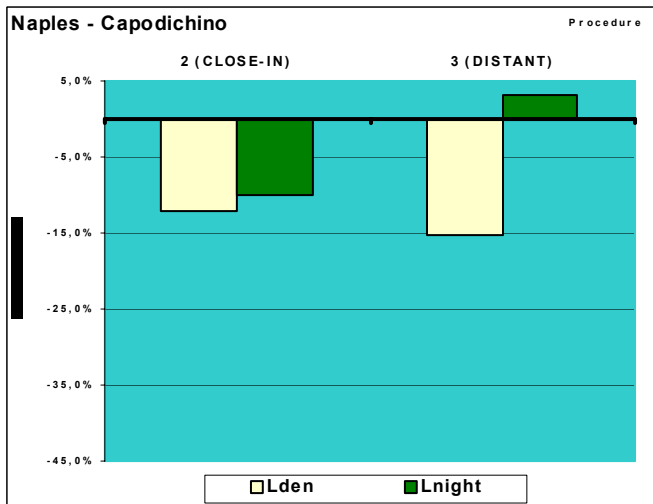
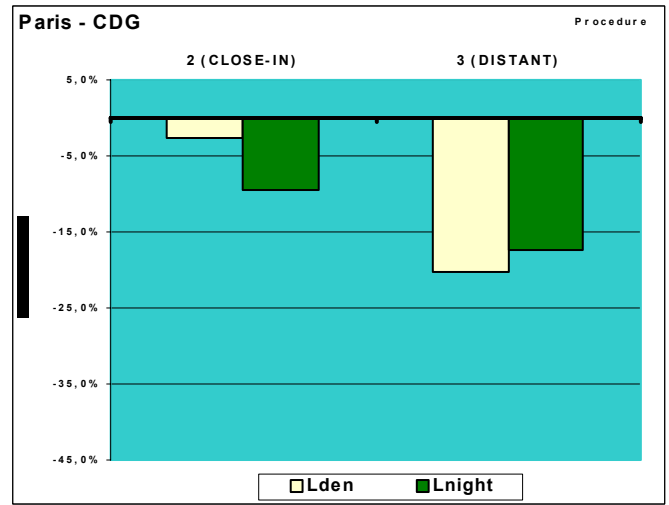
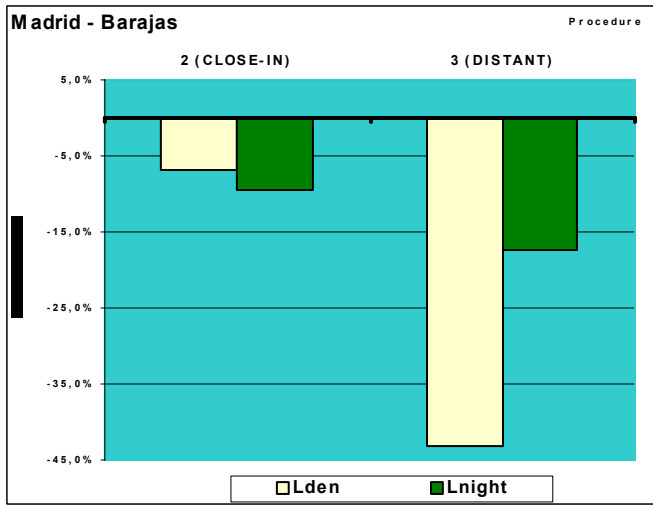


Figure 5-4. Analysis of NOISE (departures) for L_{den} and L_{night}.

Preliminary comments

- In general, procedure 3, DISTANT, shows more noise reduction than procedure 2, CLOSE IN – but in Naples. This is due to the own design of the departure procedures 2 and 3. Procedure 2 aim to reduce noise in the nearest areas of the airport and that makes larger the contour for the lowest dB levels and smaller the ones for highest ones. It just happens the opposite for procedure 3. Since average calculations for this Comparative analysis of results has taken in account a wide range of dB, procedure 3 shows better results.
- Both procedures are not comparable since they aim to different objectives. But it can be concluded that DISTANT procedure accomplishes a larger noise abatement than CLOSE IN procedure, although this noise abatement is reached in different areas of the airport surroundings.
- Procedure 2 seems to be more beneficial in night time periods but in Naples. It just happens the opposite with procedure 3 which shows better results for L_{den} than for L_{night} .

5.1.3. Analysis of SAFETY*

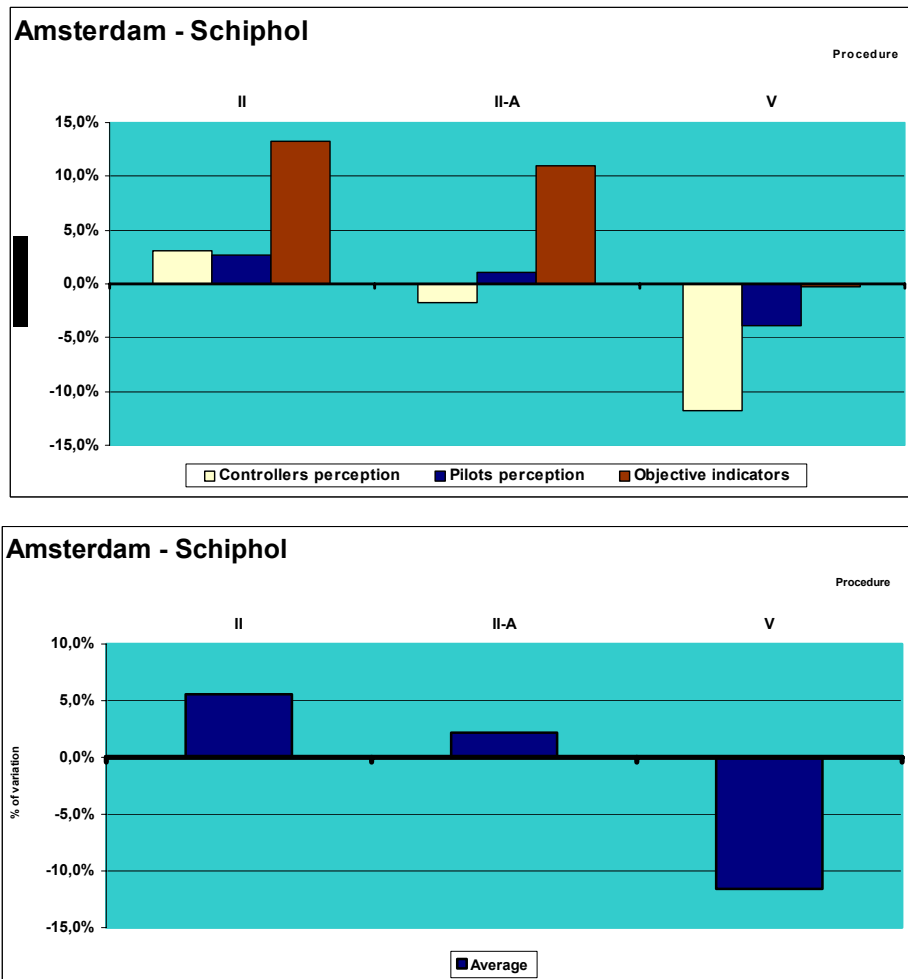


Figure 5-5. Analysis of SAFETY

* Numerical metrics and indicators for SAFETY has only been assessed in RTS in Amsterdam – Schiphol.

Preliminary comments

- Out of the procedures assessed, procedure II and its variant with speed constraints, procedure II-A, seem to be even safer than the reference. However, procedure V is considered less safe than reference procedure.
- In all cases, the differences between reference procedure and new procedures is very narrow.
- Pilots perceive similar level of SAFETY for each procedure; controllers perceive a big difference between procedure II – the safest – and V – the least safe.
- There is a significant difference between pilots and controllers safety perception for procedure V, since controllers opinion is much more negative than pilots one.
- Perception of pilots and controllers are in line with the results for objective indicators – loss of separation, time of incident event duration per ATC sector, etc. In general, for the three analyzed procedures, measured indicators show much better results than pilots and controllers perception, but they increase or decrease correspondingly.

5.1.4. Analysis of CAPACITY

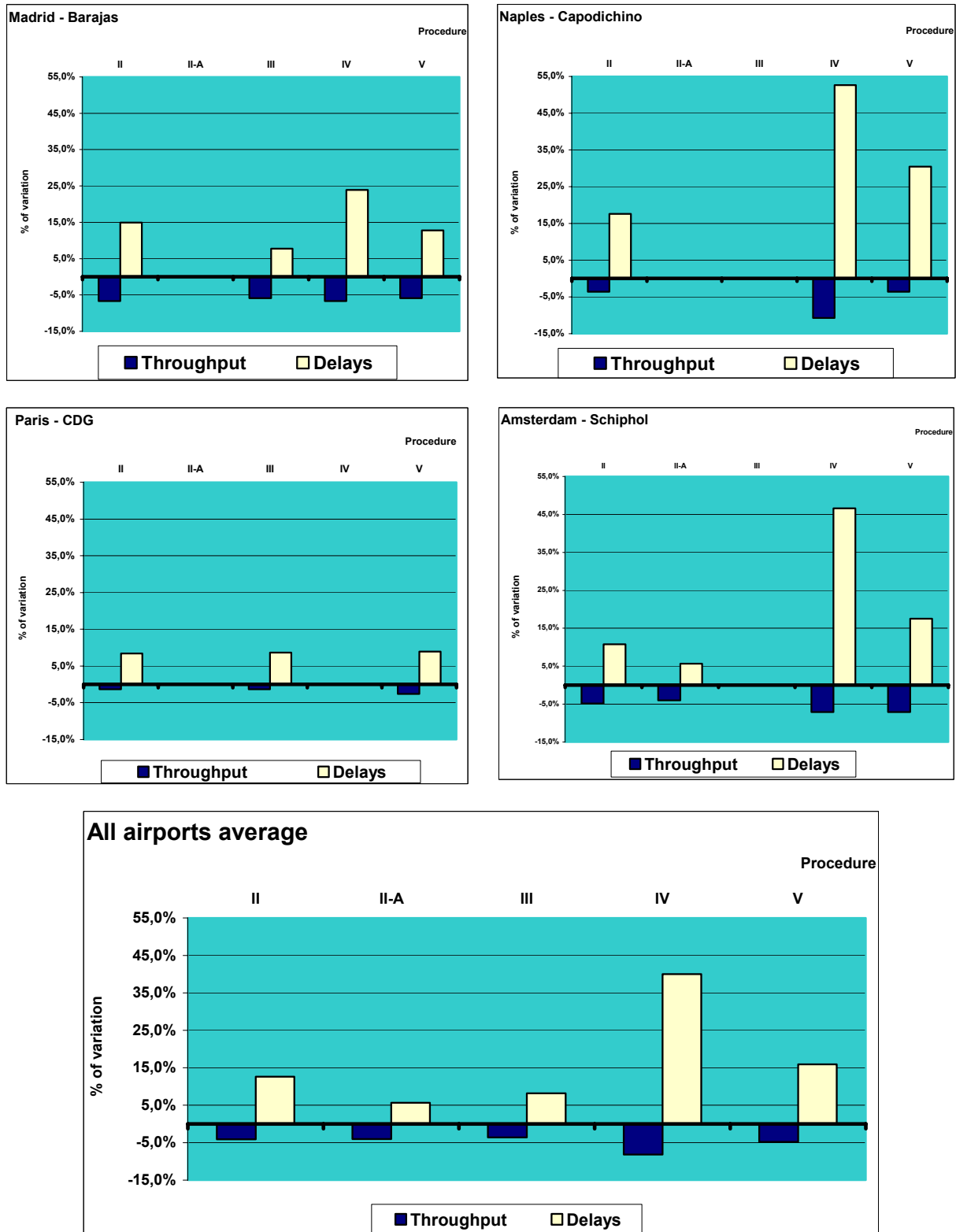


Figure 5-6. Analysis of CAPACITY

Preliminary comments

- All SOURDINE-II procedures imply a loss of capacity, more significant for procedure IV.
- The loss of capacity comes from delays - delayed minutes and number of delayed aircrafts - more than from reduction of throughput.
- According to the results, Paris - CDG is less sensitive to the changes caused by SOURDINE II procedures than the other airports.
- Procedure IV provokes a large increment of delays in Naples - Capodichino and Amsterdam - Schiphol.

5.1.5. Analysis of WORKLOAD*

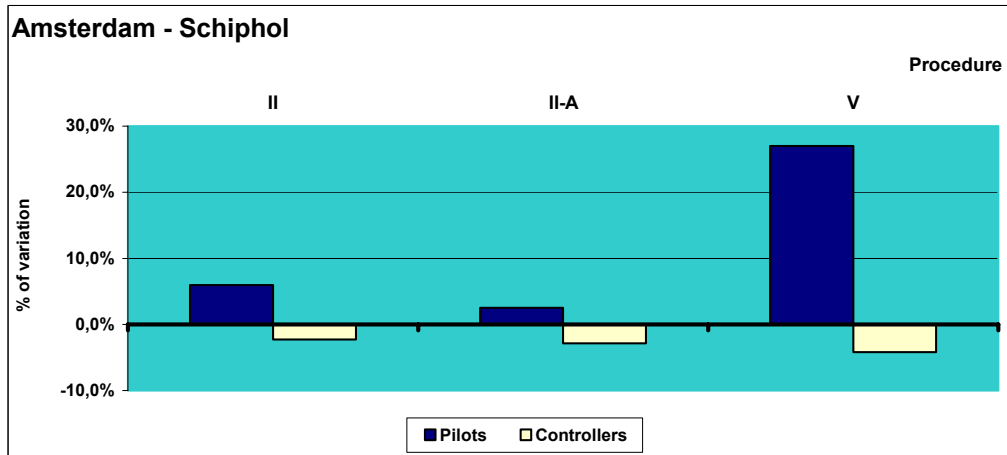


Figure 5-7. Analysis of WORKLOAD

* WORKLOAD has only been assessed in RTS in Amsterdam – Schiphol.

Preliminary comments

- New procedures entail a slight reduction of workload for controllers with respect the reference procedure.
- For pilots, there is an increment in workload for all of the procedures, very significant for procedure V.

5.1.6. Analysis of *ECONOMICS*

Since not enough quantitative results have been produced, no Comparative analysis of results can be done. The economics qualitative analysis of SOURDINE II procedures can be found in document D4-3.

5.1.7. Analysis of ACCEPTANCE (pilots & controllers)*

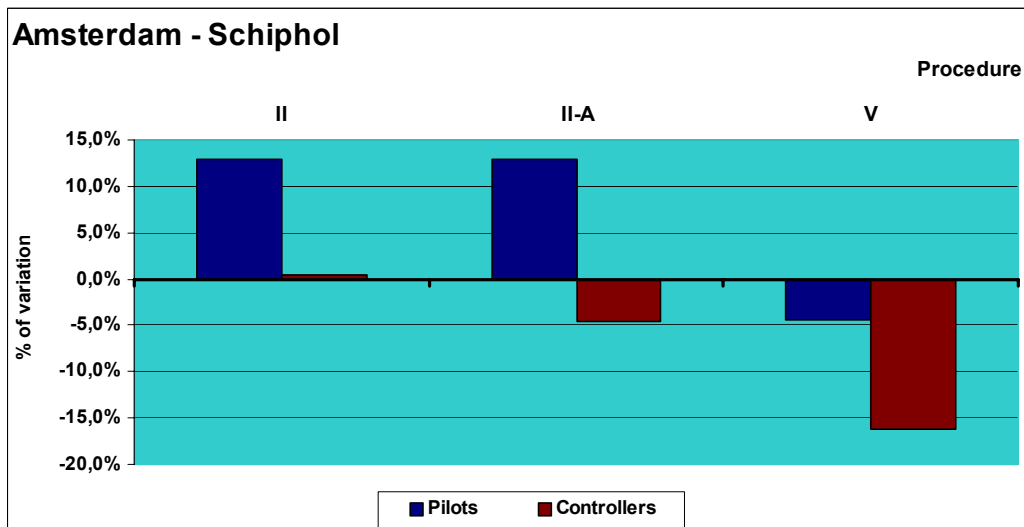


Figure 5-8. Analysis of ACCEPTANCE

* ACCEPTANCE has only been assessed in RTS in Amsterdam – Schiphol.

Preliminary comments

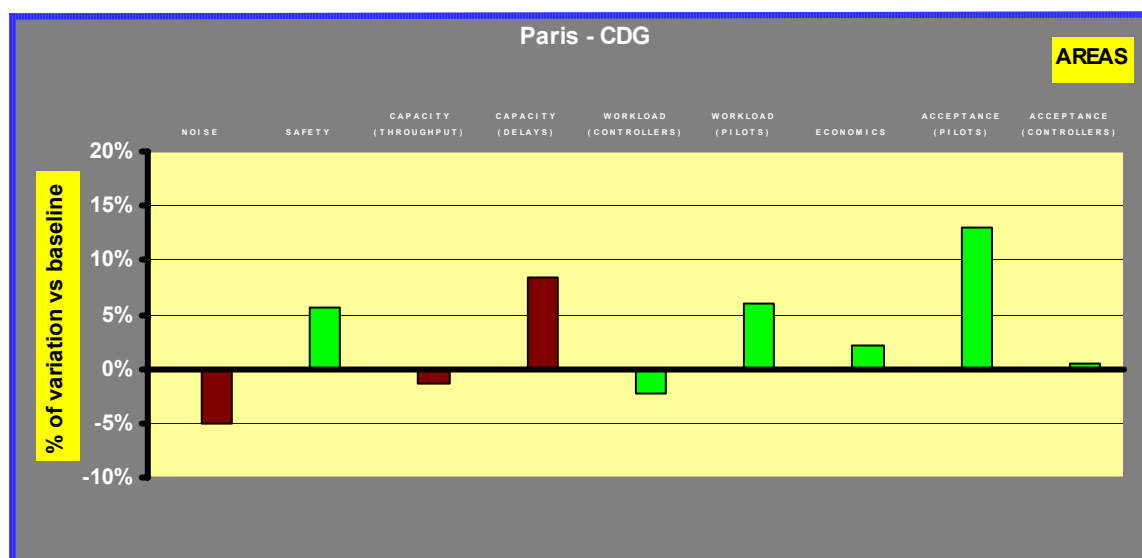
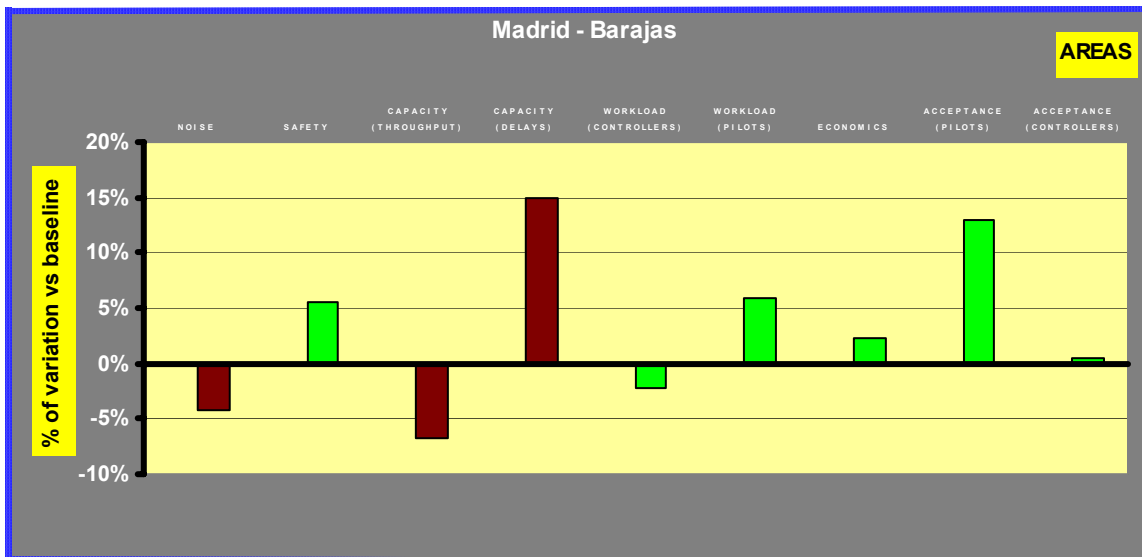
- Pilots accept procedure II and II-A but there is less success with procedure V with respect the reference procedure.
- Controllers rate procedure II similar to the reference procedure and do not accept better procedure II-A and V than the reference procedure.
- These results are connected with the ones for workload, where there is a slight reduction for procedures II and II-A. However, although procedure V implies a reduction of workload for controllers, they reject this procedure likely due to the decrease in their safety perception.
- It has to be pointed out that in spite of the slight increase in workload shown in chapter 5.1.6, pilots shows a very good acceptance of procedures II and II A.

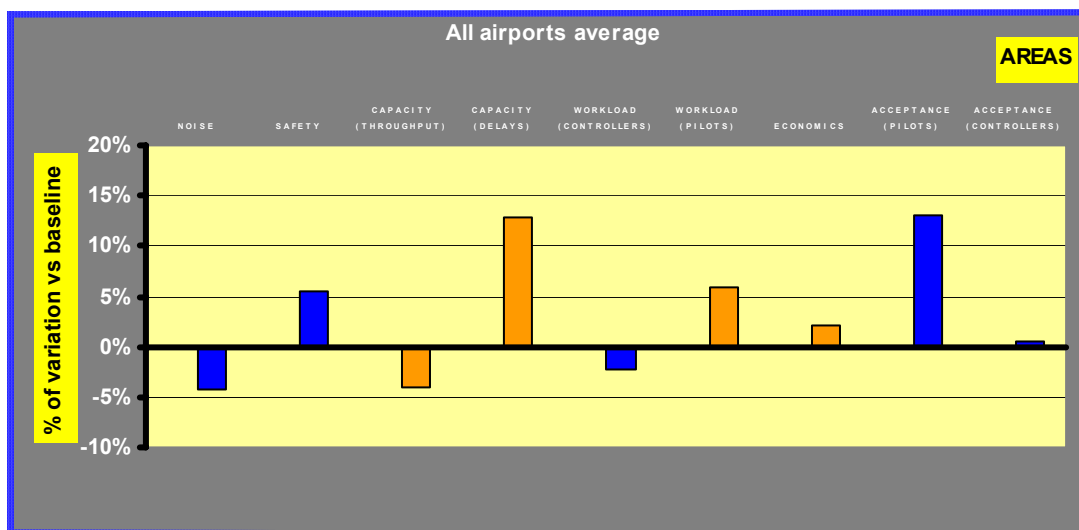
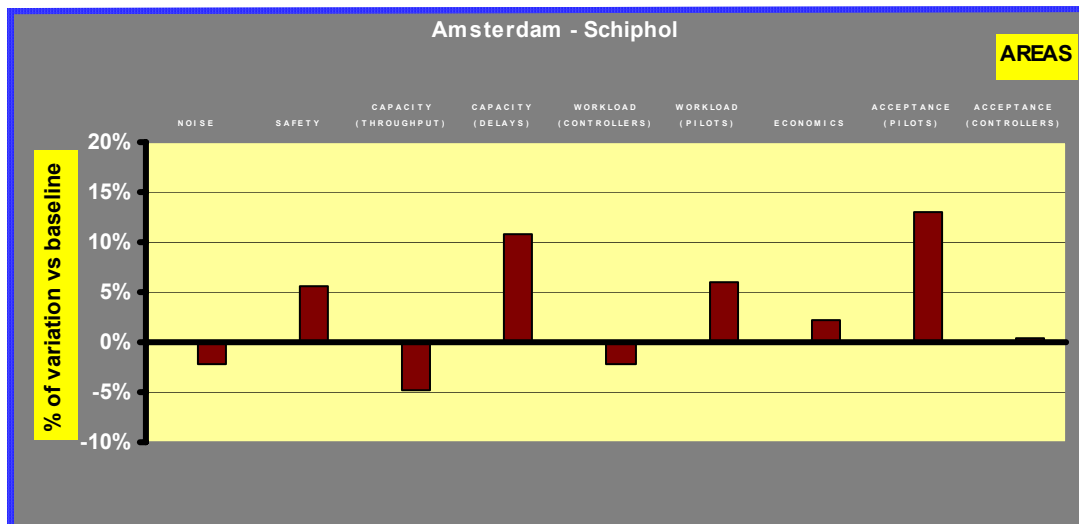
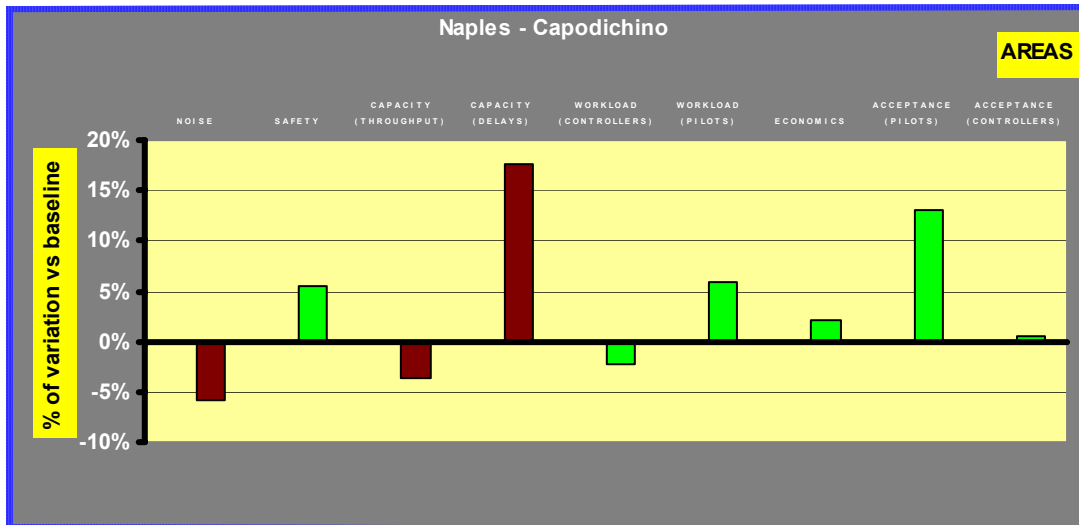
5.2. Procedure analysis (approach)

In this section, each procedure is assessed independently and the performance per airport in each of the areas is represented in the same bar chart. Thus, each of the charts shows how much better or worse is a procedure with respect the reference procedure in all of the areas altogether.

As it has been stated before, there are no results available for the all set of areas and for each airport. Specifically, no result for WORKLOAD, ACCEPTANCE, SAFETY AND ECONOMICS are available for any airport but Amsterdam – Schiphol. However, the results for Schiphol RTS have been included in the charts for the rest of the airports in order to give an indication about the magnitude of the difference of these areas against the reference procedure. These bars are represented in green colour in the bar charts.

5.2.1. Procedure II





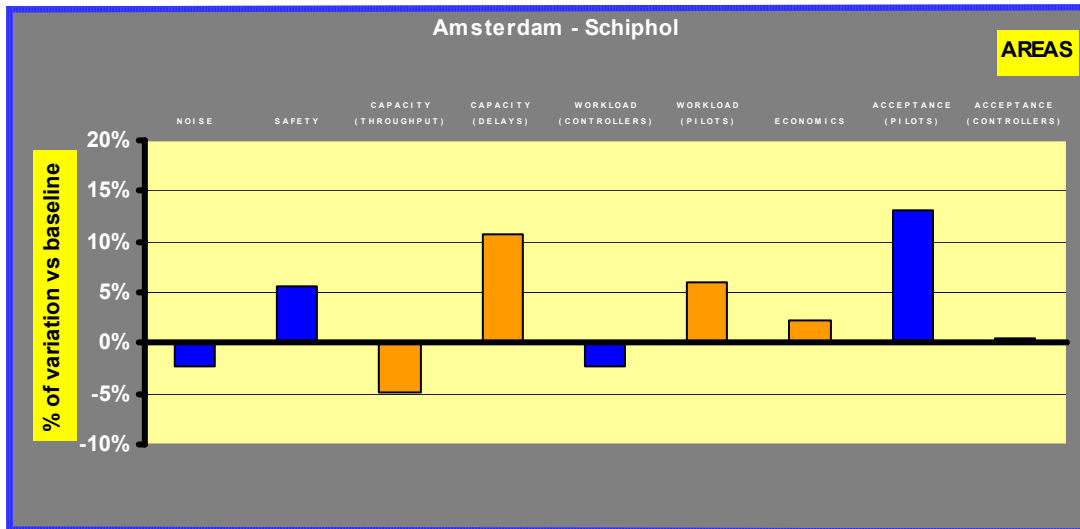
■ Improved areas vs reference procedure
 ■ Worsened areas vs reference procedure

Figure 5-9. Procedure II performance per airport

Explanations and analysis of the charts

- Procedure II accomplishes a small abatement of noise with a small reduction of capacity. The safety level is safeguarded comparing the reference procedure and entails a reduction of controllers workload and an increment of the pilots workload. However, pilots give more acceptation to the procedure than controllers. An increment of costs due to an increment of the flight time is foreseen.

5.2.2. Procedure II-A



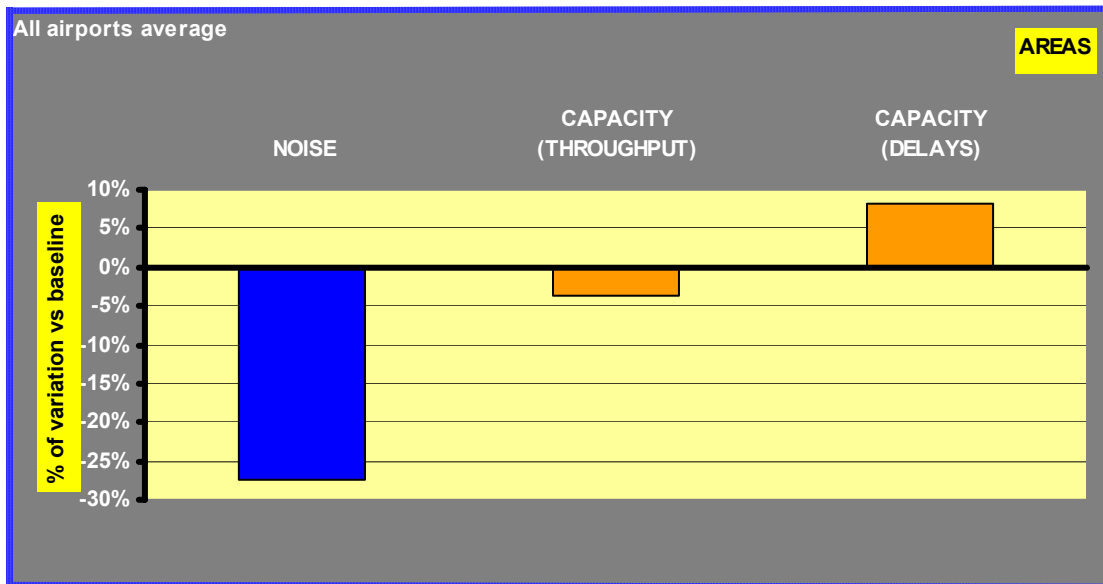
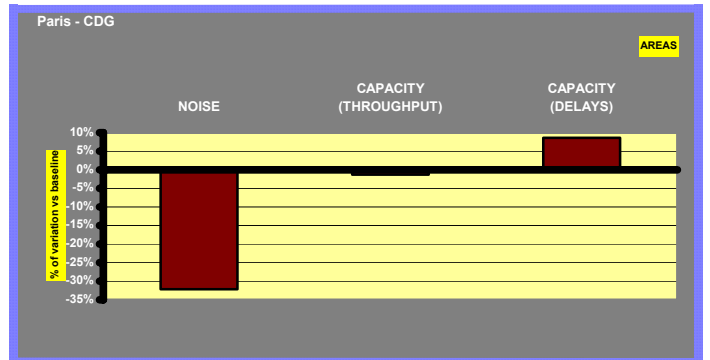
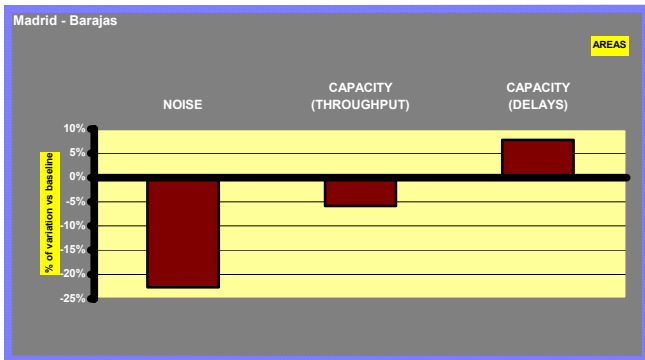
■ Improved areas vs reference procedure
 ■ Worsened areas vs reference procedure

Figure 5-10. Procedure II A performance per airport

Explanations and analysis of the charts

- Performance of procedure II-A is very similar to procedure II and no significant differences of performances versus reference procedure can be found.

5.2.3. Procedure III



Improved areas vs reference procedure

Worsened areas vs reference procedure

Figure 5-11. Procedure III performance per airport

Explanations and analysis of the charts

- Procedure III clearly and dramatically reduces the noise, but capacity is also penalized.

5.2.4. Procedure IV

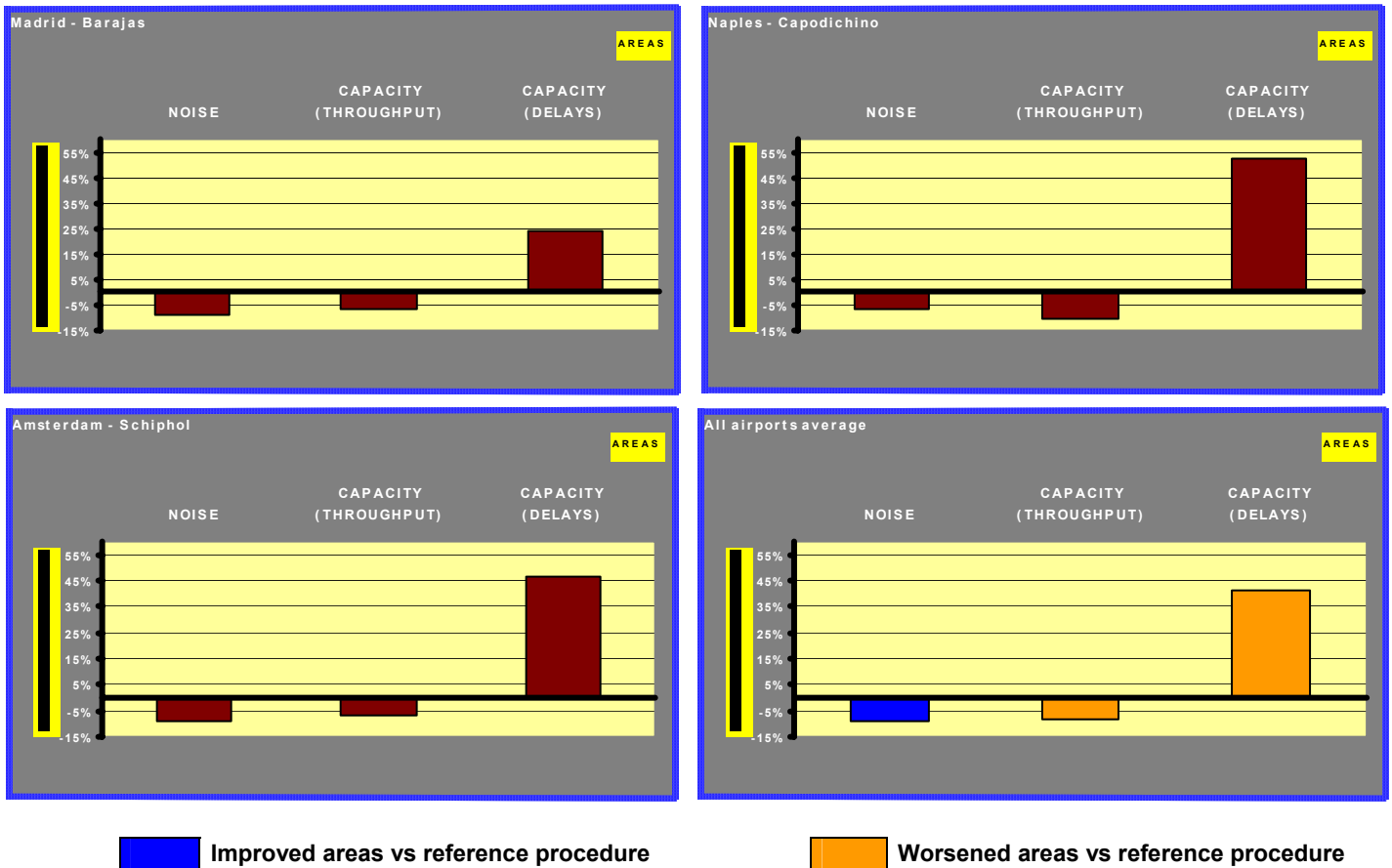
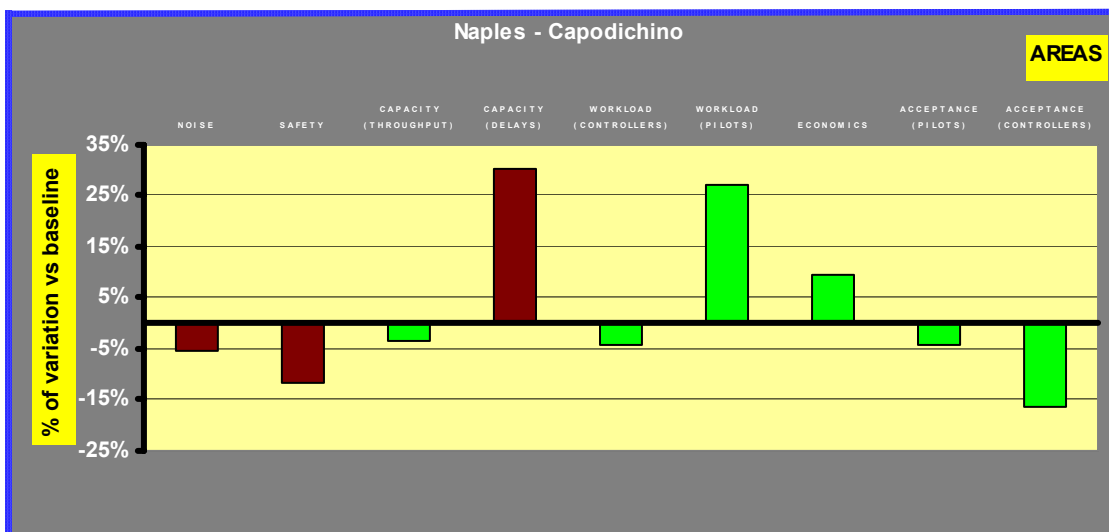
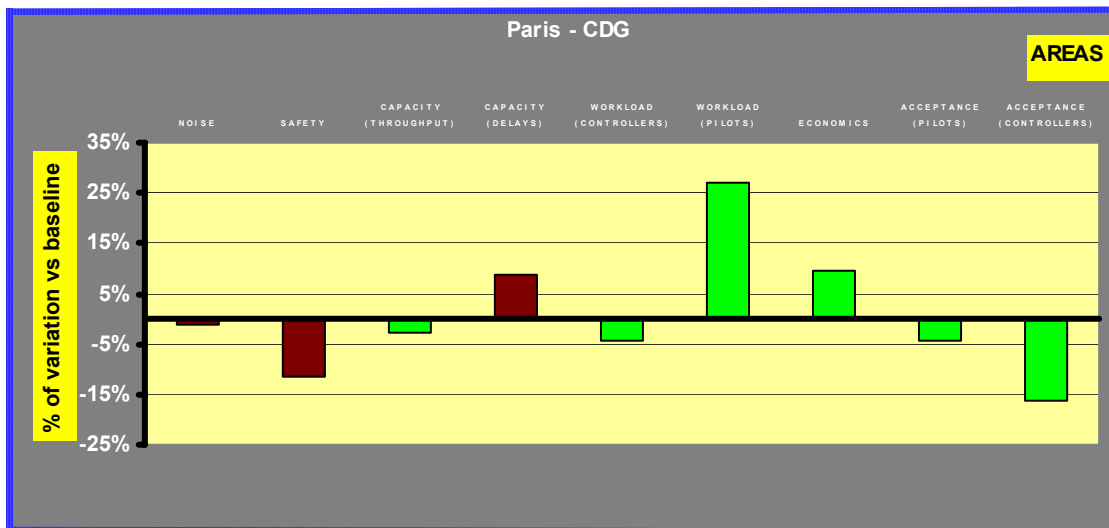
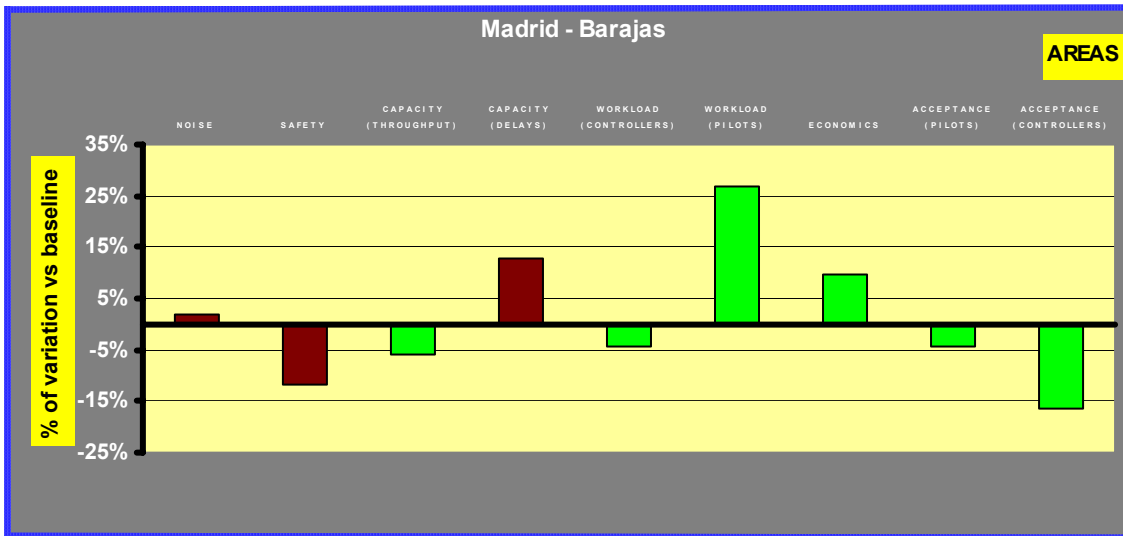


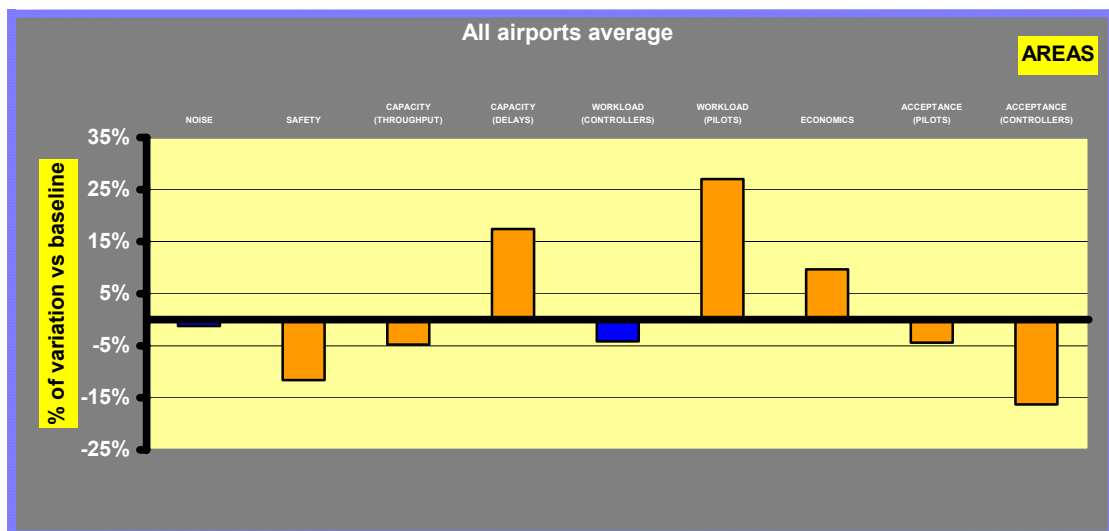
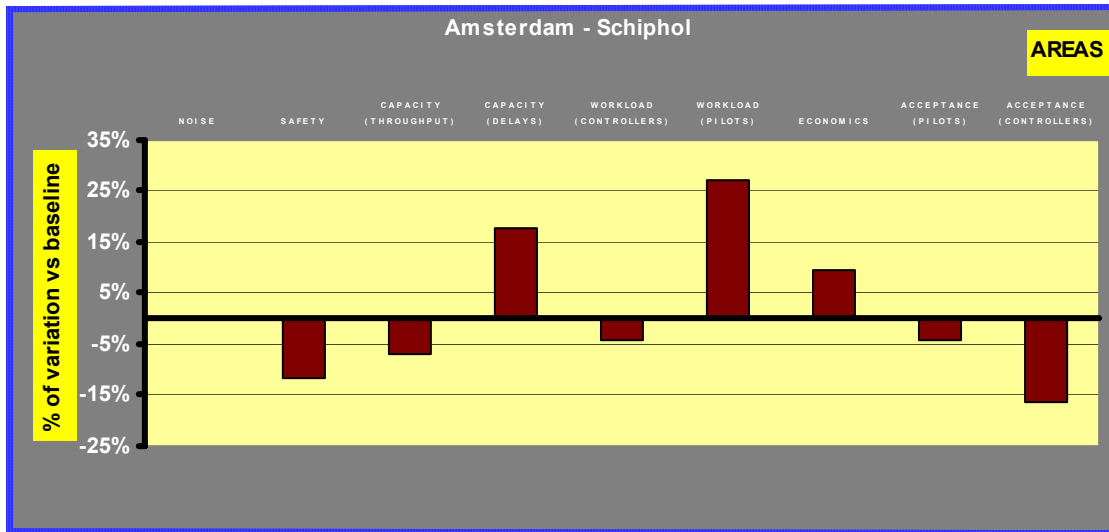
Figure 5-12. Procedure IV performance per airport

Explanations and analysis of the charts

- Procedure IV achieves the objective of a significant noise abatement, but not as much as procedure III. By the other hand, capacity is even more penalized which makes this procedure not feasible for most airports on peak hours.

5.2.5. Procedure V





■ Improved areas vs reference procedure
 ■ Worsened areas vs reference procedure

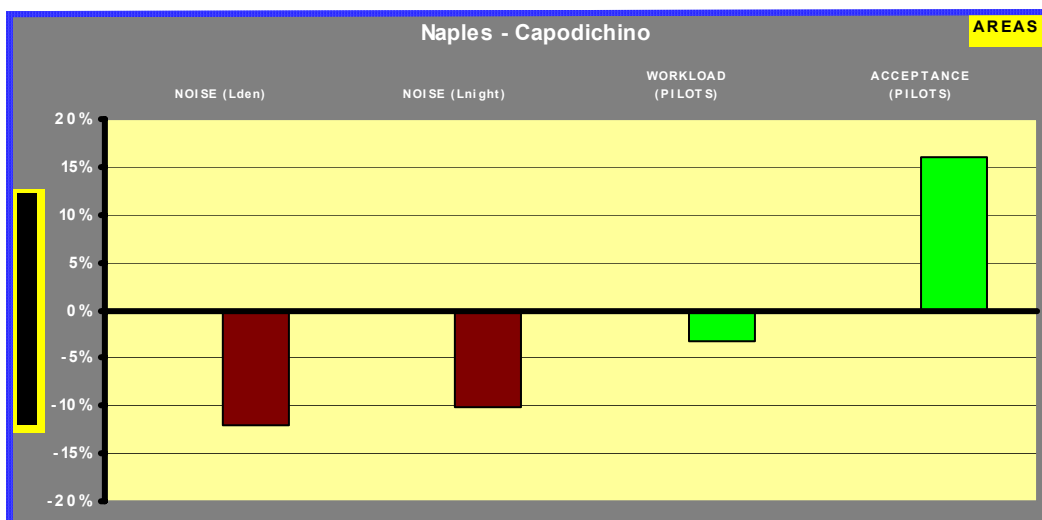
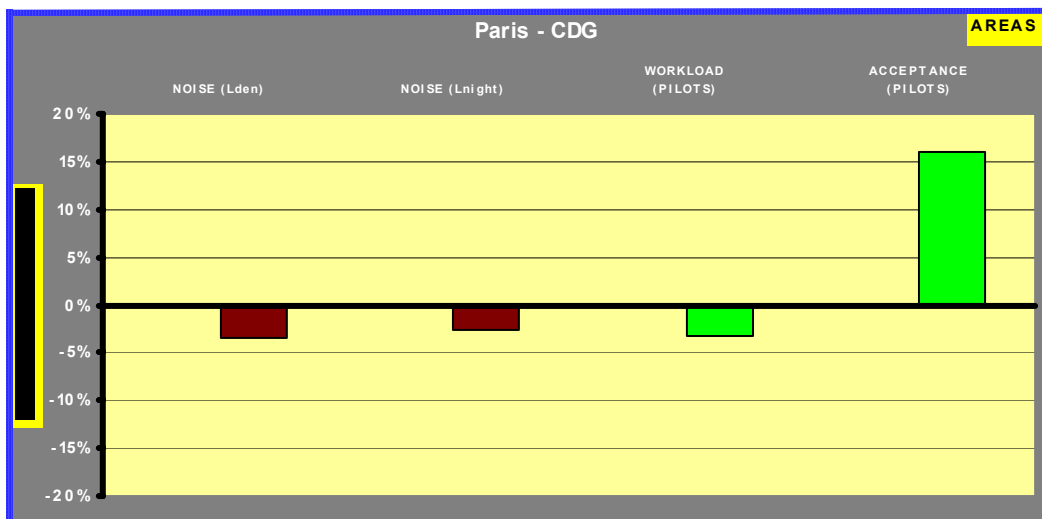
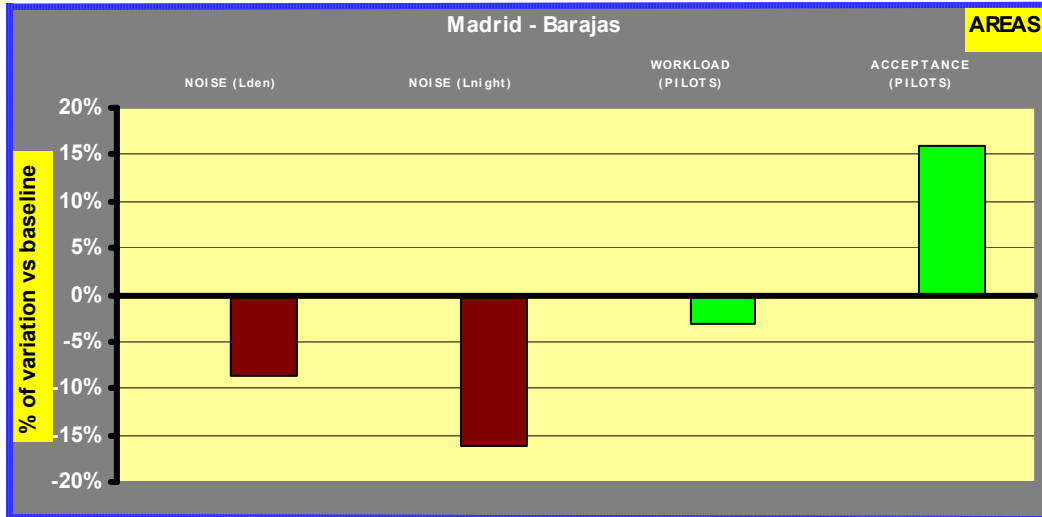
Figure 5-13. Procedure V performance per airport

Explanations and analysis of the charts

- Procedure V does not accomplish any improvements in all areas, but a small reduction of noise - but remarkable, having in account that the reference procedure is already noise friendly - and a small decrease in controllers' workload.

5.3. Procedures analysis (departure)

5.3.1. Procedure 2 Close-in



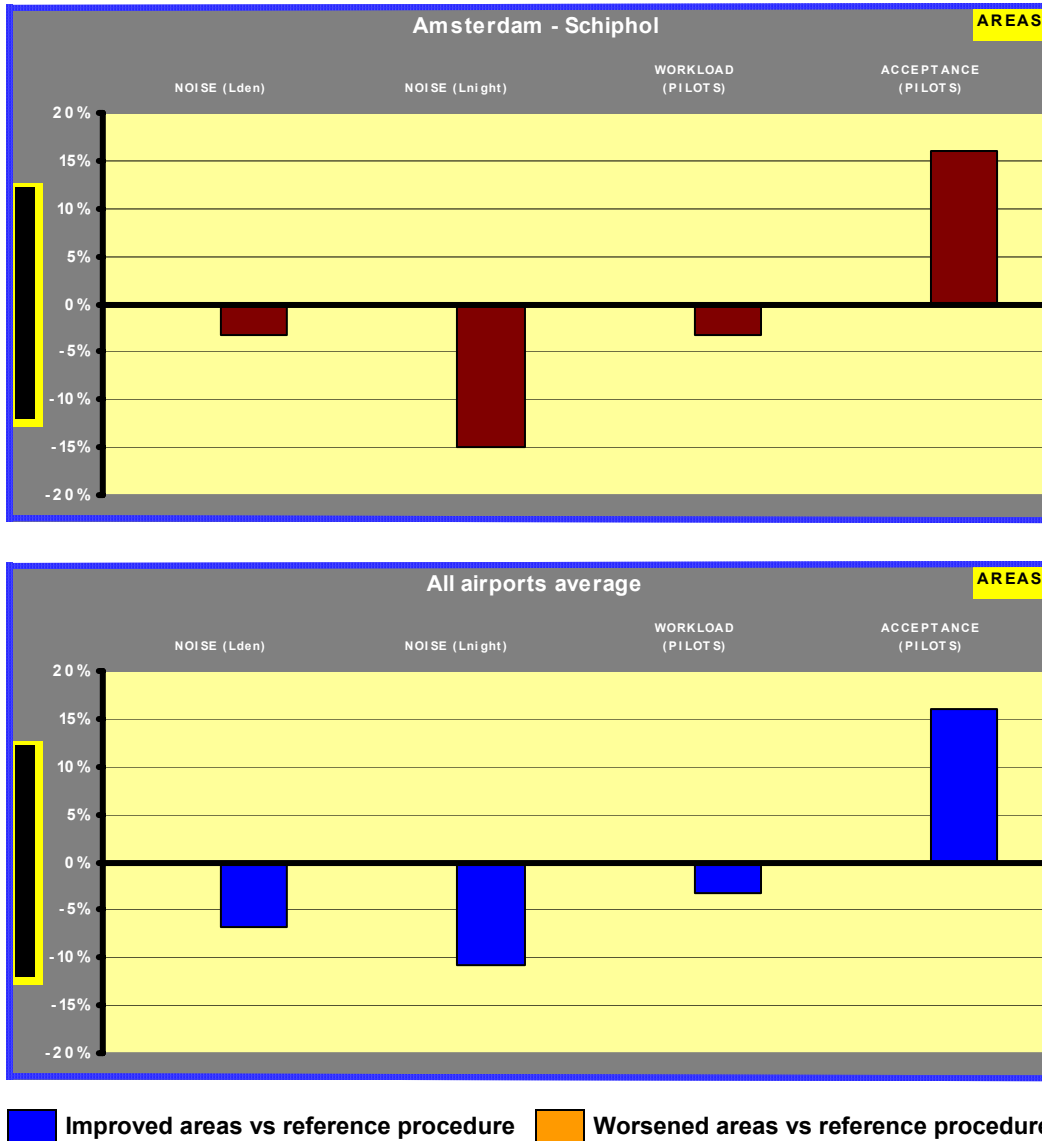


Figure 5-14. Procedure 2 performance per airport

Explanations and analysis of the charts

- Moderate improvements are achieved in the areas measured but in NOISE, where reduction is very significant.

5.3.2. Procedure 3 distant

Only results for noise are available so no Comparative analysis of results can be performed for this procedure.

6. Conclusions and recommendations

6.1. General conclusions

The following lines try to give conclusions and recommendations out of the results detailed in the previous chapters. They offer the chance to have a preliminary overview of the effects of implementing the noise abatement procedures and to make a comparative analysis amongst them highlighting the most promising ones.

As seen in the previous chapters the Comparative analysis of results of the SII NAPs has been done for each one of the SII airports then for each one of the SII NAPs. This approach has been chosen to identify the best solutions locally, taking into account the SII NAPs benefits but local constraints too. In this sense, final figures and results have to be studied carefully, since simulation results are only applicable to the related airports. Results may be extrapolated to other airports similar to the ones of the SOURDINE II project but taking in account their particular characteristics.

All the arrival noise abatement procedures cannot be currently implemented due to related safety problems, but proposed improvements both in cockpits and in controllers HMI will let to implement the SII NAPs in the future. Furthermore being able to reduce the assumptions on which the SII project is based could provide a clearer view of the problem. Meanwhile, the Comparative analysis of results is the appropriate approach to provide decision makers with a good picture about each procedure and the relative performances.

As general conclusions about arrival procedures, we can remark:

- Procedures I and II - and II A for Amsterdam – Schiphol - seems to be the most balanced ones for all areas altogether. The noise abatement is less than the other SII procedures but it is still significant against the current arrival procedure - above a weighted average of 10% in Madrid – Barajas for procedure I.
- Procedures III and IV shows the best performance for noise abatement but only partial results - not for all areas - are available, thus no definitive conclusions can be established.
- Procedure V does not have good results in most of the areas of the project. It is still a good procedure for noise abatement but the rest of the areas turns out to be penalized.

AREAS	Procedures					
	<--- Best ----- Worst ---->					
	ARRIVAL PROCEDURES					
NOISE	III	IV	V	II	I	
SAFETY	II	II A	I	V		
CAPACITY - Throughput	I	III	II A	II	V	IV
CAPACITY - Delays	I	II A	III	II	V	IV
WORKLOAD - Controllers	II	II A	V	I		
WORKLOAD - Pilots	I	II A	II	V		
ECONOMICS	I	II	II A	V		
ACCEPTANCE - Controllers	II	I	II A	V		
ACCEPTANCE - Pilots	II / II A	I	V			

Table 6-1. Ranking of arrival procedures per area

With respect to the departure procedures, they have been evaluated on a smaller scale. The departure procedures are strictly airport surroundings dependant - not only the geographical area but also the settlement degree. Therefore, the two departure procedures selected can hardly be compared among them, since one is designed to reduce noise in the nearest areas of the airport whilst the other one has major effects in the farthest ones. Comparative results are given only to provide a shallow idea about the degree of improvement of each one. The number of total movements per day also influences the choice of the departing noise abatement procedures.

AREAS	Procedures -< Best ----- Worst ->		
	DEPARTURE PROCEDURES		
NOISE – L _{den}	3	2	1
NOISE – L _{night}	2	3	1
SAFETY	1	2	
WORKLOAD - Pilots	2	1	-
ACCEPTANCE - Pilots	2	1	-

Table 6-2. Ranking of departure procedures per area

6.1.1. NOISE

The results for all the SII procedures and for all the four airports are available.

All SII arrival procedures produce a significant noise abatement and this can be applicable to all airports. That means that under NOISE strictly point of view, all of the procedures may be implemented. But since other areas are affected, some restrictions apply, above all, in terms of CAPACITY. For this reason, these procedures are more suitable for no restriction scenarios, like time of the day with no capacity constraints - night time - or no saturation problem airports.

As stated before, the noise abatement effectiveness of departure procedures is strictly airport related, so even if on average some benefits have been obtained in noise reduction, see Figure 5-2, it has to be noted a significant difference - worsening - between the application of “Close in” procedure on Madrid airport with respect to the others two airports.

6.1.2. SAFETY

The safety indicators have been assessed through the safety assessment and RTS with regard to the NAAPs II, II-A and V and NADPs 1 and 2.

Looking to the average figures, the procedures II and II-A have a slight positive impact on the safety, specifically, the procedure II shows a balanced behaviour on both pilot and controller safety perception.

For procedure II-A an opposite safety perception between pilots - positive - and controllers - negative - has been observed. This can be explained by the fact that the speed constraints resulted in a more stable approach - more time between the various configuration changes - for the pilots but also in a more re-active behaviour of the controllers. This behaviour resulted in lowered situation awareness and therefore a decrease in safety perception.

The procedure V instead has a peculiar negative effect on both pilots and controllers and the controller perception is remarkably more negative compared with the pilot perception.

The data observed allow asserting the procedure II as the safest.

6.1.3. CAPACITY

The capacity figures related to procedure II-A are available just for Amsterdam while the ones for procedure III are related to Paris and Madrid. The general trend for all the SII NAAPs and for all the test airports is in decreasing capacity with respect to the reference procedure value. It has to be underlined that the capacity performances of the SII airports have been calculated increasing the air traffic volume by the 50% (2015 scenario), that means most/all airport are saturated or close to saturation. The capacity results then cannot to be read without keeping in mind this last hypothesis.

The procedure II-A seems to have the least impact on decreasing capacity and on the opposite side, the procedure IV has the greatest negative impact on capacity followed by procedures V and II.

6.1.4. WORKLOAD AND ACCEPTANCE (PILOTS & CONTROLLERS)

As already seen for the safety validation objective, these metrics are available only for Amsterdam Schiphol airport and for the procedures II, II-A and V. These procedures entail a slight reduction of controllers workload but imply an increase in pilot workload that remains under 10% for the procedure II and II-A while the increase is quite significant for procedure V.

The only procedure accepted both by controllers and by pilots is the procedure II.

The procedure II-A is not preferred by controllers due to the fact that this procedure resulted in a more re-active behaviour even if it implies a slight reduction in the workload that is considered not significant with respect to the reference procedure. Additional hands-on experience could increase the controller acceptance. Furthermore this procedure is accepted by pilots who perceive some benefits nevertheless their workload slightly increase.

Procedure V is rejected both from pilots and controllers - only arrival controllers, since the procedure has limited impact for the FDR/DCO controllers.

6.1.5. ECONOMICS

For a Comparative analysis of results of the economics results on the SOURDINE II procedures look at document D4-3.

6.1.6. INTERACTION BETWEEN CAPACITY AND NOISE

The figures to compare noise abatement and capacity variation are not fully available.

The most promising procedure in terms of noise abatement, procedure III, implies a slight reduction of capacity per peak hour, around 5-7 % - figures available only for two airports, Paris and Madrid.

The procedure IV that could represent a good trade-off for the noise abatement has the worst effect in reducing capacity, on average more than 20%.

The SII procedures II and V show a similar behaviour gaining some noise reduction paid by a little decreasing in capacity. Procedure II seems to be worth for further investigation due to the good response in terms of safety and in terms of pilots/controllers acceptance.

6.2. Recommendations

In order to use the SOURDINE II arrival procedures necessarily advanced cockpit avionics and controllers HMI are needed, and so too training of pilots and controllers.

The qualitative safety assessment showed that the Sourdine II approach procedure V adapted to the future Barajas Airport parallel runway configuration exhibits some safety significant issues that need more detailed and quantitative analysis. It is recommended that decision support tools, such as an Arrival Manager (AMAN), and safety-net additional functionality to monitor potential longitudinal breaches of separation for localiser-established consecutive aircraft are considered in future safety assessments.

All of the SII arrival procedures implies a decreasing in capacity so, once their *flyability* is guaranteed - with advanced cockpit, controllers HMI and pilots/controllers training - they could be implemented in those airports where there is no capacity constraints. Their application elsewhere, e.g. airport close to saturation, could be envisaged to fulfil strict noise regulatory requirements. Those procedures may be applied initially only during night time hours when a slight reduction in demand is expected. When acceptance and capacity increases due to increased hands-on experience these procedures could perhaps also be implemented during peak hour operations.

Due to availability of the fragmented results, the recommendations must consider the source of the output analysed.

Procedure III is the most promising in noise abatement, but it has been assessed on capacity only on two airports (Paris and Madrid) with arrivals on parallel runways and it has resulted in a slight reduction in peak hour capacity (5-7%). In adopting this procedure it has to be taken in account that no direct information is available on capacity variation for different runway configuration as well on safety, acceptance and workload.

The safest and most acceptable procedure seems to be procedure II, in that case a slight noise reduction implies a greater decreasing in capacity. But for this procedure the results are partial too, being the metrics for safety, acceptance and workload evaluated only on Amsterdam Schiphol airport.

Surely the new SOURDINE II arrival procedures represent a milestone thanks to the achieved quantitative and qualitative results, for further and detailed elaborations in order to realize end favourite their implementation plan.

About feasibility of implementation of SII procedures, the number of them that may be implemented and compatibility of other techniques involved please refer to the SII document D8.1, "Implementation plan".

ANNEX A: SUMMARY OF SOURDINE II PROCEDURES

Approach procedure I: Reference with level deceleration at 3000 ft

Condition	Parameter values
7000 ft (fixed height)	<ul style="list-style-type: none"> - Speed 250 KTS CAS. - Level flight. - Clean configuration. - Landing gear up.
	<ul style="list-style-type: none"> - Idle thrust. - Constant CAS descent.
3000 ft (fixed height)	<ul style="list-style-type: none"> - Level flight. - Decelerate to intermediate flap speed (IFS) and change to intermediate configuration.
	<ul style="list-style-type: none"> - Fixed descent angle of 3°. - Landing gear down. - Decelerate+ and change to landing configuration++. - Decelerate to final approach speed (FAS).
Landing configuration and speed reached (resulting height, minimum 1000 ft)	<ul style="list-style-type: none"> - Adapted Thrust for descent at 3°. - Constant speed (FAS) descent to 50 ft.

⁺ To maximum allowable speed to select landing configuration.

⁺⁺ Minimum allowable flap deployment

Approach procedures II and II-A (procedure II with speed constraints): Basic CDA with 2° initial FPA

Condition	Parameter values
7000 ft (fixed height)	- Speed 250 KTS CAS. - Level flight. - Clean configuration. - Landing gear up.
	- Idle thrust. - Fixed 2° Flight Path Angle (FPA). - Decelerate to intermediate flap speed (IFS) and change to intermediate configuration.
3000 ft (fixed height)	- Fixed descent angle of 3°. - Landing gear down. - Decelerate and change to landing configuration++ - Decelerate to final approach speed (FAS).
Landing configuration and speed reached (resulting height, minimum 1000 ft)	- Adapted thrust for descent at 3°. - Constant speed (FAS) descent to 50 ft.

Approach procedure III: CDA with 2° initial FPA and increased final glide slope (RTS only)

Condition	Parameter values
7000 ft (fixed height)	- Speed 250 KTS CAS. - Level flight. - Clean configuration. - Landing gear up.
	- Idle thrust. - Fixed 2° Flight Path Angle (FPA). - Delay flap deployment as late as possible. - Decelerate and change to intermediate configuration. - Decelerate to intermediate flap speed (IFS).
3000 ft (fixed height)	- Fixed descent angle of 4°. - Landing gear down. - Decelerate and change to landing configuration++ - Decelerate to final approach speed (FAS).
Landing configuration and speed reached (resulting height, minimum 1000 ft)	- Adapted thrust for descent at 4°. - Constant speed (FAS) descent to 50 ft.

++ Minimum allowable flap deployment.

Approach procedure IV: CDA with constant speed, variable FPA segment at landing configuration

Condition	Parameter values
7000 ft (fixed height)	<ul style="list-style-type: none"> - Speed 250 KTS CAS. - Level flight. - Clean configuration. - Landing gear up.
	<ul style="list-style-type: none"> - Idle thrust. - Decelerate, landing gear down and change to landing configuration. - Decelerate+ to final approach speed (FAS).
Landing configuration reached (resulting FPA)	<ul style="list-style-type: none"> - Descend at constant speed (FAS) to 2000 ft. - Idle thrust.
2000 ft (fixed height)	<ul style="list-style-type: none"> - Adapted thrust for descent at 3°. - Constant speed (FAS) descent to 50 ft.

Approach procedure V: CDA with constant speed, variable FPA segment at intermediate configuration

Condition	Parameter values
7000 ft (Fixed height)	<ul style="list-style-type: none"> - Speed 250 KTS CAS. - Level flight. - Clean configuration. - Landing gear up.
	<ul style="list-style-type: none"> - Idle thrust. - Decelerate and change to intermediate configuration. - Decelerate to intermediate flap speed (IFS).
Intermediate configuration reached (resulting FPA)	<ul style="list-style-type: none"> - Descend at constant speed (IFS) to 3000 ft. - Idle thrust.
3000 ft (fixed height)	<ul style="list-style-type: none"> - Fixed descent angle of 3°. - Landing gear down. - Decelerate and change to landing configuration++ - Decelerate to final approach speed (FAS).
Landing configuration and speed reached (resulting height, minimum 1000 ft)	<ul style="list-style-type: none"> - Adapted thrust for descent at 3°. - Constant speed (FAS) descent to 50 ft.

+ To maximum allowable speed to select landing configuration.

++ Minimum allowable flap deployment.

Departure procedure 1: Reference (ICAO-A)

Condition	Parameter values
0 ft	<ul style="list-style-type: none"> - TOGA (Take-Off Go Around) thrust. - Conf 1+F. - Climb out at V2 + 10 kt.
1500 ft	<ul style="list-style-type: none"> - Reduce to climb thrust. - Maintain V2 + 10 kt.
3000 ft	<ul style="list-style-type: none"> - Acceleration to 250 kt, retracting flaps/slats on schedule. - Climb to 15000 ft.

Departure procedure 1-A: (ICAO-A with extended duration of climb thrust) only for RTS

Condition	Parameter values
0 ft	<ul style="list-style-type: none"> - TOGA (Take-Off Go Around) thrust. - Conf 1+F. - Climb out at V2 + 10 kt.
1500 ft	<ul style="list-style-type: none"> - Reduce to climb thrust. - Maintain V2 + 10 kt.
5000 ft	<ul style="list-style-type: none"> - Acceleration to 250 kt, retracting flaps/slats on schedule. - Climb to 15000 ft.

Remark: The airspeed of 250 KTS IAS is an ATC constraint for altitudes below 10000 ft in the Schiphol TMA.

Departure procedure 2: SOURDINE II optimized close-in

Condition	Parameter values
0 ft	<ul style="list-style-type: none"> - TOGA (Take-off Go Around) thrust. - Brake release and acceleration to rotation speed*. - Rotation and lift-off.
	<ul style="list-style-type: none"> - Retraction of undercarriage. - Climb out at a speed of V2 + 10-20 KTS IAS**.
At an altitude not lower than 800 ft***	<ul style="list-style-type: none"> - Reduce thrust to OEI climb gradient**** or max climb, whichever is lowest. - Maintain V2 + 10-20 KTS IAS.
3000 ft	<ul style="list-style-type: none"> - If OEI climb gradient thrust was selected: gradually change thrust to climb thrust. - Maintain V2 + 10-20 KTS IAS.
5000 ft	<ul style="list-style-type: none"> - Accelerate and retract flaps/slats on schedule to clean configuration. - Continue acceleration to 250 KTS. - Climb to 15000 ft.

Departure procedure 3: SOURDINE II optimized distant

Condition	Parameter values
0 ft	<ul style="list-style-type: none"> - TOGA (Take-off Go Around) thrust. - Brake release and acceleration to rotation speed*. - Rotation and lift-off.
	<ul style="list-style-type: none"> - Retraction of undercarriage. - Climb out at a speed of V2 + 10-20 KTS IAS**.
At an altitude not lower than 800 ft***	<ul style="list-style-type: none"> - Accelerate to zero-flap speed (Vzf). - Retract flaps/slats on schedule to intermediate configuration.
Upon reaching Vzf	<ul style="list-style-type: none"> - Reduce thrust to OEI climb gradient**** or max climb, whichever is lowest. - Complete flaps/slats retraction to clean configuration. - Maintain speed.
5000 ft	<ul style="list-style-type: none"> - If OEI climb gradient thrust was selected: gradually change thrust to climb thrust, maintaining constant speed. - Acceleration to 250 KTS IAS. - Maintain speed. - Climb to 15000 ft.

* cleanest possible take-off configuration

** V2+10 where possible

*** Strictly dependant on local airport

**** 1.7% for 4 engines jet, 1.2% for twinjet

ANNEX B: SUMMARY OF LWP METHODOLOGY

Level-Weighted Population (LWP) expresses both the extent and the severity of a noise impact. The extent of impact refers to the number of people who are adversely affected, while the severity represents the degree to which each person is affected. **LWP provides a simple, single number used to compare benefits of different noise reduction options.**

The computation of LWP allows one to combine the number of people jeopardized by noise above 45 dB with the degree of impact at different noise levels. Note that people closest to the noise source are more severely threatened. The partial impacts are then summed to give the equivalent noise impact. In this document, LWP methodology has been used to calculate a single index for each procedure but using the areas affected by each noise level instead of population affected. Like in LWP methodology, this approach has only comparative purposes since the calculation of these index alone provides no physical meaning.

In airport noise compatibility planning, the LWP methodology is particularly useful in comparing the results of different noise analysis scenarios. Since the percentage of people who are highly annoyed increases with increasing noise levels, the LWP values may differ between operating scenarios even though the total population within the noise impact boundary is equal.

The criterion used to predict the percentage of a community that will be "highly annoyed" - HA - by given levels of aircraft/airport noise is a function commonly known as the "Schultz curve," named for the acoustical expert who developed it. Schultz (1978) analyzed a number of studies, plotted some 161 data points, and developed a predictive equation based on a regression analysis of these data. The studies included noise from airports, highways, road traffic, railroads, and tram lines. Back in 1991, a revision of the Schultz curve was published by Fidell, Barber, and Schultz, which added 15 new studies, making a total of 453 data points. The new curve predicts slightly more annoyance than the original curve at a DNL - Decibel Noise Level - of about 75 dB and below, and slightly less than before above that point. A relatively similar update of the Schultz curve appears in the FICON (1992) report, and from Finegold et Al. in 1994, showing minor changes from the original curve.

PERCENT HIGHLY ANNOYED AT SELECTED NOISE LEVELS										
DNL	45	50	55	60	65	70	75	80	85	90
%HA	0.8	1.6	3.1	6.1	11.6	20.9	34.8	51.7	68.4	81.3

$$\text{Equation for curve: } \frac{100}{1 + e^{11.13 - 0.14DNL}}$$

These factors have been used to calculate the comparative index for LLO1-M1_x metrics.